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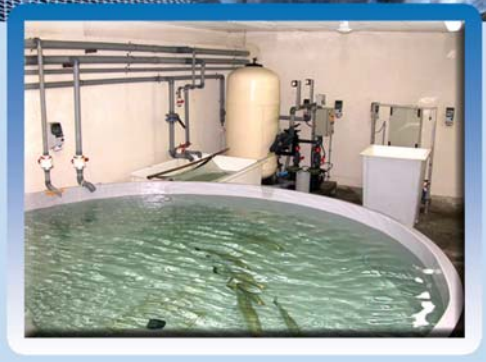
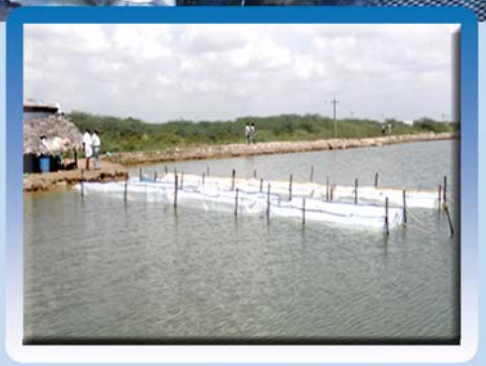
CIBA

Annual Report 2009-10

वार्षिक प्रतिवेदन





ICAR

Central Institute of Brackishwater Aquaculture

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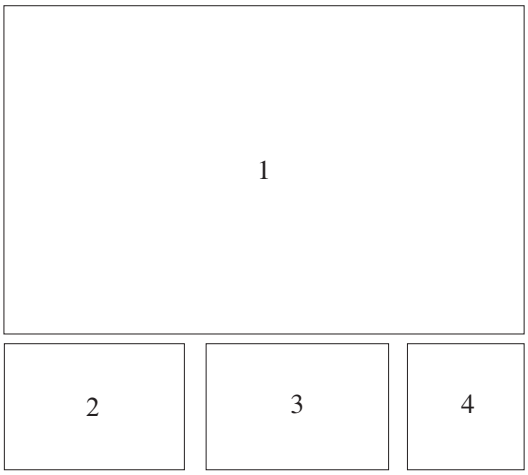
CIBA ANNUAL REPORT 2009-10



Caption

1. Harvested seabass from growout trial at Ramudupalem, Nellore funded by NFDB
2. Flow through breeding facility for seabass
3. Seabass nursery rearing in hapa at Ramudupalem, Nellore
4. Farmer Shri Hanumantha Rao Naidu holding the harvested seabass

वार्षिक प्रतिवेदन

Annual Report

2009 - 2010

केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद्)

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CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE

(Indian Council of Agricultural Research)

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CONTENTS

1

Preface

Brackishwater aquaculture is one of the most complex and dynamic aquaculture sectors in which the farmers' profit margin is not only influenced by the production technology adopted by them but also by various external factors over which they have no control. The most important factors are disease agents introduced, cost of feed which is increasing due to demand for fish meal and price fluctuations influenced largely by global markets. In this complex scenario, to prioritise research interventions with a focus on the small scale farmer is a challenge and I am proud to say that CIBA has risen to the challenge and addressed research issues across the value chain.

Frontline demonstrations are required for farmers to adopt new technologies and these also help to further refine the technologies. In this connection the ongoing demonstration of seabass nursery and grow-out technology in Tamil Nadu, Andhra Pradesh and Maharashtra would go a long way to address diversification of brackishwater aquaculture. Both the seed and feed for these demonstrations are based on technologies developed by the Institute and since these are not available from commercial sources, the Institute had to scale up and provide such inputs in large quantity for the demonstrations. I compliment the fish culture and nutrition scientists who have developed the technology base for these frontline demonstrations and their untiring efforts in the field.

Another frontline demonstration has been the three brackishwater and allied technologies to women Self Help Groups. This has been possible due to the coming together of scientists from the disciplines of social sciences, nutrition and crustacean culture. They deserve praise for their effort and this has been appreciated by Deputy Director General, Fisheries, ICAR. As can be seen from the achievements listed, CIBA scientists have risen to the challenge in not only working on present requirements but also in addressing emerging problems and carrying out strategic research to ensure sustainability and higher production.

Every year the exercise of compiling the Annual Report benefits from critical suggestions received . We are particularly thankful to Dr. E.G.Silas, the founder Director of CIBA and former Vice-Chancellor of Kerala Agricultural University, Dr. M.V.Gupta, World Food Prize winner, Prof. T.J.Pandian, Emeritus Professor, Dr. Mohan Joseph Modayil, Member, Agricultural Scientists Recruitment Board and Dr. M.N. Kutty, Former FAO/UN expert who have responded to our request and given specific suggestions to improve the presentation of the Institute's Annual Report.

During the current year, the infrastructure facilities got a boost with the laying of the foundation stone for a trainees hostel and aquatic health testing laboratory.

Our success is due to the encouragement and guidance received from Dr. Mangala Rai, Former Secretary, DARE and Director General, ICAR and Dr. S. Ayyappan, present Secretary, DARE and Director General, ICAR, and we are grateful to them. We thank Dr. V.V.Sugunan, former Assistant Director General (I.Fy) and Dr. Madan Mohan, Assistant Director General (M.Fy) for their constant support. During the current year the institute benefited from the able guidance given by the QRT team led by Prof. T.J.Pandian and we we record our thanks to them. I express my gratitude to Prof. P.N. Natarajan, Chairman of the Research Advisory Committee and other members for their research directions. We have benefitted from the interactions we had with the various stakeholders for which we thank them profusely. Last but not the least, I wish to thank all the scientists and staff of CIBA for their zeal and interest to work as a team on priority areas of work keeping the focus on farmers.

A.G. Ponniah
Director

2

Executive Summary

During the current year the Central Institute of Brackishwater Aquaculture continued its primary focus on developing environment friendly and cost effective culture technologies for small scale farmers, diversification of species and systems and in evolving a comprehensive health management system. The significant achievements of CIBA are presented under the six thrust areas identified by the QRT.

Dr. Mangala Rai, Secretary DARE & DG, ICAR and Dr. S. Ayyappan, DDG (Fy.) releasing the seabass feed 'CIBA BHETKIAHAR'

Environment friendly and cost effective culture technologies

- Successful maturation, spawning and hatching were achieved with a maturation diet in which 50% of the classical fresh feed regimen was replaced with an artificial moist diet.
- On-station farm trials indicated that it was possible to achieve the same level of production with 38 and 32 % protein in the feed and the reduced protein level of 32% would bring down the production cost by Rs. 4-5 per kg of shrimp produced.
- A collaborative project has been taken up in Gujarat with Navasri Agricultural University, in order to understand location specific culture requirements for shrimp. As a part of this programme tiger shrimp culture was taken up in the brackishwater farm developed at Danti - Umbharat Centre.
- Efforts to develop specific tiger shrimp feeds for high salinity (40 ppt) indicated significantly high growth rates at 40 and 33.5% dietary crude protein levels, when compared to lower dietary protein levels. Based on

the better protein efficiency ratio and apparent protein utilization at high salinity (40ppt), protein utilization efficiency was better at 33.5% dietary protein level.

- Under low saline regime (7-10 ppt), dietary calcium and phosphorous requirements for tiger shrimp interact with salinity and impact growth. Yard trials revealed that 3% Calcium (Ca) with 2% Phosphorus (P) supplementation resulted in a significantly higher digestibility of Ca and P as well as weight gain compared to other groups receiving lower levels of Ca and P.
- Growth, survival and protein efficiency ratio were significantly higher and Feed Conversion Ratio (FCR) was significantly lower in shrimps fed with feed supplemented with live cellulolytic bacteria as compared to control feed .
- Bagasse as biostimulator for ammonia reduction has successfully been demonstrated in zero water exchange shrimp ponds, and 29-38% reduction in ammonia level was observed.
- In yard trials, effect of carbon nitrogen ratio on dynamics of microbial and biofloc production was determined. Significant ammonia removal and utilization of biolfloc as food by juvenile tiger shrimp leading to higher growth was observed.

Comprehensive health management

- Adoption rate of bio-security protocols, singly and in combination, in shrimp farms, was correlated with white spot disease incidence and it was found that the use of reservoir pond significantly reduced disease incidence.
- Disease surveillance of shrimp monoculture and traditional bheries of West Bengal during 2007-10, covering 198 farms from three coastal districts, clearly indicates that White Spot Disease (WSD) outbreak was significantly high in those systems where seeds have been stocked without PCR testing.
- An improved diagnostic nested RT- PCR with custom designed primers targeting RdRp gene of Laem-Singh Virus (LSNV), which has been implicated in Monodon Slow Growth Syndrome (MSGS) was developed. Screening of farmed and wild broodstock samples with this improved diagnostic PCR showed a high prevalence of LSNV. High prevalence in broodstock could lead to the spread of this virus by vertical transmission.
- 'CIBA IMMUNODOT' an immunodot blot test for WSSV with detection equivalent to first step PCR sensitivity has been developed as a diagnostic kit for early detection of WSSV in shrimps for large scale epidemiological screening.

'High Health' & 'High Growth' shrimps through biotechnology applications

- A total of 1500 ESTs of tiger shrimp sequences in relation to microbial infection and environmental stress were deposited in NCBI as part of initiative to build a EST database.
- Four more penaeid allergic genes, arginine kinase, sarcoplasmic calcium binding protein, myosin light chain and troponin have been identified and characterised.
- With a view to understand the genes expressed during WSSV infection, subtractive cDNA library from WSSV infected shrimp *P. monodon* was constructed and five genes which may be useful for developing therapeutics were identified.

- In order to identify immune-related genes responsible for virus resistance in the WSSV infected tiger shrimp, a suppression subtractive hybridization library was created and more than 20 putative genes, which were suspected to be immune related were identified. Of these, three important genes-crustin, caspase 3 and antiviral gene (PmAV) were cloned and expressed.
- As a part of a joint project with CIFA, expression and purification of capsid and B2 genes of freshwater prawn nodavirus was carried out for use in immunomodulation trials.
- Under the Indo-Norwegian collaborative project to develop advanced molecular methods to enable marker assisted selection for disease resistance in tiger shrimp, RNA extracted samples of wild tiger shrimp are being processed for cDNA library preparation which will be used for making SNP chips.
- As part of the initiative for bioprospecting of genes and allele mining for abiotic stress tolerance, libraries of cDNA fragments enriched for salinity stress-regulated genes in tiger shrimp have been prepared.

Diversification of species and systems

- Successful frontline demonstration of seabass nursery and grow-out based on a feed developed by CIBA, has been demonstrated in farmers' ponds in Andhra Pradesh, Tamil Nadu and Maharashtra with funding support of National Fisheries Development Board, Hyderabad.
- Based on the seabass nursery technology developed by CIBA for the hapa-pond system, a farmer in Bhimavaram was able to raise stockable size seed in a freshwater pond with a survival rate of 95% and a profit of 1.73 lakhs.
- Seabass nursery rearing technology was developed for a tank based system and comparative analysis of input and realization cost for stocking densities ranging from 300 to 4000 nos / m^3 indicated that, for viable commercial operations, the optimum density for in-door tank nursery rearing system would be 900 nos / m^3.
- To popularize seabass culture in Gujarat, a demonstration of seabass culture was taken up in the farm developed by Navsari Agricultural University.
- The techno-economic viability of polyfarming of Asian seabass with tilapia as forage fish, was demonstrated in a farmer's pond in West Bengal.
- Specific vitamin and mineral mixtures were tested in seabass at four levels ranging from 0 to 1.5 %. Both the mixtures at 0.5 % level incorporated in feed resulted in significantly higher weight gain, protein efficiency ratio and apparent protein utilization.
- Evaluation of nutrient digestibility of three oilcakes as potential feed ingredients for seabass revealed that nutrients were more efficiently digested from mustard oil cake than other two oil cakes *i.e*. sesame and sunflower.
- On-station pond trials for developing a nursery rearing technology for mullet was evaluated for two stocking densities and two pond systems namely feed and fertilization based. Though the operational cost remained more or less the same for both systems, significantly higher survival was observed in the fertilization based system.
- Realising the potential for brackishwater fish farming in West Bengal, economically viable milkfish monoculture was demonstrated in a farmer's pond.

- Though pearlspot is not endemic to West Bengal, through broodfish supplied by CIBA, farmers have started producing pearlspot seed for sale as ornamental fish in small earthen ponds and one farmer realized about Rs.21,000/- from a pond area of 200 m^2.
- Further refinement of mudcrab nursery technology, the optimum stocking density of megalopa was determined as 50 nos/m^2 under a low cost earthen nursery system.
- In mudcrab grow-out culture, higher production was achieved under mixed sex culture compared to all female populations due to higher average body weight attained under mixed sex culture.
- Evaluation of inexpensive plant ingredients in crab feeds to reduce fish meal revealed that these are better utilized with more than 87% protein digestibility and 88% energy digestibility. Of the six ingredients evaluated ground nut cake was better utilized.
- As part of our efforts in developing organic shrimp feed, *Azolla* as an ingredient at 5 % level was evaluated and with this feed it is possible to reduce the level of fishmeal and still achieve high growth.

Utilization of economically important brackishwater microorganisms

- Diversity of nitrifying, denitrifying, nitrogen fixing, methanotrophic and sulfur oxidizing bacteria have been examined in greenwater systems of coastal aquaculture using metagenomics. Nitrite oxidizing, nitrate reducing, sulfur oxidizing and nitrogen fixing bacteria were found to be in abundance in greenwater system. Metagenomic clonal libraries have been created for seven functional genes and unique clones obtained were sequenced and deposited in gene bank.
- Multiplex PCR for detection and identification of bacteria implicated in biotransformation of potent green house gases and other nitrogenous fluxes has been developed.
- Heterotrophic bacteria isolated from coastal aquaculture systems were characterized using biochemical tests, fatty acid methyl ester (FAME) analysis, 16S rRNA and functional gene approaches, and gene sequences have been submitted in the GenBank.
- Seven ammonia oxidizing archaeabacteria were enriched and isolated from brackishwater samples and four of these isolates were found to harbour amoA gene by PCR .
- During the current year a total of 130 identified microbes including 112 bacteria, 15 Actinomycetes and three fungal isolates have been deposited in the National Bureau of Agriculturally Important Microbes (NBAIM) culture bank.
- For a 40 bacteria, 16S rRNA genes have been amplified and sequenced to identify to the species level. From these groups, agriculturally and commercially important enzyme (xylanase, pectinase, agarase, cellulase, chitinase, protease, and lipase) producing bacteria were isolated, identified and characterized. Five commercially important genes: catalase, chitinase, lipase, choline dehydrogenase and betaine aldehyde dehydrogenase have been cloned and expressed.
- A total of 15 Actinomycetes have been identified based on 16S rRNA gene. Seven of these were found to produce antimicrobials.
- Identification and characterization of bioactive compounds from two pigmented bacteria were carried out and the ethanol extract of these showed antibacterial activity against few strains of human pathogenic bacteria.
- Crude extracts of bioactive compounds have been isolated from the antagonistic bacteria *Pseudomonas* sp. and these were found to have antibacterial activity against shrimp pathogenic bacteria, *Vibrio harveyi*.

Socio-economic and policy support for aquaculture development

- To address extension needs of farmers in Gujarat, 11 posters in Gujarati as extension material, have been brought out for permanent display at the Navsari Agricultural University and also for display in extension meetings such as farmers' meet and exhibitions. An assessment of shrimp culture practices in Valsad, Navsari, Surat and Bharuch Districts was carried out to understand the current cropping practices and technical, social and institutional problems faced by the farmers.
- For diversification of livelihoods among women Self Help Groups, three brackishwater aquaculture and allied technologies namely mud crab fattening, farm made aqua feed and value added fish product development were successfully transferred . Market linkages were identified for these products through various interactions.
- Under an inter institution programme with the Directorate of Research on Women in Agriculture (DRWA), Bhubaneswar for developing strategies for gender empowerment through suitable brackishwater aquaculture in Orissa, crab fattening by SHGs in Orissa was evaluated and it was found that the success of these women SHGs was due to good support from community, family, NGO and research institutes and their positive attitude towards adoption of brackishwater aquaculture technologies.
- Based on extensive consultation and a stakeholder workshop, a conceptual framework on public-private partnership (PPP) with aqua-consultants for aquaculture extension service was developed and the enabling factors to implement the PPP approach were identified.
- District level planning document which integrates the present aquaculture resources scenario with future potential and outlines an action plan to identify and address problems present at the district level is required for sustainable aquaculture development. One model district level planning document incorporating data from different sources has been developed for Nagapattinam District.
- Using remote sensing images and GIS, it was possible to show that shrimp farms in Gujarat were developed to an extent of 3210 ha in 2009 from erstwhile waste lands and not from mangroves. This confirms what has already been proven in Tamil Nadu and Andhra Pradesh that aquaculture development has not been at the cost of mangroves.
- With regard to estimation of carrying capacity of source water to support shrimp farming, studies carried out in Vettar River as a case study confirmed that by sampling in the critical last months of maximum discharge of water, one can estimate the carrying capacity of an area instead of carrying out regular sampling throughout the culture period. In order to popularize the use of carrying capacity tool among planners, a decision support software was released and was presented before Fisheries Department officials of Andhra Pradesh and Gujarat.
- As part of the work on climate change and extreme events, surveys were conducted in West Bengal and Andhra Pradesh to assess the damage due to Aila Cyclone and Krishna River floods. Based on these surveys, more realistic estimates of loss compared to state government figures could be computed and potential adaptive strategies were identified.
- Under the Network of Aquaculture Centers in Asia-Pacific (NACA) collaborative project on strengthening adaptive capacities to the impacts of climate change in resource-poor, small-scale aquaculture farmers, farmer's perceptions and adaptive capacities were identified through focus group discussions and stakeholder workshop.

- The impact of world shrimp prices on the niche market for large sized shrimps that are farmed specifically in low density regimes for longer crop durations in Prakasam, Guntur and Nellore Districts of Andhra Pradesh was evaluated.
- To evaluate the opportunities available for sustaining brackishwater aquaculture sector by bringing a shift in focus from export to domestic markets, sale prices were collected at different points in the value chain until it reached the consumer in the Howrah market. The analysis indicated that farmers get lesser share in consumer prices for low value fishes compared to hilsa, seabass and shrimp and middlemen cornered a significant portion of share in consumer rupee
- Comparative farm level production economics of seabass and tiger shrimp revealed that in a planning horizon of 10 years, with an inclusion of 0.49 estimated probability of risk of crop failures for shrimp, an Internal Rate of Return (IRR) was 29% and 24% for seabass and shrimp farming respectively. Interestingly if there is a 10 % increase in revenue (either by increase of output quantum/price) or a 10 % decrease in costs would make both seabass and shrimp culture to return IRR values over 40 %.

General

- During the current year in addition to the 13 externally funded projects, CIBA received additional 9 with the total funds of 519 lakhs for 2 to 3 years from funding agencies *viz.,* Network of Aquaculture Centers in Asia-Pacific (NACA), Department of Biotechnology (DBT), National Fisheries Development Board (NFDB), National Agriculture Innovation Project(NAIP), Department of Animal Husbandry Dairying and Fisheries (DAH&DF) and National Agriculture Bank for Rural development (NABARD). Three projects were completed subsequently.
- Of the 64 papers published this year, 24 were in peer reviewed journals with an average impact factor of 5.38 (NAAS).
- The institute organized 4 workshops, 7 farmers meets, 9 stakeholders meetings, 13 trainings and participated in 10 exhibitions.

3

Introduction

Brackishwater aquaculture from a small-scale activity in the 1970s has expanded and reached the status of a commercial enterprise by mid 1990s. In India, shrimp farming has its roots in the traditional brackishwater aquaculture practices followed in the *bheries* of West Bengal and the *pokkali* fields of Kerala. Shrimp aquaculture in our country was centered around one species, tiger shrimp *Penaeus monodon*. This sector witnessed faster growth with the technological and promotional interventions of R&D institutions and other governmental agencies, as well as entrepreneurs during the early 1990s. The sector witnessed setbacks in the form of viral diseases in the 1990s and has slowly revived by following best management practices and enforcement of regulatory measures. The rich and diversified 8129 km long coastline of our country is bestowed with 3.9 million ha estuaries, 3.5 million ha coastal brackishwater area besides 8 million ha salt affected areas. The 1.2 million ha brackishwater area offers tremendous scope for development of brackishwater aquaculture. During 2009-10 the annual aquaculture production of shrimp was 106,000 tonnes.

The Central Institute of Brackishwater Aquaculture was established in April 1987 to serve as a nodal agency for the development of brackishwater aquaculture in the country. The Headquarters of the Institute is located at Chennai with an Experimental Field Station at Muttukadu, about 30 km south of Chennai. The Institute has one Research Centre at Kakdwip in West Bengal. The Institute has a Director, 49 Scientists, 29 Technical and 25 Administrative and 51 Supporting staff as on 31.3.2010.

Mandate

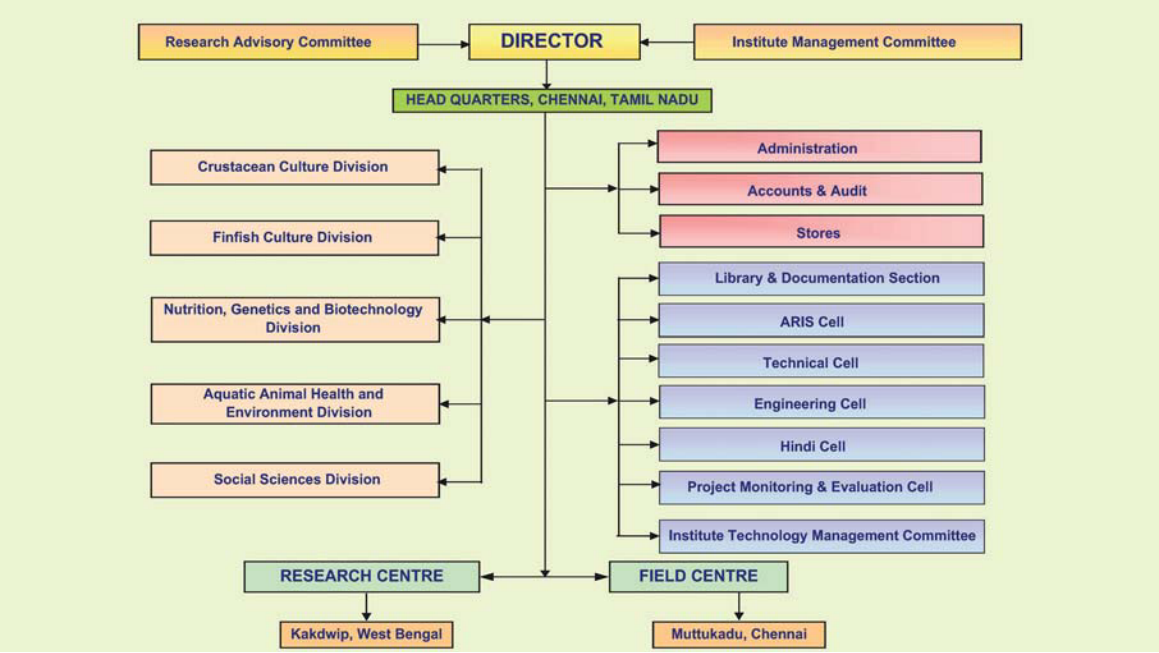
- To conduct research for development of techno-economically viable and sustainable culture systems for finfish and shellfish in brackishwater
- To act as a repository of information on brackishwater fishery resources with a systematic database
- To undertake transfer of technology through training, education and extension programmes
- To provide consultancy service

Organizational set-up

The research activities of the Institute are carried out under five divisions, viz.,

- Crustacean Culture Division
- Finfish Culture Division
- Aquatic Animal Health and Environment Division
- Nutrition, Genetics and Biotechnology Division
- Social Sciences Division

The research activities of the Institute were of diverse in nature, starting from basic research to applied and adoptive research which was carried out under 14 in-house and 22 externally funded projects during 2009-10.



ORGANISATION CHART

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Financial Statement

(Rs.in lakhs)

Sub-Head	BE	RE	Actual expenditure
NON-PLAN			
Establishment	600.00	948.61	942.63
O.T.A.	0.20	0.11	0.11
Traveling expenses	5.90	5.78	5.78
Other charges	65.00	72.23	72.23
Works	27.00	18.42	18.41
Total	**698.10**	**1045.15**	**1039.16**
PLAN			
Traveling expenses	15.00	15.00	15.00
HRD	5.00	4.00	4.00
Contingency	167.00	221.45	221.45
Works	120.00	100.00	100.00
Equipments	100.00	80.20	80.20
Information Technology	10.00	10.00	10.00
Others	3.00	3.00	3.00
Library	15.00	15.00	15.00
Furniture and Fixture	15.00	1.35	1.35
Total	**450.00**	**450.00**	**450.00**

Revenue generation

(Rs.in lakhs)

Year	Target	Achievement
2009-10	20.91	24.34

Official Language Implementation Programme

The institute organized the Hindi week celebration during 16-30 September 2009. Essay and Question-Answer competitions in Hindi were conducted and winners were awarded cash prizes. During the year, four Official Language Implementation Committee meetings were held and the usage of Hindi in official correspondences, bilingual use of Hindi and English in files, publications in Hindi were reviewed. Hindi Day was celebrated at Kakdwip Research Centre of CIBA on 23rd September, 2009 and as a part of the function quiz and speech competitions were conducted.

Hindi day celebrations at KRC

Staff position

The details of the number of positions sanctioned, filled and remaining vacant as on 31.3.2010 are as follows:

Position	Sanctioned	Filled	Vacant
Director (R.M.P)	1	1	0
Head of Division	2	2	0
Principal Scientist	1	0	1
Senior Scientist	10	4	6
Scientist	52	43	9
Technical Assistant	30	29	1
Administrative Officer	1	1	0
Finance & Accounts Officer	1	0	1
Assistant Administrative Officer	1	1	0
Junior Accounts Officer	1	1	0
Personal Assistant	3	3	0
Stenographer Gr.III	2	2	0
Assistant	5	4	1
Upper Division Clerk	6	6	0
Lower Division Clerk	8	7	1
Skilled Support Staff	60	51	9
Total	**184**	**155**	**29**

4

Research Achievements

CRUSTACEAN CULTURE DIVISION

Project Title (Institute)	**Sustainable shrimp production through domestication of *Penaeus monodon*, development of culture practices for *Marsupenaeus japonicus, Fenneropenaeus merguiensis* and adoption of Best Management Practices in farming**

Improvement in reproductive performance of tiger shrimp

The research programme envisaged optimising the maturation protocol of tiger shrimp *Penaeus monodon* in captivity, and the major objectives were i) to develop a suitable maturation diet to replace fresh feed and ii) to standardize the artificial insemination procedure.

Experiments carried out during the last year revealed that 100% replacement of fresh diet did not result in successful spawning and maturation. Hence, an experiment was initiated with 50% replacement of fresh diet with an artificial moist diet. The control group was fed with fresh diet (clam meat 50%, squid 30% and polychaete 20%). Reproductive performance was measured over a period of 30 days. Broodstock survival was high in both control and experimental groups (≥85%). Percentage animals that reached final maturity were almost similar in both the experimental and control groups (control: 41%; experimental: 38%). Although mean fecundity was significantly higher in animals that received the control diet (159000±3316) compared to the experimental (140000±1354) ($P<0.05$), there was no significant difference in hatching rate between the two treatments (Fig. 1). This study confirms the feasibility of substituting 50% of the classical fresh feed regimen with artificial moist diet in *P. monodon* broodstock diet.

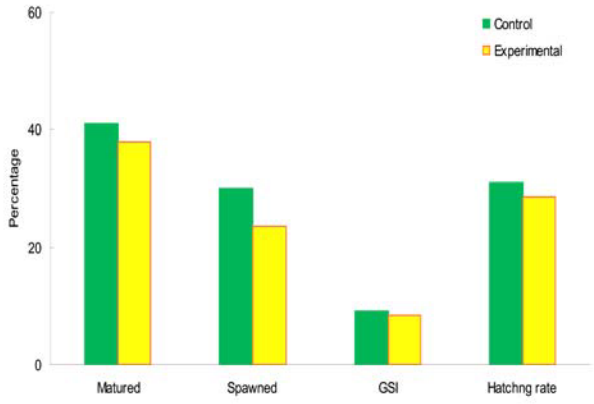
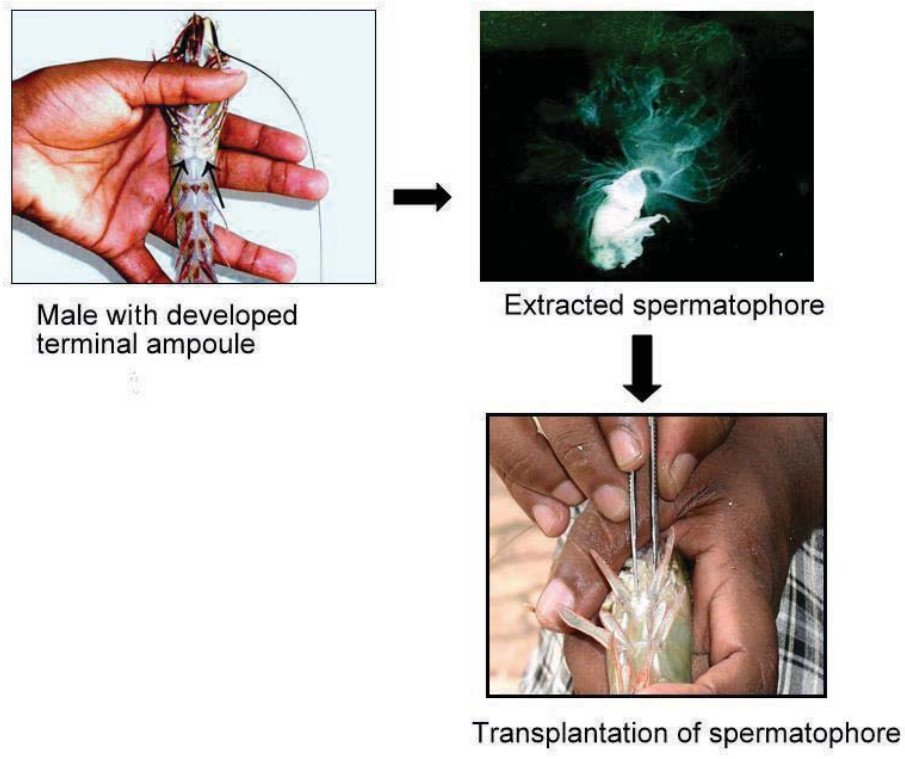


Fig. 1. Reproductive performance of tiger shrimp *Penaeus monodon* fed experimental artificial moist diet and control fresh diet

Low hatching rate of wild and pond reared *P.monodon* is a recurring problem in commercial and experimental shrimp hatcheries, and it is attributed to the low mating success or poor spermatozoan quality in captivity. Artificial insemination is a widely accepted management strategy to circumvent low mating and poor hatching. During this year, the procedures for spermatophore extraction, time of extraction and methods of transplantation were standardized. Three different methods were tested for the extraction of spermatophores: i) mild electric shock ii) squeezing and iii) using forceps. All the three methods yielded successful results; extraction using forceps always provided viable spermatophores. The disadvantage of this method is the chances of damage to the reproductive tract and the possibility

that the animals cannot be used for further studies. By electric shock, undamaged spermatophores were obtained, however, this procedure is cumbersome. By the squeezing method, undamaged and ready to use spermatophores could be obtained. However the success depends upon the moult stage of the animals. Based on the evaluation of various procedures, a combined method of squeezing and using forceps were found to be effective.

Experiments were conducted to evaluate two different approaches for transplantation of spermatophores. In the first case, the animals were acclimatized and the eyestalk was ablated unilaterally as and when the females moulted (within 8-10 hours) and transplantation of spermatheca was done with freshly extruded spermatophore. In the second treatment, animals were acclimatized and allowed to moult naturally and transplanted with spermatophore. Once females completed the post molt stages, they were unilaterally eye stalk ablated. In the first treatment, although 66% of the artificially inseminated females attained maturity, no viable spawning was observed. In the second treatment, successful spawning and viable hatching was obtained in 100% the females. The failure of the first treatment could be due to the extended period between eyestalk ablation and maturation.



Standardized artificial insemination procedure

Evaluation of a prototype recirculation system

To carry out captive maturation of tiger shrimp, a recirculation system was designed and evaluated with regard to water quality parameters. The unit consisted of 8 circular tanks of 500 litres capacity connected serially with a reservoir tank, sedimentation tank, two biological filter units and UV filtration. Performance evaluation of the recirculation system was conducted in comparison with two other systems,viz. complete (100%) and nil (0%) water

exchange systems. The results showed that the average concentration of ammonia and nitrite in the water initially was about 0.21 ppm and 0.003 ppm respectively. The concentration of nitrite in the recirculation system was low with an average of 0.006 ppm when compared to 100% water exchange and 0% water exchange where the average concentration was of 0.015 ppm and 0.120 ppm respectively. A similar trend was observed for ammonia as well. The average ammonia concentration was 0.17 mg/l in recirculation system, 0.29mg/l in 100% water exchange and 0.33mg/l in 0% water exchange system. The average microbial load was 1.6x 10^4 CFU/ml in recirculation system whereas it was 4.5x 10^4 CFU/ml in case of 100 % water exchange system. In the case of 0% water exchange system, the average number of colonies were as high as 12.0x10 ^{4} CFU /ml of water. The bacterial growth was not consistent with time in case of 100% water exchange system when compared to other two systems.

Identification of broodstock source for banana shrimp

Efforts in evaluating the potential of banana shrimp *Fenneropenaeus mergueinsis* as an alternate species for diversification, has been handicapped by the difficulties in procuring broodstock to produce seed and no commercial hatchery is ready to supply banana shrimp seed. During the period from March 2009 to April 2010, with the objective of identifying broodstock sources of banana shrimp in Tamil Nadu coastal area, an extensive enquiry was conducted with fishermen, and Gulf of Mannar was identified. Five field trips were undertaken to the fishing village zone from Adiramapattinam to Mallipattinam and 458 live adult shrimps were collected. The females were heavier (140 -180mm; 35 - 55 g) compared to males (130 -155mm; 15 - 25 g) and in all five collections, the number of males was considerably low (5.51 - 20.30 %).

Adoption rate of bio-security protocols and relation with disease incidence

Adoption rate of bio-security protocols either single or in combination in shrimp farms, was collected through a questionnaire survey (n=50) in Chidambaram and Nagapattinam Districts of Tamil Nadu (Fig.2) and this was correlated with white spot disease incidence reported during the past three years. About 50 % of the respondents were practicing chlorination of water in reservoir pond and the amount of bleaching powder applied ranged from 150–300 kg/ha. The cost involved in bird fencing varied from Rs. 7,000 to 10,000 per ha. Only 4 per cent of respondents restricted the entry of pet animals into the farms. Dogs were maintained in most of the farms for the protection of farm stock and machinery security. Categorization of the protocols indicated that none of the farms followed all the protocols and only three farms had the combination of water filtration through double mesh (WF), reservoir pond (RP), bird fencing (BF) and crab fencing (CF). Among the three important varying protocols (RP, BF and CF), 5 farms had all the three, and 17 farms had RP and BF without CF.

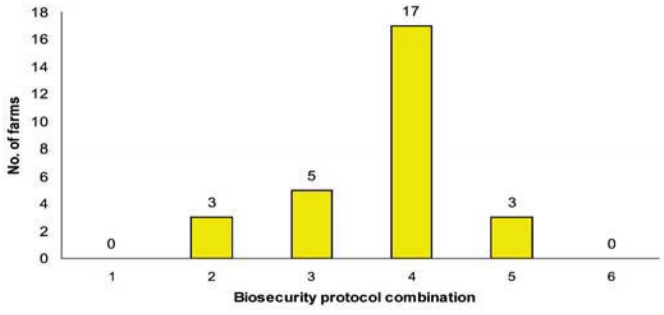


Fig. 2. Adoption rate of bio-security protocols in combination (1-All protocos; 2-WF+RP+BF+CF only; 3-RP+BF+CF only; 4-RP+BFonly without CF;5-BF+CF only without RP;6-RP+CF only without BF)

Chi-square and Phi correlation tests indicated that disease incidence is at a higher rate when disinfection of implements and reservoir ponds protocols were not followed (Table 1). The impact of two protocols of water filtration through single mesh and disinfection of vehicles and visitors could not be evaluated since all farmers in the study group followed the first one while

none followed the latter.

The strength of association between disease incidence and associated bio-security protocols was calculated by relative 'risk' and 'odds' ratio. The 'risk' of disease incidence without disinfection of implements and reservoir pond is 2 and 1.4 times respectively compared to the implementation of these protocols. The 'odds' of observing the disease in the absence of disinfection of implements and reservoir pond is 7 and 6.5 times respectively compared to the odds of observing the incidence when these protocols are followed.

Table 1. Chi-square test and Phi correlation between disease incidence and bio-security protocols

Explanatory variable	Chi-square test (p - value)	Correlation estimate (Phi)*	Disease incidence association
Water filtration double mesh	0.306	-0.145	Nil
Entry of pet animals	0.329	-0.138	Nil
Disinfection of implements	0.031	-0.306	Negative
Reservoir pond	0.017	-0.338	Negative
Bird fencing	0.333	-0.137	Nil
Crab fencing	0.864	0.024	Nil

* $P<0.05$

Effectiveness of chlorination in shrimp farming

One of the bio-security requirements is elimination of all the living organisms in the source water so as to avoid the entry of carriers. Chlorination of the water in a reservoir is being adopted by farmers for this purpose. In principle, the effective dose of chlorine has to be determined and the recommended dose of bleaching powder has to be applied based on the chlorine demand of water and per cent chlorine in bleaching powder. However, a wide variation was observed in the dosage and quality of bleaching powder used. In order to evaluate the efficiency of chlorination in preventing disease occurrence, six farms (3 with reservoir and 3 without reservoir) on Vellaiyar River in Gramathumedu, Kriyathmathumedu and Chinnathumbur villages of Nagapattinam District, Tamil Nadu were selected during 2009 summer and winter crops. Treatment and farm production details are given in Table 2. Bleaching powder @150 to 250 kg/ha was applied in the reservoir pond for chlorination of source water. Two brands of bleaching powder were used and the active chlorine content of these ranged from 31.5 to 33 per cent. Chlorine demand of source water was estimated and it ranged from 1.0 to 2.0 ppm. After chlorination, the water was retained in the reservoir ponds for 4 days. During summer crop, topping up of water in the ponds was done using reservoir pond water, whereas in winter crop, reservoir water was not used often during the culture period due to heavy rains. The water samples were analysed regularly from the ponds in all the farms and also from reservoir ponds for physico-chemical parameters, bacteria and *Vibrio* count.

Table 2. Farm and production details in summer (6/m²) and winter (8/m²) crops of 2009 with (Farm 1,2,3) and without (Farm 4, 5, 6) reservoir pond

Farm no.	Area (ha)	No. of ponds	Reservoir area (ha)	Bleaching powder (kg/ha)	Average production (t/ha)	
					Summer	Winter
1	11	17	1	150	0.914	1.115
2	1.0	2	0.2	250	1.70	1.40
3	1.5	3	0.5	150	0.914	0.98
4	0.5	1	-	-	1.62	0.72
5	1.2	3	-	-	1.145	0.945
6	1.2	3	-	-	1.142	0.850

All the farms with reservoir pond exhibited higher production during winter crop whereas this trend was not observed during summer crop. Water pH and total ammonia nitrogen (TAN) values were less in culture ponds using the chlorinated water during summer crop (pH: 7.79 - 8.14; TAN: 0.24 - 1.38 ppm) and winter crop (pH: 6.96 -7.84; TAN: 0.126 – 0.947 ppm) compared to the culture ponds which use source water directly during summer crop (pH: 7.83 - 8.54 & TAN: 0.278 – 1.78 ppm) and winter crop (pH: 7.45 - 8.2; TAN: 0.269 – 1.47 ppm). With respect to other water quality parameters there was not much difference between the treatments. During winter crop, the values of pH and TAN values decreased after the second month due to dilution of pond water by rain water. Total bacterial count (TBC) was less in reservoir pond water after chlorination and later the bacterial load increased in ponds where water was drawn from reservoir and there was not much difference in the count between the farm ponds with and without reservoir. On the other hand the *Vibrio* count was considerably lower in culture ponds with reservoirs compared to those without reservoir (Fig. 3). High production in culture ponds with reservoir could be attributed to decrease in stress to the animal with low values of pH, TAN and *Vibrio* count compared to ponds without reservoir. There was no disease incidence in any of the ponds and hence the efficiency of chlorination could not be correlated with the disease incidence.

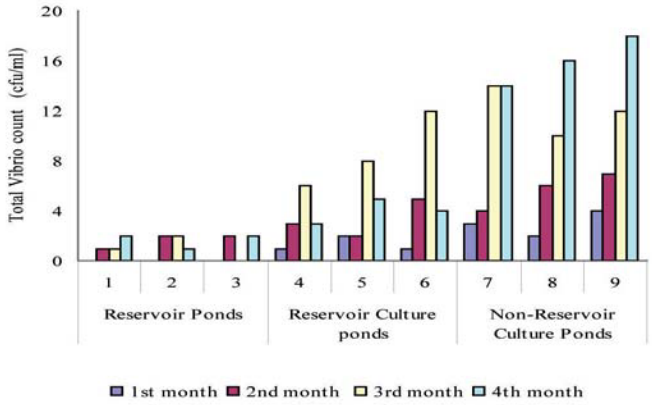


Fig. 3. Total Vibrio count in reservoir and culture ponds during winter crop (1,2,3 – Reservoir ponds; 4,5,6 – Reservoir culture ponds; 7,8,9 – Non-Reservoir culture ponds)

Reduction in feed protein level

A modified Closed Biosecure Shrimp Farming Technology (CBSFT) with *P. monodon* has been developed based on successful on-station trials in the last three years at Kakdwip Research Station. During the year under report, trials were carried out to determine whether the cost of production could be reduced through reduction of the level of protein in feed. With this objective, three protein levels in feed i.e. 38%, 32% and 24% were evaluated. For each protein level, there were triplicate ponds and all were stocked with 8 pc/m^2. Production performance indicated that in CBSFT system, a relatively low protein feed of 32 % (as in Tr-II) may suffice to give an equivalent production (Fig. 4). However, drastically lowering the protein level to 24 % may not yield similar results. With 24 % protein, survival was half (22%) compared to other treatments (45%). This study established that with a reduced protein level of 32%, the cost of production could be reduced by Rs.4-5 per kg

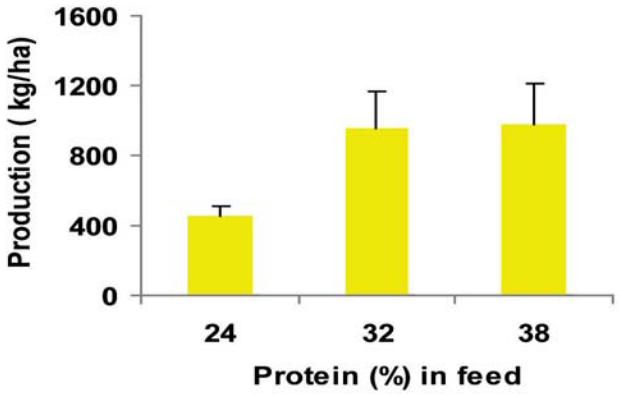


Fig. 4. Average production (kg/ha) in zero water exchange ponds fed with three levels of proteins in feed.

Horizontal transmission of White Spot disease

Earlier studies on the horizontal transmission of white spot disease in Andhra Pradesh and Tamil Nadu revealed that after the incidence of disease, its spread was mainly through water and in some farms through birds. Follow up study was carried out during 2009 winter crop in Mahendrapalli and Pulliandurai Villages, Chidambaram District, Tamil Nadu, where the shrimp farms were located on source waters, Kollidam and Kitti (Kettiani Uppunaru) rivers. All the ponds had completed the stocking within a time span of 15 days. One pond in Mahendrapalli village was stocked with seed from multiple hatcheries and was affected with the disease at 25 DOC. The spread of the disease has been mapped and shown in Fig.5. All the neighboring ponds were affected with the disease in this village through water transmission with the exception of one pond. In this pond, though stocking rate was high, measures like close monitoring of water supply from reservoir pond and restricting entry of river water into the reservoir at the time of disease, saved the crop. In Pulliandurai village, all the ponds were affected with the disease through transmission by both water and birds. The distance between the farms affected with the disease ranged from 0.5 to 2 km in Mahendrapalli Village to a maximum distance of 4.5 km in Pulliandurai Village. The disease spread within 25 days from the first farm to other farms in Mahendraplli Village and the whole area

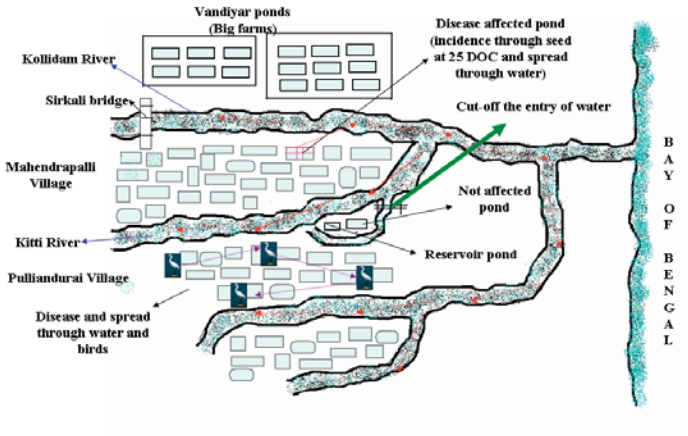


Fig. 5. Lay-out of the study site indicating the pattern of horizontal transmission of WSSV through both water and birds (red arrows show direction of disease spread)

was completely affected with the disease within 50 days. The study area did not have bird fencing and only few farms had reservoir ponds which were not being used efficiently. The spread of disease was primarily through water during exchange and aggravated through birds. Interaction with farmers (n = 25) and further analysis revealed that lack of bio-security measures such as strict maintenance of reservoir pond, use of one batch of seeds from single hatchery, testing of seed from non-certified laboratory and absence of bird netting are responsible for the incidence of disease. The study also clearly brings out the fact that when farmers have a reservoir pond and are able to adopt biosecurity protocols strictly, it is possible to save their crops even though disease is prevalent in adjacent ponds.

Elucidating the mechanism behind the action of probiotics

With the objective of comprehending the mechanism behind the action of probiotics in hatchery operations and to standardize the probiotics use, experiments were carried out. The shrimp hatchery was monitored for microbial loads with special reference to *Vibrio* spp and total bacterial counts. *Vibrio* bacterial isolates were characterized by biochemical and 16s rRNA gene analysis and commonly encountered vibrio isolates were: *Vibrio parahemolyticus, Vibrio vulificus and Vibrio alginoliticus.* Autochthonous microbes from the system and host were isolated and characterised before studying their probiotic properties. Allochthonous microbes, known for their probiotic properties and GRAS (generally regarded as safe) nature are selected for the hatchery use. The isolation, culture and scaling up of the selected probionts *L. rhamnossus* and *Sacharomyces cerevisiae* were standardised. Based on these studies, seed production of tiger shrimp *Penaeus monodon* and kuruma shrimp *M. japonicus* with probiotic interventions is presently being carried out.

District Level Planning

District level planning for aquaculture development would help to integrate the present aquaculture resources scenario with future potential, evaluate the present status, calculate the financial and infrastructure requirements to utilize the resources in a sustainable manner and derive action plans to identify and address the problems present in aquaculture sector. Nagapattinam district was selected to carry out a model study due to the presence of the highest number of shrimp entrepreneurs, maximum area under shrimp culture and multi-hazard prone nature of district with heavy winds, cyclones and floods. The primary and secondary information such as demographic details, general administrative arrangement, climate, rainfall, ground water quality, hydro geological characteristics and infrastructure facilities were collected from different sources such as farmers, State Department of Fisheries, PWD, MPEDA and State Department of Agricultural Engineering. The land and water resources location and its areal extent were assessed using remote sensing and GIS. ERDAS Imagine and Arc GIS were used along with ArcPad GS 5 + Global positioning system for ground truth verification. Major land use was for agriculture to an extent of 1,76,546 ha and mudflats occupied 2,371.73 ha. Aquaculture farms were present in coastal areas to an extent of 2,990 ha. Potential areas suitable for the expansion along with the existing farm locations has been derived based on the methodology developed by this institute. The area suitable for expansion was 359 ha in addition to the existing aquaculture farms of 2990 ha and abandoned farms of 282 ha. Issues and problems at level of policy (leasing, license for export, testing prior to export, market), farmer (species, disease, electricity) and infrastructure have been identified. The most important issue is the lack of standardized rate for different counts of shrimp produced. The financial requirements estimated were : Rs.300 lakhs for reviving abandoned farms, Rs.1800 lakhs for expanding aquaculture in potential areas, Rs.360 lakhs for infrastructure development, Rs.50 lakhs for training and demonstration, Rs.100 lakhs for creation of post harvest facilities and Rs.50 lakhs for setting up of ice factory. The planning document and methodology can be used in this study as a model to carry out the planning for aquaculture development in other coastal districts.

Project Title (Institute)	Development of packages for nursery and grow-out culture of mud crabs *(Scylla spp.)*

Towards the end of the hatchery phase, megalopa of the mud crab *Scylla tranquebarica* are weaned from the hatchery facilities and reared to a stockable size in nursery facilities. This extended nursery phase of 45 days is essential for the successful grow out culture of mud crabs. During the current year, trials were carried out to (i) further refine the nursery technology with regard to the optimum stocking density of megalopa and explore the possibility of utilizing indoor tanks for nursery rearing and (ii) evaluate if all female or mixed-sex populations result in higher production during grow-out culture.

Nursery rearing technology

In this experiment, the potential of using indoor tanks for the initial nursery phase of mud crab *S. tranquebarica* was evaluated. Two circular FRP tanks (10 ton capacity with a bottom area of 4 m^2) were used for the experiments. Artificial substrate made up of plastic was used, and each tank was stocked with 1000 megalopa. The animals were reared for 41 days and fed with a fresh diet of clam meat. The water exchange was 50% on a daily basis. The over all survival rate in the indoor tank was higher (33.7%) compared to that in the earthen ponds (30%) although it was not statistically significant. In the congeneric species, *S. paramamosain*, a similar range of survival rate was reported (30-41%) at a relatively higher stocking density (110-230 no/m^2); however, they had used an indoor recirculation system with small (15 l) containers. The harvest weight after 41 days was significantly low in the hatchery reared tanks when compared to the earthen ponds. These results were slightly contrasting to our earlier observation, where a significantly higher survival rate was obtained when compared to the earthen ponds. However, growth data obtained in the present experiment is similar to those obtained in our earlier studies. Further trials are required to standardize nursery rearing using indoor tanks.

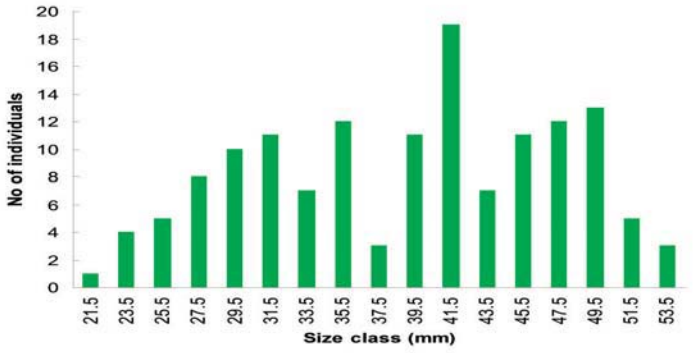


Fig. 7 Size (carapace width) distribution of nursery reared population of mud crab *Scylla tranquebarica*

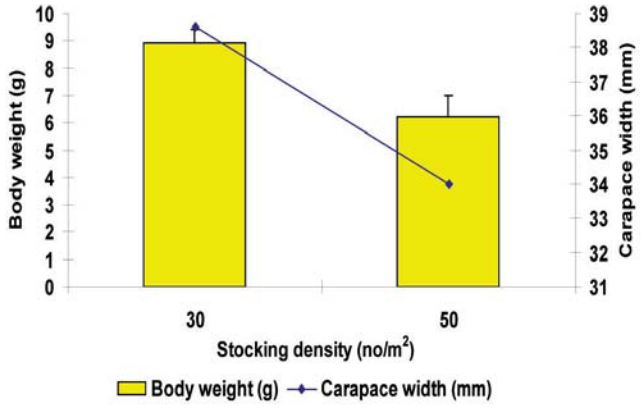


Fig. 6. Mean body weight (g) and carapace width (mm) of *Scylla tranquebarica* at two different stocking densities in earthen ponds

In order to evaluate the effect of stocking density on survival and growth, megalopa of *S. tranquebarica* were reared in earthen ponds (100 m^2) at two stocking densities (50 and 30 per m^2) and tested in duplicate. Artificial hide-outs mimicking sea weeds were used for the present study based on promising results obtained earlier. After 41 days of rearing, survival of crabs stocked at a lower density (35%) was higher when compared with crabs stocked at a higher density (28%)

(Figure 6). Similarly, the growth of crabs was also higher in crabs stocked at a lower density (CW: 38.6 ± 0.8 mm/ BW: 8.9 ± 0.4 g). Further, high specific growth rate (SGR %) was also noticed in the lower stocking density ponds. The coefficient of variation for body weight (BW) was quite high, compared to that of carapace width (CW). This discrepancy in body weight of crustaceans has often been reported. Although growth attributes are slightly better, in the lower stocking densities, the values are not significant. Therefore, 50 no/m² is recommended for the megalopa rearing for the initial nursery phase. The present trials show the potential for a low cost earthen nursery system for mud crabs.

In both earthen ponds and indoor tanks, there is a slight preponderance of males over females, however the sex ratio is not statistically significant from the expected 1: 1 ratio. Generally in crustaceans, earlier life stages show a 1:1 ratio, and there is a preponderance of one sex over other in adult hood. Fig. 7. depicts the size (CW) frequency distribution of nursery reared *S. tranquebarica* in the earthen ponds. The size distribution analysis reveals a wide range of size class (21.5-53.5mm) indicating a differential growth for this species during nursery phase, which needs to be addressed.

Mud crab grow out culture in West Bengal

Earlier pond trials confirmed that *S. tranquebarica* cultured in West Bengal was superior to the locally available *S. serrata*. Further trials were carried out this year with *S. tranquebarica* to determine if all female populations would result in higher production. Details of trials are given in Table 3. In both the treatments, nursery reared juveniles were stocked @ 0.6 nos/s m² (all female) and 0.75 pc/ m² (mixed sex ratio 1:1) and the grow-out culture experiment was carried out for 167 and 205 days respectively. The calculated production was higher in mixed sex culture (1008 kg/ha; FCR 3.64) compared to all female (613 kg/ ha FCR 3.35). The results indicate that it is possible to achieve a production of above 1000 kg/ha of *S. tranquebarica* with nursery reared stocking. Proper scheduling of the crop starting from the month of April-May could result in better survival and production. Mixed sex culture of *S. tranquebarica* yielded better productivity than monosex culture. Although survival of the crabs in all female trials was better, the mixed sex culture resulted in higher production due to the higher average weight attained. In this low saline farming of *S. tranquebarica* at Sundarban, the production cost was found to be Rs 235/- per kg with a profit margin of Rs 85,000/- per ha and a rate of return of 36 % over the operational cost. With proper scheduling of the crop and with better survival rate, better rate of return is achievable.

Table 3. Comparison of all female and mixed culture grow out pond trials on production parameters

Treatment	Pond no.	Area (m²)	Stocking ABW (g)	ABW harvest (g)	Calculated survival rate (%)	Harvested biomass (kg)	Calculated production (kg/ha)
All female	1	1200	39.7 ± 8.98	201.4 ± 61.1	49.9	72.4	613
	2	800	42.7 ± 8.68	192.9±63.74	55.4	51.3	
Mixed sex culture	1	600	39.5 ± 9.93(M) 37.2 ± 10.8(F)	324.2 ± 64.6(M) 317.2 ± 70.8(F)	43.7	62.8	1008
	2	600	33.2 ± 13.8 (M) 35.6 ± 12.84 (F)	327.8 ±73.7 (M) 293.5 ± 79.4 (F)	42.2	58.1	

Project Title (Institute)	Aquaculture farm appraisal and impact assessment using remote sensing and GIS

Assessment of the impact of aquaculture on ecologically sensitive coastal ecosystems is important for the sustainable development of aquaculture. The project had the following three objectives i) assess the impact of aquaculture on mangroves, ii) refine the methodology for the estimation of aquaculture farms in larger areas using remote sensing techniques and iii) assess the impact of shrimp farming and on coastal aquifers.

Assessment of impact of aquaculture on Gujarat mangroves

The state of Gujarat is estimated to have the longest coastline of 1600 km and a potential brackishwater area of 3,76,000 ha. In the recent years, aquaculture has been rapidly expanding in a few coastal districts such as Surat, Valsad, Navsari and Bharuch and there is a vast potential for further development of aquaculture. To ensure that the development of aquaculture in Gujarat is not adversely affecting mangroves, an impact assessment was carried out using satellite data and geographical information system. The IRS 1A of 1988 and 1C data (Row-56,57 with Path 83, 94 and 91) of 1998 and updated with Google earth data of 2009 were used. ERDAS imagine 9.1, Arc View 3.2. and Arc GIS 9.2 were used to carry out the image processing and GIS analysis respectively. The delineation of different categories such as mangroves, aquaculture farms, salt pans were verified by ground truth verification using Global Positioning System (GPS). Mangroves in Gujarat are mostly confined to Gulf of Kutch and the Kori creek. In the Gulf of Khambhat, they are sparsely distributed in small patches. About 200 sq km of moderately dense mangroves were found in Kutch area in the regions of Jamnagar, Bhavnagar, Bharuch and Surat. The potential area available for mangrove regeneration is huge (640 sq km) and of this 20 sq km has been used for regeneration in the district of Surat. The landward side in the Gulf of Kutch is mostly waste land affected by salt. The salt pans are present along the sea and closer to mangrove area in some parts of this region. In the Kori creek area, a large number of small and large creeks make up a network of creeks feeding nutrients and tidal water to the mangroves of the region. The Kori creek and its surrounding area support 65 % of the mangrove cover in the state. *Avicennia* dominated the entire mangrove belt. The Gulf of Kutch in Jamnagar has been notified as a Marine National Park and Sanctuary.

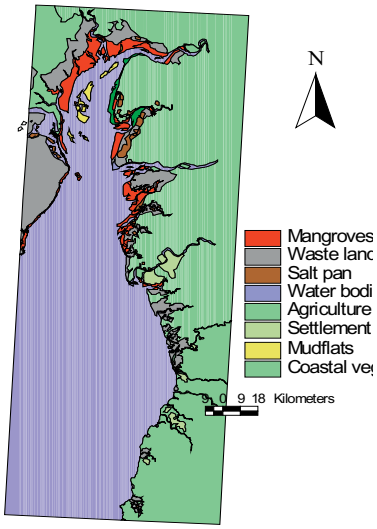


Fig. 8a. Landuse pattern in and around Gujarat mangroves (1988 scenario)

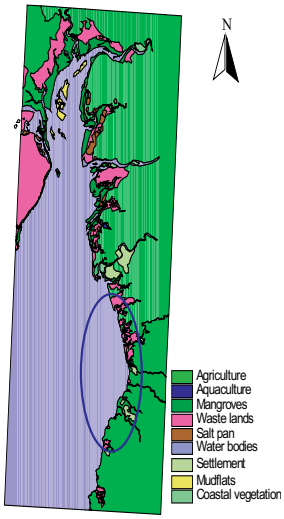


Fig. 8b. Landuse pattern in and around Gujarat mangroves in 2009 (Major area developed for shrimp farming is enclosed within the blue color oval shape)

Area of brackishwater aquaculture developed

The land use pattern drawn from the satellite data indicated that major land use was for agriculture, salt pans, aquaculture and settlements and the rest were mangroves and/or wasteland. The major aquaculture areas were located in Surat, Navasari and Valsad districts, where mangroves area were very less (24 sq. km). The total brackishwater area utilized for aquaculture development was 0.81 % (Table 1). The land use maps (Fig 8 a & b) indicated that the shrimp farms have been developed to an extent of 3210 ha in 2009 from waste lands. The district wise comparison of existing brackishwater area and shrimp farm area indicated that shrimp farm development has utilized the brackishwater area of less than 1%. (Table 4). Shrimp farms were not located in mangroves or adjacent to mangroves. The analysis indicated that aquaculture farms were not located in the districts with major mangrove areas. Aquaculture areas also do not lie close to mangroves, on the other hand salt pans were located very close to mangrove areas in some parts of Bharuch district. In this study, the methodology for estimation of total aquaculture area from remote sensing images was further refined.

Table 4. District-wise mangrove and brackishwater area in Gujarat

Districts*	Total mangrove area (ha)	Total brackishwtaer area (ha)	Shrimp farms developed (ha)	Brackishwater area utilized (%)
Surat	1700	24300	1326	0.35
Navasari	100	23152	1020	0.27
Valsad	500	9088	372	0.10
Bharuch	4200	57500	161	0.04
Kutch	77500	78400	50	0.01
Jamnagar	15700	22300	25	0.01
Other districts**	4901	161260	104	0.03
Total	107600	376000	3058	0.81

* Source: Department of Fisheries, Department of Forests, Gujarat and MPEDA; ** Data for districts having major mangrove and shrimp areas is given individually while for other 9 districts it is pooled

In Gujarat, shrimp culture has developed in the areas allotted by the revenue department of the state. Out of 3,76,000 ha, around 3,400 ha has been allotted for shrimp farming. The allotment and availability of land suitable for shrimp farming remains with the government and the misuse of lands is not possible in Gujarat state.

Impact of shrimp farming on coastal aquifer

Hydro-geochemical analysis of the groundwater was carried out to identify the status and the nature of ground water salinity in the shrimp farming area in the lower Vellar subwater shed, Chidambaram. The groundwater data indicates that the sodium and chloride are the predominant cations (Na>Ca>Mg) and chloride and bicarbonate were the main anions ($Cl>HCO_3>SO_4$) in the study area. Large variations in mean, median and standard deviation values suggest that the water chemistry in the region under study is not homogenous and it also reveals the influence of complex

hydro-geochemical processes and salinisation sources. Piper trilinear diagrams developed to depict the status of the groundwater quality, indicate that the cation exchange and mineral dissolution along with the incursion of sea water was responsible for this elevated ionic composition. The ionic ratio of Na/Cl is less than 1 except for 6 samples, and the Ca/Mg ratio ranged from 1.6 to 4.07 suggesting that natural weathering process of the underlying rocks is influencing the ionic content of ground water. Calcium and magnesium ions present in groundwater is particularly derived from leaching of limestone, dolomites, gypsum and anhydrites, whereas the calcium ions is also derived from cation exchange process. The geology of the study area also indicates that it is of marine origin. This analysis clearly confirms that the groundwater salinisation in the area is mainly due to natural process and aquaculture is not the cause for salinisation of groundwater.

Project Title (Institute)	**Collaborative project on brackishwater aquaculture development in Gujarat**

Culture for tiger shrimp

In order to develop location-specific culture technologies for shrimp and to demonstrate its techno-economic feasibility, tiger shrimp *Penaeus monodon* culture was taken up in a brackishwater farm at Danti - Umbharat Centre of the Navsari Agricultural University, Gujarat. The farm comprising four ponds of 0.16 ha each, has two reservoir ponds (0.14 ha each), one Effluent Treatment Pond (0.03 ha), five stage filtration of intake water, bird fencing, crab fencing and dog fencing to ensure biosecurity. Standard pond preparations protocols were followed and *P. monodon* seed (PL 30 & PL 40) from the CIBA hatchery were stocked @ 8.3 nos./sq m in three ponds on 4th June 2009, following the standard acclimatization procedure. However, due to the prevailing higher salinity in the pond at the time of stocking (40 ppt), the survival rate was poor. The shrimp were fed with 'Bismi feed' developed and commercialized by the Institute @ 10% of body weight initially and gradually reduced to 1.68 % at the end of culture. During the culture, agricultural lime and dolomite were applied during low pH conditions; to reduce pH, NH_3 and H_2S concentrations, fermented rice juice and zeolite were used whenever needed in all the ponds. Immunostimulant (CIBASTIM) was mixed with feed and fed to shrimp on a weekly basis in ponds 2 and 3 whereas pond 1 served as a control. During the culture and after each pond treatment, water samples were analyzed for pH, salinity, CO_3 and HCO_3 alkalinity, Ca+Mg hardness, total N and phosphate. There was not much difference between the ponds with respect to water parameters. The discharge water from the ponds during the culture was taken to the ETP and then used for raising *Salicornia* crop in the adjacent plot.

Harvesting of shrimps was done after 122 days of culture and the results of production and survival are given in Table 5. Though the survival rate was poor in all the ponds due to high salinity at the time of stocking, the survival rate was comparatively higher in CIBASTIM treated ponds. The overall survival rate was 47.1%. The production and quantity of grade A shrimp was also higher in ponds 2 and 3, compared to control by 9% and 19%, respectively. Though quantity of grade B was less in treated ponds than control, the overall production was higher by 6.6% and 11.5% in ponds 2 and 3, respectively compared to control. The total production obtained was 551kg and the productivity was 1147.9 kg/ha/4 months. A revenue of Rs.1,78,956 was realized from this culture. The results indicated that with biosecured aquaculture and by using CIBASTIM, production of healthy shrimp can be achieved with the possibility of using the discharge water to raise *Salicornia* crop as an additional source of income.

Table 5. Production details of cultured ponds treated with CIBASTIM

Pond no.	Survival (%)	Grade A quantity (kg)	Increase/ decrease* (%)	Grade B quantity (kg)	Increase/ decrease* (%)	Total quantity (kg)	Increase/ decrease* (%)
Pond 1 (Control)	44.14	155.55	0	17.62	0	173.2	0
Pond 2	48.12	169.55	9.00	15.18	-13.85	184.7	6.64
Pond 3	48.87	185.47	19.23	7.6	-56.87	193.1	11.49

* Over Control

Demonstration of seabass culture

To popularize seabass *Lates calcarifer* culture and to demonstrate its production potential, a 0.16 ha pond was stocked on 4th June 2009 with 900 fry of 7cm/ 5.0 g size produced at the Institute hatchery. Fishes were fed with CIBA seabass feed. The water management followed was similar to that of shrimp ponds, except that a higher water depth was maintained in the seabass pond. The fishes were sampled regularly by cast netting to assess their growth. The average length and weight of the fishes during the culture is given in Fig. 9. During January 2010 due to drop in temperature below15^{0}C, total mortality occurred. The dead fishes weighed 217 kg. The fishes had reached the size range of 200-800g in 225 days. The average size was 596 g. This trial has shown the potential of seabass as a candidate species for aquaculture and the culture strategy is to be regulated to avoid the adverse effects of winter. The calendar for seabass culture in Gujarat could be from March to November/December to avoid low winter temperatures.

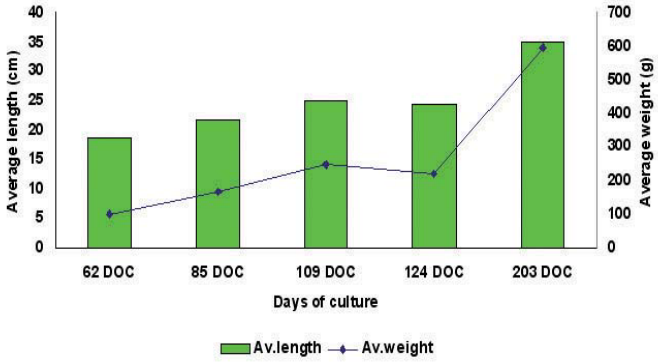


Fig. 9. Growth of seabass in pond

Evaluation of tiger shrimp farming practices in Gujarat

An assessment of shrimp culture practices in Valsad, Navsari, Surat and Bharuch Districts was conducted during November 2009 to understand the current cropping practices and to identify ethnical, social and institutional problems faced by the farmers. Valsad district has 5154 ha potential area for brackishwater aquaculture. Although 119 farmers have been allotted land, currently 72 farmers are actively involved in farming. The major water sources are Malwan creek, Bamka, Kanai, Ambika river, Auranga river and Varoli river. The culture is undertaken in three taluks namely, Valsad, Pardi and Umbergaon, but 90 % of the culture is concentrated in Valsad taluk. Most of the farmers raise one crop per year (closed season is winter) and few farmers obtain two crops. The farms are situated very close to the creek. The major soil type was found to be clayey loam. Water filtration is done at least two times during the crop. Some farmers discontinued bird fencing due to the recurring high expenditure. Most farmers possess a reservoir pond. Few farmers also possessed an Effluent Treatment Pond (ETP) individually and few had also established ETP

jointly with neighbouring farmers. Almost all the farmers culture tiger shrimp except the private company, namely Onaway industry which cultures *L. vannamei* in a part of their farm.

The stocking density varied from 5 to 12 PL/m^2 as revealed by farmers and the seeds were sourced from Diu, Chennai and Visakhapatnam. Farmers have reported to obtain FCR of 1.3 to 1.7 for *P.monodon.* One farmer from Nargol, cultured *F.indicus* with FCR of 2. About 7 to 10 % of the total cost for farming is spent by the farmers on probiotics. It is normally applied after 15 to 20 days of culture. Most farmers encountered WSSV in 2004, 2005 and 2006. Few farms during the current culture were infected with WSSV. Farmers obtained a production of 1.2 to 2.5 t / ha. The average count was 27 and the current price realization was Rs. 315 / kg for 30 count shrimps. The production cost varied from Rs. 160 to 180 / kg.

The survey has identified certain issues which are to be addressed for developing sustainable brackishwater aqua farming. The major technical problems identified by the farmers were: non-availability of quality seed, incidences of diseases such as *Zoothamnium* infestation, loose shell, lack of adequate analytical laboratories, low feed intake and growth during winter when temperature drops leading to slow growth and longer crop period and increased cost of production, high level of salinity during summer (beyond 50 ppt), high level of turbidity, muddiness in ponds due to heavy rainfall making feed management very difficult. In some areas, scarcity of good quality source water in the creek during the entire culture period is also a major concern. The major social problems faced by the farmers were: non-availability of required labour, pollution of source water due to factory effluents and mass mortality of shrimps due to release of polluted water in sea/ creeks According to farmers, the institutional problems they faced were : non-availability of three phase electricity connection, absence of cold storage facility to store emergency harvest, lengthy procedure in allotting land to beneficiaries, declaration of highly water logged areas as agricultural land by government and lack of good buyers during winter season.

Addressing the extension needs of farmers

In order to disseminate the Institute technologies to the stakeholders in Gujarat, 11 posters in Gujarati language, as extension material, have been brought out for permanent display at the Navsari University and for use in extension meetings such as farmers' meet, exhibitions, etc.

Irrigating *Salicornia* with farm discharge water

Harvested *P.monodon*

FINFISH CULTURE DIVISION

Project Title (Institute)	Seed production technology for commercially important brackishwater fishes

Broodstock development of seabass

To refine and upgrade the technology of seed production, domesticated broodstock (F_4 generation) of Asian seabass, *Lates calcarifer* (43 fish; 2.2 – 8.0 kg) were maintained under controlled conditions in RCC tanks (100 ton capacity), pond and recirculation system. The stocking density in the RCC tanks was maintained at 1 kg/m^3 whereas in the recirculation system, it was maintained at 10 kg/m^3. The broodstock was strengthened with new stock from three sources *viz*. fishes (27 nos.; in the size range of 2.0 – 4.0 kg) raised from wild seed in a fresh water pond at Bhimavaram, wildseed (15 nos.; 2.5 – 4.0 kg) cultured in a seawater pond at Perunthottam, Sirkazhi and wild fishes (40 nos.; 1.5 – 8.0 kg) caught in the vicinity of Kovalam and Muttukkadu area. Fishes from Bhimavaram and Perunthottam were transported in containers maintaining a biomass density of 6.8 and 5 kg/m^3 respectively. The travel time was 10-14 hours and the fishes were transported without any mortality. The fishes were kept in the quarantine facility for a period of 10 days and then transferred to the holding facilities.

The broodstock fish were fed with forage fishes like tilapia and oil sardine @ 5% of their body weight. Tanks were partially covered with net mesh. The health of the broodstock was regularly assessed. During this year, recurrent mortality was observed during the period between September 2009 and March 2010. Fishes exhibited upside down movements and abnormal behavior without feed intake before death. The biopsy of dead fish revealed the deterioration of spleen and liver tissues. The cause of mortality was suspected to be a viral agent and not due to water quality. Water exchange was effected to the extent of 70% daily and water quality parameters were regularly monitored. Water temperature was in the range of 27 – 32°C, salinity 22 – 32 ppt, pH 7.8 – 8.4, dissolved oxygen 3.4 – 6.3ppm and ammonia 0.02 – 1.4 ppm. A significant number of broodstock have been added this year.

Captive maturation, spawning and larval rearing of seabass

Maturation of the captive broodstock was observed during the period from May to November in the RCC tanks and up to February in the recirculation system. Oozing males and gravid females with an ova diameter of about 400µm could be obtained. During this year, successful spawning was observed in ten of the twelve trials conducted in RCC tanks and 6 spontaneous spawnings were observed in the recirculation facility during the months of July – August. Induced spawning was achieved in the months of September and October by intramuscular LHRHa hormone administration at a dose of 60 -70 µg/kg body weight in the case of females and half the dose in the case of males. The total number of eggs spawned in the natural spawning ranged from 0.3 to 1.7 million eggs with a fertilization rate from 58- 95 % and hatching rate of 60 - 92 %. In the induced spawning trials, the number of eggs spawned ranged from 0.25 to 1.0 million eggs with a fertilization rate of 38 - 86 % and the hatching rate ranged between 45 - 86 %. Of the 10 spawnings, a second spawning was observed in six. Though the fertilization rate was less in the second spawning, no differences were observed in terms of the number of eggs/ hatching percentage between the first and second spawning. Hatchlings obtained either from natural or induced spawning was further reared under controlled conditions following the protocols standardized earlier.

Development of a nursery rearing technology for seabass fry

To develop a tank based nursery technology for seabass, two sets of experiments were carried out in RCC tanks of 5 m^3 (2.5 x 2.0 x 1.0 m) in the hatchery. Daily water exchange to the extent of 40% was done. In the first set, densities of 1000, 2000, 3000 and 4000/ m^3 were tested with a initial stocking size of 1.2 cm and in the second set of the experiment, densities of 300, 500, 600, and 900 were tested with initial stocking size of 1.1 cm. The duration of both trials was 40 days. The details of weight gain (%) and survival (%) are shown in Figs. 10 & 11.

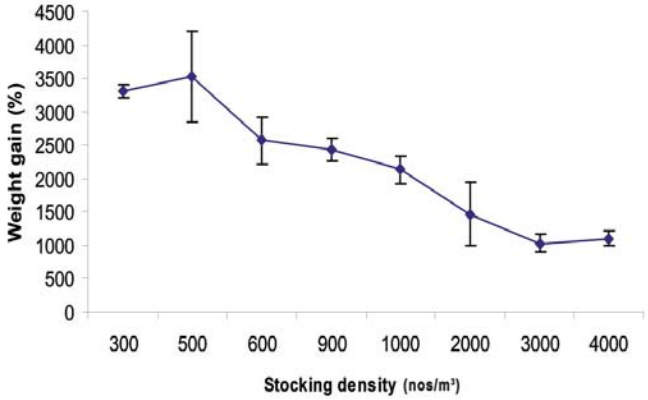


Fig. 10. Weight gain (%) of Asian seabass *L. calcarifer* reared at different stocking densities in nursery tanks

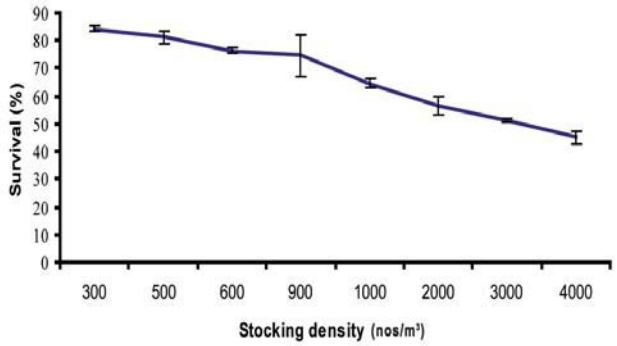


Fig. 11. Survival rate (%) of Asian seabass *L. calcarifer* fry reared at different stocking densities

The fry were fed with formulated feed @ 20% initially which was reduced gradually to 10% by the end of the experiment. Though the rearing protocols were similar, it was observed that when seabass fry were reared in tanks, the survival rate was not influenced by the density upto 900 nos / m^3. However, at higher densities, it had a significant effect on the survival. The weight gain (%) was higher in lower densities (300 to 600 nos / m^3) compared to those in higher densities. The analysis of input and realization cost indicated that for viable commercial operation of a seabass nursery, a density between 500 nos / m^3 to 900 nos / m^3 is desirable (Table 6).

Table 6. Analysis of input and realization cost with varying stocking density of seabass fry

Stocking density (nos/m^3)	Stocked (nos)	Final size (TLcm/Wt. gm)	Recovered (nos)	Total biomass (kg)	Sale price (Rs./ pc)	Realisation (Rs.)	Total expenditure (Rs.)	Gross profit (Rs.)
300	1500	4.3/2.35	1270	2.984	5.0	6350	4450	1900
500	2500	4.1/2.4	1450	3.480	5.0	7250	5250	2000
600	3000	3.70/1.70	2650	4.505	3.0	7950	6150	1800
900	4500	3.5/1.67	3250	5.428	3.0	9750	7350	2400
1000	5000	3.2/1.5	3300	4.905	3.0	9900	8250	1650
2000	10000	3.0/1.0	5950	5.950	2.0	11900	12250	-350
3000	15000	3.0/0.85	7820	6.647	2.0	15640	16750	-1110
4000	20000	2.70/0.80	9200	7.360	2.0	18400	20750	-2350

Based on the technology developed by CIBA, nursery rearing operations were carried out by a farmer in Bhimavaram in a freshwater pond. The pond was supplied with fresh water from the adjoining irrigation canal. Hatchery produced fry (1.2-1.5 cm) from CIBA were transported under oxygenated packing at a stocking density of 250 – 400 nos/l (depending upon the size of the fry). After a transportation period of 12 hrs by road, the survival rate was 94%. The fry were stocked in net cages of 2 x 1 x 1 m size initially @ 750 nos/m^3 and gradually the stocking density was reduced to 200-300 nos/ m^3. The net hapas were maintained in ponds of 0.5 ha area. Feeding was done with egg and fish meat custard given *ad libtum* twice a day. Regular grading and size grouping was done at an interval of 4 days. At the end of the 30 day rearing period, 4 size groups were obtained: (i) 2-3 cm, (ii) 4-5 cm,(iii) 6-7.5 cm and (iv) 12-13 cm. The over all survival rate was 95% (68,000 out of 71,188). The economics of producing stockable seabass seed is given in Table 7.

Table 7. The economics of producing stockable seabass seed

Parameters	Amount (Rs.)
Cost of fry (Rs. 0.8 / fry)	56,950/-
Transportation cost	10,000/-
Cost of net cage hapa	25,000/-
Labour cost	35,000/-
Feed cost	30,000/-
Miscellaneous	10,000/-
Total	1,66,950/-
Total value (Rs. 5/pc x 68,000)	3,44,000/-
Gross profit (Rs. 3,44,000 - 1,66,950)	1,73,050/-

The final harvest of 68,000 seed has been stocked in 30 acres of a farm and the culture is in progress with an expected total production of 100 tons from the seed. This case study clearly demonstrates that nursery rearing technology can be adopted by farmers as a short term culture operation to produce stockable seed for their own ponds as well as to provide an additional income by selling the extra seed to other farmers. Nursery rearing of seabass can also be taken as the only culture operation, given the demand for stockable seabass seed and due to the possibility of year round operation in both fresh and brackishwater.

Broodstock development of grey mullet

The focus of this programme was to develop a viable land based captive broodstock of grey mullet *Mugil cephalus*. During the current year a total of 180 broodstock (0.25 – 1.5 kg) were developed and maintained in the RCC tanks and ponds. The broodstock included fish collected from wild and farm reared stock. Fishes from the wild caught in the vicinity of Muttukkadu and Kovalam were procured and transported under mild sedation, in polythene bags in order to avoid fast movement and hence injury to the fishes. The wild collection was mainly during the months of November, February – March. Fishes were fed a formulated feed @ 5% of body weight twice in a day. The composition of the feed was - dried fish (*Anchoviella* sp.) (15%), soya cake (17%), ground nut cake (20%), cotton seed cake (5%), alfalfa (5%), wheat flour (15%), maida (2.5%), wheat bran (14.3%), fish oil, binder, minerals, vitamins and other additives such as yeast, lecithin and α-tocopherol. Water exchange @ 80% daily was carried out. Broodstock tanks were cleaned once in three days and water quality was regularly monitored. Captive broodstock fishes were regularly monitored for health status. As a prophylactic treatment protocol, 100 ppm formalin for one hour was given at monthly intervals which was found to be effective in controlling parasitic infestations, mainly due to *Caligus* spp.

Maturation and breeding of mullet

The maturity stages of the stock were monitored regularly. Male maturity was observed during the months of September – December. To maintain spermeation for longer duration, fishes were implanted with alpha methyl testosterone pellet intramuscularly at a dosage of 5 mg/ kg body weight. Ova diameter ranged from 230 -301 µ during September which increased to 381 – 481 µ in November and thereafter no progress was observed. Booster dose of carp pituitary extract @ 5 mg/kg body weight administered intramuscularly was also not effective in increasing the ova diameter.

Broodstock development of milkfish

The fishes reared from the year 2004 from fingerling stage were maintained as the captive broodstock for breeding trials under controlled conditions. Thirty five adult milkfish in the size range of 2.5 – 5.0 kg of 5+ years were maintained in 100 ton capacity RCC tanks. The fishes were fed daily with a formulated feed @ 2% of body weight. Water exchange was done @ 70% daily. Water quality in the broodstock holding tanks was monitored regularly. The captive stock was monitored regularly for maturity. Oozing milt was observed during April – May and October – November. Full maturity was not observed in the female fish though primary oocytes were present. In order to accelerate the maturation through manipulation of the environmental conditions, the fishes have been transferred and maintained in a recirculation system and maturity is being monitored.

Broodstock development of ornamental fishes

Continuous efforts were made to develop a broodstock of ornamental fishes and breeding trials were also conducted during the year. A total of 90 spotted scat (*Scatophagus argus*) in the size range of 65- 423 gm were maintained in two 8 ton capacity RCC tanks (20 per tank) and in an earthen pond (50 nos). The salinity was maintained at 20 to 30 ppt. During the current year, the RCC tanks were provided with re-circulated water, using sand filters and again re-circulated to the rearing tanks. The fish were fed daily with a formulated feed @ 5% body weight. Fortnightly examinations were carried out to check for parasitic infection. A fresh water bath for 3-5 minutes was found to be an effective prophylactic treatment in controlling parasites (*Caligus* spp.).

A female fish of 426g/210mm with a mean oocyte diameter of 510 µm was administered HCG @ 500 IU/ kg body weight as two split doses over two days . LHRHa hormone was injected as the resolving dose @ 35 µg/ kg body weight. Male fish (47-310g/122-198mm), in an oozing condition were kept along with the female fish in a 1:2 ratio in the spawning tank . The male fish were also administered a similar dose of LHRHa. The female fish spawned spontaneously, after 24 hours of LHRHa administration. The mean diameter of spawned eggs was 627±6µm. However the eggs were not fertilized as the males did not respond and release milt.

Spotted scat *Scatophagus argus* brood fish

Spotted scat broodstock recirculation system

Evaluation of Andaman Tilapia as a candidate species

During this period, more trials on the evaluation of Andaman Tilapia (*Oreochromis urolepis)* as a candidate species in relation to the locally available tilapia *O. mossambicus,* under normal saline conditions were conducted. The broodstock maintained in FRP tanks were found to mature and continuous breeding was observed. The fecundity varied from 500 -1000 eggs/fish. The relative growth rate of Andaman Tilapia and *O. mossambicus,* confirmed the previous year's findings that there was no significant difference in growth between the two species.

Project Title (Institute)	**Culture of commercially important brackishwater fishes**

Nursery rearing technology for grey mullet

During this period, greater emphasis was given on developing a nursery rearing technology for the grey mullet culture and for the transportation of grey mullet fry.

Nursery rearing of wild collected striped grey mullet *Mugil cepahlus* fry was conducted in 12 brackishwater tide-fed ponds (0.06 ha) to evaluate the effect of feed and fertilization systems under two stocking densities for production

of advanced fingerlings. Grey mullet fry (0.17g/ 23.77mm) were stocked in ponds with a 2 x 2 factorial design in triplicate (Table 1) and reared for 6 months. In the feeding system, low cost feed prepared from locally available ingredients was provided daily in feed trays in powder form during the initial 4 months. Feeding rate was initially 20% and gradually reduced to 5% of body weight. For the remaining two months a pellet form of the feed was used and feeding rate was gradually again reduced to 3.5% of body weight. In the fertilization system, ponds were fertilized with cattle dung, urea and single super phosphate @ 500, 30 and 30 kg/ha, respectively at fortnightly intervals. After 180 days of rearing, fishes in the fertilization system, achieved higher growth and survival compared to those in the feed system. The calculated operational cost for grey mullet seed production in feed system was Rs.0.58lakh/ha and Rs.1 lakh/ha in lower and higher density rearing, respectively, whereas, in the fertilization system, it was Rs.0.57lakh/ha and Rs.0.95 lakh/ha, respectively. This experiment indicated that grey mullet seed could be reared at higher densities in both feed and fertilization systems and provided the preliminary information of a suitable rearing method. Further work is in progress to refine the nursery rearing method by evaluating the performances of three systems, viz. feed, fertilization and combined feed and fertilization at higher densities for better economic viability.

Table 8. Size at harvest and survival of *Mugil cephalus* seed reared in feed and fertilization systems under two stocking densities

Stocking density (nos/ha)	Rearing system	Size at harvest		Total weight gain (g)	Survival (%)
		Length (mm)	Weight (g)		
7500	Feed	162.4±3.90	42.3±3.36	42.1±3.63	51.5±2.80
	Fertilization	184.2±10.02	61.6±8.07	61.4±8.07	62.5±8.88
15,000	Feed	156.9±8.56	42.2±7.02	42.0±7.02	51.0±1.62
	Fertilization	163.1±12.72	44.9±9.06	44.8±9.06	61.7±7.88

Optimum conditions for transportation of grey mullet fry

In order to evaluate the optimal requirements in terms of packing density for long distance transportation of grey mullet (*M. cephalus*) fry, an experiment was conducted. Fry of mean size (0.17 g) collected from the wild and conditioned at Kerala Agriculture University Fisheries Research Station was oxygen-packed at different densities of 80nos/l, 160nos/l, 240nos/l, 320nos/l, 400nos/l, with a biomass of 48gm, 96gm, 144gm, 182gm and 240gm respectively in each bag with four replicates. The duration of transport was about 18 hours. At the destination point, the survival and water quality parameters under different stocking densities were assessed. Initial and final values of temperature, salinity, pH, carbon dioxide, ammonia, nitrite and dissolved oxygen were estimated. Percentage survival and muscle glycogen level were also estimated, and the fish from each treatment after transportation were held in separate tanks (800l capacity) to calculate percentage survival after 96 h. The pH value and CO_2 concentration

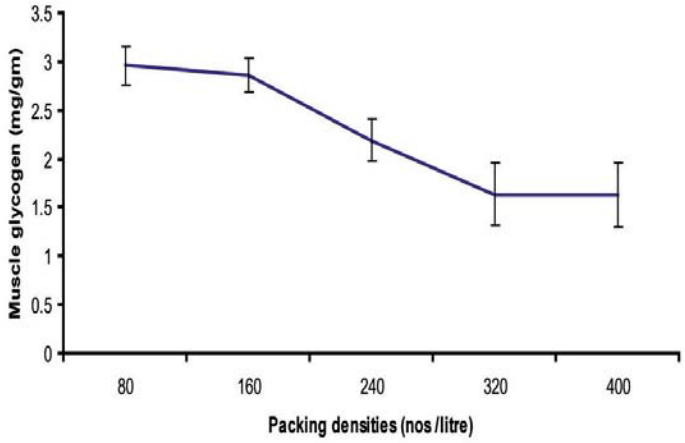


Fig.12. Effect of different packing densities (nos/litre) on muscle glycogen level in mullet fry

were found to be inversely related. The pH value increased significantly ($P<0.05$) with increase in stocking density. Carbon dioxide, ammonia and nitirite concentration increased significantly ($P<.0.05$) with increased stocking density while dissolved oxygen level decreased significantly ($P<0.05$). Muscle glycogen decreased significantly ($P<0.05$) with increasing packing densities (Fig. 12). Survival dropped from 100 to 90, 81 and 76 % at stocking densities of 240, 320 and 400/l respectively. Based on the significant build up of metabolites beyond 160 nos / l and to ensure nearly 100 % survival, stocking density up to 160/l is recommended for an 18 hours transportation time of 0.17 g size mullet seed.

Demonstration of polyfarming of Asian seabass and tilapia

To evaluate the techno-economic viability of polyfarming of Asian seabass and tilapia as forage fish, a demonstration was carried out in a farmer's pond (0.2 ha) at Madanganj, Namkhana. Tilapia broods were stocked in the well prepared brackishwater pond @1500 nos/ha for two months prior to stocking of seabass fry. The seabass fry (0.15g/ 21.5mm) were stocked @10,000 nos/ha in the pond. By the time seabass fry were stocked, there was adequate availability of tilapia spawn, fry and juveniles, which served as forage fish to seabass. Tilapia broods were fed with a mixture of rice bran and mustard oil cake (1:1) @ 2% body weight. At the end of 270 days of culture, fishes were harvested with total production of 313.5 kg (73.46% seabass and 26.54% tilapia).Seabass size at harvest ranged from 450-950g. The total productivity estimated from this trial was 1568 kg/ha and within this, the contribution of seabass was 1153 kg/ha. The fishes were sold in the local wholesale market and the farmers earned a total revenue of Rs.39,398/- (Rs.33,872/- from seabass and Rs.5526/ - from tilapia); the estimated net income being Rs.1.5 lakh/ha.

Stocking of seabass fry

This demonstration confirmed the techno-economic viability of seabass-tilapia polyfarming system and is a significant improvement from the earlier trial during 2007-08 at Akshaynagar, Kakdwip, where an estimated seabass production of 794.81 kg/ha and net income of Rs.1.18 lakh/ha were obtained.

Harvested seabass from sewage-fed freshwater pond

Demonstration of polyfarming of Asian seabass in sewage-fed pond

Seabass farming demonstration was undertaken at East Kolkata Wetland to evaluate the culture possibility and production performance in sewage-fed freshwater pond system. A pond with water area of 0.025 ha and 1 m depth was stocked with seabass fry (0.25g/ 28mm) @ 35,000 nos/ha. Initially, fishes were fed with formulated feed and trash fish. Adult tilapia were stocked @1000 nos./ha. Trash fish feeding was continued until the

availability of hatchlings/fry as a result of breeding of tilapia. After 3 months, the density of fishes was reduced and half the stock transferred to another adjacent pond of similar size. After 14 months of culture, fishes were harvested and a total production of 226.8 kg (80% seabass, 20% tilapia) was achieved amounting to an estimated productivity of 4.54 ton/ha. This demonstration indicated a good production performance and culture possibility of seabass in sewage-fed freshwater pond system.

Demonstration of milkfish monoculture in West Bengal

Low density monoculture of milkfish was demonstrated in a farmers pond at Madanganj, Namkhana to evaluate production performance in a brackishwater pond of West Bengal. Milkfish, *Chanos chanos* is not naturally available in West Bengal coast. Milkfish advanced fingerlings (29.81g) were stocked @7000 nos./ha and were fed with a mixture of rice bran and mustard oil cake (1:1) @2-3% body weight daily. After 10 months of culture, the fishes were harvested. The fishes attained a final average size of 282g and a yield of 48.50 kg was obtained with a productivity of 1620 kg/ha and 61% survival. The production was significantly higher than the high density (25,000 nos/ha) farming conducted at Bhuvan Nagar, Kakdwip during 2007-08, where productivity of 661.76 kg/ha was achieved with 42% survival. This demonstration exhibited that milkfish monoculture is an economically viable venture with a net return of Rs.0.83 lakh/ha.

Harvested milkfish from farmer's pond

Pearlspot seed as ornamental fish

The scope for producing pearlspot (*Etroplus suratensis)* seed as ornamental fish in small farmers ponds was documented. Pearlspot is not endemic to West Bengal as was evident from a study conducted at Kakdwip, Namkhana fish markets and other Sunderban areas where farmers as well as fishers were ignorant about this species. No specific culture practice exists in West Bengal for this species. Farmers supplied with seeds from KRC farm were maintaining them in polyculture mode along with other freshwater or brackishwater fishes in and around Kakdwip. Pearlspot seed was available in some of the farmer's ponds due to natural reproduction. One such case of a farmer's pond located at Kamarhat, Kakdwip is documented to show the potential for deriving additional income by selling this as an ornamental fish. In a small pond (200 m^2) with water depth of 1.2 m, the farmer maintained 80nos of brood fish of size 200-250g (sex ratio of 1:1) with supplementary feeding of 250 g /day (rice bran and mustard oil cake in the ratio3:1). The salinity was 5-10 ppt and he had carried out pond liming only during winter. The breeding period was April-August and October-November and during 2009-10 he had sold 7000 nos. (5-8 g size) pearlspot seed as ornamental fish @Rs.2-3 per piece. The farmer could realize about Rs.21,000/-, from a pond area of 200 m^2 exclusively through sale of pearlspot seed proving the viability of such practices for pearlspot seed production.

Secondary aquaculture in the Effluent Treatment Pond

An experiment was initiated in August 2009 with the objective to identify fish and shell fish species suitable for cultivation in a finfish hatchery Effluent Treatment Pond (ETP).Trials were carried out in the ETP at the Muttukadu

Experimental Station to document different environmental parameters and growth of different species . The trials covered a period of 9 months (August 2009 to April 2010). The ETP which receives the discharge water (approx 20,000 litres/day) from the fish broodstock tanks and the sea bass hatchery was divided into 3 compartments of approximately 200 sqm (E1 was the first compartment which received the inlet water, E2 the middle compartment and E3 the last compartment with the outlet). The individual compartments were stocked with milkfish (200nos / compartment, avg. stocking size 5.91g/8.66cm), mullets (150nos/compartment, avg. stocking size 0.20g/2.51cm), tiger shrimp (1000nos/compartment avg. stocking size 0.04g/1.99cm) kuruma shrimp (45nos/compartment avg. stocking size 0.80g/2.85cm) and clam (200nos/compartment). All species showed excellent growth, with milk fish showing maximum growth of 200- 250g weight increment in 3 months. Growth was greatly related to the seasonal operations of the sea bass hatchery and was observed to slow down during off season periods. The salinity during the culture period varied from 30 to 32 ppt.

Temperature, pH and salinity were recorded on a daily basis. Dissolved oxygen, alkalinity, ammonia, nitrate, nitrite and phosphate were monitored on a weekly basis. There was a marked improvement in water quality as indicated by decreasing values of ammonia N, Nitrate- N (Fig. 13) and alkalinity from the inlet point, through the three compartments to the outlet point .Compartment E3 showed a significant improvement in water quality.

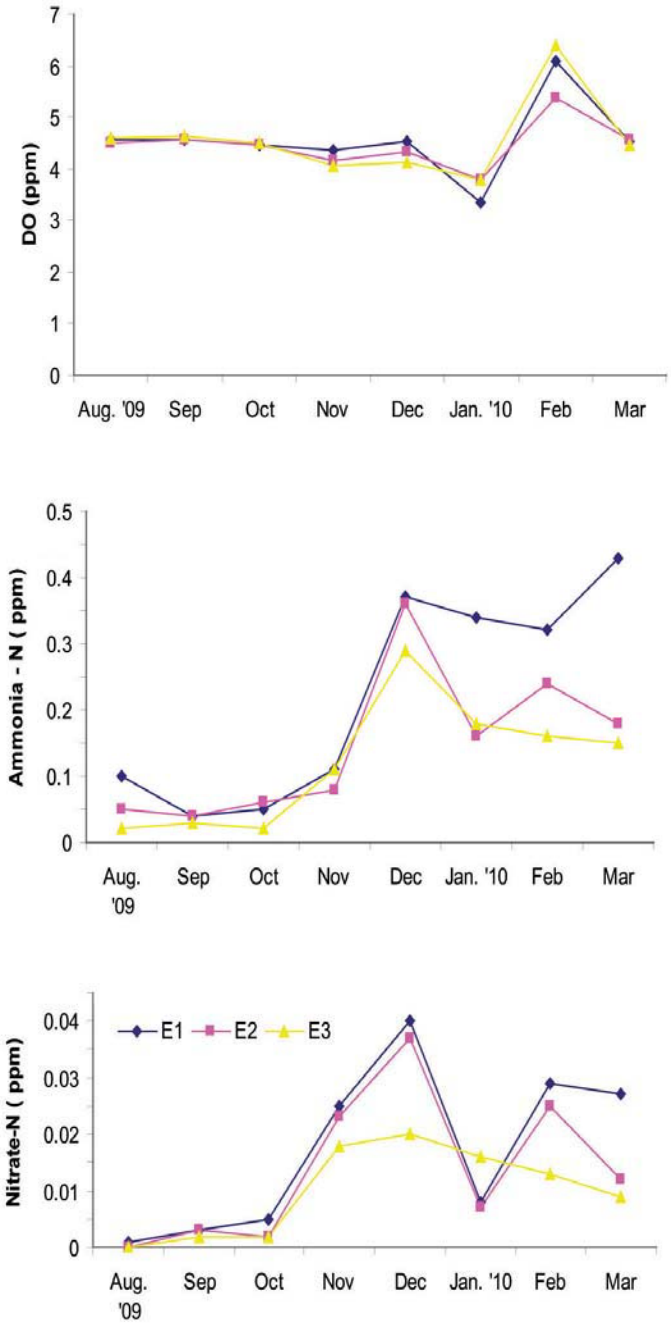


Fig. 13. Variations in dissolved oxygen DO (ppm), ammonia-N (ppm) and nitrate-N (ppm) in 3 compartments of the ETP in finfish hatchery

From this study it could be inferred that milkfish in combination with mullets and shrimp are potential candidate species for secondary aquaculture in effluent treatment ponds and they also serve to ameliorate the quality of the discharged water be it from broodstock maintenance tanks/ponds or fish hatcheries.

Project Title (NAIP Funded)	Export oriented marine value chain for farmed – seafood production using cobia, *(Rachycentron canadum)* through rural entrepreneurship

Development of cobia broodstock

Cobia broodstock fish acclimatisation

The objective of this project is to develop a land based broodstock of cobia, *Rachycentron canadum* and thereafter to develop seed production protocols from this broodstock. As a first step, in order to build a broodstock, a baseline survey was conducted on the availability of cobia in the districts of Chennai, Kancheepuram and Cuddalore. Cobia fishery was fairly good during the months of October- December 2009 at Kalpakkam, Nemmeli Kuppam, Kovalam and Kanathur Reddy Kuppam. Cobia in the size range of 0.05 to 20 kg were usually caught using hook and line, sardines, shrimps and squids being used as baits. Live cobia fish of sizes 0.05 to 10 kg were procured through active interaction with fishermen. A total of 179 fishes were procured from January 2009 to February 2010, of which 124 were transported live to Muttukadu Experimental Station. Cobia, being a very active species, requires a dissolved oxygen concentration of above 5 ppm. The wild fish were transported in an open 500 l container having oxygen-aerated sea water and a biomass of 20-100g/liter. For a short transportation period of 2 to 4 hours, there was no water exchange, but for longer durations, water was exchanged twice or thrice. The transported fishes were initially stocked in 8 ton capacity rectangular RCC tanks at a stocking rate of 1 kg biomass per ton of water. As a prophylactic measure, the fish were treated with 100 ppm formalin for 1 hr to avoid any ecto-parasite infection. Considerable mortality was observed due to fishing by hook and line, rough handling in the boat and subsequent transportation stress. After maintaining the fish for a period for 7 to 10 days, the healthy fishes were transferred to the broodstock tank (100 ton capacity RCC tank) to develop them as viable brooder fish. A polythene-lined pond having an area of 300 m^2 with a water depth of 2 metres, was used as an additional broodstock facility.

Cobia broodstock fishes in RCC Tank

A total number of 40 cobia fish in the size range of 2 to 10 kg are presently being maintained in the 100 ton RCC tank and polythene-lined pond. The fishes are being fed with forage fish such as tilapia, ray fish and squid once day @ 5% of body weight. Temperature, dissolved oxygen, pH and salinity are being monitored regularly for the two broodstock holding facilities (Table 9).

Table 9. Range of water quality parameters in cobia broodstock RCC tanks (May 2009 to March 2010) and pond (September 2009 to March 2010)

Facility	Temperature (˚C)	pH	Salinity (‰)	Dissolved Oxygen (ppm)	Alkalinity (ppm)	Ammonia (ppm)	Nitrite (ppm)
RCC tanks	29.5 - 30.4	7.5 - 8.0	25.7 - 31	4.4 - 6.7	146 - 161	0.004 - 0.305	0.0002 - 0.05
Pond	31.1 - 32.7	7.7 - 8.1	26.9 - 32.5	4.1 - 4.7	148 - 154	0.002 - 0.152	0.0002 - 0.02

Fishes were examined regularly for parasitic infections. A severe infection of *Caligus* spp., a common parasite, was observed in the months of September and October 2009. The infected fish were treated with either 100 ppm formalin or in some cases they were given a quick freshwater dip which led to the shedding of the parasite. Treatments were repeated at 15 day intervals to control parasitic infections.

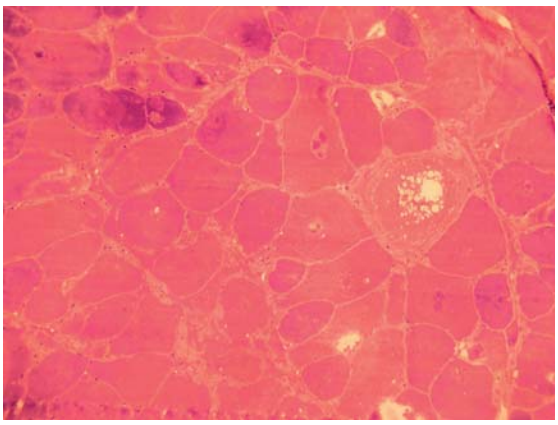
Cobia fish parasite *Caligus* sp.

Growth performance of cobia

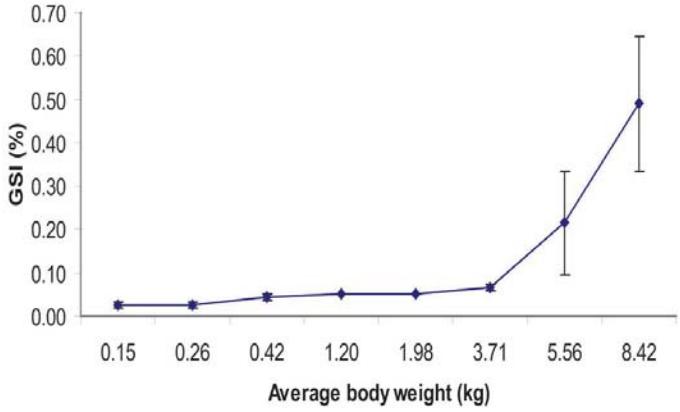
To evaluate the growth performance of cobia, juveniles were stocked in a rectangular 8 ton cement tank having running water and continuous aeration. The salinity ranged between 28 to 32 ppt and water temperature from 26 to 31° C. Fishes with an average body weight of 1.88 kg was fed with tilapia @ 10% of body weight. After 41 days of rearing, the fishes had attained an average body weight of 2.96 kg with an average daily gain of 26.34 gm indicating their enormous growth potential which is comparable to the growth rate found in other studies.

Assessment of maturity of cobia

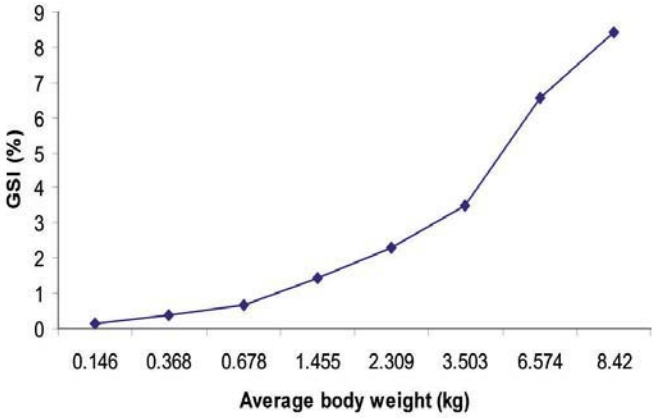
To understand the natural reproductive biology of cobia under local conditions, fish which died after transport were analyzed. The data on gonadosomatic index (GSI) of both male and female fish was collected and histological examination on gonads were made. The histological studies showed fish with previtelogenic follicles even in the size of 1.6 kg, indicating that maturation process starts even at a small size. In a female fish weighing 17 kg, the ovary weighed 370 gm with a mean oocyte diameter of 579 ±52 µm yielding a



Previtellogenic follicles of cobia

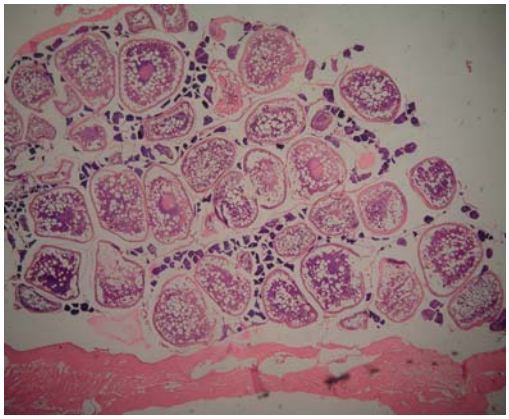


(a) Male

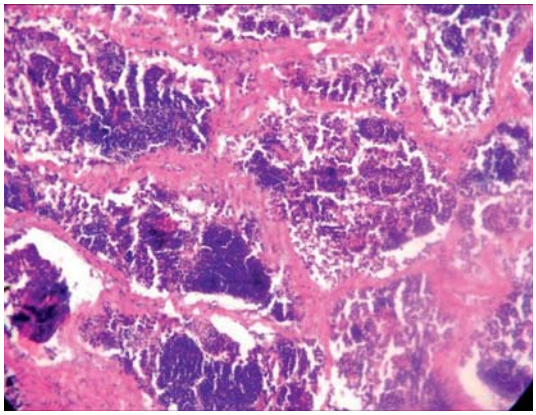


(b) Female

Fig. 14. Gonadosomatic index (GSI) of male (a) and female (b) cobia in relation to body weight



Preovulated follicle of cobia



Testis with spermatid of cobia

GSI of 1.8 which indicated maturation (Fig.14). One male fish of 7.42 kg with a testes weighing 36 g (GSI-0.49) showed spermatids (Fig. 14). Fully gravid females are reported to have an ova diameter of about 650 µm. Matured females have been reported in the size of 5 kg from Indian waters. From this observation, it could be inferred that fishes in the final stages of maturation could be obtained in the vicinity of Muttukadu, thereby enhancing the scope for induction of maturation and spawning.

Project Title (NFDB Funded)	**Demonstration of Asian seabass *Lates calcarifer* farming in pond culture systems**

The objective of the project is to upgrade and validate the technologies developed for the pond culture of Asian seabass using hatchery produced seed and formulated feed developed by the institute. A demonstration programme in the farmers' ponds at Andhra Pradesh (Ramudupalem, Gangapatnam, Nellore District), at Tamil Nadu (Mahendrapalli, Sirkazhi Taluk, Nagapattinam District) and at Maharashtra (Pancham Aquafarm, Saphale) was taken up with funding from National Fisheries Development Board, Hyderabad.

The major accomplishment was the harvest of uniform sized fish which were cultured with a formulated sinking pellet feed in pond culture systems. This was hitherto considered as a bottleneck in the pond culture of this species. The viability of rearing sea bass fry in the nursery, juveniles in the pre-grow out and marketable sized fish in the growout phase was demonstrated and with the incorporation of innovative approaches, uniformed sized fish were produced.

Demonstration at Nellore

A 2.5 ha of water spread area at Ramudupalem Village, 35 km from Nellore was selected and all the components of the technology package like nursery rearing, pre grow-out and grow-out were demonstrated (Table 10).

Table 10. Details of seabass demonstration at Nellore

Particulars	Nursery rearing		Pre-growout		Grow out
	I batch	II batch	I batch	II batch	I batch
DOC (days)	65	60	60	140	258
Pond area (ha)	-	-	0.9	0.9	1
Water depth (m)	-	-	1.5	1.5	1.5
Numbers stocked	25,000	25,850	11,500	13,000	5800
Stocking size (cm/g)	0.02	0.032	5.2/3.2	8.01/4.8	21/81
No. of grading	14	7	-	-	-
Grading interval (days)	4	7	-	-	-
Average harvest size (cm/g)	5.2/3.2	8.01/4.8	21/81	21.6/161.3	35 /733
Biomass harvested (kg)	36.8	62.4	469.8	1722.6	3660
Feed supplied (kg)	47	97.50	543kg	2471kg	6065
FCR	1.28	1.56	1.254	1.43	1.9
Survival (%)	46	50.29	66.7	82.31	86.09
Temperature (°C)	28-31	28-30	28-35	24-30	24-32
Salinity (ppt)	25-32	10-25	25-32	13-30	10-32

Nursery rearing of seabass fry was done in hapa net cages of 2 x 1 x 1m in ponds. The first nursery rearing was initiated on 27.2.2009. A total of 25,000 nos of hatchery produced seabass fry were oxygen-packed and transported from the Muttukadu Experimental Station by road to Ramudupalem. The duration of transport was 8 hrs and no mortality was observed. Fry were stocked @ 250-300 nos/m^2 in hapas and installed in a 1.0 ha pond. Grading was done every 4 days. The fry were fed with a formulated diet initially @ 20% of body weight for a period of one week and gradually reduced to 10% of body weight. Hapas were cleaned and re-fixed at the time of grading. The second batch of nursery rearing was started on 18.8.2009 and was continued for 65 days following the same protocol.

Nursery rearing

Fingerlings obtained from the nursery rearing were shifted to the pre-grow out pond at a stocking density of 11,500 in the first trial and 13,000 in the second trial in a 0.9 ha pond, in order to produce juveniles which can be stocked in the growout system and to be harvested at the shorter duration. From the experience gained in the first trial, the pre-grow out pond was divided into three compartments, enabling the stocking of varying sizes of fingerlings in each compartment. With proper management strategies like adjustment of feed and density, uniform sized juveniles could be obtained.

Juveniles reared in the pre-grow out pond were shifted to the grow-out pond of area 1.0 ha and reared for a period of 258 days. Average size at the time of harvest was 35cm/733g. The total production was 3.66 tons. The feed supplied was 6.065 tons and FCR worked out to be 1.9.

Demonstration at Pancham Aqua Farm, Saphale

Demonstration was carried out Pancham Aquafarm, Saphale on all the three phases of culture viz. nursery, pre-grow out and grow out culture (Table 11). Hatchery produced sea bass fry were oxygen-packed and transported by road from Muttukadu experimental station to Chennai airport and thereafter airlifted to Mumbai airport from where the consignment was transported to the farm site by road. Fry were stocked in 20 hapas @ 625 nos/m^2 for 45 days.

The fingerlings reared in the hapa were transferred to the pre-grow pond of 1.3 ha. Though survival rate was found to be satisfactory during grading, due to damages in the hapas, a considerable number of fry were lost and hence the survival rate was poor. In the first pre-grow out trials, fingerlings were transferred to the pond; however at the time of harvest it was observed that juveniles showed a wide range in size. Hence the pre-grow out pond was partitioned into compartments and different size groups were stocked separately, which enabled reduction of size differences in pre-grow out phase.

The juveniles obtained in the first and second pre-grow out trials were stocked in the growout ponds of 1.1 ha each and monitored for growth and production potential. In the first crop, the fish attained an average size of 750 g over a period of 7 months and in the second crop, the fish attained an average size of 300 g over a period of 4 months.

Table 11. Details of seabass demonstration at Anam Farm, Cuddalore

Particulars	Nursery rearing		Pre-growout	
	I batch	II batch	I batch	II batch
DOC (days)	49	46	61	109
Pond area (ha)	-	-	1.3	1.3
Water depth (m)	-	-	1-1.5	1-1
Numbers stocked	25,000	26,500	6,835	7,000
Stocking size (cm/g)	1.2/0.02	1.3/0.03	6/2.5	3.5/2.0
No of grading	16	15	-	-
Grading interval (days)	3	3	-	-
Harvest size (cm/g)	6/2.5	3.5/2.0	16.5/52.5	20.2/ 80.5
Biomass harvested (kg)	17.09	14	220.50	362.25
Feed supplied (kg)	30	20	410	891
FCR	1.76	1.43	1.86	2.46
Survival (%)	27.34	26.42	61.45	60.0
Temperature (°C)	30-35	20-34	28-35	24-30
Salinity (ppt)	24-37	2-15	25-43	05-30
pH	8.2-9.5	8.2-8.8	8.4-8.9	8.2-8.7

Demonstration at Sirkazhi

The demonstration site at Sirkazhi was initiated in BISMI farm, Perunthottam, Sirkazhi. Nursery rearing trials were carried out in hapas in the reservoir ponds. Grow out trials was carried out in a 0.5 ha pond (Table 12). However during the course of the experiment, the farmer expressed his inability to spare the ponds, consequent to which, the fish were shifted to a nearby farm at Mahendrapalli.

The seed were transported from the Muttukadu Experimental Station to Sirkazhi (Perunthottam) by road. The transportation time was 9 hrs and no mortality was observed. The nursery rearing was done in hapa net cages following the routine protocols. The growout culture was monitored to asses the growth potential at the newly stocked site from the month of October. The stocking density of the fish was low (1200/ha) and the fish grew to an average size of 800g over a culture period of 5 months from the initial size of 450g. In the second growout culture, the average size of the fish was 600g for the culture period of 2 months from an initial size of 245g. The higher growth rate could be attributed to the low stocking density (1500/ha).

Table 12. Details of seabass demonstration in Tamil Nadu_

Particulars	Nursery rearing		Pre-growout	
	I batch	II batch	I batch (BISMI)	II batch (Mahendrapalli)
DOC (days)	65	40	78	114
Pond area (ha)	-	-	0.5	0.7
Water depth (m)	-	-	1-1.2	1-1.2
Numbers stocked	25,000	25,000	16,000	10,900
Stocking size (cm/g)	0.2	0.3	6/3.2	6.3/2.7
No of gradings	13	8	-	-
Grading interval (days)	5	5	-	-
Harvest size (cm/gm)	6/3.2	6.3/2.7	29/450	26/245
Biomass harvested (kg)	56	20.7	382.5	312.8
Feed supplied (kg)	60	45	677	763
FCR	1.07	2.1	1.76	2.43
Survival (%)	64	43.9	5.3	21.68
Temperature (°C)	29-33	25-33	30-32	27-30
Salinity (ppt)	30-38	29-31	40-43	15-20
pH	8-8.5	7.8-8.3	8.4-8.7	7.8-8.2
DO (ppm)	4-5	3.8-4.3	4-5	5-7

Interaction meeting and awareness program

As a part of this project, in order to motivate the farmers to take up farming of seabass based on the technology developed by the institute, an interaction meet and awareness programme was conducted at Nellore on 19.02.2010 where the participants witnessed the demonstration of the farming practices of seabass. This success in seabass farming was a publicity campaign in itself and the meeting was attended by more than 175 farmers, academicians, entrepreneurs and officials of the Fisheries Departments.

AQUATIC HEALTH AND ENVIRONMENT DIVISION

Project Title (Institute)	Investigations on epidemiology of infectious diseases of fish and shellfish and development of diagnostics and prophylactics

Genotyping of WSSV

As data available on the WSSV genotypes prevalent in India is scanty, this study was undertaken to know the WSSV genotypes in India as part of a larger objective of using the variable number tandem repeats (VNTRs) of WSSV as markers for identification of virulence factors. The work was initiated during the previous year with genotyping of WSSV based on ORF 94. In the current year, in order to know further VNTR diversity, the study was extended to ORF 125 and 75 regions of the WSSV genome. The PCR protocols were optimized with different published primers for these regions and it yielded different PCR amplicons of variable number tandem repeats (Fig.15). These results indicate prevalence of variant WSSV strains in different hosts and different viral strains in each location. The PCR products were purified for sequencing the respective VNTR regions and analysis of this would indicate if there is a distinct geographical distribution of WSSV isolates.

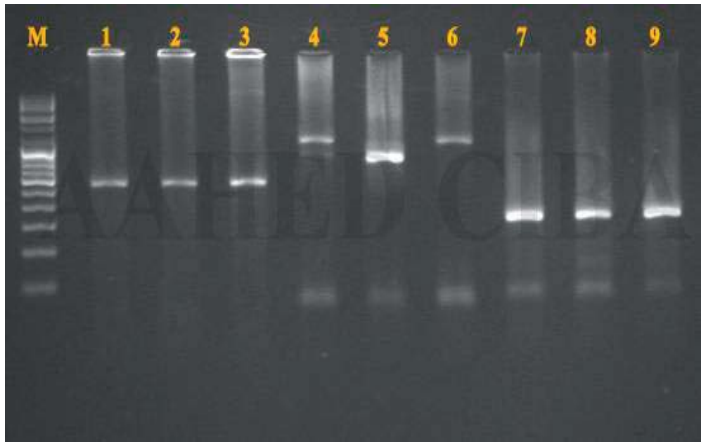


Fig. 15. PCR amplicons of different tandem repeats of variable regions of WSSV positive samples (M: 100 bp DNA ladder; Lane 1-3: VNTRs of ORF 75 specific PCR amplicons of WSSV; Lane 4-6: VNTRs of ORF 94 specific PCR amplicons of WSSV; Lane 7-9: VNTRs of ORF 125 specific PCR amplicons of WSSV)

Monodon Slow Growth Syndrome of Black Tiger Shrimp

A survey conducted by this Institute revealed that the economic loss due to shrimp diseases was estimated to be Rs.1022 crores and that due to slow growth syndrome and white gut disease was Rs. 120 crores annually. One of the emerging diseases is the abnormal slow growth syndrome which exhibits marked size-differences among individuals with obscure etiology. This is an emerging disease in farmed black tiger shrimp in India. Further investigations carried out during last year with 110 samples indicated that the symptoms of the affected shrimp fitted to the case definition of Monodon Slow Growth Syndrome (MSGS) as given by Thai research workers. The Laem-Singh Virus (LSNV) was also detected in 75.5 % of the samples analyzed. During the current year, 85 samples were collected from Andhra Pradesh and Tamil Nadu and a detailed investigation was carried out using histopathology, electron microscopy and molecular diagnostic methods. Histopathological examination indicated characterstic lesions such as haemocytic infiltration and enlargement of vessels in the eye-stalk, collectively termed as retinopathy in the MSGS affected shrimp. Electron microscopy of tissues of selected suspected samples showed numerous naked virus-like particles (20 nm).

In the past year, only a RT-PCR assay based on 200 bp was developed. This year, a nested RT-PCR assay for the detection of LSNV the suspected causative agent of MSGS, was developed using published primers. The assay produced amplicons of 200 bp and 140 bp size respectively (Fig.16). An improved diagnostic nested RT- PCR with custom designed primers targeting the full RdRp gene of LSNV was developed using sequence data available at NCBI (Accession No: DQ127905). The optimized RT - PCR protocol produced 597 bp and 340 bp amplicons (Fig 17). Screening of 10 farmed samples from 10 locations in Andhra Pradesh and wild broodstock showed prevalence of LSNV (65% and 54% respectively) by improved nested PCR (Table 13). Brood stock with sub clinical infections might be responsible for spread of disease by vertical transmission. Future research aims are to confirm the transmission of this virus so as to formulate suitable control strategies.

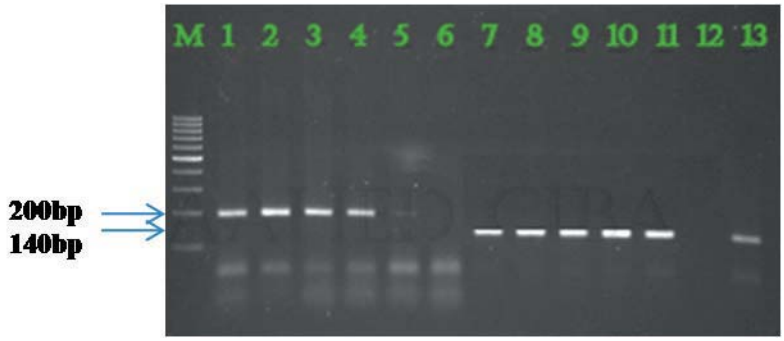


Fig. 16. RT-PCR for detection of LSNV with published primers (M: 100 bp DNA ladder, Lane 1-4: shrimp samples positive for LSNV (first step), Lanes 3 – 5: shrimp samples negative for LSNV in (first step), Lane 7 – 11 &13: shrimp samples positive for LSNV in nested PCR, Lane 12: shrimp samples negative for LSNV in nested PCR)

Table 13. Detection of Laem - Singh virus in farmed and wild tiger shrimp during the year 2008-09 and 2009-10

Location	No. of samples	Positive no.	
		First step	Nested
Uppaluru	10	2	4
Royakuduru	10	2	5
Bhuvanapalli	10	3	6
Pennada	5	1	3
Yandagandi	5	0	2
Ganapavaram	10	3	4
Undi	5	0	3
Komaragiri	10	4	3
T.Kothapalli	10	2	4
Katturu	10	2	3
Farmed total	**85**	**19**	**37**
Wild Total	**120**	**8**	**57**

Multiple viral infections in tiger shrimp

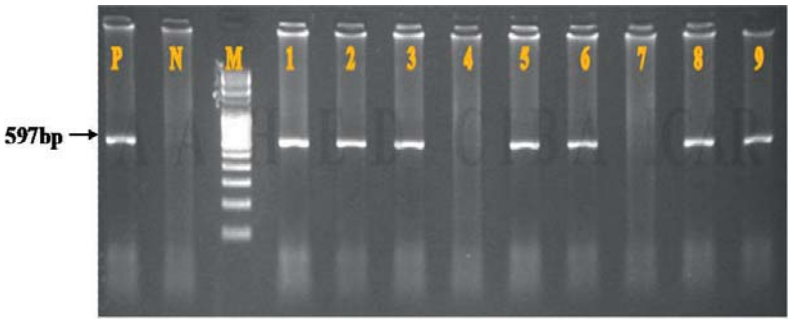


Fig. 17. Improved diagnostic RT-PCR for detection of LSNV (P : Positive control , N : Negative control , M: 100 bp DNA ladder, Lane1-3, 5-6 & 8-9: Shrimp samples positive for LSNV in first step RT- PCR, Lanes 4&7: Shrimp samples negative for LSNV in first step RT- PCR)

Shrimp samples affected by Loose Shell Syndrome (LSS) were processed by conventional polymerase chain reaction (PCR) to understand co-infection with other known shrimp viruses. Seventy LSS affected shrimp samples were screened for viruses such as white spot syndrome virus (WSSV), infectious hypodermal and hematopoietic necrosis virus (IHHNV), *Penaeus vannamei* nodavirus (PvNV) and infectious myonecrosis virus (IMNV). Out of the 70 LSS affected tiger shrimp samples screened for these viruses, 4.2%, 5.7%, 4.2% and none were also found to be infected with WSSV, IHHNV, PvNV and IMNV respectively. The results clearly indicated that these viruses are not implicated in LSS.

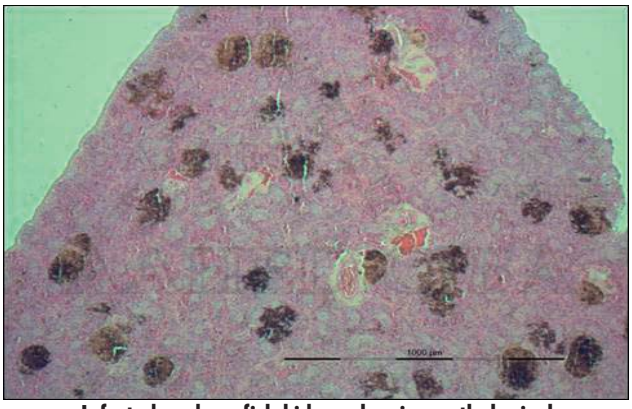
Disease prevalence among the different types of culture systems in West Bengal was observed in the surveillance during 2006-09 (Table 14). The prevalence of white spot disease (WSD), shell associated problems and gill associated problems were found to be statistically significant among different types of culture systems. Newly emerging diseases such as stunted and uneven growth was observed among all types of culture system whereas white faecal disease were observed among shrimp monoculture system. This is the first survey of shrimp diseases from different culture systems of West Bengal.

Table 14. Prevalence of shrimp disease (%) in farming systems of West Bengal during 2006-09

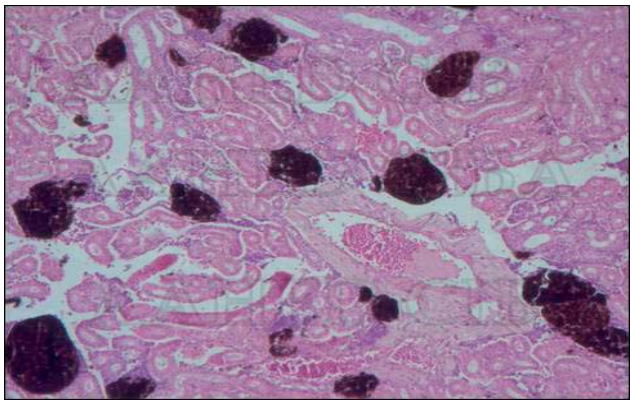
Diseases	Shrimp monoculture	Traditional culture	Paddy-cum-fish culture
No disease*	66.88 ^{b} ±7.64	37.73 ^{a} ± 8.15	25.0 ^{a} ±9.64
White spot disease**	9.2^{a} ±1.56	55.9 ^{b} ± 4.48	12.5 ^{a} ± 7.22
Vibriosis	5.33 ±1.75	0.5 ±0.5	22.37 ±12.41
Shell associated problems**	7.05 ^{a} ±3.13	2.0 ^{a} ±1.0	20.87 ^{b}±0.03
Gill associated problems*	4.65^{b} ±1.49	1.47 ^{a} ±1.47	8.37 ^{b}±2.4
Stunted & Uneven Growth	3.95 ±1.77	1.0±1.0	4.17 ±4.17
White Faecal Disease	2.1±1.34	0	0
Gas bubble disease	0	0	1.4±1.4
Yellow discoloration	0.7±0.7	0	1.4±1.4
Diseases in finfishes	0	1.5±1.5	4.2±2.42

Values followed by different superscripts differ significantly from each other *P<0.05; **P<0.01

Disease of seabass brooders



Infected seabass fish kidney showing pathological lesions (H&E, 40x)



Infected seabass fish spleen showing pathological lesions (H&E, 40x)

Progressive mortality of seabass L. *calcarifer* brooders held in the Muttukadu experimental station of CIBA was investigated to understand the cause of the disease and mortality. Moribund fish of 4.1 kg, and 5.8 kg (>3years old) showing signs of external haemorrhages and those floating upside down were examined and samples for bacteriology, histopathology molecular diagnostics and electron microscopy were collected. The histopathological examination indicated marked pathological symptoms in kidney and spleen tissues Transmission electron microscopic examination indicated presence of viral-like particles in kidney and spleen. The investigation has revealed that the disease of *L. calcarifer* brooders was of unknown viral aetiology and required further detailed study.

Epidemiology of Iridovirus in fish

Table 15. Detection of iridovirus infection in brackishwater and marine fishes by first step and nested PCR assay during the years 2008-09 and 2009-2010

Species	Location	n	Positive no. (%)	
			1st step PCR	2nd step PCR
Lates calcarifer	Andhra Pradesh	30	22(73)**	24(80)
	Puducherry (UT)	15	6(40)**	12(80)
	West Bengal	23	0	7 (30)
	Kerala	16	0	0
Mugil cephalus	Kerala	10	0	0
	West Bengal	4	0	1(25)
Chanos chanos	Tamil Nadu	2	0	0
	West Bengal	6	1(17)	ND
Liza parsia	West Bengal	8	1(13)	ND
Liza tade	West Bengal	3	1(33)	ND
Other fishes*	Tamil Nadu	23	0	5 (22)
Total		**140**	**31(22)**	**49(35)**

* Low value fish: being used as trash fish as feed in hatchery/farm - *Thrissocles dussumieri***(1),** *Therapon jarbua***(4),** *Synodus indicus***(8),** *Leiognathus*

splendens(1), *Amblygaster clupeoides*(3), *Nemipterus sp.*(6); ** Clinical outbreak of the disease ; ND- Not done;n-no of sample

Moribund and healthy fishes were collected during 2009 -10, from the wild and farms in Kerala, Tamil Nadu, Andhra Pradesh, West Bengal and the Union Territory of Puducherry (n=55). The samples were analyzed for iridovirus by molecular diagnosis (PCR), histopathology and electron microscopy. In the previous year, positive samples were based on published primers and were only single step. This year, an improved nested PCR was developed and while most of the samples tested for iridovirus were negative by 1st step PCR, nested reaction using known primer showed the presence of low viral load (Table 15). Positive samples were processed for electron microscopy and this confirmed the observations made last year. Since trash fish which are used to feed fish brood stock have iridovirus, the possibility of virus transmission through this route needs to be checked.

Tracing antimicrobials in shrimp aquaculture

With the objective to trace the suspected source of antibiotic residues in farmed shrimp, 17 shrimp samples and inputs used in the hatchery, 5 feed samples, 1 sample of Artemia cysts, 4 water samples and 3 samples of probiotics and other mixes, were collected from a shrimp hatchery as well as shrimp farms located in Tamil Nadu and Andhra Pradesh and screened for the residues of chloramphenicol and nitrofuran derivatives. No detectable levels of residues of these two antibiotics could be found in these samples.

The draft HACCP manual for shrimp hatcheries has been discussed in the HACCP training programme and circulated among the participants and stakeholders for giving their suggestions. After ascertaining the views and suggestions of the stake holders, it would be finalized in the proposed HACCP workshop and published as a special publication of the insititute.

Molecular cloning expression of seabass CuZnSOD

Superoxide dismutase (SOD) gene has been cloned and expressed in *E.coli*. Full-length CuZnSOD gene of *Lates calcarifer* was obtained by the procedure of reverse transcription polymerase chain reaction (RT-PCR) and rapid amplification of cDNA ends (RACE) method. The ORF region was amplified and cloned into the expression vector. The expressed CuZnSOD were purified using His-Link purification system (Fig.18). The purified CuZnSOD is being tested as a therapeutic agent against microbial infection.

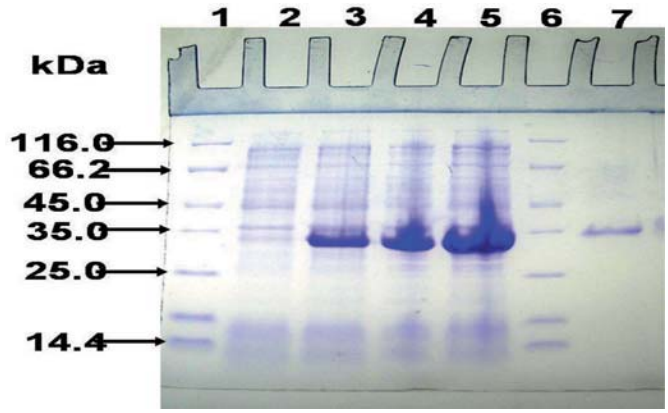


Fig. 18. Molecular cloning, expression of *Lates calcarifer* CuZnSOD (Lanes 1 - marker; 2 - un Induced; 3 - induced (1 Hour); 4 - induced (2 Hours); 5 - induced (3 Hours); 6 - marker; 7 - purified CuZnSOD)

Development of immunodiagnostic test for detection of WSSV

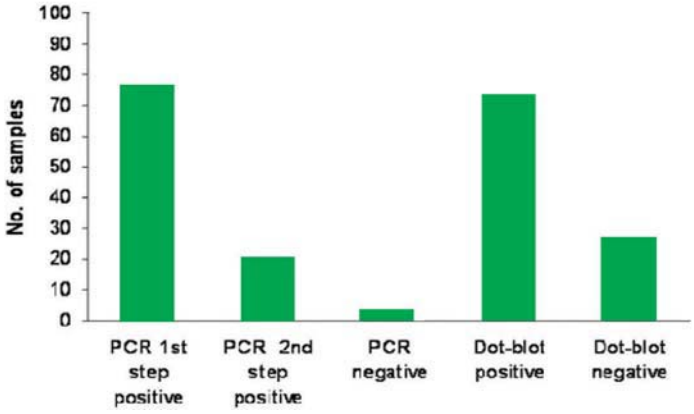


Fig.19. Comparative analysis of PCR and immunodot blot

The purified recombinant protein (39.9 kDa) of White Spot Syndrome virus VP 28 gene was used for polyclonal antibody production. The specificity of this polyclonal anti rVP28 antiserum to detect presence of virus in WSSV infected *Penaeus monodon* was verified by immunodot blot assay. Highest signal intensities of the immunodots were observed in infected shrimp pleopod extracts and haemolymph. On comparison with PCR, immunodot blot could detect 76% of PCR positive WSSV infected shrimp samples. Immunodot blot was found equivalent to first step PCR sensitivity to detect WSSV particles estimated to contain 1.0 x 10^5 viral DNA copies (Fig.19). This technique called as 'CIBA IMMUNODOT' has been developed as a diagnostic kit for early detection of WSSV in shrimps for field level application.

Development of inhibitors against luminescence causing *V. harveyi*

Marine bacteria such as *Tetragenococcus halophilus*, *Arthrobacter protomniae* are known to reduce the production of luminescence process in *V. harveyi*. Garlic extract reduced the virulence production as measured by the exopolysaccaharide and protease produced by *V. harveyi.* Garlic extract was observed to inhibit the growth of *V. harveyi* for 4 days in LB broth as evident from the OD of the sample which reduced from 0.24 to 0.02 whereas in control the OD increased from 0.24 to 2.0.

Project Title (DBT Funded)	**Functional genomics of Penaeus monodon and Fenneropenaeus indicus in relation to microbial infection and environmental stress**

EST database for penaeid shrimps

The main objective of the project is building up a EST database and characterizing important genes for the penaeid shrimps *P. monodon* and *F. indicus* in relation to microbial infection and environmental stress. A total of 1500 EST sequences were sequenced and deposited in dbEST in NCBI (Table 16). The EST sequences that have been reported for the first time are presented in Table 17.

Table 16. EST sequences deposited in NCBI

Library name	Accession numbers	No of clones
WSSV infected EST library from Indian tiger shrimp *Penaeus monodon*	FG342006- FG342067	61
EST library from normal Indian tiger shrimp *Penaeus monodon*	FK826755- FK826811	56
RACE PCR Amplified *Penaeus monodon* cDNA Library	GR588506- GR588779	273
	GR891136-GR891976	840
	GR884731-GR885001	270
Total		**1500**

Table 17. EST sequences that have been reported for the first time in *Penaeus monodon*

Gene sequence	Accession number
Histone H3	GR884948
Trypsin-like serine proteinase	GR884950
α- actin	GR884954
Chitin binding 4 super families	GR884979
Abhydro_lipase	GR884981
Ribosomal protein	GR588655
NADB Rossmann Super Family	GR884994
Rhodopsin	GR885001
ATP synthase	GR588657
NADH dehydrogenase subunit	GR588661
40S ribosomal subunit	GR588662
Cytochrome b (cyt.b) gene	GR588663
ESSS subunit of NADH:ubiquinone oxidoreductase	GR588509
Opsinin	GR885007

Characterization of allergenic immune related shrimp genes

Crustaceans are widely consumed as delicious food throughout the world. However, they are simultaneously recognized as one of the common causes of immunoglobulin E (IgE)-mediated food allergy. Although shrimp contains a wide variety of proteins, only few of them cause an allergic reaction. Tropomyosin was considered the major allergen in shrimp because more than 80% of shrimp-allergic patients have been found to have specific IgE to this protein and many of the IgE-binding epitopes on this allergen are present in various shrimp species. Arginine kinase (MW 40 kDa) has also been found to be another allergen, playing an important role in sea food allergy. Earlier we had identified tropomyosin and this year, four more allergic genes viz. arginine kinase, sarcoplasmic calcium binding protein (SCP), myosin light chain (MLC) and troponin C (Fig. 20 a & b) were identified.

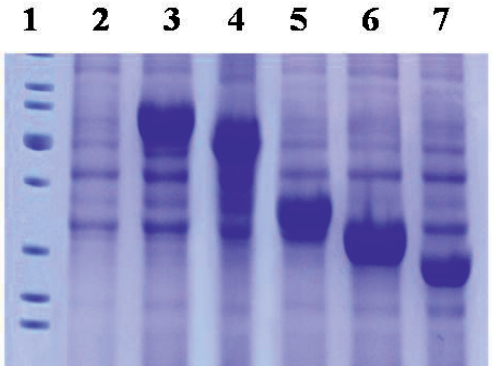


Fig. 20a. Recombinant allergenic protein (Lanes 1 - Protein marker; 2- uninduced BL21DE3; 3 - arginine kinase (40kDa); 4 - tropomyosin (34kDa); 5 - sarcoplasmic Ca+ binding protein (22kDa); 6 - myosin light chain (19.2kDa); 7 - troponin C (16.8kDa))

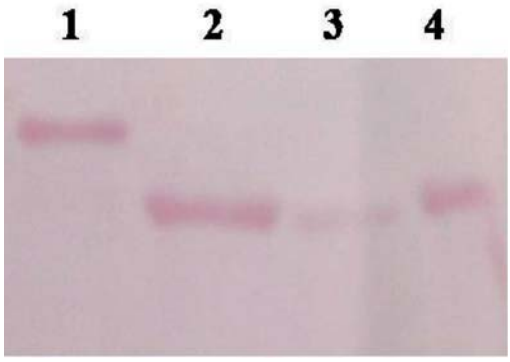


Fig. 20b. Allergenic protein confirmation (WB) (Lanes 1- tropomyosin 34kDa; 2 - MLC 19.2kDa; 3 - troponin C 16.8kDa; 4 - SCP 22kDa)

In order to identify immune-related genes responsible for the virus resistance in WSSV infected shrimp, a suppression subtractive hybridization library was created. From this library more than 20 genes were identified, which were suspected to be immune related. Of these, toll like receptors were charcterised last year and this year, three more important genes of *Penaeus monodon* - crustin (antimicrobial peptide), caspase 3 and *Penaeus monodon* antiviral gene (PmAV) were cloned and expressed (Fig. 21 a,b & c).

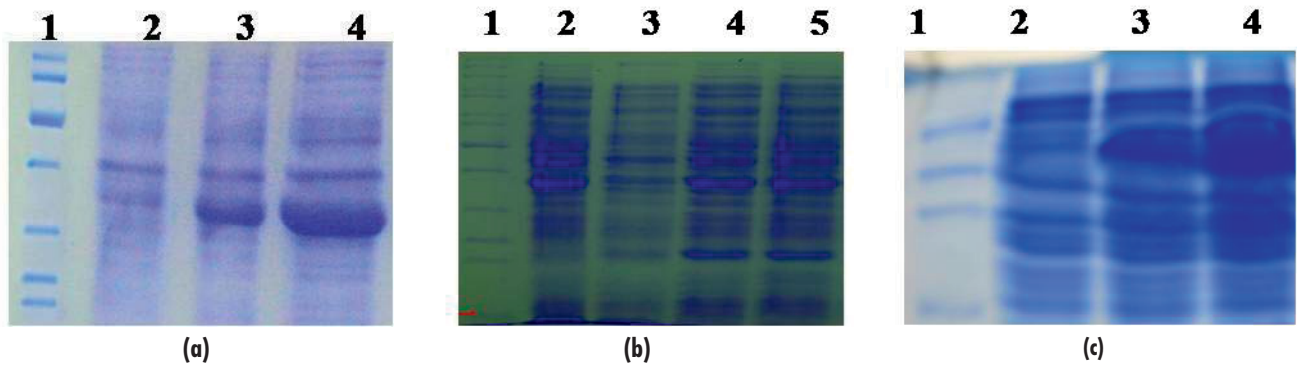


Fig.21. (a) Cloning and expression of crustin (Lanes 1- protein marker; 2 - un induced; 3 - 1 hr after induced; 4 - 3 hr after induced)
(b) Cloning and expression of Caspase 3 (Lanes 1 - protein marker; 2 - un induced; 3 - 0 hr after induced; 4 - 3 hr after induced
(c) Cloning and expression of PmAV gene (Lanes 1- protein marker; 2 – uninduced; 3 - 1 hr after induced; 4 -1 hr after induced *(P. monodon)*; 5 -1 hr after induced *(F. indicus)*

cDNA libraries from LSS and WSSV affected tiger shrimp

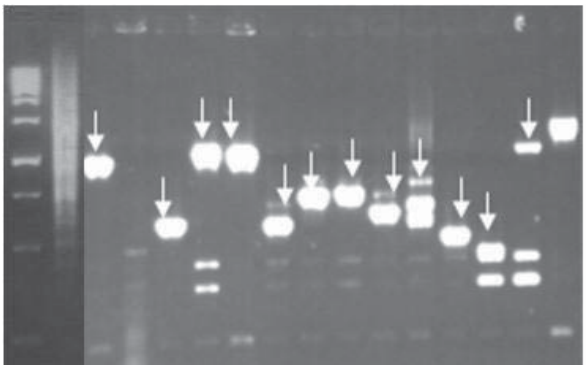


Fig. 22. Amplification and Screening of cDNA clones by RACE (PCRM – Marker (1Kb); 1 – cDNA amplification using RACE PCR; arrow indicates the amplified product)

RNA Ligase-Mediated (RLM) and oligo-capping Rapid Amplification of cDNA Ends (RACE) methods were used to construct full length cDNA library (clones) from Loose Shell Syndrome (LSS) affected *P.monodon*. The RACE PCR products were purified using the PCR product purification kit from RBC. Full length PCR product was cloned into TA cloning vector (Fig. 22).

With a view to understand the genes expressed during WSSV infection, subtractive cDNA library from WSSV infected shrimp *P. monodon* was constructed using commercial PCR-Select cDNA subtraction kit as per manufacturer's specifications. The products of the PCR thus obtained were cloned in the pGEM T vector and transformed into *XL1 BLUE* competent cells (Fig. 23). The genes identified were: PmAV, DD9 chitin gene, NADH complex 1 protein,16S

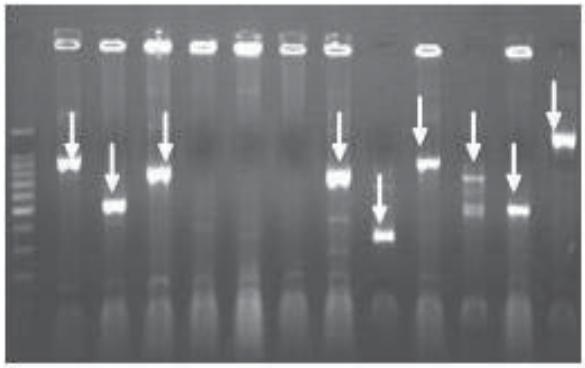


Fig. 23. PCR-Select cDNA subtractive hybridisation cloning (Image shows the presence of amplification of clones using T7 promoter primer. Arrow indicates the amplified product)

ribosomal RNA Periplasmic Binding Protein Type 1, C-type lectin 2, phosphoenolpyruvate carboxykinase (pepck gene) plectin and cytochrome oxidase subunit III. The identification of genes expressed during infection may be useful for developing therapeutic strategies.

Antiviral therapy using double stranded RNA

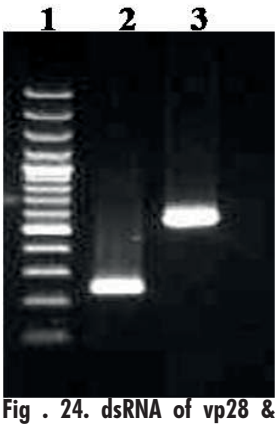


Fig . 24. dsRNA of vp28 & rr1 genes synthesized in the bacterial strain HT115 (DE3) DNAase and RNAase treated dsRNA. (Lanes 1- 100bp marker; 2 - vp28 (250bp); 3 - rr1 (600bp))

Partial sequences of WSSV genes viz., *vp28* and *rr1*were amplified and cloned in pLitmus 28i vector. Corresponding dsRNAs were synthesized by *in vitro* transcription (Fig. 24). Large scale bio-synthesis of dsRNA in bacteria has been standardized which is required for experimental studies. These dsRNAs were injected into adult *P.monodon,* experimentally infected with WSSV and the efficacy of dsRNA as antiviral therapeutic against WSSV was evaluated. For each RNA, the experiment was carried out in triplicate with 10 animals each.

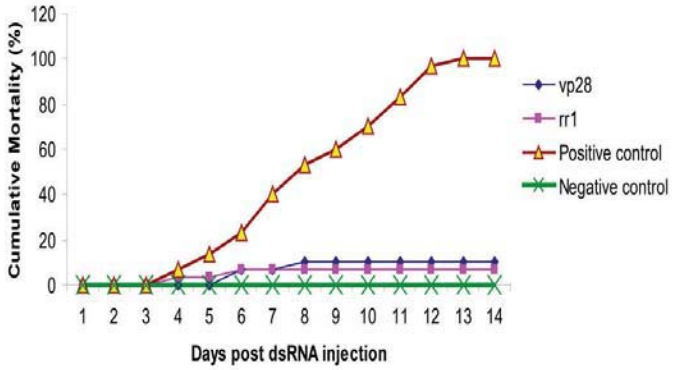


Fig. 25. Cumulative mortality (%) in *P. monodon* infected with WSSV and injected with dsRNA corresponding to WSSV structural genes vp28 and rr1

To test the efficacy of dsRNAs of the two genes, bacteria synthesized dsRNA (vp28 and rr1) were administered @ 6µg/g bodyweight in WSSV infected animals of 30-35 g . Both the dsRNA were effective in giving protection; rr1 was slightly better than vp28. This was found to be better than genes studied earlier namely W474 and W230 which only delayed the mortality. The results are shown in Fig. 25. Results of IQ 2000 analysis revealed the viral clearance from the experimentally infected animals with WSSV and are depicted in Fig. 26.

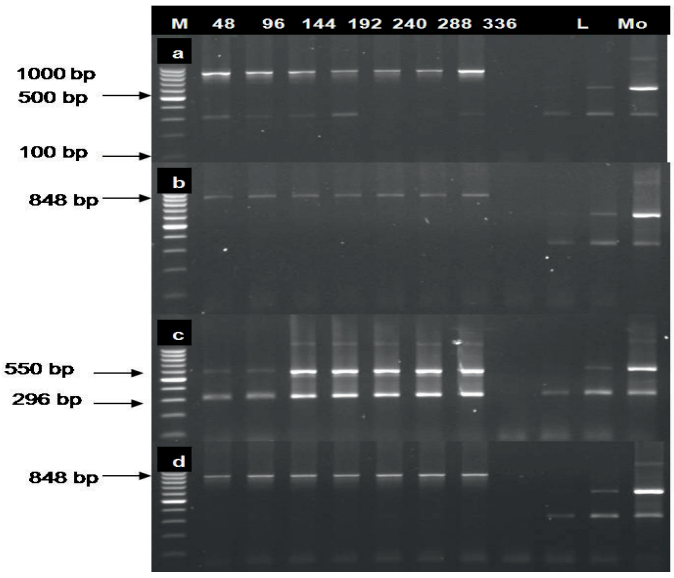


Fig. 26. Determination of level of WSSV infection by IQ 2000 kit in all groups at various time points from 48 h to 336 h post dsRNA treatment

(The presence of a band only at 848 bp indicates negative result; at 848 bp and 296 bp indicates very light infection; at 550 bp and 296 bp indicates moderate infection; at 550 bp, 296 and 1200 bp indicates severe infection; Lanes M: 100 bp DNA ladder; L: manufacturer's standard corresponding to 20 copies/reaction (light); Mo : manufacturer's standard corresponding to 200 copies/reaction (moderate); S : manufacturer's standard corresponding to 2000 copies/reaction (severe); 26a shows the vp28 dsRNA treated groups. The samples tested at all time points are very light positive; 26b shows the rr1 dsRNA treated groups, all the samples were negative for WSSV; 26c shows the positive control group which received only WSSV. Samples tested at 48 h and 96 h were moderate and all the remaining samples were severe positive; 26d shows the negative control group which did not receive any dsRNA or WSSV, and these were negative for WSSV).

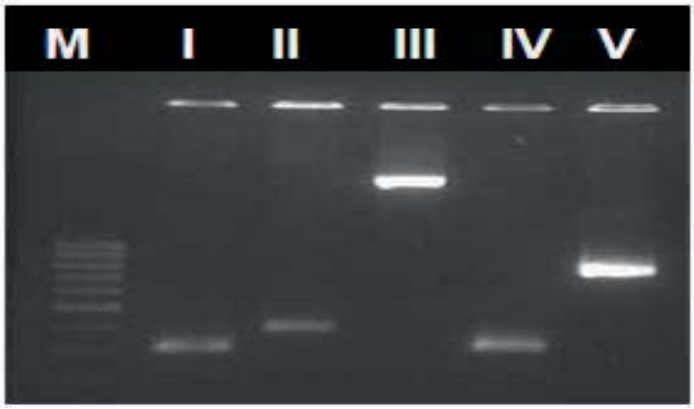


Fig. 27. MBV clones selected for sequencing (Lanes I - 100bp marker; II - 300bp clone; III - 400bp; clone; IV - 1200bp clone; V - 300bp clone; VI - 700bp clone)

One clone of 700 bp, designated MBV4 had a ORF that matched the p74 envelope protein gene of baculoviruses when subjected to sequence homology search via. BLAST, with maximum homology with envelope protein p74 of *Lymantria dispar* MNPV. Suitable primers have been designed to amplify this gene and clone it in pLITMUS28i for dsRNA synthesis. Amplification and cloning of the putative MBV p74 gene are underway (Fig. 27).

Project Title (NBAIM/ICAR)	**Application of micro-organisms in agriculture and allied sectors - Microbial diversity and identification**

During 2009-10, a total of 130 identified microbes including 112 bacteria, 15 *Actinomycetes* and 3 fungal isolates have been deposited in the NBAIM culture collection bank.

RNA typing and characterisation

For a total of 40 bacteria, 16S rRNA genes have been amplified using universal 16S rRNA primer and sequenced. From these 40 bacteria, based on 16S rRNA sequence, the groups that have potential for commercial importance were selected. From these, agriculturally and commercially important enzymes like xylanase, pectinase, agarase, cellulase, chitinase, protease, and lipase producing bacteria were isolated, identified and characterized.

A total of 15 *Actinomycetes* have been identified based on 16S rRNA gene (Fig. 28). Some of the identified actinomycetes *viz. Streptomyces sps, S.chugwhensis, S.pseudogriseolus, S.thermocarboxyedes, S.pseudogriseolus,, Stretomyces sps,* and *S. albogriseolus* are shown to produce antimicrobials (Fig. 29).

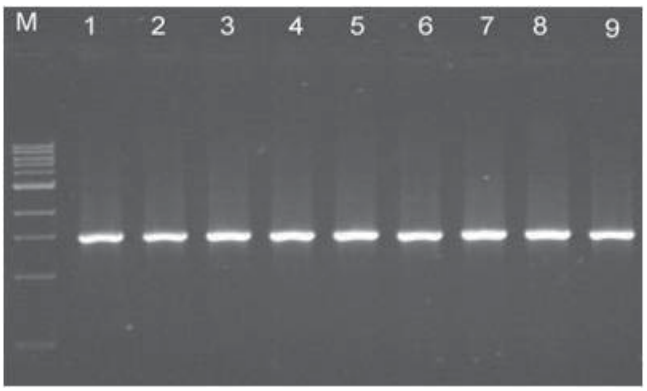


Fig. 28. Amplification of 16srRNA gene of brackishwater Actinomycetes isolates; Lanes M – marker; 1-9 amplified product

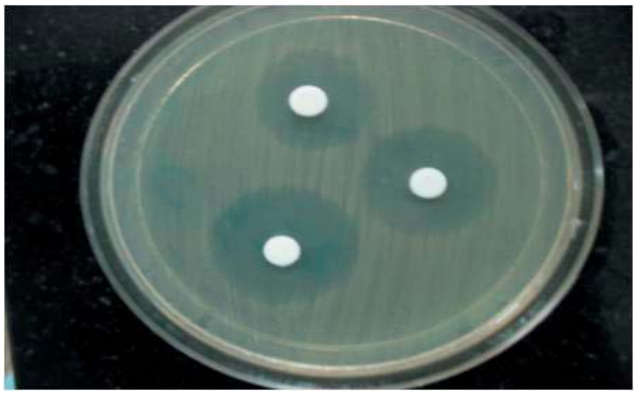


Fig. 29 . Concentrated extract of *Streptomyces chugwhensis* showing antibacterial activity

Identification and characterization of bioactive compounds from pigmented bacteria *Chromobacterium violaceum* and *V.rhizosphaerae* was carried out. Ethanol extract of *C. violaceum* showed antibacterial activity against a few strains of human pathogenic bacteria like *Staphylococcus aureus* and *Streptococcus sp.* Ethanol extract of *V.rhizosphaerae* showed activity against gram negative bacteria like *Salmonella typhi, S. paratyphi, Vibrio* sp and few strains of *S.aureus.*

Expression of economically important genes

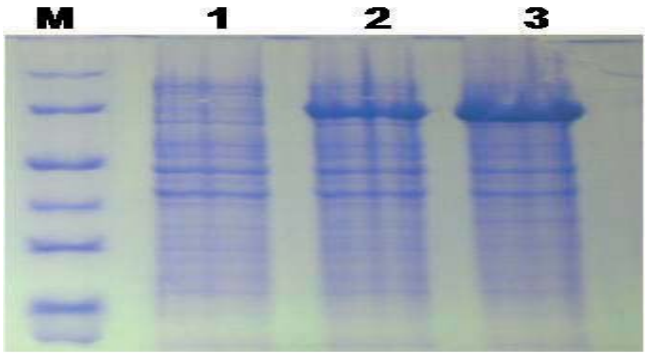


Fig. 30. SDS PAGE showing over expression of chitinase gene after IPTG induction

Five commercially important genes: catalase, chitinase, lipase, choline dehydrogenase and betaine aldehyde dehydrogenase have been cloned and expressed: (i) lipase gene was amplified from *C.violaceum* (ii) chitinase gene, and the salt resistant genes choline dehydrogenase and betaine aldehyde dehydrogenase gene(s) were amplified from *V.alginolyticus* by using the primers designed using online primer designing tools from the NCBI data base sequences. The resulting 1464bp PCR purified fragment of chitinase gene and 980bp PCR purified fragment of lipase gene were individually digested with BamHI and Hind III and cloned in to pET32A vector system and transformed into *E.coli* DH5α. The plasmids (pET32A vector with chitinase gene) were isolated from DH5α and transformed into BL21 *E.coli* expression host. The chitinase gene was over expressed by IPTG induction. The over expression of the three genes were confirmed using SDS PAGE (Fig. 30).

Project Title (NBAIM/ICAR) **Application of micro-organisms in agriculture and allied sectors - Agrowaste management, bioremediation and microbes in post harvest processing**

Environmentally important groups of bacteria involved in nitrogen and sulfur cycles in the environment such as ammonia oxidizing archaeabacteria, γ-proteobacteria, chemolithotrophic and heterotrophic sulphur oxidizers were isolated from shrimp culture pond water and sediment samples using enrichment protocols, and evaluated for their efficiency to oxidize ammonia, nitrite and sulfide *in vitro*. These microbes were characterised using molecular tools. Seven ammonia oxidizing archaeabacteria were enriched and isolated from brackishwater samples and four of these isolates were found to harbour amoA gene by PCR (Fig. 31). Two γ-proteobacterial AOB were enriched, isolated from brackish water ecosystems and were characterised for the presence of amoA

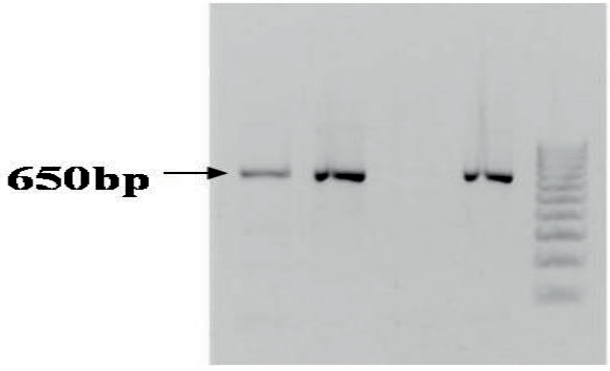


Fig. 31. PCR reaction for amoA gene in ammonia oxidizing archaeabacteria showing a 650 bp product

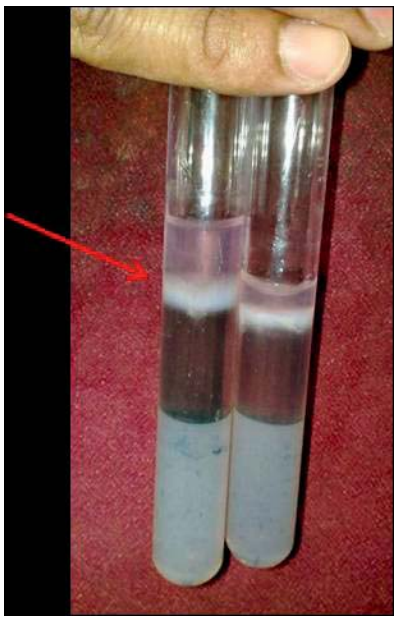


Fig. 32. Growth of *Beggiatoa* sp in sulfide gradient medium

gene by PCR. An anammox bacterium from shrimp culture pond was also successfully enriched and further work on characterisation is in progress.

Five isolates of sulphur bacteria, *Beggiatoa* sp. were successfully enriched and isolated from sediments of shrimp culture ponds and estuaries. Twelve different culture media were evaluated for enrichment and isolation of *Beggiatoa* spp. from brackishwater ecosystems, and the sulphide gradient medium was found to be useful in its maintenance *in vitro* (Fig. 32). One pure culture of *Beggiatoa* sp. was submitted to NBAIM.

Project Title (DBT-NORWEGIAN PROJECT)	**Development of bacterial vaccine (*Vibrio anguillarum*) for seabass**

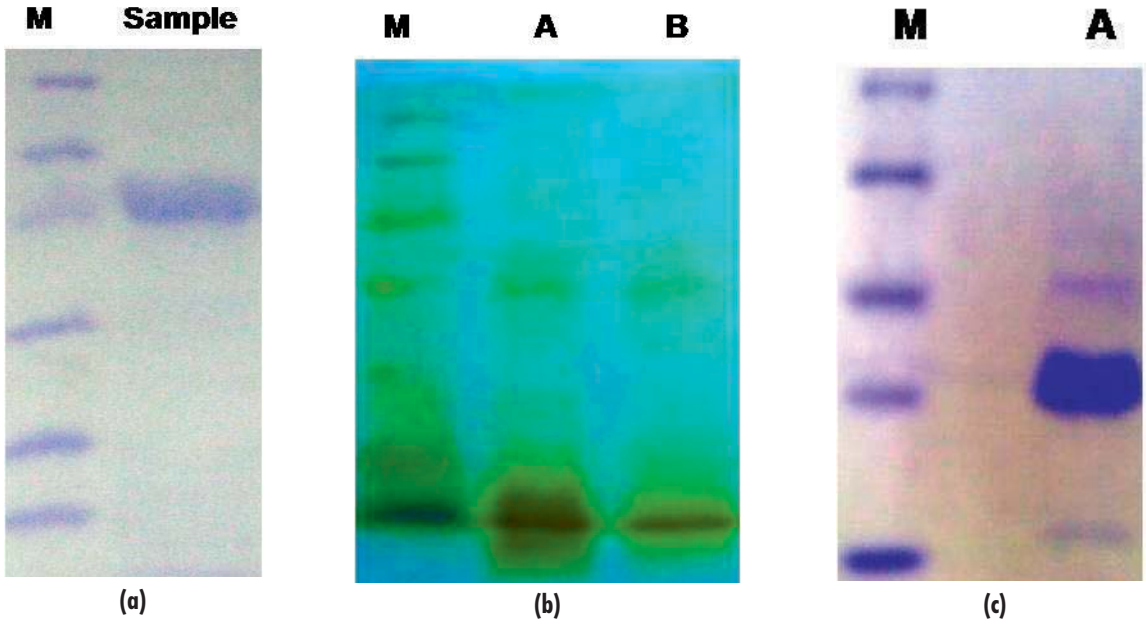


Fig. 33. (a) Isolated extra cellular protein (ECPs) from *Vibrio anguillarum* SDS-PAGE (12%) of the extracted ECPs from the *Vibrio anguillarum; M, Molecular* weight markers (from top to bottom in Kilodaltons; 116.0, 66.2, 45.0, 35.0,25.0,18.4,14.4); A-*V. anguillarum* isolated ECP
(b) Isolation of lipopolysaccharide(LPS) from *Vibrio anguillarum* SDS-PAGE (12.5%) of the extracted LPSs from the *Vibrio anguiillarum;* M-Molecular weight markers (from top to bottom in Kilodaltons; 116.0 , 66.2, 45.0, 35.0, 25.0,18.4,14.4); A - *E.coli* LPS; B-*Vibrioanguillarum* isolated LPS
(c) Isolation of Outer Membrane protein (OMPs) from *Vibrio anguillarum* SDS-PAGE (12%) of the extracted OMPs from *Vibrio anguillarum;* M-Molecular weight marker (from top to bottom in kilodaltons; 116.0, 66.2, 45.0, 35.0, 25.0, 18.4,14.4); A-*V. anguillarum* isolated OMP

The project commenced from October 2009. Sixty isolates of *V.anguillarum* were taken from kidney and intestine of the infected fish and also from water samples of the tanks. The identification of the *V. anguillarum* was characterized by biochemical and molecular techniques. Species-specific PCR detection of *V.anguillarum* was carried out using amiB gene primer (N-actylmuramoyl-L- amidase). Further confirmation of *V. anguillarum* was by 16s rDNA sequence analysis. The DNA was amplified by FD1 and RP2 primers and the PCR product was purified and sequenced. The sequenced data was compared with NCBI (BLAST) and identified as *V. anguillarum.* The pathogenicity of *V. anguillarum* depends on its plasmid. Plasmid profiling was done to determine the pathogenicity. Plasmid was isolated

by alkaline lysis method. Cell surface antigens, extra cellular proteins (ECP) (Fig.33a), lipopolysaccharide(LPS) (Fig. 33b) and outer membrane proteins (OMP) (Fig. 33c) were isolated from *V. anguillarum*

Project Title (DBT Funded)	**Characterization and development of diagnostics for Viral Nervous Necrosis in seabass *(Lates calcarifer)* and mullet *(Mugil cephalus)***

Betanodavirus is the causative agent of a highly destructive disease Viral Nervous Necrosis (VNN) in larvae and juveniles of several species of marine and freshwater fin fishes commercially reared across the world. The causative agent is 23-35 nm in size with two positive stranded RNAs, RNA1 and RNA2 as genome. Molecular epidemiology of VNN in wild habitats, farms or hatcheries of Tamil Nadu, West Bengal, Andhra Pradesh, Kerala, Orissa and UT of Pondicherry revealed 14.5 % (31/220) cases of infection without apparent clinical symptoms. Complete nucleotide sequences of betanodavirus RNA2 from persistently infected samples were analyzed and deposited in NCBI Genbank (Accession nos. GU592791, GU826692, GU826693 and GU953669). Two strains of betanodavirus were isolated using established cell lines out of total 16 samples analyzed (13 %). The isolates showed characteristic CPE and the viral identity was confirmed by RT-PCR and partial nucleotide sequencing.

Development of nested RT-PCR assay for the early diagnosis of VNN in fish

Based on the 1434 bases long RNA2 sequence information, gene specific primers were designed using online tools (available at NCBI) to develop an RT-PCR diagnostic assay. Multiple sets of primers were designed, synthesized and evaluated. Two sets of best performing primers were selected and a complete diagnostic assay system for the early detection of betanodavirus was optimized in nested RT-PCR format. The assay is validated to detect acute disease as well as asymptomatic infection and is the first of its kind in the country. The developed diagnostic would be ready for commercialization after patenting (Fig. 34).

Sample collection sites in West Bengal and Kerala

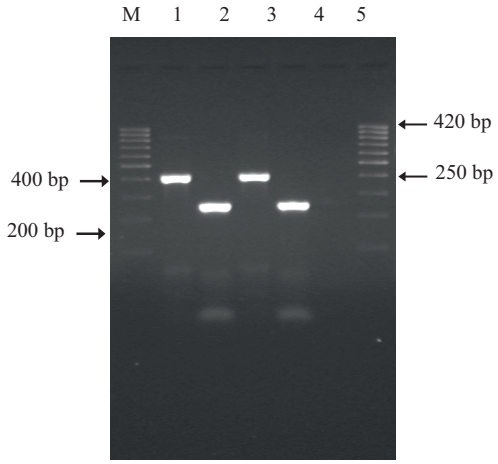
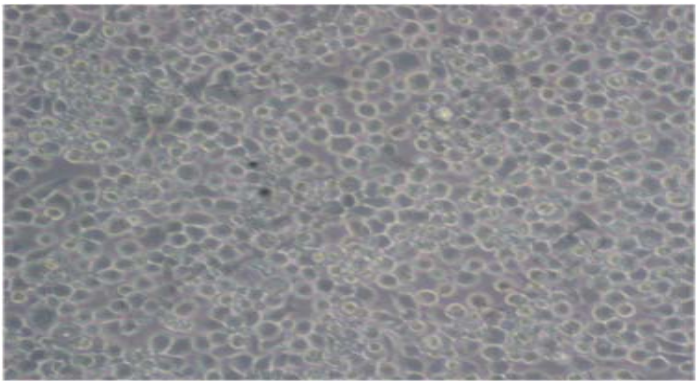


Fig 34. Agarose gel picture showing betanodavirus specific amplicon in the developed RT-PCR (Lane M :100 bp ladder;Lanes 1 & 2:suspect sample; 3 & 4:positive control;5:negative control.Lanes1 & 3: with degenerate primers; 2 & 4 with designed primers)

Project Title (DBT Funded)	**Development of *in vitro* system from *Fenneropenaeus indicus* and freshwater crab *Paratelphusa hydrodomous* for WSSV replication, pathogenesis and quantification**



Primary ovarian culture of *Fenneropenaeus indicus*

White spot disease is an important viral disease caused by white spot syndrome virus (WSSV) and is responsible for huge economic loss in the shrimp culture industry worldwide. Progress in the study of WSSV particularly on its replication, pathogenesis, quantification and control measures has been hampered by the lack of *in vitro* cell culture system. Hence the study is taken up with the objective to establish *in vitro* cell culture system for isolation, characterization of WSSV and to understand its pathogenesis. The DBT funded project was sanctioned in October 2009. Primary cell cultures from different organs tissues viz., heart, gill, ovary, hemocyte and hepatopancreas of *Fenneropenaeus indicus* were made. It was observed that primary cultures from ovary, heart and hemocyte was possible, even though sub culturing was difficult after 2 – 3 passages. Primary ovarian culture could be maintained up to three months without sub-culturing. Further work on standardization of media to obtain the maximum number of passages is in progress.

Project Title (Institute)	**Shrimp pond soil and water management practices and products that mitigate environmental impact and increase productivity**

Effectiveness of bagasse in shrimp ponds

Shrimp aquaculture leads to the generation of ammonia due to loading of feed and the high excretion rate of shrimp. This in turn could lead to poor growth. In this study, removal of ammonia was attempted through biostimulation involving the addition of electron acceptors, nutrients/ electron donors in order to stimulate the indigenous microbial population, which are known to be ecologically superior in terms of bioremediation in comparison to introduced populations. In order to revalidate the biostimulation technology for ammonia detoxification in different environmental conditions and to study the effect of initial ammonia concentration on ammonia removal, bagasse as a biostimulator has been successfully demonstrated in shrimp ponds practicing zero water exchange system; 29-38% reduction in ammonia level was observed in the ponds treated with bagasse (Fig. 35 a&b). The percentage ammonia removal was found to decrease with an increase in initial ammonia concentration of pond water. The presence of biostimulation through supporting the biofilm mode of growth of nitrifying consortia on the bagasse, has been substantiated by quantifying *ammonia monooxygenase* gene (10^5-10^6 gene copies/g) by real-time PCR. In order to ascertain the biodegradability of bagasse-biostimulator, a field trial was also conducted in a shrimp pond at Nagapattinam, which revealed that bagasse can be placed in the culture pond for two months.

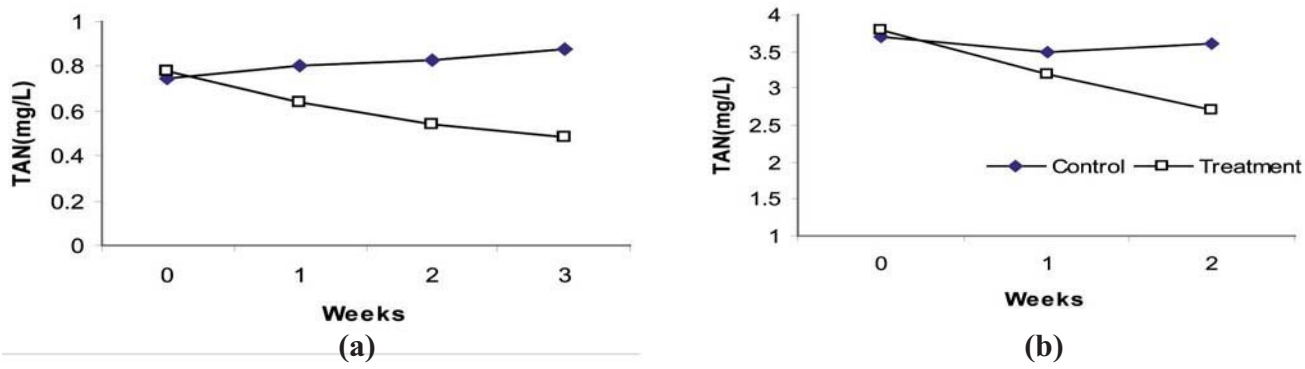


Fig. 35. Removal of TAN in the shrimp pond waters treated with bagasse (a) Initial TAN concentration 0.75-0.78 mg/l (b) Initial TAN concentration 3.7-3.8 mg/l

C/N ratio on dynamics of microbial and biofloc production

The possibility of reducing ammonia concentration by altering the dynamics of microbial and biofloc production through varying carbon /nitrogen (C/N) ratio was evaluated. Four different C/N ratios viz. 5, 10, 15 and 20 were fixed by adding a constant amount of 4 mg/l ammonia-N using ammonium sulphate (21% nitrogen) and varying amounts of molasses (25% carbon) and were tested in yard experiments. Reduction of 20 - 40 percent in ammonia level was observed within 6 hours and 50 - 80 percent after 24 hours at different C/N ratios with increasing trends towards the higher C/N ratio (Fig. 36 a). The reduction in ammonia level was highly related with the increase in microbial load which was assessed by way of live bacterial count over different time periods. The minimum microbial load was observed with C/N-5 and maximum in C/N-20 (Fig. 36 b). Two peaks followed by decreased microbial load were observed in higher C/N ratio which reflects the increased oxygen demand and death of microbial cells. Such peaks and through was not observed in lower C/N ratio which reflects the sustainability of biofloc production. Biofloc volume ranged from 0 to 30.3 ml in 14 days trial of continuous supply of carbon and nitrogen sources and the maximum values were 14, 18, 24 and 31ml/l for C/N-5, 10, 15 and 20 respectively. The result indicated that ammonia reduction is effective and faster for higher C/N ratios, and slow for lower C/N ratios.

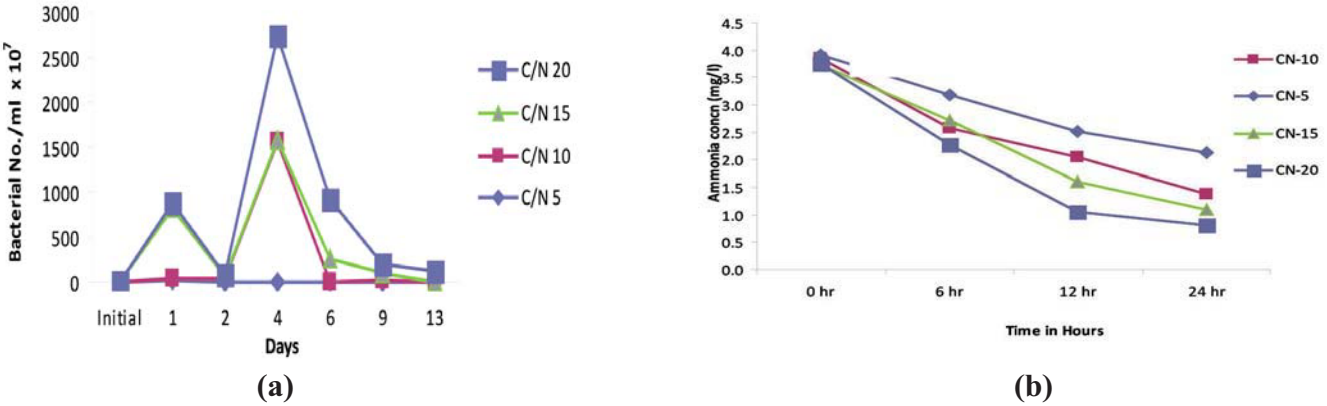


Fig. 36 a & b. Total viable count of bacteria at four different C/N ratios and their effect on ammonia removal

Effect of biofloc on growth of tiger shrimp

Bioflocs not only reduce ammonia concentration, but they also serve as an important source of food for the juvenile tiger shrimp *P. monodon*. A yard trial was carried out for two months with the objective of evaluating the effect of two modes of supply of biofloc as feed source for tiger shrimp: (i) produced in the same tank where animals are growing (internal biofloc) and (ii) produced in an external tank and supplied to the experimental tank after filteration by 10µ nylon bag (T2 - external biofloc). The control animals were fed with 40% protein (commercial feed) while in both the treatments, only biofloc was supplied. Molasses was used as the carbon source for biofloc production. The internal biofloc treatment showed significantly higher growth compared to control and external biofloc. The growth in external biofloc was not significantly different from control. The experiment reveals that biofloc could be a viable option to replace costly feed to the extent of 40% during the juvenile period (Table 18).

Table18. Growth of tiger shrimp under two different modes of feeding with biofloc

Treatment	Days of experiment				
	0	15	30	45	60
Control	$1.3^{a}\pm0.04$	$1.8^{a}\pm0.09$	$2.5^{a}\pm0.15$	$2.3^{a}\pm0.25$	$3.1^{a}\pm0.18$
Internal biofloc	$1.3^{a}\pm0.02$	$1.7^{a}\pm0.03$	$2.2^{a}\pm0.17$	$2.4^{a}\pm0.13$	$3.4^{b}\pm0.12$
External biofloc	$1.3^{a}\pm0.03$	$1.8^{a}\pm0.03$	$2.3^{a}\pm0.08$	$2.3^{b}\pm0.15$	$2.8^{a}\pm0.14$

Means within periods followed by different superscripts are significantly different ($P<0.05$)

Nitrogen budgeting for different culture practices of shrimp farming

Nitrogen budgeting helps to understand the sinks of nitrogen and its quantification to optimize the level of inputs under different culture practices. Input and output data were collected from two culture periods to determine the nitrogen budget under different culture stocking densities. Total input nitrogen for low stocking density was 131 kg/ha, which includes 127.5 kg through feed and 7.9 kg through inlet water. For high stocking density, total input N used was 294.3 kg/ha, out of which 289.5 kg was from feed and 4.7 kg from water. The sinks of nitrogen were discharge water at harvest time, nitrogen deposited in shrimp tissue, sediment nitrogen and loss to atmosphere. Out of the total input, shrimp could assimilate 43.7 % and 35.5 % nitrogen, and the drained water at harvest contained 14.05% and 11.7 % under low and high stocking density respectively (Fig. 37 a&b). Nitrogen accumulation in sediment was more under low stocking density (27.5%) and less amount of nitrogen is lost to the atmosphere (14.7%) (Fig.3a & b). Further studies with tracer technique might throw more light in comprehending the nutrient budgeting and help in formulating management practices for maximizing the N recovery and minimizing unaccounted losses.

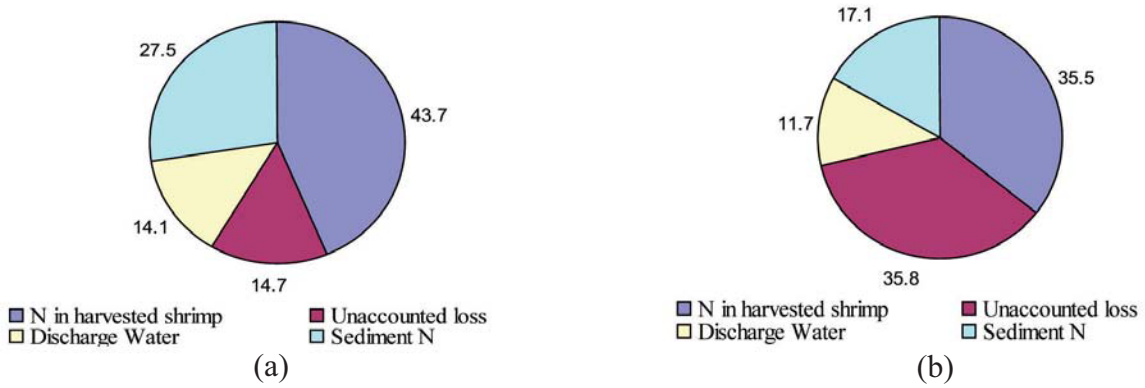


Fig. 37. Sinks of nitrogen (%) under low (a) and higher (b) stocking densities

Nanoparticle preparation and its effect on water quality

Nano-remediation is one of the methods to improve the water quality. The ZnO nanoparticle was prepared by hydrolysis method using zinc acetate in ethylene glycol medium. Nano Zinc oxide-PVA was prepared using poly vinyl alcohol as a capping material as it helps to increase the stability of the particles. Both the prepared particles were confirmed by its X-ray diffraction pattern using XRD (Fig. 38 a). The morphology of the nanoparticles so obtained was characterized by SEM (Fig. 38 b&c). The size of nanoparticles ranged from 50-85 nm and 70-90 nm for nano ZnO and nano ZnO-PVA respectively. The proportion of element in each particle was confirmed by EDX method. ThebZnO nanoparticles act as antimicrobial agents and have enhanced bioactivity against *Vibrio harveyi* compared to bulk ZnO. The minimum inhibitory concentration (MIC) was determined for effective antimicrobial activity. Nano-remediation could be an option to help control *V. harveyi* in the mass culture of live feed in shrimp/ fish hatcheries.

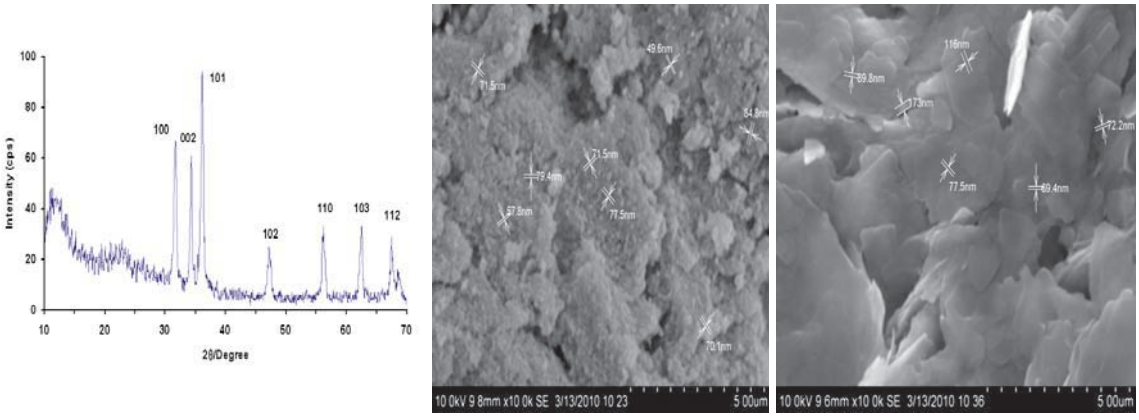


Fig. 38. (a) XRD pattern of prepared ZnO NPs SEM image (b) prepared ZnO NPs (c) prepared ZnO-PVA NPs

Carrying capacity estimation of source water by sampling during critical months

Earlier case studies on the assessment of carrying capacity of source waters for shrimp farming in Andhra Pradesh and Tamil Nadu revealed that maximum nutrient loading from shrimp farms was observed during the last month of culture period and at harvest time. It was postulated that sampling at the end of culture is adequate for estimating the

carrying capacity of an area. To confirm this, a study was conducted on Vettar River in Nagapattinam District, Tamil Nadu where shrimp farming is the major activity. Water samples were collected from the shrimp farm discharge points and also from the source water during the critical months i.e. the period of maximum discharge from farms unlike monthly sampling in previous studies. The study area from Nagur bridge point to Mangalambody on the water body covers a length of 6 km with average width of 11 m. The average depth of water body is 2.44 m. Due to varying freshwater inflow from Cauvery River, the salinity of source water ranges from 5 to 42 ppt. The area developed for shrimp farming was 195 ha and the cultured area was 80 ha for summer crop and 62 ha for winter crop. The water exchange was practiced only after 80 days during the culture period. The nutrients loading from the farms was within the carrying capacity of the water body (Fig.39). Based on the assimilation capacity that looks at actual nutrient loading and flushing/ dilution rates and supportive capacity of the ecosystem, the area recommended for shrimp aquaculture was 212 ha and further development is recommended as per the guidelines of Coastal Aquaculture Authority (CAA) and Coastal Regulation Zone. The present study confirmed that by sampling in the critical months of maximum discharge of water, one can estimate the carrying capacity of an area.

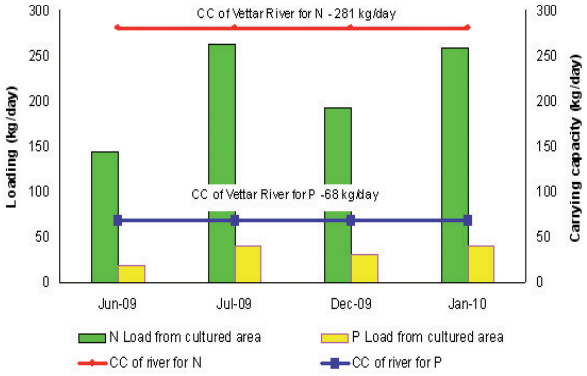


Fig. 39. Nutrients loading vs. carrying capacity of Vettar River

In order to popularize the use of carrying capacity tool among planners, the decision support software was released during the National Workshop on 'Environmental sustainability of brackishwater aquaculture' on 30th July 2009. Additionally, the tool has been demonstrated to potential end users such as State Fisheries Department officials of Andhra Pradesh and Gujarat in the workshops on "Carrying capacity of water bodies in coastal aquaculture" organised on 27th July and 6th August, 2009 at State Institute of Fisheries Technology, Kakinada and Navsari Agricultural University, Navsari respectively to create awareness and help fishery /planning professionals to develop management systems that will reduce the likelihood of aquaculture development exceeding the carrying capacity thereby helping in the planning of sustainable aquaculture.

Environmental database of shrimp farm discharge water

The impact of shrimp farm discharge water on the receiving water bodies is a frequent question raised by stakeholders. In order to augment the data which is already with the institute, additional data was collected. Water samples were collected during the months of maximum release of discharge water during the summer and winter crops, from shrimp farms, intake points, ponds, discharge and receiving points on the Madavamedu River in Chidambaram District, Tamil Nadu. The area under culture, stocking density and average production were 39.24 ha, 6-8/m^2 and 0.82 kg/ha respectively during the summer crop and 52 ha, 10-12/m^2 and 1.25 kg/ha respectively during winter crop The discharge water parameters are within the limits prescribed by CAA at the final discharge point (Table 19) and it clearly indicates that aquaculture does not contribute towards environmental pollution as evidenced by the water quality analysis and confirmation in earlier studies.

Table 19. Water parameters (values of 3 farms and 2 months in each crop mean ± SD) at different sampling points from shrimp farms located on Madavamedu River, Chidambaram District

Water parameter	Intake water		Pond water		Discharge water		Receiving water body		CAA standards
	Summer crop	Winter crop	Summer crop	Winter crop	Summer crop	Winter crop	Summer crop	Winter crop	
pH	7.42±0.54	7.88±0.19	7.19±1.14	7.88±0.48	7.64±0.24	7.96±0.45	7.36±0.39	7.92±0.29	6.0-8.5
TSS (mg/l)	38.2±15	51.8±12	49.2±17	63.8±15	79.6±18	89.4±15	56.6±16	78.7±11	100*
Total N (mg/l)	1.01±0.62	0.97±0.59	1.65±0.21	1.73±0.44	1.67±0.41	1.86±0.59	1.49±0.32	1.58±0.41	2*
Total P (mg/l)	0.46±0.12	0.52±0.18	0.61±0.21	0.69±0.19	0.76±0.27	0.73±0.22	0.67±0.28	0.71±0.35	0.2**

* CAA standards – maximum allowable; ** CAA standards for phosphorus is given as dissolved phosphate P max

Climate change and impact of extreme climatic events

It is postulated that climate change would lead to increased frequency and intensity of extreme events. As part of the institute's efforts to evaluate climate change and the impact of natural calamites like cyclones, floods and drought on brackishwater aquaculture, surveys were conducted in West Bengal and Andhra Pradesh to assess the damage due to Aila Cyclone and Krishna River Floods, respectively.

The cyclone Aila which hit West Bengal in May 2009 severely affected brackishwater aquaculture in the blocks of Sandeshkhali I and Sandeshkhali II under North 24 Parganas and Basanti, Gosaba and Namkhana blocks under South 24 Parganas. The tidal water in most of the farms was 0.6 m or more above the bund height and the inundation continued for 15 to 20 days. Water and soil quality assessment revealed changes in water colour, increase in salinity, and 2.5 to 5 cm of siltation on the bheri/pond bottom. In the Sunderbans mangrove forest area, traditional fishery was severely affected. The extent of damaged area was collected from the Fisheries Department. The loss was assessed with the questionnaire survey, focus group meetings, visual inspection of the sites and further calculations. The actual damage assessed was higher than the figures released by the Fisheries Department as they have used the norms and rates of Calamity Relief Fund (CRF). In Sandeshkhali –II block, the total loss was Rs. 150 million and even if the employment is considered to be met from family labour, the loss would be Rs. 79 million. The loss is much higher than the relief of Rs.28.5 million which is calculated on the basis of CRF rates of Rs.6000/ha for de-siltation and Rs.4000/- per ha for inputs subsidy. This clearly indicates that state governments have to develop new norms for distributing relief for aquaculture and it cannot be done on the basis of norms developed for agriculture.

The Krishna River Floods during October 2009, severely affected the shrimp farms in Diviseema region in Krishna District (862 ha) and Repalle Mandal in Guntur District (344 ha) located within a radius of 1-2 km from the shore of the Krishna and 10 – 15 km from the shore of the Bay of Bengal. The estimated loss by the State Fisheries Department was Rs.25 million. The water level rose to 2 to 3 feet higher than the bund height of ponds and the ponds were inundated for 7-10 days. The farmers lost the standing crop, civil structures and machinery. The bottom of

the ponds were loaded with 4 - 6.5 cm silt and the salinity decreased by 5 to 10 ppt due to the inflow of river water. The damage in this case was mainly due to the heavy rains in the upstream parts of the river leading to overflow of water downstream, which resulted in the inundation of ponds. In case of Aila Cyclone, the damage was due to tidal water from the sea which inundated the ponds and led to salinisation of freshwater ponds. The Nisha Cyclone which hit Tamil Nadu in 2008 was associated with extremely heavy rainfall and led to the inundation of ponds due to overflow of source waters. In all these extreme events, irrespective of their origin, the damage to aquaculture ponds was mainly due to inundation of ponds along with heavy winds damaging the infrastructure and loss of stock.

Damaged pond dykes due to Aila Cyclone at Chunakhali, Basanti

Inundation of ponds and storage structures due to Krishna River floods at Gullalamoda in Krishna District

Project Title (DBT Funded)	Development and evaluation of greenwater technology for aquatic bioremediation in coastal aquaculture

Diversity of bacterial population in coastal aquaculture

Knowledge of bacterial diversity in ecosystems is required for the predictability and reliability of bioremediation processes. Diversity of nitrite, nitric-oxide and nitrous oxide reducing denitrifying bacteria has been examined in greenwater systems in coastal aquaculture areas using metagenomics. Metagenomic clonal libraries have been created for functional genes i.e. nitrous oxide reductase (*nosZ*), nitrite reductase (*nirS/nirSK*) and nitric oxide reductase (*qnorB*). Unique clones obtained were sequenced and released in the GenBank (Accession numbers: *nosZ* GU122967 to GU122973, *nirS/nirSK* GU122963 to GU122964, *nirS* GU553357-GU553359, GU553355 and *qnorB* GU553356). Nitrite oxidizing, nitrate reducing, sulfur oxidizing and nitrogen fixing bacteria were found to be in abundance in greenwater systems. Nucleic acid methods based on sequencing of meta-genomic clone libraries provided novel sequence information, based on which oligonucleotide primers have been developed and used for multiplex PCR. This was used for detection and identification of bacteria implicated in biotransformation of potent green house gases and other nitrogenous fluxes (Fig. 40 a,b,c&d).This also has an application in that it provides more accurate understanding of these fluxes in the aquatic environment.

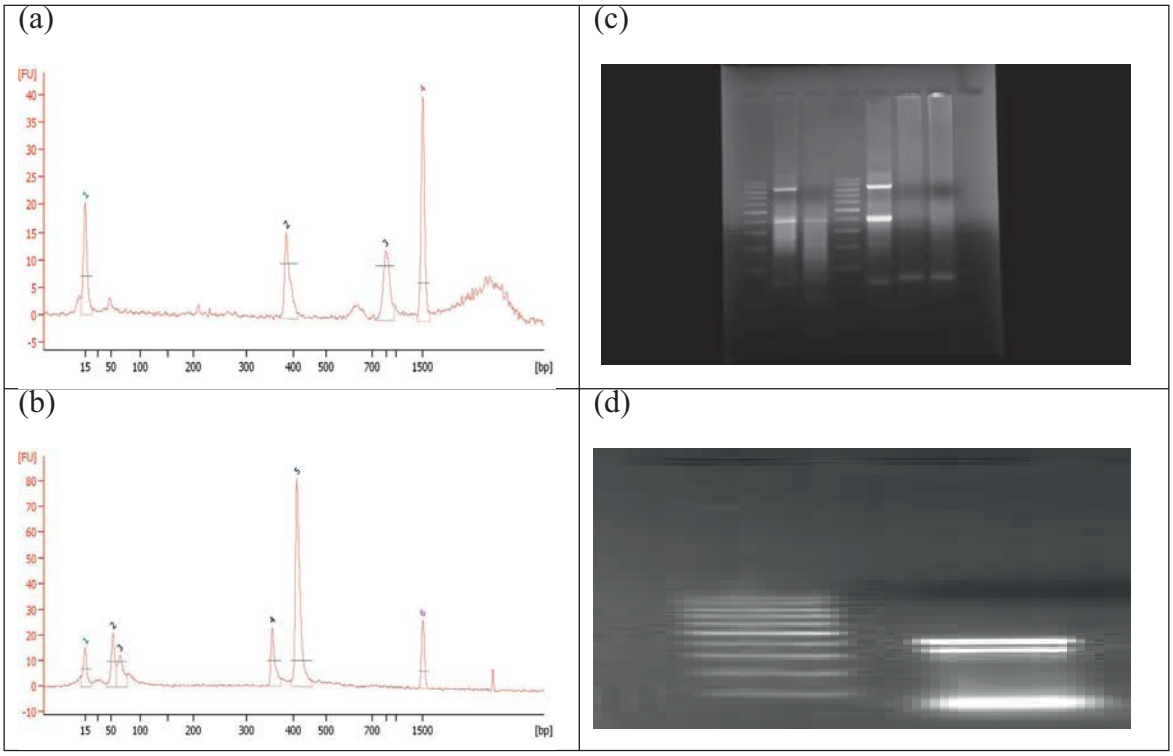


Fig. 40. Multiplex PCR for detection of bacteria implicated in biotransformation of nitrogenous fluxes. (a,b) Bioanalyzer (Lower marker 15 bp and upper marker 1500 bp) **(c,d) Gel electrophoresis** (100 bp marker)

Remediation for chemical and microbial pollutants

Heterotrophic bacteria have been isolated from coastal aquaculture systems and characterized using biochemical tests, 16S rRNA and functional gene approaches. They were further characterised using fatty acid methyl ester (FAME) analysis since the fatty acid profile is specific for bacterium. Gene sequences have been submitted to the GenBank (accession numbers GU122947 to GU122962, GU181421). Functional genes have been amplified and sequenced (Accession numbers: *norB* GU122974, GU181420, *nosZ* GQ214398, GQ214400, GQ214402, FJ976653, GU122965, GU122966, *nirS* FJ976652, GU122963, GU122964). Based on the screening of bacterial isolates, various *Alcaligenes sp.* have been tested as heterotrophic nitrifier and aerobic denitrifier for the development of bioaugmentors for detoxification of nitrogenous metabolites. A bacterial isolate was found to possess a plasmid coding for nitrite reductase (*nirS*) and nitrous oxide reductase *(nosZ) genes*. *Pseudomonas* sp. have been found to have antagonistic effect against shrimp pathogenic bacteria. Crude extracts of the bioactive compounds have been isolated from the antagonistic bacteria (*Pseudomonas* sp.) and were found to have an antibacterial activity (Fig. 41 a,b,c&d) against shrimp pathogenic bacteria i.e. *Vibrio harveyi*.

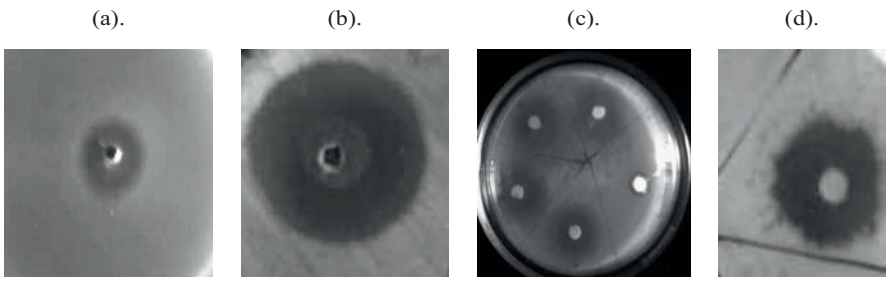


Fig. 41. Antibacterial activity of crude extract isolated from *Pseudomonas* sp. (a,b) agar well diffusion method and (c,d) disc method

Crude protein has been isolated from a couple of bacterial isolates, which have been found to remove ammonia under laboratory conditions. The isolated plasmid was transformed into the *E.coli* cells for expression studies. Harvested cells were lysed and loaded on SDS-PAGE along with the markers. One major band (~35 kDa) was observed after induction for the plasmid.

Project Title (NACA Funded)	**Strengthening Adaptive Capacities to the Impacts of Climate Change in Resource-poor Small-scale Aquaculture and Aquatic Resources-dependent Sector in the South and South-east Asian Region**

The project in short known as 'Aqua Climate' is coordinated by the Network of Aquaculture Centers in Asia-Pacific (NACA) and funded by the Norwegian Agency for Development Cooperation (NORAD) with an aim to strengthen the adaptive capacities of poor people from small-scale aquaculture and related sectors to the impact of climate change. The project is being implemented in Vietnam, India, Philippines and Sri Lanka with technical help from international partners viz., Faculty of Fisheries, Kasetsart University, Bangkok Thailand; Bioforsk – The Norwegian Institute for Agricultural and Environmental Research, Norway; Akvaplan-niva AS –Tromso, Norway; and Fisheries Victoria, Australia.

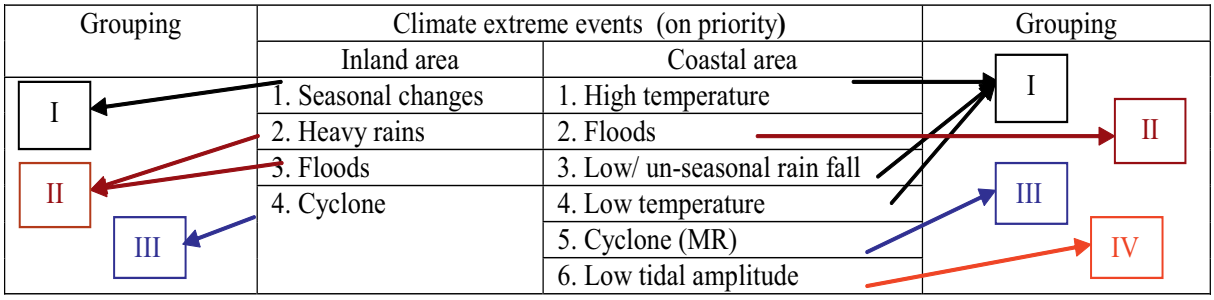
The focus of the project in India is (i) preparation of a comprehensive document on impacts of extreme climatic events on aquaculture in India and to (ii) conduct a comprehensive study on the potential vulnerabilities of small and poor shrimp culture farmers in low-lying coastal lands to climate change (CC) impacts. The project was started in India, from September 2009. The draft report on 'Impacts of extreme climatic events on brackishwater aquaculture in India' has been submitted to NACA and is under final revision. The report is based on the work done by the Institute on extreme climatic events. Krishna District in Andhra Pradesh has been selected as the study area. The reason for selecting this area was that it had been affected by severe and sudden climatic changes in the recent years including the worst drought ever in 50 years which occurred in early to mid 2009 followed by a severe flooding of the Krishna River in October 2009, the kind of which was not observed in the last hundred years. This area is an extremely high-risk zone being more vulnerable to sea level rise in the future.

Farmer's perceptions and adaptive capacities

In order to assess the farmer's perceptions, attitudes and adaptive capacities towards climate change impacts, shrimp farmers under the National Centre for Sustainable Aquaculture (NaCSA) societies in Krishna District in Andhra Pradesh were selected as the target group. Survey by way of a questionnaire for farmers, focus group discussions on 'Perception of Climate change impacts on small-scale shrimp farmers in inland and coastal shrimp farming areas', and a stakeholder workshop on 'Impact of Climate Change on shrimp farming' were conducted in Krishna District, Andhra Pradesh along with the international partners of the project. This part of the work was undertaken in co-ordination with NaCSA. The Focus Group Discussion (FGD) meetings were conducted with small-scale shrimp farmers of varying age, experience in farming and farm sizes both from NaCSA societies and others. The discussion was simultaneously conducted in two different locations viz., Chinnapuram (inland area) and Gullalamoda (coastal area) on 3rd December 2009. The FGDs were organised in vernacular language (Telugu) and English with arrangement for translations. The discussions were carried out in sub-groups of farmers with each group exploring individually the farmer's perception of climate change (CC), impacts of climate change on shrimp farming, risk assessment, seasonal and crop calendar activities, solutions and the responsible agencies to implement them. The ideas were posted on cards and then displayed on charts to the farmers.

The inland and coastal area shrimp farmers have experienced a more or less similar impact of climate change extremes though there was a difference in the order of priority with regard to impacts. On a priority basis, these were seasonal changes, heavy rains, floods and cyclones in inland shrimp farming areas and high temperature, floods, low/un-seasonal rainfall, low temperature, cyclone and low tidal amplitude in coastal shrimp farming areas (Table 20).

Table 20. Priority and grouping of climate change events in inland and coastal shrimp farming areas



Each CC event was assessed in terms of consequences and likelihood and their scores were averaged for the group and then multiplied to get the risk rating. The likelihood and consequence ratings were plotted in a matrix table to arrive at the risk priority level for each extreme event. (Table 21). The adaptation measures identified in FGDs for a particular climate change were more or less similar in inland and coastal shrimp farming areas.

Table 21. Risk priority matrix of extreme events in inland and coastal areas

Consequence / Likelihood	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
5. Almost certain					
4. Likely		Low rainfall		Flood	
3. Possible			Heavy rain, cyclone Flooding	Seasonal change High temperature	
2. Unlikely			Low temperature, cyclone, Low tidal movement		
1. Rare					

The CC events marked in white are for inland area and black for coastal area.

Extreme	High	Medium	Low

Stakeholder's perception

In order to comprehend the perception of different stakeholders, a stakeholder workshop (SW) was organized on 4th December 2009 in Vijayawada which was attended by farmers and individuals representing different organizations. Key stakeholders were characterized based on their understanding on CC issues and impact on shrimp farming,

adaptive capacity and interests in implementing them. The adaptive measures identified to be implemented by the farmers were most often 'Better Management Practices' (BMP) for which they sought advise from the Department of Fisheries, NaCSA and CIBA. The technical/scientific adaptive measures were mainly refinement of the existing or innovation of new technologies that would help adapt the existing shrimp farming practices to climate change events such as improvement of BMPs, identification of alternate species, and adoption of scientific principles in planning, mitigation measures such as mangrove plantations and construction of flood walls. The adaptive policy measures are mostly on quality input supply, electricity supply, loans and insurance schemes, flood walls construction and mangrove plantations, and efficient forecasting of extreme climatic events.

The use of these participatory processes such as facilitated semi-structured focus group discussion and facilitated stakeholder workshop were novel in that they helped in comprehending the perceptions, vulnerability and adaptability to climate change of small scale shrimp farmers and other stakeholders in Andhra Pradesh.

NUTRITION, GENETICS AND BIOTECHNOLOGY DIVISION

Project Title (Institute)	Development and demonstration of balanced feeds for Asian seabass, crabs and improvement of shrimp feeds

Optimum crude protein levels for high saline tiger shrimp farming

The effect of crude protein level on growth and protein utilization was studied in the juveniles of tiger shrimp *Penaeus monodon* in high saline conditions. The experiment was conducted with 2.5 g size animals at 40 ppt salinity for period of 6 weeks with four dietary crude protein levels of 40, 33.5, 27.3 and 23%. The experimental animals were acclimatized by changing 2 ‰ per day using crude common salt obtained from Kelambakkam salt pans. Significantly ($P<0.05$) high growth rates were observed at 40 and 33.5% dietary crude protein levels (Table 22) compared to lower levels. At 33.5% crude protein, significantly ($P<0.05$) better Protein Efficiency Ratio (PER) and Apparent Protein Utilization (ATU%) were observed. The Free Amino Acid (FAA) levels of non-essential amino acids both in haemolymph and muscle was not significantly different across all the treatments whereas the essential FAA levels were higher at 33.5% CP fed shrimp both in haemolymph and muscle. Haemolymph ammonia and urea N levels were highest at 40% CP fed shrimp (Fig. 42) indicating that the shrimps are under stress. Based on these results it can be concluded that at high salinity (40‰), protein utilization efficiency was better at 33.5% dietary protein level.

Table 22. Effect of dietary crude protein level on weight gain, protein efficiency ratio (PER) and Apparent Protein Utilization (APU-%) of *Penaeus monodon* at 40 ppt salinity

Parameters	Crude Protein (%)			
	40	33.5	27.3	23
Weight gain (%)	$213.8^{b} \pm 3.73$	$204.9^{b} \pm 3.82$	$165.6^{a} \pm 1.69$	$155.4^{a} \pm 4.37$
PER	$1.23^{a} \pm 0.006$	$1.52^{b} \pm 0.007$	$1.47^{b} \pm 0.016$	$1.47^{b} \pm 0.023$
APU (%)	$23.4^{a} \pm 0.11$	$30.2^{b} \pm 0.16$	$27.7^{b} \pm 0.29$	$27.2^{b} \pm 0.43$

Values followed by different superscripts differ significantly ($P<0.05$)

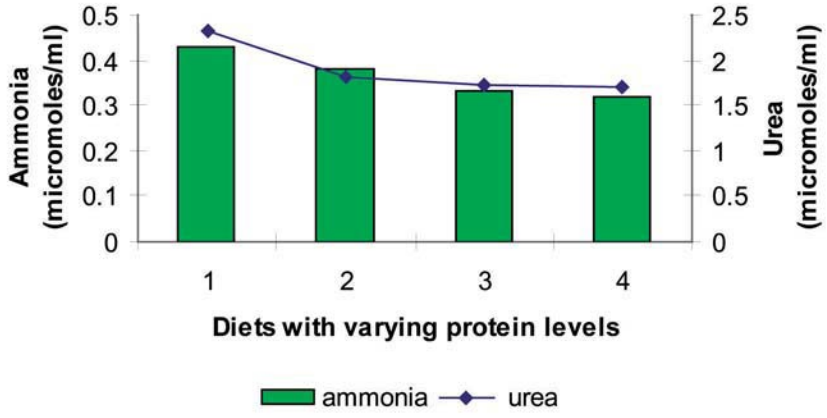


Fig. 42. Effect of dietary protein level on haemolymph ammonia and urea in tiger shrimp (1-40%, 2-33.5%, 3-27.3%, 4-23% of protein levels)

Digestibility of potential inexpensive feed ingredients in mud crab

A feeding experiment was conducted to determine the apparent digestibility coefficient of dry matter, protein and energy of six inexpensive feed ingredients viz. ground nut cake, gingili oil cake, sun flower cake, cotton seed cake, rice bran and wheat bran in adult mud crab *Scylla tranquebarica* (weight 450±17.8g). The apparent digestibility of nutrients in feed ingredients was done using a reference diet with chromic oxide as an inert indicator. Reference diet consisted of fishmeal, acetes meal, squid meal, soybean meal wheat flour and binder together constituting 60.15% along with other common ingredients chromic oxide 1.0%, lecithin 0.25%, cholesterol 0.1%, mineral mixture 0.5 %, di-calcium phosphate 2.0%, vitamin mixture 1.5%, fish oil 2.5% and carboxy methyl cellulose 2%. The test diets consisted of 70% reference diet and 30% test ingredient to be tested.

The test diets were prepared as dry pellets. The feeding trial with test diets was carried out in a completely randomized design on individually held crabs in oval FRP tanks with a capacity of 100 l with four replicates for each treatment. All the crabs were fed with reference diet for 3 weeks and then fed with respective test diets for three weeks. After a week of feeding, faeces samples were collected by siphoning 4-5 hours after feeding. Faeces samples were rinsed with distilled water and stored at -20°C until analysis. The apparent digestibility coefficient (%) of dry matter (ADMD), crude protein (ACPD) and energy (AED) of the test ingredients are given in Table 23.

Table 23. Digestibility of selected feed ingredients in mud crab *Scylla tranquebarica*

Ingredients	ADMD %	ACPD %	AED %
Groundnut cake	83.68	91.03	90.93
Gingili cake	81.48	87.90	90.08
Sunflower cake	78.50	87.20	88.98
Cotton seed cake	81.77	89.77	89.60
Wheat bran	74.425	82.57	83.9
Rice bran	68.80	73.30	73.65

Ground nut cake had the highest DM digestibility (83.68%) and rice bran had the lowest DM digestibility (38.80%). Crude protein digestibility was also highest in GNC (91.03%) and lowest in Rice bran (73.30%). Results revealed

that inexpensive plant ingredients are better utilized with more than 87% protein digestibility and 88% energy digestibility. The products like wheat bran and rice bran are moderately utilized. These finding indicate the scope for utilizing these inexpensive plant ingredients in crab feeds.

Dietary Ca and P requirements for low saline tiger shrimp farming

A six week feeding experiment was conducted to evaluate the response of juvenile *P. monodon* to dietary calcium (Ca) and phosphorus (P) levels in low saline water (7-10 ppt) since the availability for Ca is less in low saline water, the dietary requirements are expected to be higher. Ten isonitrogenous and isoenergetic purified diets (Table 24), containing five graded levels of calcium (0, 0.5, 1, 2, and 3 %) with two levels of phosphorus (1, 2%) for each Ca level, were tested with juvenile shrimp. The experiment was conducted in 100 l FRP tanks with 10 individuals in each with an average body weight of 0.95 g with 10 treatments and three replicates for each treatment. Shrimp fed with diet containing 3% Ca and 2% P supplementation showed a significantly (P<0.05) higher weight gain among the groups (Fig 43). Utilization of Ca and P was also significantly (P<0.5) higher in *P. monodon* fed diet supplemented with 3% Ca and 2% P (Table. 24).

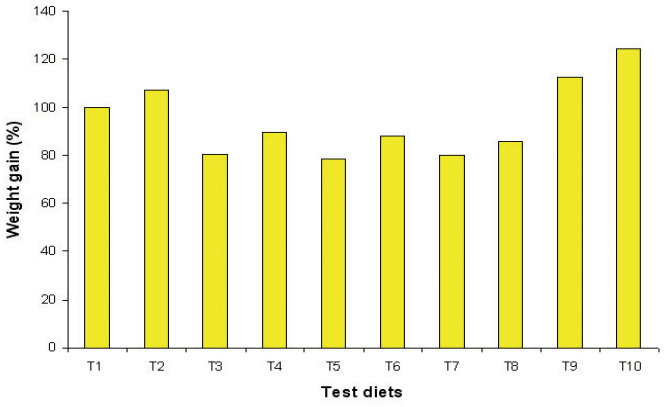


Fig. 43. Weight gain(%) of shrimp fed with different levels of dietary calcium and phosphorus

Table 24. Utilization of dietary Ca and P in *P.monodon*

Treatments	Dietary Supplements		Utilization	
	Ca (%)	P (%)	Ca (%)	P (%)
T1	0	1	-	88.29 ± 1.59
T2	0	2	-	94.21 ± 0.79
T3	0.5	1	38.16 ± 5.31	85.94 ± 2.09
T4	0.5	2	40.18 ± 5.18	90.61 ± 1.63
T5	1.0	1	49.55 ± 6.94	78.18 ± 2.08
T6	1.0	2	46.21 ± 4.32	88.04 ± 1.81
T7	2.0	1	66.74 ± 1.69	84.93 ± 3.09
T8	2.0	2	69.68 ± 1.42	90.17 ± 1.34
T9	3.0	1	85.31 ± 0,60	87.63 ±1.34
T10	3.0	2	84.29 ± 0.28	91.72 ± 0.73

Cellulolytic bacteria as a feed supplement

Bacillus macerans, a potential cellulolytic bacteria, isolated from the gut of *Lates calcarifer,* was identified for testing as feed supplement in plant protein based shrimp feed. Formulated feed (test feed) was incubated with *B. macerans* @ 2.94 x 10^7 cfu per 100 gram of feed with 50 % moisture content for 24 h, 48h, 72h, 96h and 120h to know the optimum incubation period with regards to nutrient enrichment of feed. It was found that after 48 hrs of incubation, crude protein content, free glucose concentration and microbial count was maximum in the feed and dry matter loss was less. Therefore it can be concluded that 48 hrs of incubation is optimum with regard to nutrient enrichment of feed. This fermented test feed was used as a treatment for the experiment. A six week feeding trial was conducted with four treatment groups in triplicate containing ten shrimps (average body weight 2.73g) fed with control feed (Group I). Group II was fed with untreated test feed, group III fed with test feed treated with live microbial (*B. macerans*) supplement (2.94 x 10^7 cfu/ml) @ 1% (v/w) at the feeding time and group IV were fed with 48 hrs fermented test feed. The proximate composition of the test feeds I only was relatively different from others. It was found that growth (weight gain: 138.48 %) , survivability (87.50 %) and protein efficiency ratio (PER) was significantly ($P<0.01$) higher and FCR (1.64) was significantly($P<0.01$) lower in animals of group III fed with feed supplemented with live microbes as compared to animals fed with fermented test feed, untreated test feed and control feed (Table 25).

Table 25. Performance of *P. monodon* fed different types of treatment feed

Parameter	Group I	Group II	Group III	Group IV
Initial body wt. (g)	2.73 ± 0.006	2.73 ± 0.04	2.73 ± 0.01	2.73 ± 0.003
Final body wt. (g)	6.31^{b} ± 0.02	6.33^{b} ± 0.02	6.52^{c} ± 0.03	6.10^{a} ± 0.01
Total wt. gain (g)	3.58^{b} ± 0.01	3.60^{b} ± 0.04	3.79^{c} ± 0.02	3.37^{a} ± 0.02
ADG (mg/d)	85.31^{b} ± 0.35	85.71^{b} ± 1.03	90.23^{c} ± 0.63	80.15^{a} ± 0.48
Weight gain percent	131.41^{ab} ± 0.27	131.96^{ab} ± 3.46	138.48^{b} ± 0.79	123.17^{a} ± 0.88
FCR	1.76^{b} ± 0.00	1.78^{b} ± 0.02	1.64^{a} ± 0.00	1.89^{c} ± 0.00
SGR (%)	1.99 ± 0.003	2.00 ± 0.03	1.99 ± 0.07	1.91 ±0.008
PER	1.47^{a} ± 0.00	1.60^{b} ± 0.01	1.75^{c} ± 0.01	1.47^{a} ± 0.00
Survivability (%)	83.33 ± 8.33	70.83 ± 4.16	87.50 ± 0.00	83.33 ± 4.16

Values bearing different superscripts in a row differ significantly ($P<0.01$)

From this trial it could be concluded that *Bacillus macerans,* a cellulolytic gut bacteria can be used a live feed supplement in plant protein based shrimp feed as it improves the nutrient utilization efficiency and growth performance of shrimp.

Popularisation of farm-made aqua feed

The concept of farm-made aqua feed gains importance when farmers and entrepreneurs look forward for cost reduction technologies in order to sustain profitable aqua farming in the long run as they are encountering number of problems like ever-escalating input costs and wide fluctuations in the farm gate price for shrimp. CIBA has been able to downscale the individual components of a feed mill to prepare feed of very small quantity as per demand. This scaled down version of a feed mill costs only about four lakhs with a capacity to produce 200 kg/ day. To popularize farm-made aqua feeds and motivate potential entrepreneurs to establish small feed mills of need based capacity, a two day workshop 'Awareness cum practical experience workshop on farm made aqua feeds' was conducted on 29th and 30th September 2009. A total of 35 participants including 25 farmers actively took park in the deliberations and demonstration of the techniques involved in farm made aqua feed preparation. Apart from giving lectures on the farm-made feeds, the participants were taken to the feed mill of the Muttukadu Experimental Station of CIBA where various steps involved in practical feed preparation, handling of machineries (such as hammer mill, pulveriser, sieve assembly, mixer, wet extruder and dryer) were demonstrated. The major ingredients used in farm made feed and commercial feeds were also displayed and their characteristics were explained to the farmers. A field trip was arranged to Thonirevu village, Pulicat in Tiruvallur district of Tamil Nadu which is about 70 km away from CIBA headquarters. A model farm made aqua feed mill had been established in this village under the assistance of Department of Bio-technology, Government of India. The participants actively took part in all the processing stages of farm made feed preparation.

Project Title (Institute)	**Outreach on nutrient profiling and evaluation of fish as a dietary component**

The geographical and seasonal variations in the nutrient profiles of brackishwater shrimp and finfishes were analysed for building a base line data base for brackishwater species. Wild samples of tiger shrimp, *P. monodon,* Indian white shrimp, *F. indicus*, Asian seabass, *L. calcarifer* and grey mullets, *M. cephalus* were collected from Andhra Pradesh, Kerala, Tamil Nadu and West Bengal from February 2009 to January 2010. Different size groups of samples were analysed for nutrient profiles for its edible portions. In tiger shrimp, the crude fat values were highly variable with seasons (Table 26). The higher fat values were observed in cold dry season compared to hot-dry season. Similar results were observed for Indian white shrimp. The proximate composition of both cultured and wild tiger shrimp were analysed and the crude fat values were higher in farmed tiger shrimp compared to wild shrimp. The size variation in proximate composition of Asian seabass indicates that with increase in size, higher crude fat values were observed (Table 27). The proximate composition of size variations in grey mullet were analysed from < 150 g size to > 500 g size(Table 28). The fatty acid profiles of cultured shrimp indicates higher 18:2n-6 fatty acid compared to wild (Fig 44).

Table 26. Seasonal variations in the proximate principles (g/100 g edible portions) of *Penaeus monodon* and *Fenneropenaeus indicus*

Seasons	*Penaeus monodon*				*Fenneropenaeus indicus*			
	Moisture	Crude Protein	Crude Fat	Total Ash	Moisture	Crude Protein	Crude Fat	Total Ash
Hot-Dry	74.74 ±0.65	21.24 ±0.32	0.76 ±0.23	1.68 ±0.09	74.3 ±0.8	20.5 ±0.4	0.9 ±0.1	1.7 ±0.1
Hot-Wet	73.53 ±0.84	21.69 ±0.49	1.09 ±0.27	1.88 ±0.15	72.5 ±0.7	22.1 ±0.4	1.2 ±0.2	1.5 ±0.2
Retreating SW	74.22 ±0.43	21.74 ±0.39	1.05 ±0.22	2.22 ±0.24	73.2 ±0.7	21.0 ±0.3	1.1 ±0.2	1.9 ±0.1
Cold-dry	70.03 ±4.71	20.12 ±1.35	1.13 ±0.25	1.86 ±0.21	73.1 ±0.8	21.3 ±0.5	1.1 ±0.3	1.5 ±0.1

Table 27. Variations in the proximate principles due to size (g/100 g edible portions) of *Lates calcarifer*

Size	Moisture	Crude Protein	Crude Fat	Total Ash
< 500 g	73.51 ±0.68	19.85 ±0.78	1.42 ±0.17	1.48 ±0.04
500 to 1000g	73.18 ±1.05	21.20 ±0.81	1.61±0.2 9	1.63 ±0.22
1000 to 1500 g	70.49 ±0.52	21.84 ±0.32	3.59 ±0.62	1.98 ±0.25
> 1500 g	71.04 ±1.04	21.77 ±0.73	3.99 ±0.37	1.40 ±0.17

Table 28. Variations in the proximate principles due to size (g/100 g edible portions) of *Mugil cephalus*

Size	Moisture	Crude Protein	Crude Fat	Total Ash
< 150 g	74.54 ±0.50	20.95 ±0.63	1.75 ±0.69	1.24 ±0.15
150-250 g	75.51 ±0.33	21.59 ±0.26	0.91 ±0.15	1.38 ±0.04
250-500 g	74.15 ±0.37	21.06 ±0.37	1.61 ±0.13	1.48 ±0.04
> 500 g	70.40 ±1.42	22.02 ±1.02	2.92 ±0.41	1.63 ±0.34

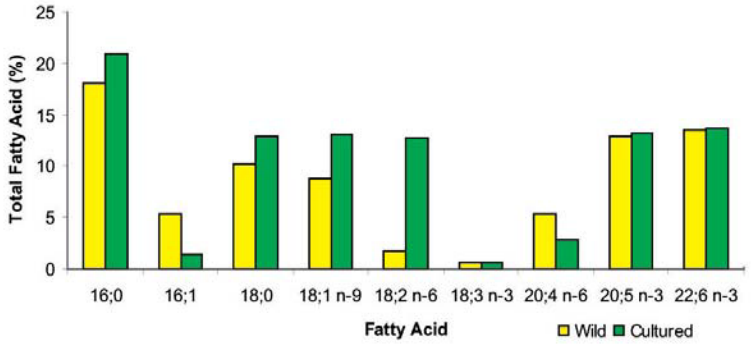


Fig. 44. Fatty acid profile of wild and cultured *Penaeus monodon*

Project Title (Institute)	Outreach on fish feed

Vitamin mixture for Asian seabass grow out feed

A vitamin mixture consisting of all the vitamins of B-group, vitamin C and fat soluble vitamins was formulated and it was tested in a practical feed at 0, 0.5, 1.0 and 1.5% for Asian seabass. The test feeds were fed to seabass juveniles of initial average weight of 5.31g. A six week feeding trial was conducted with 20 animals per tank with three replicates for each treatment. The results indicated (Table 29) that significantly ($P<0.05$) higher weight gain (%), protein efficiency ratio and apparent protein utilization (%) were observed in seabass juveniles fed with 0.5% of vitamin mixture incorporated feed. Based on the results, it can be concluded that supplementing 0.5% vitamin mixture improves growth and feed efficiency in seabass.

Table 29. Effect of vitamin mixture incorporation on weight gain (%), survival (%), PER and APU of Asian seabass *Lates calcarifer*

Parameters	Vitamin mixture (%)			
	0	0.5	1.0	1.5
Weight gain (%)	$351.6^{a}\pm8.61$	$478.0^{b}\pm2.32$	$467.1^{b}\pm10.32$	$456.9^{b}\pm2.65$
Survival (%)	98.3	98.3	100.0	96.6
Feed Conversion Ratio	$2.2^{b}\pm0.01$	$2.0^{a}\pm0.06$	$2.0^{a}\pm0.07$	$2.2^{ab}\pm0.02$
Protein Efficiency Ratio	$1.1^{a}\pm0.01$	$1.2^{b}\pm0.03$	$1.2^{ab}\pm0.04$	$1.2^{ab}\pm0.01$
Apparent Protein Utilization (%)	$19.1^{a}\pm0.13$	$22.8^{c}\pm0.63$	$20.5^{ab}\pm0.63$	$21.2^{b}\pm0.17$

Values bearing different superscripts in a row differ significantly

Mineral mixture for Asian seabass grow out feed

A mineral mixture has been formulated and tested by incorporating in a practical feed for seabass at 0, 0.5, 1.0 and 1.5%. These feeds were tested on seabass juveniles with an initial weight of 12.2g. A six week feeding trial was conducted with 15 animals per tank with three replicates for each treatment. The results indicated that significantly ($P<0.05$) higher weight gain (%), protein efficiency ratio and apparent protein utilization (%) were observed in seabass juveniles fed with 0.5% of mineral mixture incorporated feed (Fig. 45). Based on the results it can be concluded that 0.5% mineral mixture is optimum for seabass practical feed.

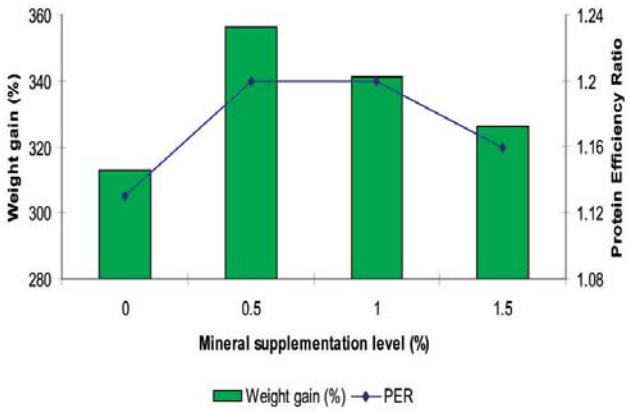


Fig. 45. Variations in weight gain in Asian seabass fed with mineral mixture supplements at different level

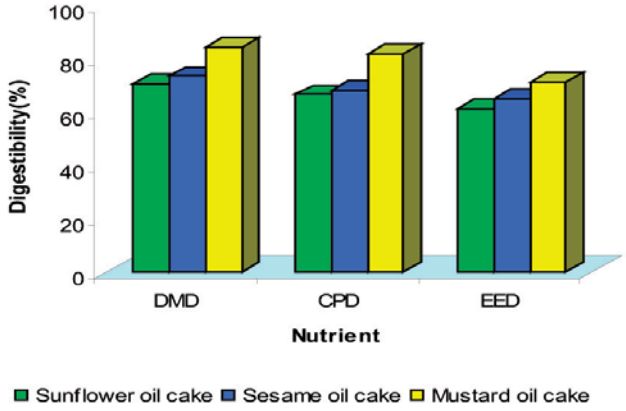


Fig.46. Nutrient digestibility of three oil cakes tested in Asian seabass (DMD-Dry Matter Digestibility, CPD-Crude Protein Digestibility, EED-Ether Extract Digestibility)

Digestibility of selected plant protein ingredients in Asian seabass

The nutrient digestibility of three oilcakes namely sunflower, sesame and mustard was determined for Asian seabass (*L. calcarifer*) for evaluating them as potential feed ingredients for this fish. The three oilcakes were individually incorporated in standard reference diet (45% protein) at 30% (reference diet: ingredient = 70:30). Chromic oxide (0.5%) was used as an internal marker. The apparent dry matter digestibility (%) of mustard oil cake (Fig. 46) was significantly ($P<0.05$) higher (84.5±0.20) as compared to that of sesame (73.3±0.11) and sunflower oil cake (70.49±0.33). The apparent crude protein digestibility for mustard oil cake was significantly ($P<0.05$) higher (81.6±0.18) followed by sesame and (68.2±0.13) and sunflower (66.54±0.15) oilcake. Apparent crude fat digestibility for mustard oil cake was also significantly higher (71.01±0.4) as compared to sesame (64.76±0.80) and sunflower oil cake (61.31±0.09).

The study shows that *L. calcarifer* could digest nutrients (protein, fat and dry matter) more efficiently from mustard oil cake than other two oil cakes i.e. sesame and sunflower. The data will be utilized for inclusion of mustard oil cake as well as sunflower cake meal for the formulation of diet for Asian seabass.

Feed processing technology for seabass pellet feeds

Processing the feed into appropriate pellet form acceptable and palatable to Asian seabass is essential for developing feed technology for large-scale farming of this fish. In this context the successful feed formulations were selected for processing into different types of pellets namely sinking, slow-sinking and floating pellets using a laboratory extruder available at the institute. Besides the processing conditions and operational configuration of the extruder, the source of starch and its quantity in the feed formulation play an important role in processing and obtaining the desired type of pellet.

With a view to find out the suitability of different sources of starch for extrusion, maize, maida, rice, wheat, finger millet, sorghum and pearl millet were selected. Using these starch sources individually in the feed formulation, the feeds were processed in the extruder and floating pellets were produced following uniform processing conditions. The bulk density of the pellets in each case was determined by standard method. The results indicated that pellets made using maize have the lowest bulk density followed by maida and rice. Finger millet is having medium bulk density while sorghum and pearl millet are having higher bulk density. When different moisture levels were tested, additional moisture at 17.5% resulted in slow sinking and floating pellets. The effect of speed of the extruder shaft on product output was studied by subjecting the feed mix at shaft speed of 200, 300, 350, 400 and 450 RPM and found that at 400-450 RPM speed, slow sinking and floating pellets are produced, while at lower speed, only sinking pellets are produced with scant gelatinization of starch. The effect of temperature on the products output also was studied by setting the extruder temperature at 90,100,110,120 degree centigrade and it was observed that at 110°C the product started puffing and at 120° C floating pellets are produced. Temperature up to 100° C had no effect on extrusion and the product comes out as sinking pellets.

Extrusion trials with seabass feed formulation containing 40% protein and 10% fat were conducted using standard pelleting conditions arrived at by the above studies. Different levels of starch source such as wheat flour and maida were tested and the resultant feed pellet properties were studied. The results indicated that it is possible to produce sinking, slow-sinking and floating pellets by varying the amount of starch source and also by altering the working configuration of the extruder. Thus by conducting these trials, all the three types of feeds namely sinking, slow-sinking and floating pellet could be successfully produced for Asian seabass as per requirement.

Project Title (DBT Funded)	**Development of substrate specific fibrolytic enzymes for enhancing nutrient utilisation in shrimp**

Optimum concentration of fibrolytic enzymes for maximum sugar release

An experiment was carried out to identify the unit (activity) of fibrolytic enzymes required individually to evoke the maximum sugar release from potential selected feed ingredients. The ingredients were subjected to *in vitro* digestion with individual fibrolytic enzymes. Ten grams of the sample was taken and enzymes cellulase, hemicellulase and pectinase were added at 0, 2.5, 5, 7.5 and 10 mg/10 g of feed, whereas xylanase was added at 0, 0.05, 0.10, 0.15 and 0.20 mg/10 g of feed. The variation in the levels chosen depended upon the actual activity present in the enzymes. A significantly higher release of D-glucose was observed in soy bean meal (SBM) supplemented with cellulase at 7.5mg/10g. In the case of sun flower oil cake (SFOC), rape seed meal (RSM) and COC, 10mg cellulase /10g of respective substrates resulted in significantly higher level of D-glucose release. Cotton seed cake (CSC), ground nut cake (GNOC), wheat bran (WB) and rice bran (RB) showed maximum D-glucose release at 5mg/10g of the respective substrate and further increase in the enzyme concentration did not lead to any further significant increase in sugar release. Based on the *in vitro* findings, the concentration of cellulase required was standardized. A significantly higher D-glucose release from all the selected ingredients implies that cellulase is one of the choice of fibrolytic enzymes for improving utility, hence cellulase will be included in designing the customized fibrolytic enzyme mixture of the selected ingredients.

The *in vitro* studies using xylanase on D-xylose release indicates that GNOC,WB showed maximum sugar release at 0.20 mg/ 10 g in RSM, 0.15 mg/ 10 g in CSC and 0.10 mg/ 10 g in COC and SFOC. Interestingly, there was no significant difference in D-xylose release from SBM, RB when incubated with xylanase at 0, 0, 0.05, 0.10, 0.15 and 0.20 mg/10 g. This result indicates that xylanase may not be the choice for RB and SBM while other ingredients needed this enzyme as one of the enzyme mixture. Hemicellulase supplementation to the D-xylose released indicates that a significantly higher amount of D-xylose at 10mg/10g for SBM and RB, 7.5mg/10g for GNOC and WB, 10mg/10g for RSM and COC and 2.5mg/10g for SFOC and CSC. This result also indicates that hemicellulase is also to be considered while designing the customized fibrolytic enzyme mixture as it releases significantly higher level of D-Xylose from all the ingredients compared to control with out enzyme supplementation. Pectinase supplementation and the amount of D-galacturonic acid released indicated that a significantly higher level of D-galacturonic acid was observed at 10mg/10 g in all the ingredients except WB and RSM. It could be inferred that this enzyme elicits maximum sugar at highest concentration in the selected levels and there is scope for utilizing the combination in the ingredients having response to pectinase supplementation.

Customised fibrolytic enzyme mixture (CEM) combination for selected ingredients

This experiment was carried out to optimize the level of inclusion of CEM in selected ingredients. Based on the earlier *in vitro* study using the four fibrolytic enzymes, the CEM was arrived and is presented in Table 30.

Table 30. Identified customized enzyme mixture combination

Ingredients	Customized enzyme mixture
SBM	Cellulase + Hemicellulase + Pectinase
RSM	Cellulase + Xylanase
SFOC	Cellulase + Xylanase
CSC	Cellulase + Xylanase + Pectinase
GNOC	Cellulase + Xylanase + Pectinase
COC	Cellulase + Xylanase + Pectinase
WB	Cellulase + Hemicellulase
RB	Cellulase + Hemicellulase + Pectinase

To extract the synergistic effect of enzyme combination and to find out the minimal amount of enzyme combination to elicit maximum sugar release, tests were carried out to supplement the designed CEM for the respective ingredient, at inclusion level of 0,25,50,75 and 100 % of the designed CEM specific for each ingredient and the results indicates that the selected CEM at 75% inclusion level is optimal for SBM,RSM,GNOC, COC. The RB and CSC showed a beneficial effect at 50% supplementation of the designed customized enzyme mixture. However there is no advantage in the combination of CEM for SFOC and the beneficial effect was observed at 100% inclusion of CEM.

Customised enzyme mixture on growth and digestibility

The selected fibre/NSP rich ingredients were subjected to digestibility studies with supplementation of customized combination of fibrolytic enzyme mixtures. The apparent dry matter (ADMD) and protein digestibility (APD) were determined by feeding the practical diets comprising of 70% reference diet plus 30% of test ingredient with selected inclusion level of customized enzyme mixture specific for each ingredients and chromic oxide as the inert marker. The apparent DM and protein digestibility of selected ingredients and the effect of CEM supplementation on its digestibility is presented in Table 31. The DMD of the ingredients ranged from 49.48% in RB to 70.18% in SBM. CEM supplementation resulted in improved DMD in all the ingredients and it ranged from 57.79% in RB to 81.12% in SBM. The results indicate that maximum improvement in DMD of about 10.94% was observed in SBM supplemented with CEM had the increase in DMD in RSM,SFOC,GNOC,COC,WB and RB was also good with improvement in DMD of 6.11% to 8.31% . Among the ingredients CSC showed a limited improvement in DMD for CEM supplementation (2.87%).

Table 31 . Apparent dry matter and protein digestibility of selected ingredients with and without customized combination of fibrolytic enzyme mixture

Diets	Digestibility (%)			
	Dry matter		Protein	
	Without enzymes	With enzymes	Without enzymes	With enzymes
SBM	70.18±0.40	81.12±0.19	81.26±0.30	93.60±1.12
RSM	62.82±0.63	69.16±0.24	79.28±0.87	87.65±0.86
SFOC	61.30±1.07	67.41±1.16	79.03±0.44	88.43±0.60
CSC	60.74±0.54	63.61±0.50	75.65±0.82	81.16±0.61
GNOC	67.67±0.62	73.77±0.53	80.29±0.90	88.13±0.28
COCO	62.54±0.59	70.44±0.91	73.52±0.89	83.52±0.62
WB	55.32±1.09	61.44±0.63	64.76±0.58	72.80±0.39
RB	49.48±0.82	57.79±0.44	57.43±1.15	65.56±0.60

The apparent protein digestibility of the ingredients ranged from 57.43% in RB to a high of 81.26 % in SBM. CEM supplementation resulted in improvement of protein digestibility in the ingredients and the APD ranged from 65.56% in RB to 93.60 in SBM. Similar to ADMD, maximum increase in APDMD (12.54%) was observed in SBM supplemented with CEM. The RSM,SFOC,GNOC,COCO,WB and RB also had good improvement in protein digestibility for the CEM supplementation and the actual improvement in these ingredients ranged from 8.04% to 10.00% . However, CSC showed only a moderate improvement (5.5%) in protein digestibility for CEM supplementation.

Project Title (DBT Funded)	Enrichment of aquafeed with cellulolytic and amylolytic microbes isolated from digestive tract of brackishwater fishes

Isolation and identification of anaerobic gut microbiota

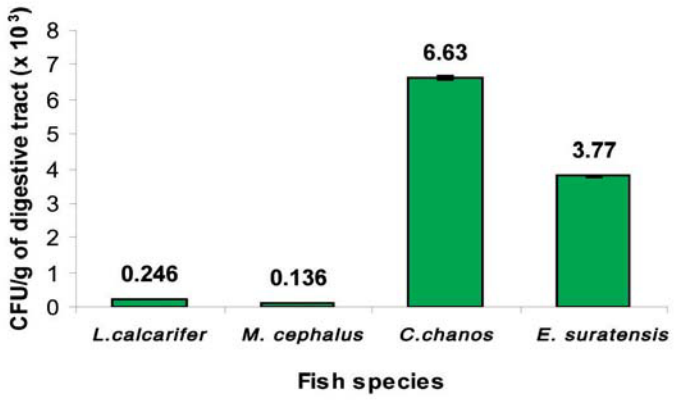


Fig. 47. Total anaerobic bacterial population in gut

The objective of the project is to identify potential aerobic and anaerobic cellulolytic and amylolytic gut microbiota which can be used to enrich feed for brackishwater species. Test fish species with different feeding habits, namely, Asian seabass, *L. calcarifer* (903 ± 38.4g); milkfish, *C. chanos* (93 ± 2.0g); grey mullet, *M. cephalus* (700 ± 5.8g) and pearlspot, *E. suratensis* (112 ± 7.3g) were starved for 48 hours and dissected for isolation of anaerobic gut microbiota inside an anaerobic culture hood. Analysis of anaerobic gut microbiota from the digestive tract of the selected brackishwater fish species (Fig. 47) showed higher ($P<0.01$) anaerobic population in the gut of *C. chanos* (CC) followed by *E. suratensis* (ES), *L. calcarifer* (LC) and *M. cephalus* (MC).

Eight obligate anaerobic bacterial colonies were isolated from the gut of the four brackishwater test fishes (Table 32). Isolated anaerobic bacterial colonies were characterized and identified on the basis of their morphological, physiological and biochemical characteristics. Four isolates (LCan2, MCan1, CCan1 and ESan2) were gram positive bacilli and remaining four were gram positive cocci. All bacilli were endospore producers and motile.

Table 32. Identified anaerobic bacterial isolates from the gut of the four brackishwater test fishes

Fish species	Bacterial isolates	Species
Lates calcarifer	LCan1	*Pediococcus* sp.
	LCan2	*Clostridium sardiniense*
Mugil cephalus	MCan1	*Clostridium septicum*
	MCan2	*Pediococcus* sp.
Chanos chanos	CCan1	*Clostridium septicum*
	CCan2	*Pediococcus* sp.
Etroplus suratensis	ESan1	*Pediococcus* sp.
	ESan2	*Clostridium sardiniense*

* Some physical and biochemical characteristics did not match the standard conditions for the species

All the isolates could tolerate pH from 5-8 and temperature from 15-40 °C. The MCan1 and CCan1 could reduce nitrate in an anaerobic condition. All the bacilli belonged to the genus *Clostridium* sp. and all the cocci to the genus *Pediococcus* sp. For bacterial isolates, CCan1 identified as *C. septicum* and ESan2 was identified as *C. sardiniens.* One of the biochemical characteristics did not match the standard conditions for the species, hence, these could be different strains.

Identification of different aerobic bacterial isolates

A total of 36 aerobic gut bacteria were isolated from the gut of four brackishwater fishes, out of which 11 isolates had already been identified last year. The remaining 25 isolates were identified based on their morphological, physiological and biochemical characteristics (Table 33). All isolates could tolerate a temperature range of 15° to 40 °C and a pH range of 5-10.

Table 33. Identified aerobic bacterial isolates

Fish species	Bacterial isolates	Name of isolates
Lates calcarifer	LC4	*Staphylococcus capitis*
	LCx	*Micrococcus colpogenes*
	LCy	*Bacillus larvae*
	LCp	*Bacillus licheniformis*
	LCq	*Stomatococcus mucilagenosus*
Mugil cephalus	MC1	*Micrococcus varians*
	MC2	*Staphylococcus saccharolyticus*
	MC4	*Micrococcus varians*
	MCx	*Stomatococcus mucilaginosus*
	MCy	*Micrococcus varians*
	MCz	*Micrococcus varians*
	MCp	*Micrococcus colpogenes*
	MCq	*Staphylococcus cohnii*
	MCr	*Staphylococcus saccharolyticus*
Chanos chanos	CC1	*Staphylococcus saccharolyticus*
	CC2	*Micrococcus colpogenes*
	CC3	*Staphylococcus xylosus*
	CC5	*Micrococcus nishinomiyensis*
	CCy	*Stomatococcus mucilaginosus*
	CCp	*Staphylococcus sciuri*
	CCq	*Staphylococcus sciuri*
Etroplus suratensis	ES1	*Stomatococcus mucilaginosus*
	ESx	*Staphylococcus saccharolyticus*
	ESy	*Staphylococcus lentus*
	ESp	*Micrococcus varians*
	ESq	*Stomatococcus mucilaginosus*

Extracellular enzyme activity of different anaerobic bacterial

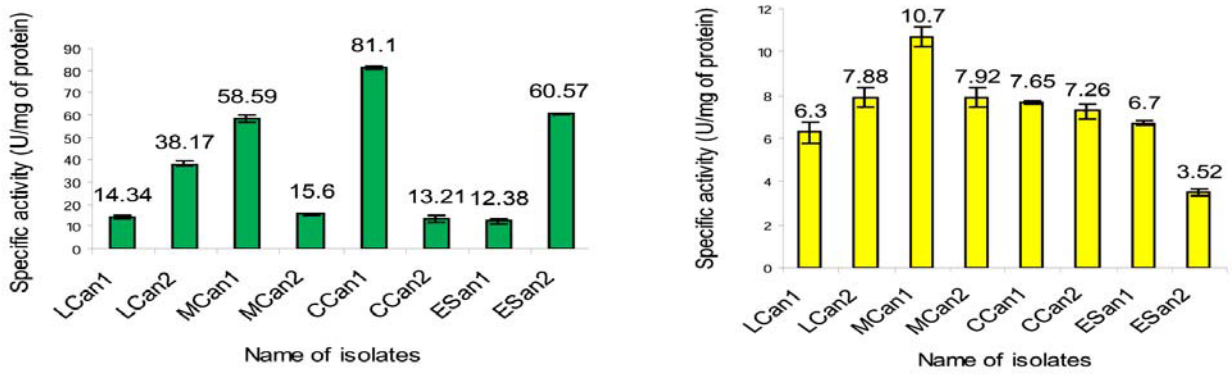
The intensity of extracellular amylase, cellulase and protease activity by eight anaerobic bacterial isolates was assayed qualitatively (Table 34).

Table 34. Profile of qualitative extracellular enzyme activity of different anaerobic bacterial isolates

Fish species	Enzyme activity			
	Bacterial isolates	Amylolytic	Cellulolytic	Proteolytic
Lates calcarifer	LCan1	++	+	++
	LCan2	++	++	++
Mugil cephalus	MCan1	+++	++	++
	MCan2	++	+	+
Chanos chanos	CCan1	++	+++	++
	CCan2	++	+	+
Etroplus suratensis	ESan1	++	+	+
	ESan2	+	++	++

+++ High, ++ Moderate, + low

Among the eight anaerobic isolates from the gut of four fish species, 4 isolates (LCan2, MCan1, CCan1 and ESan2) were promising cellulase producers (Fig. 48a) and among them CCan1 (*C. septicum*) showed higher ($P<0.01$) cellulase activity. Among all isolates, MCan1 (*C. septicum,* different strain) showed higher ($P<0.01$) amylase activity (Fig. 48b).



(a) (b)

Fig. 48. (a) Specific Cellulase activity of different anaerobic isolates (μg of maltose liberated / mg of protein / min) (b) Specific amylase activity of different anaerobic isolates (μg of D-glucose liberated / mg of protein / min)

Project Title (Institute)	Outreach on Fish genetic stocks

Tissue samples and digitized images of tiger shrimp were collected from Chennai, Tuticorin, Vizag, Andaman Islands (East Coast), Ratnagiri and Kollam in the West Coast. CIBA has been identified for helping the participating institutions in the outreach project to generate morphometric measurements from digitized images and analyse truss morphometric data. For this purpose, a technical document entitled '*Generation of truss data from digitized images*' detailing the procedure of generating truss data using free-to-download software, has been prepared and sent to the lead institution. This would shortly be uploaded in the outreach project website by NBFGR. For morphometric characterization, a preliminary analysis was carried out on size-adjusted truss data of Andamans and Kollam stocks to detect shape differences. Burnaby's orthogonal projection method and Rolhf and Bookstein's sheared principal components analysis were able to pick up shape differences between the two stocks. (Fig. 49 a&b). To document intra-specific genetic variability, mitochondrial DNA extraction is in progress.

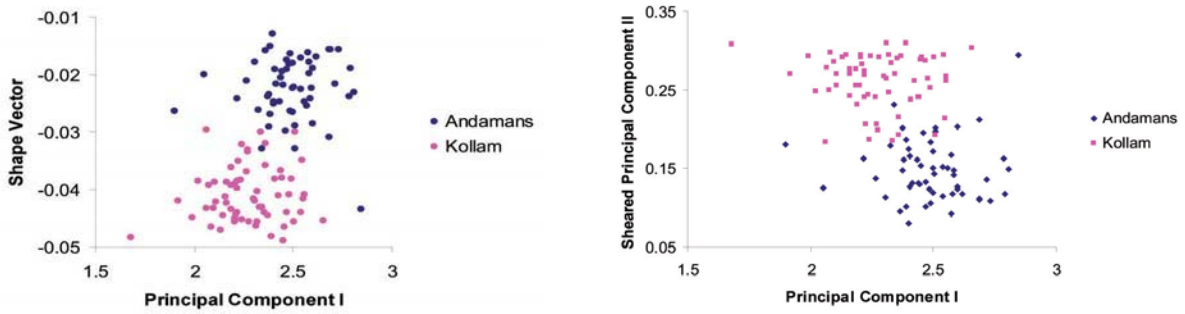


Fig. 49. (a) Burnaby's orthogonal projection method (b) Sheared Principal Components Analysis

Project Title (DBT Funded)	Improved disease resistance of rohu carp and tiger shrimp farmed in India: Developing and implementing advanced molecular methods and streamlining access to and use of genetic resources

Comparison of intramuscular and venocatch modes of infection

For intramuscular route of infection, Log rank test indicated that the Kaplan-Meier survival curves of 6 doses ($5x10^4$, 10^5, $2x\ 10^5$, $3x\ 10^5$, $4x\ 10^5$ and $5x\ 10^5$) copies of virus/animal are significantly different ($P<0.001$). The log rank test for trend is also significant ($P<0.0001$) indicating that the mortality is as per the dose administered; a higher mortality occurring with a higher dose. In Fig. 50 depicting KM curves, '1' corresponds to the lowest dose given and '6' corresponds to the highest dose. To study the influence of body weight and sex along with the viral dose on the mortalities of shrimp after WSSV challenge with intramuscular route, a Cox proportional hazard model was run. The analysis revealed that the effect of dose is significant ($P<0001$), whereas, the effect of weight and sex were not significant. With oral route of infection, a mortality pattern was observed which was not consistent with the dose administered. It was concluded that intramuscular route of administration would be used for challenging shrimp with WSSV and the oral route of infection may be abandoned. A modified experimental setup to avoid cannibalism was developed.

Collection of live tiger shrimps for RNA extraction

For the purpose of extracting RNA, samples of various tissues like gills, heart, hepatopancreas, eye-stalk, pleopods, muscle, lymphoid organ, thoracic ganglion, ovary/testes were collected from wild tiger shrimp belonging to Chennai, Tuticorin, Vizag, Kollam and Andamans. The tissues were stored in *RNALater* and sent to M/S Genotypic Technology Pvt Ltd. Bangalore for cDNA preparation.

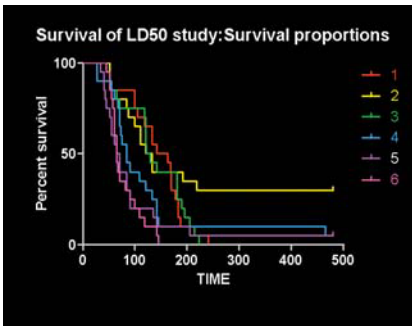


Fig. 50. Kaplan-Meier Survival curves of 6 doses (IM)

Larviculture of post larvae in hapas

Venocatch mode of infection

Project Title (DBT Funded)	Immunomodulation studies in freshwater prawn *Macrobrachium rosenbergii* using recombinant proteins of *Macrobrachium rosenbergii* nodavirus

Cloning and expression of recombinant proteins of RNA-directed RNA polymerase (RdRp), Capsid and B2 genes of *Macrobrachium rosenbergii* nodavirus

PCR amplification was carried out for RNA-directed RNA polymerase (RdRp), Capsid and B2 genes of *Mr*NV. The PCR products of RdRp (738 bp), B2 (402bp) and Capsid protein (1116bp) were ligated to pET32a (+) vector using *Nco*I and *Hind*III restriction enzymes. Expression of *Mr*NV recombinant proteins of RdRp (44.5 kDa), Capsid (58.4kDa) and B2 (32.2kDa) genes were analyzed by SDS-PAGE which included un-induced bacterial culture as negative controls. Purification of recombinant proteins was done using affinity column for use in immunomodulation studies in prawns.

Project Title (NAIP Funded)	Bioprospecting of genes and allele mining for abiotic stress tolerance

Identification of differentially expressed genes

Suppression subtractive hybridization (SSH) was performed to generate libraries of cDNA fragments enriched for salinity stress-regulated genes in *P. monodon* . Gill tissues of shrimps acclimatized at 35 ppt and 3 ppt salinity were used for RNA extraction and cDNA synthesis. Approximately 200 numbers of recombinant colonies were obtained on blue white screening. The insert from each of the SSH cDNA fragments was PCR-amplified using lysed bacteria containing recombinant plasmids. PCR products were scored for size, intensity and specificity. The amplified products obtained were in the size range of 200-850 bp, which needs to be analysed for sequence information.

SOCIAL SCIENCES DIVISION

Project Title (Institute)	Studies in resource use efficiencies and development strategies in coastal aquaculture

High count shrimp farming

High count shrimps or large-sized shrimps are those that are farmed specifically in low density regimes for longer crop durations to maximize growth. High count shrimp farming has developed as a niche segment in shrimp production in Prakasam, Guntur and Nellore districts of Andhra Pradesh. In order to estimate the supply response of small and medium farmers to price changes in exports market, Error Correction Models (ECM) were used to study weekly data of prices across counts, ex-export markets for the period 2007-2009. The study revealed that prices of high count shrimps in all the four export markets show significance in amenability to co-integration of degree one. The overall results indicated a lag period of 2 crop seasons.

Understanding of price movements and relationship across export markets to destination markets will aid production and investment decisions in terms of intensity of operations, timing of stocking, harvesting and product destinations. This study, therefore, recommends that government agencies which are mandated to promote shrimp production and the overall efficient trade of such commodities, should take serious measures beyond promotional activities that motivate disclosure of market information. These measures should be directed to traders at levels (e.g. wholesale and retail) whose price bids lead the other markets (e.g. producers and small traders at farm gates).

Emerging culture of Indian white shrimp

To tide over the problems encountered in the marketing of tiger shrimp, some farmers in Tamil Nadu, Andhra Pradesh and Gujarat have initiated the culture of Indian white shrimp *F. indicus* as it has a good demand in the domestic market. In order to assess emerging culture practices of this species, which was once cultivated extensively in India, information was collected from hatchery operators who supplied white shrimp seed and six farmers, (Gujarat-1; Tamil Nadu-5). It was observed that the farm size was generally 1- 3 ha and the production was 0.93-2.8 t/ha and FCR obtained was 1: 1.1-1.8. It was also observed that in the case of white shrimp, two to three crops (75-100 days) were possible while only one or two crops of 4- 5 month duration are possible with tiger shrimp. A farmer in Gujarat who reported a profit margin of about 50 % carried out a partial harvesting after 70 days of culture, so as to cater to the domestic market demand which was about 300 kg/day in the week days and 500 kg on Sundays. The shrimps were sold @ Rs.150-170/kg in Tamil Nadu and Rs.200/kg in Mumbai. A progressive farmer in Pattukottai, Tamil Nadu cultured and supplied the white shrimp to domestic markets in Bangalore, Goa and in Tamil Nadu during closed fishing seasons to realize a higher profit. Though no disease problems were reported in Gujarat, WSSV, LSS, *Vibrio* spp and Slow Growth Syndrome were reported from one farm at Tamil Nadu. From the observations made in this study, it could be inferred that, further spread of *F.indicus* culture would depend on the ability of farmers to exploit the domestic market.

Domestic marketing of aquaculture produce

Two case studies were taken up to evaluate the opportunities available for sustaining brackishwater aquaculture sector by bringing a shift in focus from export to domestic consumption.The Sundarbans of West Bengal and Ernakulam district of Kerala were the sites chosen for this study.

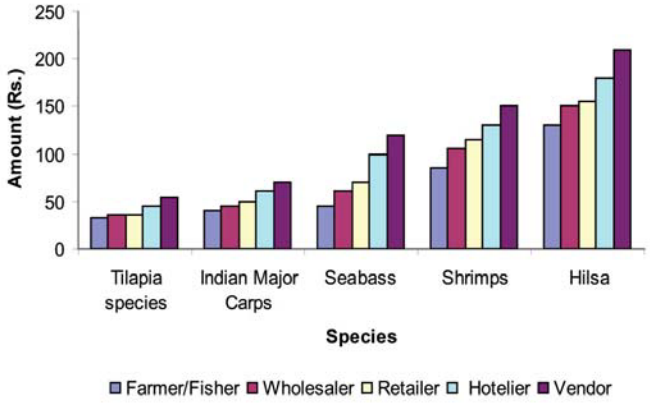


Fig. 51. Average selling price of fish across the value chain in West Bengal (Rs./kg)

The average sale prices collected from the market intermediaries in Howrah and Kakdwip fish markets are depicted in Fig. 51. There was a wide variation in the price of tiger shrimp due to variation in size/count per kilogram. The demand for hilsa and sea bass peaked during festival seasons. Though large quantities of Indian Major Carps (IMC) received from Andhra Pradesh were consumed, they fetched a very low price due to lack of freshness compared to locally available farmed or captured fish species. Tilapia was observed to be the cheapest fish available in local markets mainly catering to the poor people. The data collated (Fig. 51) indicates that the farmers received a lesser share in the consumer prices when compared to middle men in the case of low value fishes compared to hilsa, seabass and shrimp (Fig. 51). The significance of the share of the middlemen in the consumer rupee is evident from Fig.51 .

The second case study was conducted in Kerala. The Kerala State Co-operative Federation for Fisheries Development Ltd. (MATSYAFED) has introduced the Fresh Fish Express Points and Fish booths' under the Tsunami Emergency Assistance Programme (TEAP) with an aim to generate additional income to affected families.

Table 35. Domestic marketing of fish in Kerala

Sale volume/ price details	Fresh Fish Point	Fresh Fish Express	Fish booth/ Kiosk
Quantity of fish purchased (ton/year)	22.11	2.7	28.41
Quantity of fish sold (ton/year)	22.09	2.6	27.9
Cost of fish purchase (Rs (in lakh/year))	20.47	2	26.5
Total sale value (Rs (in lakh/year))	28.01	2.9	31
Profit over sale & expenses (Rs (in lakh/year))	4.21	0.85	4.9
Average rate of return (Rs./investment)	1.37	1.45	1.17
Fish sale (kg/day)	60.52	7.12	76.44
Profit per member (Rs./day)	230.68	38.81	268.49

The Self Help Group (SHGs) were encouraged to procure fish from landing centers, stock the procurement in ice boxes and then supply it to small restaurants and markets in far-flung areas. Apart from fresh fish, fish pickles, prawn pickles, dryfish were also sold in fish booths and hence their profit realization was the highest among the three models (Table. 35). This is the first time in the country that community based marketing stalls were introduced specially for

women fisher folk with the active participation, infrastructure support, and technical back-up from the government. The three models developed by MATSYAFED need to be emulated in other states as they provide a livelihood security to fisherwomen, increase the price realization by fishers and helps eliminate middlemen.

Crab fattening by Self Help Groups in Orissa

The objective of this study was to develop strategies for gender empowerment through suitable brackishwater aquaculture in Orissa. The project was conducted in collaboration with the Directorate of Research on Women in Agriculture (DRWA), Bhubaneswar. Crab fattening in ponds was successfully carried out by 10 women SHGs and 5 men SHGs in Mahensa village, Nuapada, Puri. It was carried out in ponds (1-5 ha) 3 times/year with crabs purchased from the markets of Balugaon. The duration of each fattening cycle was 30 days and the profit realized from each cycle was Rs. 4000/- pond. The farmers received financial support from DRWA, National Institute of Ocean Technology and Chilka Lake Development Authority. Their success was due to good community/family/ NGO and research institutional support and their positive attitude towards the adoption of brackishwater aquaculture technologies.

Women from Self Help Groups in Mahensa, Nuapada, Puri preparing the fattened crabs for marketing

Jelly fish processing - an alternative livelihood

The scope for jelly fish processing as an alternate livelihood for women crab farmers was assessed in Thonirevu village, Tiruvallur district, Tamil Nadu. Of the 75 women and 100 men working here in this unit, 50 were women beneficiaries practising crab fattening under the CIBA - DBT project. The total catch of jelly fish per day was about 1 to 2 tons. A Chennai based company was engaged in processing and exporting jelly fish to different countries all over the world. The daily wage paid for women was Rs. 200 per person and for men it was Rs 350. Though there is gender disparity in wages, jelly fish processing serves as an alternative livelihood occupation for the women crab farmers especially during the lean season.

Awareness on farm biosecurity

In order to develop extension literature on farm-level biosecurity, a study was undertaken to assess the awareness of farmers regarding farm biosecurity measures. A sample of 69 shrimp farmers in eight villages of Thiruvallur district

of Tamil Nadu were interviewed in this regard. This study documented the adoption of the biosecurity measures by farmers to reduce the risk of shrimp disease outbreaks and improve production. Almost all the farmers purchased shrimp seed after testing for pathogens in more than one laboratory. Though tested seed was used in many cases, the farmers opined that PCR-negative seed did not necessarily guarantee disease free culture. It was noticed that 96% had high level of knowledge about seed i.e. on the screening of brooders for pathogens, healthy / disease free brood stock, purchase of seeds from reputed hatcheries and seed testing in 2-3 labs for detecting WSSV. Almost all the farmers in Thiruvallur district used branded feed for rearing *P. monodon*. Among the farmers, 19% do not have reservoir ponds, 12% of farmers were conscious of biosecurity measures and treated the source water. Screening to exclude the carriers was adopted by 75% of the farmers. None of the farmers have adopted the effluent treatment system due to the prohibitive cost in establishing the same. To educate and sensitize farmers with regard to farm biosecurity protocols, an awareness programme was organized by the institute. Based on the feedback received from the survey and the awareness programme, an extension brochure is being developed on the need to adopt biosecurity protocols in shrimp framing to prevent WSSV.

Effectiveness of aquafarmers groups

A sample of 32 aquafarmers groups operating in Andhra Pradesh (20) and Tamil Nadu (12) were assessed for their effectiveness in terms of (i) collective biosecurity action, (ii) group operation management, (iii) interaction with stakeholders and (iv) compulsory membership. The assessment was made using an Aqua Farmers Group Effectiveness Index (AFGEI) developed by institute scientists. Only 12 groups, 7 in Tamil Nadu and 5 in Andhra Pradesh were found to be effective based on the AFGEI score of more than 70 and 100% compulsory membership for all the farms operating in the cluster which was the criteria adopted for effectiveness. Group effectiveness is the function of group cohesiveness, hence, a four point scale on the Perceived Group Cohesiveness of Farmers Groups was prepared with responses based on literature, expert consultations and focus group discussions with farmers. A purposive sample of 40 members was chosen from eight farmer groups to comprehend the determinants of group cohesiveness. Respondents rated homogeneity of group members, compulsory membership for all the farms in the cluster, size of the farmers group/association, sense of 'owning the group' by the members and equality of all members irrespective of farm holdings as the major five determinants for group cohesiveness eventually leading to group effectiveness.

Aquaculture extension through aqua-consultants

Based on the primary data collected from 45 aqua-consultants in Andhra Pradesh and Tamil Nadu and extensive consultations made in the workshop conducted at Ongole in Andhra Pradesh with 96 participants, it was observed that on-farm research (validation of technologies, inputs & primary data collection for social sciences research), technology transfer through demonstrations, field trainings and awareness campaigns, monitoring of water bodies for water quality parameters and sensitizing the farmers regularly and joint aquatic disease surveillance were the potential areas identified for partnership. A conceptual framework on public-private partnership (PPP) with aqua-consultants for aquaculture extension service was formulated. In addition, it was identified that economic incentives, authorship in publications, free access to scientific discussions and priority in government schemes/programmes might be necessary to ensure the participation of consultants in the PPP mode. A successful PPP would lead to better extension service, quality shrimp/fish seed, improved production & productivity, improved product quality, addressing environmental and food safety concerns, informed decisions and the sustainability of the sector.

Factors responsible for adoption of e-Learning module in aquaculture

Discriminant function analysis was used to identify the factors responsible for discriminating the adopter and non-adopter of an e-Learning module in aquaculture. The opinion of 70 users *viz*, 35 adopters and 35 non-adopters in Village Knowledge Centers (VKCs), in Pondicherry and Thangachimadam were investigated. Analysis of data indicated that ease of use, relative advantage, compatibility, image, education, social participation, mass media communication through print materials, mass media communication through Information and Communication Technology (ICT) and ICT center persons are responsible for discriminating between adopters and non-adopters for the e-Learning module in aquaculture. The canonical correlation value was 0.985 indicating that 97.02 % of the variance in the discriminant function scores could be explained by group differences (Table 36). Thus, a linear combination of the 22 independent factors explained 97 % of the variance in the dependent factor. The Wilk's λ criterion of 0.029 percent and the standard canonical discriminant function confirmed that the factors identified in the model were significant discriminating factors.

Table 36. Canonical discriminant function and its characteristics discriminating the adopter and non-adopter of e-Learning module in aquaculture

Function	Eigen value	% of variance	Cumulative λ	Canonical correlation	Wilk's λ	χ^2	df	P-value
1	33.596	100	100	0.985	0.029	205.54	20	0.00

Project Title (DAHDF Funded)	**An assessment of literacy, income and health status of fishers in India**

Under this project initiated in the second fortnight of March 2010, it was envisaged to make a rapid estimation of literacy, income and health of fishers in India. The CMFRI, Kochi is leading the project. This Institute has been entrusted with the responsibility of covering 5 sectors that includes marine, inland, freshwater, brackishwater and processing & marketing in Andhra Pradesh. Data collection work covering the primary concerns of the project was initiated in AP with the help of the Department of Fisheries and Regional Stations of ICAR Fisheries Research Institutes in AP. The master table for data entry has been received from CMFRI, Kochi, and data entry has been initiated for inland fisheries of Andhra Pradesh. Data from fisheries of Ramappa and Lakhnavaram reservoirs in Warangal district and Wyra and Paleru reservoirs in Khammam districts are being compiled. It is contemplated to complete the data coding, compilation and entry by July 2010.

Project Title (NABARD Funded)	**Cost effective shrimp farming through adoption of indigenous innovative feed and better management practices by small scale farmers**

The sustainability and profitability of shrimp aquaculture depends largely on feeds, as feeds make up more than 50 percent of the total production cost. Most of the commercial shrimp feeds available in the market cost Rs.50-55/kg while the feed marketed with technology developed by CIBA using indigenous raw materials costs Rs. 5 less than the commercial feeds. This can considerably increase profits in shrimp production. To demonstrate this and to increase the production through Better Management Practices (BMP), a NABARD funded project has been initiated in March 2009, in Ramanathapuram district of Tamil Nadu for a period of two years. The choice of the areas was based on a

baseline survey which indicated that majority of the population in this district comprise marine fish folk, marginal farmers and landless labourers and no large scale agricultural farming is possible due to limited irrigation sources. A large number of coastal shrimp farms and hatcheries which had come into existence since 1990 have wound up due to combined effects of legal interventions, social opposition, white spot disease and the formation of acid sulphate in farm ponds. Through the proposed technological interventions, it is proposed to increase the profit margins in shrimp aquaculture and to make it an attractive livelihood option in this district.

Project Title (DBT Funded)	**Diversification of livelihoods among women Self Help Groups through coastal aquaculture technologies**

The main objective of the project was to refine and disseminate brackishwater aquaculture technologies to Women Self Help Groups (WSHGs). During the earlier period 2007-2009, about 200 women from the coastal villages of Thonirevu village, Light House kuppam, Kattur village, Tiruvallur district and Alambarai kuppam, Kancheepuram district were trained in the following brackishwater aquaculture and allied technologies *viz* (i) mud crab fattening (ii) preparing farm-made aqua feed using a small feed pellet unit and (iii) preparing value added fish products. The technology was further disseminated to 69 SHGs through installation of units and hands-on training.

Mud crab fattening technology

Soft crabs used for the demonstration was purchased @ Rs.180/kg. The hardened crabs were sold at Rs.250/kg to Rs.480/kg. Majority of the beneficiaries adopting this technology (75%) belonged to the low income group. The profit realized was Rs. 5600/cycle and one of the major reasons for this was that the labour was shared by the members of SHGs (Table 37). The profit gained from this enterprise was saved in the banks by the SHGs Based on the savings, these beneficiaries received bank loans from the bank. Each group received a loan amount of Rs. 60,000. This community-based crab fattening project has generated extra income to the family and created awareness among coastal women on potential alternate livelihoods. This has also motivated fifteen women SHGs of Irrular tribal community at Kulathumedu, Pulicat (Tiruvallur district), Tamil Nadu to adopt crab fattening technology.

Table 37. Details and economics of crab fattening in pen by women SHGs

S.No.	Particulars	Units
1	Pen size (sq.ft)	1200
2	Culture period (days)	21
3	Cycle per year (cycle)	6-8
4	Stocking density (Nos /m^2)	2
5	Stocking (@ Rs.180/kg)	60
6	Survival rate (%)	80
7	Mortality rate (%)	20
8	Weight gain during harvest (g)	50 – 100
9	Harvest (sold at @ Rs. 250-480/kg)	56
10	Working capital (water crabs, feed, watchman & transportation) (Rs.)	16, 400
11	Income through sales (Rs.)	22, 000
12	Profit / cycle (Rs.)	5600

Farm made aqua feed technology

The scaled down version of farm-made aqua feed unit developed by the institute can produce 20 kg of feed in an hour and costs Rs. 4 lakhs.The cost of feed works out to Rs. 30/kg and can be stored for 2 months. A study conducted among the beneficiaries in Kancheepuram and Tiruvallur district revealed that almost 94 percent of the WSHG members were willing to adopt this technology. The availability of raw materials (80%) and sufficient space for drying the feed ingredients (96%) were identified as crucial factors in adopting this technology.

Value added fish product development

A total of 50 women from the Women Self Help Groups of Tiruvallur District and Kancheepuram Districts were the beneficiaries identified for adopting this technology. Based on the training imparted by the institute, value added fish food products like fish cutlets, fish pickle, shrimp pickle and fish wafers were developed by these beneficiaries in a hygienic manner and packed in attractive covers developed by this institute. Market linkages were identified for these products through various interactions. The potential of this intervention to generate additional income is evident from the analysis of net returns for the three items developed and marketed by them: fish pickle-Rs. 240 (batch of 12 bottles); shrimp pickle –Rs. 300 (batch of 12 bottles); and fish samosa-Rs 137.50 (batch of 55 nos.).

Value added fish product development by the WSHGs

Establish market linkages

Market linkages were created for the products developed by the beneficiaries by conducting various programmes *viz*.: (i) by setting up of stalls for display and sales during the CIBA-QRT meeting held on 27th June 2009 ; (ii) Seminar on 'Building Market Linkages for the Fish Food Products Developed by the Coastal Women beneficiaries' and a 'Food Pro' to display the fish food products on 27th November 2009 (iii) 'Stake Holders Meeting to Strengthen Sustainable Development Among the Coastal Women Self Help Groups Beneficiaries' on 20th February 2010 at the institute during which an exhibition was also conducted to promote the sales. All the three products like crabs, feed and value added fish products developed by the beneficiaries were put on display for sale to the public. The beneficiaries also marketed their fish food products in the nearby petty shops. The aqua feed was supplied to the nearby farms.

Members of the women SHGs displaying the harvested crabs in the exhibition

Project Title (NFDB Funded)	Prospective study on marketing and value chain improvement strategies for promoting Asian seabass *(Lates calcarifer)*

SWOT analysis of Asian seabass farming

The SWOT analysis on Asian seabass farming was done by interacting with a cross section of stakeholders in this sector. The study revealed the major Strengths, Weaknesses, Opportunities and Threats as listed in Table 38. Availability of land and water resources and technology were the strengths while the weakness was the availability of seed. Governmental assistance in development of nucleus nursery centers would help to overcome this weakness. Other opportunities available are: skilled manpower, large domestic demand and exports possibilities.

Table 38. SWOT analysis of Asian seabass farming

Value chain point	Strength	Weakness	Opportunity	Threat
Hatchery-Nursery	• Technical know how • Year round breeding	• Inadequate hatcheries /nucleus nursery centres • Inadequate seed availability	• Availability of educated youth for skilled nursery work	• Development above demand may reduce the price
Farming	• Large land area & land and water bodies	• Comparatively lower profit margins	• Abandoned shrimp ponds • Price crash of shrimps	• Lower price if farmed on large scale
Processing value addition	• Filleting • Ethnically liked fish	• Skin, bones of sea bass • Processing technologies suiting ethnic tastes are yet to be developed	• Cheaper labour • Excess processing capacity	• Acceptability of value added sea bass • Consumer willingness to pay for value addition
Marketing & Consumption	• Easy reach to live fish market in domestic and South East Asia. • Liking for Asian seabass in North European countries	• High food safety standards of export markets	• Large domestic markets • Indian exposure in European fish markets	• Thailand, Australia, Greece and Turkey are technically advanced and nearer to major consumption centers.

Comparative farm level production economics of Asian seabass and tiger shrimp

The financial profitability of seabass farming was worked out as 29% of Return on Investment (ROI). On comparison with tiger shrimp in a planning horizon of 10 years, with inclusion of 0.49 estimated probability of risk of crop failures for shrimp, Internal Rate of Return (IRR) values of 29% and 24% were computed for seabass and shrimp farming respectively (Table 39).

Table 39. Comparative economics of seabass and tiger shrimp farming

Sample characteristics	Cost (Rs./ha)			
	Asian seabass		tiger shrimp	
	Cost	% [5]	Cost	% [5]
A. Variable costs (Rs.)				
1. Seed cost[1]	50000	10	26284	9
2. Feed[2]	300000	64	130106	43
3. Others	126475	27	95969	30
4. Total variable costs	426475	91	252359	82
B. Fixed Cost				
5 Total fixed costs (Rs.)	42000	9	52575	18
6. Total cost (Rs.)	468475	100	304935	100
7. Output (kg/ha)[3]	4000		1577	
8. Average price kg/ha (Rs.)	150		250	
C. Economic indicators (Rs.)				
9. Gross Returns	600000		394263	
10. Gross Profit	173525		141903	
11. Net Profit	131525		89328	
12. Capital recovery per month[4]	21921		22332	

Seabass seed at 40-50 g size @Rs.10 each; [2.] Feed: Seabass - trash fish @ Rs.15/kg (including transport); [3.] Seabass & seabass equivalent of tilapia by-catch; [4.] Net profit /crop duration: Shrimp 4 months and Sea bass 6 months; [5.] percentage of total cost

Interestingly it was observed that a 10 % increase in revenue (either by increase of output quantum/price) or a 10 % decrease in costs would make both seabass and shrimp culture to return IRR values over 40 %. Unplanned development of seabass farming without suitable domestic marketing plan in place may bring down the domestic prices. Extensive value chain player surveys are being carried out across the country and it is proposed to give a suitable business plan for developing Asian seabass farming in India.

Project Title (NAIP Funded)	**Agroweb – Digital Disseminations System for Indian Agricultural Research (ADDSIAR)**

The CIBA website was completely using JOOMLA open source software platform following uniformity guidelines issued recently by ICAR. An intranet module and databases on aquaculture production and export scenario, candidate species, major diseases and preventive and curative measures and policy issues were developed and integrated with the website as online modules. The intranet was further augmented with circulars, forms, photo gallery, bilingual format for making banners for official meetings etc. A digital repository of institute scientific publications was added

with abstracts of 502 publications which emerged from the institute in the past years. National training as approved by NAIP for the five project staff was completed. A training workshop on 'Distributed ownership of Institutional websites for content management and up-date' was conducted on 16th March, 2010. A total number of 35 participants attended the programme and experts from NAARM, Hyderabad, IIT, Chennai, FC&RI, Tutucorin and MSSRF, Chennai participated. Issues relating to format, content authoring and approval of web content management with distributed ownership were discussed.

KAKDWIP RESEARCH CENTRE

Project Title (Institute)	**Refinement of traditional brackishwater aquaculture systems for sustainable production of shrimp and fishes improving shrimp culture practices and developing organic farming systems**

Periphyton based shrimp farming

Periphyton is a significant and dominant contributor to primary production, especially in shallow waters. As shrimp in their natural habitats prefer to forage on micro invertebrates and zooplankton, periphyton can form an excellent source of natural food, apart from improving diversity of benthic fauna in confined culture systems. To evaluate a periphyton based farming system for *Penaeus monodon*, a yard experiment was conducted for a period of 75 days in 100 l tanks in triplicate with and without (control) bamboo substrates. Daily, both the groups received CIBA feed containing 32% protein at @ 6-10 %. The salinity during the experiment was 10 ppt and water exchange of 20 % was carried out thrice a week. A significantly ($P < 0.05$) higher growth was observed in treatment group (4.12g) compared to control (2.89g). Further, it was observed that the treatment group had a higher survival rate, better water quality and a higher microbial load in the gut of animals. Based on these results, it was proposed to test periphyton as a additional factor in the protocol standardized for low input shrimp organic farming in ponds.

Organic shrimp farming technology

Low input shrimp farming based on organic principles with low stocking and using all organic inputs was successfully carried out in three year field trials with *P. monodon* and the technology developed is summarised below. This Low Input Low Cost (LILC) farming with 6 pc/sq m stocking yielded better growth rate (Final ABW >30g). Besides an improvement in the quality of shrimps, the production range was higher at 1289-1308 kg/ha/crop. There was a substantial gain in production level (14-21 %), size at harvest (10-19 %) and better FCR (lowered by 4-18 %) in LILC ponds by practicing the organic mode of farming compared to conventional farming.

In the low input low cost farming system following organic principles developed by the institute, the production cost was Rs. 135-140/ kg of shrimp compared to a higher production cost of Rs 165-170/ kg in conventional farming systems (Table 40).

Table 40. Economic evaluation of LILC farming system compared to that of the conventional farming system for 1 ha

Parameters	LILC Farming (Rs.)	Conventional farming (Rs.)
Operational cost		
0.60 lakh seeds@ 0.5/ per PL	30,000/-	30,000/-
Pond preparation *	25,000/-	28,000/-
Feed cost **:	48,000/	60,000/-
Lime and other inputs	25,000/	30,000/-
Labor and other management cost	27,000/-	27,000/-
Harvesting and related expenditure	15,000/-	15,000/-
Total operational cost	1,70,000/-	1,90,000/-
Cost of production (per kg)	136/-	165/-
Revenue to be generated		
Production expected (tons)	1.20-1.30	1.10-1.20
Revenue expected@ 240/- per kg	3,00,000/	2,76,000/-
Rate of Return over operational cost	70 %	45 %

* manure and other organic inputs ** LILC: 1.5 tonnes (FCR: 1.2) @ Rs 32/- Conventional :1.43 tonnes (FCR:1.25) @ Rs 42/-

Organic shrimp feed using *Azolla*

Four types of low fish meal (20, 18, 16, and 14 %) shrimp diets were formulated with the inclusion of 5 % level of *Azolla* and tested with *P. monodon* in triplicate. After 42 days of the experiment, it was found that the feed containing 18% fish meal and 5% *Azolla* (Table 41) performed significantly ($P<0.05$) better, recording a higher weight gain. This study indicated that by incorporation of *Azolla* at 5 % level, it is possible to reduce fishmeal and still achieve good growth.

Table 41. Performance of *Penaeus monodon* fed with feed containing 5 % *Azolla* and different levels of fish meal

Parameters	Inclusion level of fish meal (%)			
	20	18	16	14
Initial body weight (g)	0.97±0.04	0.98±0.03	0.96±0.03	0.98±0.04
Final body weight (g)	3.52^{b} ±0.01	3.58^{c} ±0.00	3.50^{b} ±0.03	3.44^{a} ±0.12
Average daily gain (mg/day)	60.79^{bc}±0.42	62.06^{c} ±0.29	60.40^{b} ±0.65	58.73^{a} ±0.35
Total Weight gain (g)	2.55^{bc}±0.02	2.61^{c} ±0.01	2.53^{b} ±0.03	2.47^{a} ±0.01
Weight gain (%)	263.27^{b} ±3.38	266.96^{b} ±3.66	263.33^{b} ±3.23	252.55^{a} ±0.77
FCR	1.64^{c} ±0.00	1.47^{a} ±0.34	1.64^{c} ±0.02	1.55^{b} ±0.02
TDMI (g)	4.18^{b} ±0.03	3.83^{a} ±0.07	4.15^{b} ±0.02	$3.84\pm^{a}$ 0.04

Means followed by the same superscript do not significantly differ from each other.

Low cost feed with plant ingredients for polyculture

For formulation of a low cost feed for polyculture of mullets and shrimp, the inclusion levels of Sunflower Cake (SFC), Deoiled Karanja Cake (DOKC), Mung Husk (MH), Mango Seed Kernel (MSK) and Tamarind Seed Powder (TSP) in diets for *M. cephalus* was determined. Considering the inclusion level of non-conventional ingredients, three types of low cost feed were formulated with 22, 10 and 7 per cent of fish meal (Table 42) and were tested in a yard trial. It was found that feed (CP-27.49%) containing different non-conventional ingredients (sunflower cake, mung husk etc.) with 10% fish meal performed at par with that of feed (CP-29.40%) containing 22 % fish meal in respect to growth and FCR (Table 43).

Table 42. Low cost feed developed with plant ingredients for polyculture

Ingredients	Feed type		
	I (%)	II (%)	III (%)
Wheat flour	12	12	12
Fish meal	22	10	7
MOC	35	40	38
Ricebran	30	22	25
Sunflower cake	0	10	10
Karanja Cake	0	0	2.5
Mung husk	0	5	5
Min. mix.	1	1	1
	CP-29.40 %	CP-27.49 %	CP-25.76 %
	Rs.15.19/ kg	Rs.14.49/ kg	Rs.13.74/ kg

Table 43. Performance of *Mugil cephalus* fed with different types of low cost feed formulated with locally available ingredients

Parameter	Feed I (fish meal-22%)	Feed II (fish meal-10%)	Feed III (fish meal-7%)
Initial body wt. (g)	0.43±0.03	0.43±0.03	0.43±0.03
Final body wt. (g)	1.36 [b] ±0.07	1.26 [b] ±0.04	0.99 [a] ±0.05
Total wt. gain (g)	0.93 [b] ±0.05	0.82 [b] ±0.02	0.55 [a] ±0.02
Total feed intake (g)	3.91±0.12	3.87±0.12	3.89±0.12
FCR	4.26 [a] ±0.13	4.73 [a] ±0.19	7.05 [b] ±0.15
PER	0.75 [b] ±0.02	0.71 [b] ±0.03	0.52 [a] ±0.01
SGR (%)	2.73 [b] ±0.06	2.56 [b] ±0.12	1.98 [a] ±0.06
Dry matter (DM)	85.68 [b] ±0.20	84.52 [b] ±0.18	60.47 [a] ±9.03
Organic mater (OM)	87.95 [b] ±0.41	86.81 [ab] ±0.43	86.73 [a] ±0.32
Crude Protein (CP)	94.94 [b] ±0.11	93.65 [ab] ±0.17	93.24 [a] ±0.37
Ether Extract (EE)	93.23 ±0.56	92.47±0.32	93.47±0.17
Crude Fibre (CF)	65.41 [a] ±0.60	64.51 [a] ±0.49	68.53 [b] ±0.23
Nitrogen Free Extract (NFE)	86.38±0.76	85.72±0.75	86.63±0.23

Means followed by the same superscript do not significantly differ from each other

Disease surveillance in different shrimp farming systems

Disease surveillance was carried out through a structured questionnaire in 198 farms from three coastal districts of West Bengal during 2007-10. Traditional bhery culture was practised in North 24 Parganas whereas shrimp monoculture was predominant in East Medinipur. Both the systems of culture were practiced in South 24 Parganas while paddy-cum-fish culture was carried out along Ichchamati river bank of North 24 Parganas. The total farm area surveyed was 797 ha, including 626.64, 38.48 and 131.88 ha in North 24 Parganas, South 24 Parganas and East Medinipur and 143.6, 636.45 and 16.95 ha in shrimp monoculture, traditional bheries and paddy-cum-fish culture, respectively. The blockwise details of the farms surveyed in West Bengal : North 24 Parganas: Taki (25), Basirhat (14), Haroa (12), and Barasat-2 (17), South 24 Parganas: Kakdwip (16), Kulpi (2), Sagar Island (7), and Namkhana (9), East Medinipur: Contai-2 (20), Contai-3 (7), Deshpran (6), Basantia (5), Khejuri (7), Narghat (5), Nandakumar (9), Mahisadal (3),

Chandipur (4), Nandigram-1 (3), Nandigram-2 (8), Roea para (3), Heria-1 (1), Heria-2 (1), Kalagachia (1), Kamarda (10), and Sourabera Japi (3).

The *P. monodon* samples were screened for white spot disease (WSD) by polymerase chain reaction (PCR). The WSD outbreak was significantly high among the PCR non-tested seeds. Prominent clinical signs observed were white spots, red discoloration, and healthy (PCR nested positive). Co-infection of *Vibrio mimicus* and WSD was observed in a shrimp monoculture pond (Fig. 52). The LD_{50} for *V. mimicus* was computed to be $10^{7.32}$ in a yard experiment with *P. monodon* and no unusual resistance was observed in the isolate with 22 antimicrobial compounds. Strict biosecurity measures such as farm, crab and bird fencing were found to play a major role in containing the disease outbreak in shrimp monoculture farms.

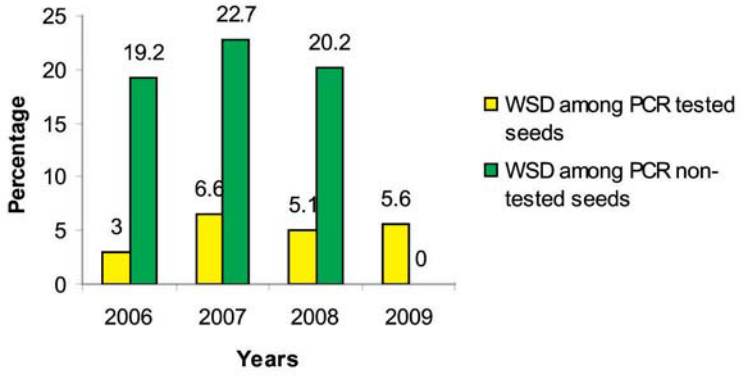


Fig. 52: Comparison of WSD outbreaks among PCR tested and non-tested seeds.

In the case of polyculture farms that were surveyed (n= 250) gill infection, epizootic ulcerative syndrome and skin infections were the common diseases observed in fish. A small percentage of fish in two farms were observed positive for Iridovirus and viral nervous necrosis.

Project Title (NAIP Funded)	Strategies for sustainable management of degraded coastal land and water for enhancing the livelihood security of farming communities

The objectives of the project are to promote the enhancement of productivity of degraded land and water resources through integrated approaches viz., livelihood security, employment generation for the poor farming communities , empowerment through capacity building and skill development of stakeholders including men and women farmers of the coastal region.

Stakeholders drawing resource map at project site

Discussion with the village women

The work was initiated with a baseline survey which was conducted in six selected villages viz. Akshaynagar, Gangadharpur, Jumainaskar, Ganeshnagar, Dwariknagar and Uttar Chandanpiri from two clusters (Kakdwip and Namkhana) . Beneficiaries are being selected for implementation of the interventions. Most of the farmers belong to poor and lower middle class category. The major brackishwater aquaculture activity was found to be the monoculture of shrimp during June to September and polyculture of finfishes and shrimps from July to November. Freshwater aquaculture with IMC and grass carp/ silver carp is a common practice in almost all the households. Major agricultural crops include paddy, betelvine, brinjal, chilli, potato, tomato etc.

5

List of Ongoing Research Projects for the year 2009-2010

CRUSTACEAN CULTURE DIVISION

Project Title 1	**Sustainable shrimp production through domestication of *Penaeus monodon,* development of culture practices for *Marsupenaeus japonicus* and adoption of best management practices in farming – CCD/B&C/2**
Project Leader	**Dr.P.Ravichandran, Head, CCD**
Project Location	**Chennai and Kakdwip**

Sub-Project Title, Leader and Team

1.1 Improvement of reproductive performance in domesticated *Penaeus monodon*

Sub-Project Leader: Dr. C.P. Balasubramanian

Sub-Project Team: Dr. P. Ravichandran, Dr. S.M Pillai, Dr. C. Gopal, Dr. M. Jayanthi, Dr. P. Nila Rekha & Dr. Syama Dayal

1.2 Evaluation of biosecurity BMPs in shrimp farming

Sub-Project Leader: Dr. M. Muralidhar

Sub-Project Team: Dr. P.Ravichandran Dr. K.Ponnusamy, Dr. A.Panigrahi, Dr. M.Kumaran & Dr. R. Saraswathy

1.3 High density culture of *F. merguiensis*

Sub-Project Leader: Dr.S.M. Pillai

Sub-Project Team: Dr.C.Gopal, Dr.A.Panigrahi & Ms.Shyne Anand

1.4 To develop and demonstrate culture technologies for *M. japonicus*

Sub-Project Leader: Dr. A. Panigrahi

Sub-Project Team: Dr.P.Ravichandran, Dr. S. M.Pillai & Dr.C.P.Balasubramanian

1.5 To study the pattern of horizontal transmission of WSSV in shrimp farms

Sub-Project Leader: Dr. C.Gopal

Sub-Project Team: Dr.P.Ravichandran, Dr. M. Muralidhar & Dr. D. Deboral Vimala

1.6 Probiotic seed production techniques for tiger shrimps

Sub-Project Leader: Dr.A. Panigrahi

Sub-Project Team: Dr.C.Gopal, Dr P. Ravichandran, Dr.S.M.Pillai & Dr. P.K. Patil

1.7 District level planning for brackishwater aquaculture

Sub-Project Leader: Dr. M.Jayanthi

Sub-Project Team: Dr. P.Ravichandran, Dr. M.Muralidhar, Dr. K.Ponnusamy & Dr. M.Kumaran

1.8 Domestication of tiger shrimp

Sub-Project Leader: Dr. G. Gopikrishna

Sub-Project Team: Dr. C.Gopal, Dr. C.P. Balasubramanian, Dr. Sherly Tomy & Dr. K. Vinaya Kumar

Project Title 2	**Development of packages for nursery and grow-out culture of mud crabs *(Scylla* spp.)**
Project Leader	**Dr. S. Kulasekarapandian, Principal Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title, Leader and Team

2.1 Development of packages for nursery rearing of mud crabs (*Scylla* spp.)

Sub-Project Leader: Dr. S. Kulasekarapandian

Sub-Project Team: Dr. C.P. Balasubramanian, Dr. K.K. Krishnani & Dr. Ezhil Praveena

2.2 Development of packages for larval rearing in mud crabs (*Scylla* spp.)

Sub-Project Leader: Dr. C.P. Balasubramanian

Sub-Project Team: Dr. S. Kulasekarapandian, Dr. K.K. Krishnani & Dr. Ezhil Praveena

2.3 Development of packages for grow-out culture of mud crabs (*Scylla* spp.)

Sub-Project Leader: Dr. C.P. Balasubramanian

Sub-Project Team: Dr. S. Kulasekarapandian, Dr. K.K. Krishnani & Dr. Ezhil Praveena

Project Title 3	**Aquaculture farm appraisal and impact assessment using remote sensing and GIS**
Project Leader	**Dr. M.Jayanthi, Senior Scientist**
Project Location	**Chennai**

Sub-Project Title, Leader and Team

3.1 Assessment of impact of aquaculture on mangroves and agricultural lands

Sub-Project Leader: Dr. M.Jayanthi

Sub-Project Team: Dr. P.Ravichandran, Dr. M.Muralidhar & Dr. P.Nila Rekha

3.2 Impact assessment of shrimp farming on coastal aquifer

Sub-Project Leader:Dr P. Nila Rekha

Sub-Project Team: Dr. M.Jayanthi & Dr. P. Ravichandran

Project Title 4	**Collaborative project on brackishwater aquaculture development in Gujarat**
Project Leader	**Dr.S.M.Pillai, Principal Scientist**
Project Location	**Navsari Agricultural University, Navsari**

Sub-Project Title, Leader and Team

4.1 To develop and demonstrate culture technologies for banana shrimp *Fenneropenaeus merguiensis/ Penaeus monodon* and Asian seabass *Lates calcarifer*

Sub-Project Leader: Dr. S.M.Pillai

Sub-Project Team: Dr. C.Gopal, Dr. M.Muralidhar, Dr. Ezhil Praveena & Dr. Prem Kumar

4.2 To evaluate *Penaeus monodon* farming practices in Gujarat and assess the potential for culture of brackishwater finfishes

Sub-Project Leader: Dr. K.Ponnusamy

Sub-Project Team: Dr. C.Gopal, Dr.M.Muralidhar, Dr.Prem Kumar & Dr. S.M.Pillai

4.3 To address the extension needs of brackishwater aqua farmers

Sub-Project Leader: Dr. V.S.Chandrasekharan

Sub-Project Team: Dr. K.Ponnusamy & Dr. S.M.Pillai

4.4 To understand the farming practices of *L.vannamei* and to generate the database

Sub-Project Leader: Dr. C.Gopal

Sub-Project Team: Dr. S.M.Pillai & Dr. C.Gopal

Project Title 5	**Seed production Technology of commercially important brackishwater fishes**
Project Leader	**Dr. A. R. Thirunavukkarasu, Head, FCD**
Project Location	**Chennai & Kakdwip**

Sub-Project Title, Leader and Team

5.1 Development of seed production technology for Asian seabass *Lates calcarifer*

Sub-Project Leader: Dr. A. R. Thirunavukkarasu

Sub-Project Team: Dr. M.Kailasam, Dr. J.K.Sundaray, Dr. Shiranee Pereira, Sh. G. Biswas & Dr. Krishna Sukumaran

5.2 Development of controlled breeding techniques for grey mullet *Mugil cephalus*

Sub-Project Leader: Dr. M.Natarajan

Sub-Project Team: Dr. M.Kailasam, Dr. Shiranee Pereira, Dr. J.K.Sundaray & Dr. Krishna Sukumaran

5.3 Development of breeding technology for ornamental fishes

Sub-Project Leader:Dr. M.Kailasam

Sub-Project Team: Dr. A. R. Thirunavukkarasu, Dr. J.K. Sundaray & Dr. Shiranee Pereira,

5.4 Development of breeding and larval rearing techniques for milkfish *Chanos chanos*

Sub-Project Leader: Dr. J.K.Sundaray

Sub-Project Team: Dr. A. R. Thirunavukkarasu, Dr. M. Kailasam, Dr. Shiranee Pereira & Dr. K. Ambasankar

5.5 Development of breeding and seed production techniques for other brackishwater finfishes Cobia (*Rachycentron canadum*), Andaman Tilapia (*Oreochromis urolepis*)

Sub-Project Leader: Dr. A. R. Thirunavukkarasu

Sub-Project Team: Dr. M. Kailasam & Dr. J.K.Sundaray

Project Title 6	**Culture of commercially important brackishwater fishes**
Project Leader	**Dr. M. Natarajan, Principal Scientist**
Project Location	**Chennai & Kakdwip**

Sub-Project Title, Leader and Team

6.1 Culture of Asian seabass *Lates calcarifer* in ponds and cages

Sub-Project Leader: Dr. A. R. Thirunavukkarasu

Sub-Project Team: Dr. J. K. Sundaray, Shri G. Biswas & Dr. S. A. Ali

6.2 Culture of grey mullet *Mugil cephalus*

Sub-Project Leader: Dr. M. Natarajan

Sub-Project Team: Dr. M. Kailasam, Shri G. Biswas & Dr. T. K. Ghoshal

6.3 Culture of pearl spot *Etroplus suratensis* in tide fed farms at Kakdwip and backyard farms of farmers at Kakdwip

Sub-Project Leader: Dr. M. Natarajan

Sub-Project Team: Dr. M. Kailasam, Shri G. Biswas & Dr. Debasis De

6.4 Monoculture of milkfish *Chanos chanos* in pens and ponds at Muttukadu and Kakdwip Research centre

Sub-Project Leader: Dr. J. K. Sundaray

Sub-Project Team: Shri G. Biswas

6.5 Secondary aquaculture in effluent treatment pond

Sub-Project Leader: Dr. Shiranee Pereira

Sub-Project Team: Dr. A. R. Thirunavukkarasu, Dr. M. Natarajan, Dr. M. Kailasam, Dr. J.K. Sundaray & Dr. Krishna Sukumaran

Project Title 7	**An export oriented marine value chain for farmed seafood production using Cobia (*Rachycentron canadum*) through rural entrepreneurship**

Project Location: Chennai

Funding Agency: National Agricultural Innovation Project

Lead Centre: Tuticorin Fisheries College

Co-Principal Investigator: Dr.A.R.Thirunavukkarasu

Co-Investigators: Dr. M. Kailasam & Dr. J.K.Sundaray

Project Title 8	**Demonstration of Asian seabass *Lates calcarifer* farming in the pond culture system**

Project Location: Chennai

Funding Agency: National Fisheries Development Board

Principal Investigator: Dr.A.R.Thirunavukkarasu

Co-Investigators: Dr.. M. Kailasam, Dr. J.K Sundaray, Dr.Prem Kumar, Dr. S.A. Ali, Dr. K. Ambasankar & Dr. J. Syama Dayal

AQUATIC ANIMAL HEALTH AND ENVIRONMENT DIVISION

Project Title 9	**Investigations on epidemiology of infectious diseases of fish and shellfish and development of diagnostics and prophylactics**
Project Leader	**Dr.T.C.Santiago, Principal Scientist**
Project Location	**Chennai & Kakdwip**

Sub-Project Title, Leader and Team

9.1 Screening for emerging diseases and development of suitable diagnostic techniques

Sub-Project Leader:Dr. S.V.Alavandi

Sub-Project Team: Dr. T.C.Santiago, Dr. N. Kalaimani, Dr. M.Poornima, Dr. Ananda Raja, Dr. S. Sujeet Kumar & Dr. P. Ezhil Praveena

9.2 Assessing risk to shrimp farming due to increased crab culture

Sub-Project Leader:Dr. M. Poornima

Sub-Project Team: Dr. T.C. Santiago, Dr N. Kalaimani, Dr.K.P. Jithendran, Dr. S.V. Alavandi, Dr. Ananda Raja & Dr. S. Sujeet Kumar

9.3 Use of antimicrobials, prophylactics and therapeutics in shrimp aquaculture

Sub-Project Leader: Dr. N. Kalaimani

Sub-Project Team: Dr. T.C. Santiago, Dr. S.V.Alavandi , Dr. M.Poornima & Dr. S.K. Otta

9.4 Epidemiology of Iridovirus in fish

Sub-Project Leader: Dr. K.P. Jithendran

9.5 Studies on therapeutics and immunodiagnosis for shrimp viral disease

Sub-Project Leader:Dr. M.S.Shekhar

9.6 Development of quorum sensing (luminescence) inhibitors against *V. harveyi*

Sub-Project Leader: Dr. S. Kannappan

Project Title 10	**Shrimp pond soil and water management practices and products that mitigate environmental impact and increase productivity**
Project Leader	**Dr.B.P.Gupta, Principal Scientist**
Project Location	**Chennai & Kakdwip**

Sub-Project Title, Leader and Team

10.1 Bioremediation products to be used in shrimp farming

Sub-Project Leader: Dr. K.K. Krishnani

Sub-Project Team: Dr. B.P. Gupta & Dr. K. Ponnusamy

10.2 Nutrients dynamics in culture ponds under varying culture practices

Sub-Project Leader: Dr. R. Saraswathy

Sub-Project Team: Dr. B.P.Gupta, Dr. M. Muralidhar, Dr. K.K. Krishnani, Dr. A. Panigrahi & Dr. M. Kailasam

10.3 Tools for assessment of carrying capacity of creek based ecosystem

Sub-Project Leader: Dr.M.Muralidhar

Sub-Project Team: Dr. B.P.Gupta, Dr. M.Jayanthi, Dr. R.Saraswathy & Sh. S. Nagarajan

10.4 Communicate environmental impact information and render services

Sub-Project Leader: Dr. B.P.Gupta

Sub-Project Team: Dr. K.K.Krishnani, Dr. M.Muralidhar, Dr. R.Saraswathy, Dr. K.Ponnusamy & Dr. Sujeet Kumar

10.5 Microbiological dynamics with special reference to bioflocs

Sub-Project Leader: Dr. Sujeet Kumar

Sub-Project Team: Dr. T.K. Ghoshal & Ms. Shyne Anand

Project Title 11	**Application of micro-organisms in agriculture and allied sectors - agrowaste management, bioremediation and microbes in post harvest processing**

Project Location: Chennai

Funding Agency: National Bureau of Agriculturally Important Microbes

Principal Investigator: Dr. S.V. Alavandi

Co-Investigators: Dr.T.C.Santiago & Dr. N. Kalaimani

Project Title 12	**Application of micro-organisms in agriculture and allied sectors - microbial diversity and identification**

Project Location: Chennai

Funding Agency: National Bureau of Agriculturally Important Microbes

Principal Investigator: Dr.T.C.Santiago

Co-Investigators: Dr. N. Kalaimani & Dr. S.V. Alavandi

Project Title 13	**Indo-Norwegian platform on fish and shellfish vaccine development**

Sub-project : Development of bacterial vaccine (*Vibrio anguillarum*) for seabass

Project Location: Chennai

Funding Agency: Department of Biotechnology

Principal Investigator: Dr.T.C.Santiago

Co-Investigators: Dr. N. Kalaimani & Dr. M. Poornima

Project Title 14	Indo-Norwegian platform on fish and shellfish vaccine development

Project Location: Chennai

Funding Agency: Department of Biotechnology

Principal Investigator: Dr.T.C.Santiago

Co-Investigators: Dr. N. Kalaimani & Dr. M. Poornima

Project Title 15	Functional genomics of *Penaeus monodon* and *Fenneropenaeus indicus* in relation to microbial infection and environmental stress

Project Location: Chennai

Funding Agency: Department of Biotechnology

Lead Centre: Mangalore Fisheries College

Principal Investigator: Dr. T.C.Santiago

Project Title 16	Characterization and development of diagnostics for viral nervous necrosis in seabass *(Lates calcarifer)* and mullet *(Mugil cephalus)*

Project Location: Chennai

Funding Agency: Department of Biotechnology

Lead Centre: C. Abdul Hakeem College, Melvisharam

Principal Investigator: Dr. K.P.Jithendran

Co-Investigators: Dr. M. Poornima & Dr. M.S. Shekhar

Project Title 17	Development and evaluation of green water technology for aquatic bioremediation in coastal aquaculture

Project Location: Chennai

Funding Agency: Department of Biotechnology

Principal Investigator: Dr. K.K.Krishnani

Co-Investigators: Dr. M. Kailasam

Collaborating Centre: CMFRI

Project Title 18	Development of in vitro system from *Fenneropenaeus indicus* and freshwater crab *Paratelphusa hydrodomous* for WSSV replication, pathogenesis and quantification

Project Location: Chennai

Funding Agency: Department of Biotechnology

Lead Centre: C. Abdul Hakeem College, Melvisharam

Principal Investigator: Dr. M. Poornima

Project Title 19	**Strengthening adaptive capacities to the impacts of climate change in resource poor small scale aquaculture and aquatic resources dependent sector in the South and South-East Asian regions**

Project Location: Chennai

Funding Agency: Network of Aquaculture Centres in Asia-Pacific

Lead Centre: NACA

Principal Investigator: Dr. M. Muralidhar

Co-Investigators: Dr. M. Kumaran & Dr. M. Jayanthi

Collaborating Centre: NaCSA

NUTRITION, GENETICS AND BIOTECHNOLOGY DIVISION

Project Title 20	**Development and demonstration of balanced feeds for Asian seabass, crabs and improvement of shrimp feeds**
Project Leader	**Dr. S.A.Ali, Principal Scientist**
Project Location	**Chennai & Kakdwip**

Sub-Project Title, Leader and Team

20.1 Optimization of nutrients and ingredients for development of cost effective feeds for mud crabs

Sub-Project Leader: Dr. K. Ambasankar

Sub-Project Team: Dr. J. Syama Dayal & Dr.S. A. Ali

20.2 Dietary interventions for high saline shrimp culture

Sub-Project Leader: Dr. J. Syama Dayal

Sub-Project Team: Dr. K. Ambasankar & Dr. S.A. Ali

20.3 Dietary interventions for low saline shrimp culture

Sub-Project Leader: Dr. T.K. Ghoshal

Sub-Project Team: Dr. Debasis De & Dr. S.A. Ali

20.4 Testing of cellulolytic gut microbiota as a feed supplement in plant protein based shrimp feed

Sub-Project Leader: Dr. Debasis De

Sub-Project Team: Dr. T.K.Ghoshal & Dr. S.A.Ali

20.5 Development and testing of microbial products as nutraceutical supplements for shrimp

Sub-Project Leader: Dr. S. Kannappan

Sub-Project Team: Dr. S. A. Ali & Dr. J. Syama Dayal

20.6 Popularization of CIBA shrimp feed technologies

Sub-Project Leader: Dr. K. Ponnusamy

Sub-Project Team: Dr. S.A.Ali & Dr. K.Ambasankar

Project Title 21	**Outreach on nutrient profiling and evaluation of fish as a dietary component**
Lead Centre	**CIFRI, Barrackpore**
Project Leader	**Dr. J. Syama Dayal, Senior Scientist**
Project Location	**Chennai**

Sub-Project Title, Leader and Team

21.1 Assessment and structured surveys on fish consumption profile and clinico-epidemiological studies on general health profiles of population vis-a-vis fish intake

Sub-Project Leader: Dr. J. Syama Dayal

Sub-Project Team: Dr. S. Kannappan

21.2 Nutrient profiling of candidate species

Sub-Project Leader: Dr. J. Syama Dayal

Sub-Project Team: Dr. S. Kannappan

21.3 Collection of published literature on shrimp lipid profiles vis-à-vis other non-vegetarian food items

Sub-Project Leader: Dr. J. Syama Dayal

Project Title 22	**Outreach on fish feeds**
Lead Centre	**CIFA, Bhubaneswar**
Project Leader	**Dr.S.A.Ali, Principal Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title, Leader and Team

22.1 Formulation and evaluation of important feed additives for seabass

Sub-Project Leader: Dr. J. Syama Dayal

Sub-Project Team: Dr. S. A. Ali & Dr. K. Ambasankar

22.2 Standardization of feed processing and testing of feeds for seabass in farmers ponds

Sub-Project Leader: Dr. K. Ambasankar

Sub-Project Team: Dr. S.A. Ali, Dr. J. Syama Dayal, Dr. A. R. Thirunavukkarasu, Dr. M. Kailasam & Dr. J.K. Sundaray

22.3 Interventions to improve feed digestibility efficiency and growth performance in seabass

Sub-Project Leader: Dr. T.K.Ghoshal

Sub-Project Team: Dr. Debasis De & Dr. K.Ambasankar

22.4 Formulation and testing of farm-made feeds for the culture of seabass in West Bengal

Sub-Project Leader: Dr. Debasis De

Sub-Project Team: Dr. T.K. Ghoshal & Dr. S.A. Ali

Project Title 23	**Outreach on fish genetic stocks**
Lead Centre	**NBFGR, Lucknow**
Project Leader	**Dr. G. Gopikrishna, Principal Scientist**
Project Team	**Dr. K. Vinaya Kumar**
Project Location	**Chennai**

Project Title 24	**Development of substrate specific fibrolytic enzymes for enhancing nutrient utilization in shrimp**

Project Location: Chennai

Funding Agency: Department of Biotechnology

Principal Investigator: Dr.K.Ambasankar

Co-Investigators: Dr. S.A. Ali & Dr. J. Syama Dayal

Project Title 25	**Improved disease resistance of rohu carp and tiger shrimp farmed in India : Developing and implementing advanced molecular methods and streamlining access to and use of genetic resources**

Project Location: Chennai

Funding Agency: Department of Biotechnology

Principal Investigator: Dr. G.Gopikrishna

Co-Investigators: Dr. P.Ravichandran, Dr. C. Gopal, Dr. M.S.Shekhar, & Dr. K.Vinaya Kumar

Collaborating Centre: CIFA, NOFIMA (Norway)

Project Title 26	**Immunomodulation studies in freshwater prawn *Macrobrachium rosenbergii* using recombinant proteins of *Macrobrachium rosenbergii* nodavirus**

Project Location: Chennai

Funding Agency: Department of Biotechnology

Lead Centre: CIFA

Co-Investigator: Dr. M.S.Shekhar

Project Title 27	**Bioprospecting of genes and allele mining for abiotic stress factors**

Project Location: Chennai

Funding Agency: National Agricultural Innovation Project

Consortium Co-Principal Investigator: Dr. M.S.Shekhar

Co-Investigators: Dr. C. Gopal, Dr. Sherly Tomy & Dr. K. Vinaya Kumar

SOCIAL SCIENCES DIVISION

Project Title 28	**Studies in resource use efficiencies and development strategies in coastal aquaculture**
Project Leader	**Dr. M.Krishnan, Principal Scientist**
Project Location	**Chennai**
Collaborating Centre	**DRWA, Bhubaneswar**

Sub-Project Title, Leader and Team

28.1 A Study of High Count Shrimp Markets

Sub-Project Leader: Dr. M.Krishnan

Sub-Project Team: Dr. V.S.Chandrasekaran

28.2 Diversified species farming: status study in TN, AP and Gujarat

Sub-Project Leader: Dr. V.S.Chandrasekaran

Sub-Project Team: Dr. M.Krishnan

28.3 Domestic marketing of aquaculture produce

Sub-Project Leader: Dr. T.Ravisankar

Sub-Project Team: Dr. M.Kumaran & Dr. D.Deboral Vimala

28.4 An Assessment of Gender Participation and Women Entrepreneurs in Aquaculture in TN and Orissa

Sub-Project Leader: Dr. B. Shanthi

Sub-Project Team: Dr. M.Krishnan, Dr. V.S. Chandrasekaran, Mrs. P. Mahalakshmi, Dr. S. Kannappan & Dr. K. Ambasankar

28.5 Transfer of Technology through ICT and capacity building

Sub-Project Leader: Dr. D. Deboral Vimala

Sub-Project Team: Dr.M.Krishnan, Dr .T.Ravisankar,Dr M.Kumaran & Smt .P.Mahalakshmi

28.6 Manpower Planning for Coastal Aquaculture Development

Sub-Project Leader: Dr. K.Ponnusamy

Sub-Project Team: Dr. M.Krishnan, Dr.V.S.Chandrasekharan & Dr.M.Kumaran

28.7 Cluster farming and dynamics of its success in shrimp aquaculture

Sub-Project Leader: Dr.M.Kumaran

Sub-Project Team: Dr.Ponnusamy

28.8 Strengthening Information Infrastructure for Aquaculture Development through ICT

Sub-Project Leader: Mrs. P. Mahalakshmi

Sub-Project Team: Dr. M.Krishnan, Dr. T.Ravisankar & Dr. D.Deboral Vimala

28.9 Organisation and conduct of extension and outreach activities

Sub-Project Leader: Dr. M.Krishnan

Sub-Project Team: Dr. V.S.Chandrasekaran, Dr. K.Ponnusamy & Dr. T.K.Ghoshal

Project Title 29	**An assessment of literacy, income and health status of fishers in India**

Project Location: Chennai

Funding Agency: Department of Animal Husbandry, Dairying and Fisheries

Lead Centre:CMFRI

Principal Investigator: Dr. M.Krishnan

Co-Investigators:Dr. K.Ponnusamy

Project Title 30	Diversification of livelihoods among women SHGs through coastal aquaculture technologies

Project Location: Chennai

Funding Agency: Department of Biotechnology

Principal Investigator: Dr.B.Shanthi

Co-Investigators: Dr. M.Krishnan, Dr. V.S.Chandrasekaran, Dr. C.P. Balasubramanian, Dr. S. Kannappan & Dr. K. Ambasankar

Project Title 31	Prospective study on marketing and value chain improvement strategies for promoting Asian Seabass *(Lates calcarifier)*

Project Location: Chennai

Funding Agency: National Fisheries Development Board

Principal Investigator: Dr. T. Ravisankar

Project Title 32	Agro-web digital dissemination system for Indian agricultural research

Funding Agency: National Agricultural Innovation Project

Project Location: Chennai

Lead Centre: NBPGR, New Delhi

Principal Investigator: Dr. T.Ravisankar

Co-Investigators: Mrs. P. Mahalakshmi, Sh.R. Elankovan, Sh. M.Shenbagakumar, Sh. S.Rajukumar & Sh.S. Nagarajan

Project Title 33	Cost effective shrimp farming through adoption of indigenous innovative feed and better management practices by small scale farmers

Project Location: Chennai

Funding Agency: National Bank for Agriculture and Rural Development

Principal Investigator: Dr. K.Ponnusamy

Co-Investigators: Dr.K. Ambasankar

KAKDWIP RESEARCH CENTRE

Project Title 34	Refinement of traditional brackishwater aquaculture systems for sustainable production of shrimp and fishes
Project Leader	Dr. T.K. Ghoshal
Project Location	Kakdwip

Sub-Project Title, Leader and Team

34.1 Improving traditional shrimp culture practices and developing organic farming systems

Sub-Project Leader: Dr.A. Panigrahi

Sub-Project Team: Ms.Shyne Anand, Dr.T. K. Ghoshal, Dr.R. Saraswathi Sh. G. Biswas, Dr. R Ananda Raja & Dr. Sujeet Kumar

34.2 Developing organic shrimp feeds

Sub-Project Leader: Dr.T.K. Ghoshal

Sub-Project Team: Dr. A.Panigrahi & Dr. Debasis De

34.3 Improving traditional fish culture practices

Sub-Project Leader: Sh. G. Biswas

Sub-Project Team: Dr. A.Panigrahi, Dr. Debasis De, Dr. R Ananda Raja & Dr.Sujeet Kumar

34.4 Evaluating feed ingredients of local origin

Sub-Project Leader: Dr Debasis De

Sub-Project Team: Dr. T.K.Ghoshal

34.5 Documentation, assessment and monitoring of the traditional brackishwater aquaculture systems in West Bengal

Sub-Project Leader: Dr A Panigrahi

Sub-Project Team: Dr. T.K.Ghoshal, Dr. M. Jayanti, Sh. G. Biswas, Dr. R Ananda Raja, Dr. Sujeet Kumar, Smt. Shyne Anand & Smt. P. Mahalakshmi

Project Title 35 — Strategies for sustainable management of degraded coastal land and water for enhancing livelihood security of farming communities

Project Location: Kakdwip

Funding Agency: National Agricultural Innovation Project

Principal Investigator: Dr. T. K. Ghoshal

Co-Investigators: Dr. T.K. Ghoshal, Dr. Debasis De, Sh. G. Biswas, Dr. R. Ananda Raja, Dr. Sujeet Kumar, Ms. Shyne Anand, Dr. A. Panigrahi & Dr. M.Kumaran

Project Title 36 — Enrichment of aquafeed with cellulolytic and amylolytic microbes isolated from digestive tract of brackishwater fishes

Project Location: Kakdwip

Funding Agency: Department of Biotechnology

Principal Investigator: Dr.Debasis De

Co-Investigators: Dr. T.K. Ghoshal & Dr.R.Ananda Raja

6

Technology Assessed and Transferred

The technologies / knowledge-base developed by the Institute were extended during the year to progressive fish farmers, private entrepreneurs, officials of state and central governments, etc., through the following short-term training programmes.

Sl.No	Training Programme	Duration	No. of participants
1	On farm training programme on brackishwater aquaculture	9 -24 June 2009	7
2	NFDB sponsored training programme on Asian seabass fish seed production and culture	1 - 10 September 2009	11
3	Resource use management techniques and interfaces in extension and information technology approaches	1-11 September 2009	7
4	NFDB sponsored training programme on advanced technologies for the management of soil and water environment in brackishwater aquaculture	2 - 11 September 2009	7
5	NFDB sponsored training programme on better management practices in shrimp farming	14 -19 September 2009	10
6	NFDB sponsored training programme on mud crab breeding and culture	14 - 19 September 2009	11
7	Fourth HACCP training in collaboration with Central Institute of Fisheries Technology and Society for Aquaculture Professionals	26 - 28 October 2009	13
8	NFDB sponsored training programme on entrepreneurship development in coastal aquaculture	26 - 31 October 2009	25
9	National workshop on sampling design and survey methodology	13 November 2009	26
10	SGSY (Swarna Gram Swarojagar Yojana) special project training on finfish farming in floating net cages	1 - 15 March 2010	26

11	Training workshop on distributed ownership of institutional website for content management and up-date	16 March 2010	35
12	Disease diagnostics using PCR	4-8 May 2009	4
13	Mushroom cultivation	1-2 March 2010	12

On farm training to B.F.Sc trainees at KRC of CIBA

Participants in the training program on finfish culture in floating cages

Participants in the training program on advanced technologies for the management of soil and water environment in brackishwater aquaculture

Trainees in feed mill at MRC of CIBA

7

Training and Education

HUMAN RESOURCE DEVELOPMENT

International

Sl. No.	Name & Designation	Training Programme	Duration	Organisation
1	Dr.S.V. Alavandi Senior Scientist	Viral metagenomics	23 February - 22 August 2009	Department of Marine Biology, College of Marine Science, Florida
2	Dr.M.Kailasam Senior Scientist	Molecular mechanisms underlying in stress response of the rotifer *Brachionus plicatilis*	25 February - 13 August 2009	Laboratory of Aquatic Molecular Biology & Biotechnology, Graduate School of Agriculture and Life Sciences, Tokyo

National

Scientists

Sl. No.	Name and Designation	Training programme	Duration	organisation
1	Dr.N.Kalaimani Principal Scientist	Food safety management system	20 April 2009	National Institute of Training for Standardisation, Cochin
2	Dr.(Mrs.)M.Poornima Senior Scientist	Insect cell lines	4-9 May 2009	Indian Institute of Science, Bangalore
3	Dr.J.K.Sundaray Senior Scientist	Management development programme on Public – Private Partnerships for innovation in agriculture	20-24 July 2009	Indian Institute of Management, Lucknow

4	Dr. K. Ponnusamy Senior Scientist	Enhancing skills in ICT based DSS for market and agri-business orientation of research and sustaining rural livelihoods	17-26 August 2009	National Institute of Agricultural Extension Management, Hyderabad
5	Mrs. P. Mahalakshmi Scientist (SS)			
6	Dr. (Mrs.) R. Saraswathy Scientist	Brainstorming session on Nanogeoscience	20-21 August 2009	Bharathidasan University, Tiruchirapalli
7	Dr. S.M.Pillai Principal Scientist	Technical consulting	9 October 2009	Consultancy Development Centre, Bangalore
8	Dr. S.A.Ali Principal Scientist			
9	Dr. K.K. Krishnani Senior Scientist			
10	Dr. M. Shashi Shekar Senior Scientist			
11	Dr. (Mrs.) M. Poornima Senior Scientist	Advanced molecular biological techniques including microarray, real time PCR and 2D Gel electrophoresis	1-14 October 2009	Cancer Institute, Chennai
12	Dr. M. Kailasam Senior Scientist	Priority setting, monitoring and evaluation for innovation in agriculture	19-23 October 2009	Indian Institute of Management, Lucknow
13	Dr. K.P. Jithendran Principal Scientist	Technology commercialization for senior scientists	19-30 October 2009	Administrative Staff College of India, Hyderabad
14	Dr. J.K. Sundaray Senior Scientist	Knowledge discovery in database	11-15 January 2010	Indian Statistical Institute, Kolkata
15	Dr. Debasis De Senior Scientist	Training/ workshop for the procurement point persons of NAIP sub-projects	25-26 February 2010	National Agricultural Innovation Project, New Delhi
16	Dr. (Mrs) Deboral Vimala Senior Scientist	Sustainable agriculture and rural development – Bio-Village as a delivery model	2-6 March 2010	M.S.Swaminathan, Research Foundation, Chennai
17	Dr.(Mrs.)M.Jayanthi Senior Scientist	Scientific project formulation, implementation and evaluation	15-26 March 2010	Administrative Staff College of India, Hyderabad

19	Dr.T.K.Ghoshal, Senior Scientist	Management development programme on priority setting, monitoring and evaluation for innovation in agriculture	22-26 March 2010	Indian Institute of Management, Lucknow

Technical Staff

Sl. No.	Name and Designation	Subject of Training	Duration	Organisation
1	Shri S.Nagarajan Technical Officer (T-5)	Managing bibliographical research information on agriculture and allied sciences	25-29 May 2009	Directorate of Information and Publications of Agriculture, New Delhi
2	R.Subburaj Technical Officer (T-5)	Technical and administrative support for consortia based research in agriculture	26-31 October 2009	National Academy for Agricultural Research Management, Hyderabad
3	Shri. N.Ramesh Technical Assistant (T-3)	6-Week technical training program on welding practices	10 March-23 April 2010	Sri Venkateswara College of Engineering, Sriperumbudur

Administrative Staff

Sl. No.	Name and Designation	Subject of Training	Duration	Organisation
1	Shri P.Srikanth Lower Division Clerk	Decision support system using IT	3-7 August 2009	Anna Institute of Management, Chennai
2	Shri.A.Muthuraman, A.O	Handling of CAT cases and court cases	10-12 August 2009	Institute of Secretariat Training and Management, New Delhi
3	Shri K.G. Gopala Krishna Murthy, Personal Assistant			
4	Smt.V.Usharani Assistant	Effective communication and presentation using IT	10-12 August 2009	Anna Institute of Management, Chennai

5	Smt.K.Subhashini Stenographer Gr.III	Decision support system using IT	19-23 October 2009	Anna Institute of Management, Chennai
6	Shri.A.Muthuraman, A.O	Technical and administrative support for consortia based research in agriculture	26-31 October 2009	NAARM, Hyderabad
7	Smt.R.Vetrichelvi, LDC	Spreadsheet for accounts and finance	9-11 November 2009	Anna Institute of Management, Chennai
8	Shri.R.G.Ramesh Asst.Admn.officer	"New pension scheme" related to NPSCAN software interface of NSDL (Uploading of data on NSDL website) at PDBC Bangalore	23 November 2009	ICAR, New Delhi
9	Smt.V.Usharani Assistant			
10	Smt.K.Nandhini Junior Accounts Officer			
11	Shri P.Srikanth Lower Division Clerk			
12	Shri R.Kandamani Assistant	MS-ACCESS for database management	23-27 November 2009	Anna Institute of Management, Chennai
13	Mrs.K.Hemalatha, Stenographer Gr.III	Decision Support System using IT	30 November - 4 December 2009	Anna Institute of Management, Chennai
14	Sh K.G.Gopala Krishna Murthy Personal Assistant	Advanced Hindi application training programme on computer	7-11 December 2009	National Information Centre, Chennai
15	Smt.E.Amudhavalli, Upper Division Clerk	Spreadsheet for accounts and finance	21-23 December 2009	Anna Institute of Management, Chennai

Students project work and study visit

Final year M.Sc/B.Tech/B.E students (29) from different colleges and universities were guided for short term projects in relation to brackishwater aquaculture.

Lectures and demonstrations were conducted for the following at CIBA, Chennai and Muttukadu Experimental Station

Sl. No	Name of the Organization	Date of Visit	Visitor's Profile	Purpose	Place of visit
1.	Fisheries Staff Training Institute, Chennai	16 April 2009	1 Assistant Director of Fisheries, 5 Sub-Inspectors, 2 staff members.	Study tour	MES*
2.	Tamil Nadu Agricultural University, Coimbatore	18 April 2009	55 Students, First year B.Sc (Agribusiness Management) & B.Tech (Agrl. Information Technology)	Study tour	HQ**
3.	Biosys Biotech Lab Research Centre, Chennai	30 May 2009	18 trainees and 2 staff members	Study tour	HQ
4.	CSI Institute of Technology, Secunderabad, (AP)	3 June 2009	3 students	Study tour	HQ
5.	Dept of Bio-technology, Indian Institute of Technology, Chennai	23 July 2009	30 students & 2 staff members	Hatchery operations & aquaculture	MES
6.	Fisheries Staff Training Institute, Chennai	31 August 2009	50 students	Hatchery visit	MES
7.	Department of Zoology, Carnal Collage, NVVEM,Goa	6 October 2009	6 students & 1 staff member	Study tour	HQ
8.	CAS in Marine Biology, Annamalai University	7 October 2009	22 students & 2 staff members	Hatchery & Main office visit	HQ & MES
9.	Brackish water aqua farmer and State Fisheries Department	9 October 2009	24 Aqua farmers & 2 DoF officers	Hatchery and main office	HQ & MES
10.	Madras Christian College, Tambaram, Chennai	12 October 2009	20 students & 2 staff members	Shrimp and seabass hatchery feed mill	MES

11.	Institute of Ocean Management, Anna University, Chennai	20 October 2009	7 students & 1 staff member	Practical exposure to Bio-engineering aspects of coastal aquaculture	MES
12.	College of Fisheries, Dauli Rajendra Agri University, Bihar.	18 November 2009	8 students & 1 staff member	Study tour	HQ
13.	Fisheries Staff Training Institute, DoF, Chennai	18 November 2009	18 DOF (TN) Trainees	Exposure visit	MES
14.	Department of Fisheries, A&N Administration, Port Blair	6 January 2010	14 fishermen & one Supdt.	Exposure visit	HQ
15.	Central Institute of Fisheries and Nautical and Engg. Training (CIFNET) Cochin	11 January 2010	18 students & 2 staff members	Hatchery operations	MES, HQ
16.	Microbiology Department ALMIBS, Madras Univ., Chennai	29 January 2010	8 Students	Dept. visit	MES

* Muttukadu Experimental Station

* Head Quarters

8

Awards and Recognitions

- Drs. B.Shanthi, K.Ambasankar, C.P.Balasubramanian and S.Kannappan, Senior Scintists and Drs. V.S.Chandrasekaran and M.Krishnan, Principal Scientists received an appreciation letter from Dr. S. Ayyappan, Secretary DARE and Director General, ICAR for exemplary work done under the DBT Funded Project 'Diversification of livelihoods among Women SHGs through coastal aquaculture technologies' undertaken in Tiruvallur and Kancheepuram districts of Tamil Nadu.

- Dr. A. Panigrahi, Senior Scientist, was awarded the Best Young Scientist Award for the year 2008-09 by the Dr Hiralal Chaudhuri Fisheries Foundation, Central Institute of Fisheries Education, Mumbai on 10 July 2009.

- Dr. B.Shanthi, Senior Scientist was recognized and appreciated with a 'Shield' by 'SIGA', NGO and Coastal Women Self Help Group of Tiruvallur District, Tamil Nadu during a function conducted on the occasion of Women's Day Celebration. on 27 March 2010 at Pulicat for the efforts taken in empowering the coastal women Self Help Group.

Dr.A.Panigrahi, Senior Scientist receiving Best Young Scientist Award

Ph.D. Programme

Miss.M.Meenakshi was awarded Ph.D from Madras University on 12 January 2010 for the thesis 'Growth and reproductive physiology of wild and domesticated banana shrimp, *Fenneropenaeus merguiensis,* (Deman,1888)' under the supervision of Dr. S. M.Pillai, Principal Scientist.

Award recommended for the women aqua farmer

Mrs. Mala, Crab farmer, Kadapakkam, Kancheepuram District, Tamil Nadu was nominated by CIBA, received the Jamsetji Tata National Virtual Academy NVA Fellow on 4th December 2009 from MSSRF, Chennai.

Dr.A.G.Ponniah, Director, CIBA felicitating Mrs.Mala

9

Linkages and Collaboration

The Institute maintained linkages with the following national and international organizations:

National

ICAR Institutes

- Central Institute of Fisheries Education, Mumbai
- Central Marine Fisheries Research Institute, Cochin
- National Academy for Agricultural Research Management, Hyderabad
- National Bureau of Agriculturally Important Microorganisms, Mau
- Directorate of Seed Research, Mau
- Central Agricultural Research Institute, Port Blair
- Central Inland Fisheries Research Institute, Barrackpore
- Central Institute of Fisheries Technology, Cochin
- National Bureau of Fish Genetic Resources, Lucknow
- Central Research Institute for Dryland Agriculture, Hyderabad
- Directorate of Research on Women in Agriculture, Bhubaneswar

Other Institutes / SAU / State Agriculture Depts.

- College of Fisheries, University of Agricultural Sciences, Mangalore
- College of Fisheries, Sri Venkateswara Veterinary University, Muthukuru
- Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi
- West Bengal University of Animal and Fisheries Sciences, Kolkata
- Navsari Agricultural University, Navsari, Gujarat

- Tamil Nadu Veterinary and Animal Sciences University, Chennai
- Dept. of Horticulture, Govt. of Tamil Nadu, Chennai.
- Dept. of Animal Husbandry, Govt. of Tamil Nadu, Chennai.
- Tamil Nadu Agricultural University, Coimbatore
- University of Madras, Chennai
- Center for Advanced Studies in Marine Biology, Annamalai University, Chidambaram
- National Fisheries Development Board, Hyderabad
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Coastal Aquaculture Authority, Chennai
- Ministry of Science and Technology, New Delhi
- Agricultural & Processed Food Products Export Development Authority, New Delhi
- Marine Products Export Development Authority, Cochin
- Department of Biotechnology, New Delhi
- National Institute of Ocean technology, Chennai

State Fisheries Departments/BFDAs

The Institute has well established linkages with State Fisheries Depts. /BFDAs mainly for transfer of technology programmes.

International

NORAD

- A project entitled "Genetic improvement of *Penaeus monodon* (Tiger shrimp) through selective breeding for growth and white spot disease resistance" is taken up with AKVAFORSK, Norway.

- A project entitled "Strengthening adaptive capacities to the impacts of climate change in resource-poor small-scale aquaculture and aquatic resources-dependent sector in the South and South-east Asian Region" (Aqua Climate project), coordinated by Network of Aquaculture Centres in Asia-Pacific (NACA), Bangkok.

10

List of Publications

INSTITUTE PUBLICATIONS

- CIBA Annual Report (2008-2009)
- Training programme calendar (2010-2011)
- Bulletin No.20 – Diseases of mud crabs in India
- Special publications
  - Training manuals on Brackishwater aquaculture
  - Asian seabass fish seed production and culture
  - Advanced technologies for the management of soil and water environment in brackishwater aquaculture
  - Training manual on better management practices in shrimp farming
  - Training manual on mud crab breeding and culture
- Technology Series
  - Low input low cost shrimp farming system based on organic principles (No. 3)
  - Identification of potential brackishwater aquaculture areas using remote sensing and geographical information system (No. 4)

CHARTS

- Impact of extreme climatic events on brackishwater aquaculture
- Vulnerability reduction and building resilience in brackishwater aquaculture
- Climate change-pathways of impact on brackishwater aquaculture
- Identification of potential brackishwater aquaculture areas using Remote Sensing and Geographical Information System
- Assessment of aquaculture on environment using Remote Sensing and Geographical Information System

- Environmental technologies of CIBA
- Technologies from CIBA
- Farm-made feed : An option for reducing production cost in low-density shrimp aquaculture
- CIBA Aqua feed technologies: Public-Private Partnership

Tamil

- Farm-made feed : An option for reducing production cost in low-density shrimp aquaculture

Gujarati

- Mud-crab fattening
- Remote sensing and GIS for sustainable aquaculture development
- Impact assessment and carrying capacity for sustainable shrimp aquaculture
- Aquatic bio-remediation
- Aquatic animal health management
- Aquaculture feed for mud crab and Asian seabass
- Indigenous low cost shrimp feed technology
- Domestication and selective breeding in brackishwater aquaculture
- Asian seabass - hatchery seed production
- Asian seabass - farming
- Diversification of shrimp aquaculture using *M. japonicus* and *F. merguiensis*

REFERRED JOURNALS

Ahamad Ali, S., Gopal, C., Ramana, J.V., Sampoornam, B., Arul Vasu, C., Vaitheeswaran, T., Selvakumar, P., 2010. Evaluation of selected binders in a ring-die pellet mill for processing shrimp feed pellets. Indian J.Fish. 57, 103-106.

Azad, I.S., Thirunavukkarasu, A.R., Kailasam, M., Subburaj, R., Rajan, J.J.S., 2009. Ontogeny of lymphoid organs in the Asian seabass (*Lates calcarifer*, Bloch). Asian Fish.Sci. 22, 901-913.

Bindhuja, M.D., Meenakshi, M., Revathi, K., Gopal, C., Muralidhar, M., Abraham, A.V., 2010. Copper concentrations in different tissues during ovarian development of Indian white shrimp, *Fenneropenaeus indicus* (H. Milne Edwards, 1837). Asian J Microbiol Biotechnol Environ Sci. 11, 863-867.

Biswas, G., Thirunavukkarasu, A.R., Sundaray, J.K., Kailasam, M., 2010. Optimization of feeding frequency of Asian seabass *(Lates calcarifer)* fry reared in net cages under brackishwater environment. Aquaculture 305, 26-31.

Gopal, C., Gopikrishna, G., Krishna, G., Jahageerdar, S.S., Rye, M., Hayes, B.J., Paulpandi, S., Kiran, R.P., Pillai, S.M., Ravichandran, P., Ponniah, A.G., Kumar, D., 2010. Weight and time of onset of female-superior sexual dimorphism in pond reared *Penaeus monodon*. Aquaculture 300, 237-239.

Gopalakrishnan, A., Musammilu, K.K., Lijo, J., Basheer, V.S., Padmakumar, K.G., Dinesh, K., Lal, K.K., Mohindra, V., Punia, P., Ponniah, A.G., Lakra, W.S., 2009. Low genetic differentiation in the populations of the Malabar carp *Labeo dussumieri* as revealed by allozymes, microsatellites and RAPD. Asian Fish.Sci. 22, 359-391.

Kiron, V., Puangkaew, J., Panigrahi, A., Scharsack, J.P., Satoh, S., 2010. Antioxidant and immune defenses of rainbow trout (*Oncorhynchus mykiss*) offered plant oils differing in fatty acid profiles from early stages. Aquacult.Nutr. DOI: 10.1111/j.1365-2095.2009.00715.x.

Krishnani, K.K., 2010. Detection and diversity of nitrifying and denitrifying functional genes in coastal aquaculture. Aquaculture 302, 57-70.

Krishnani, K.K., Gopikrishna, G., Pillai, S.M., Gupta, B.P., 2010. Abundance of sulphur- oxidizing bacteria in coastal aquaculture using *soxB* gene analyses. Aquacult Res 10.1111/j.1365-2109.2009.02415.x.

Krishnani, K.K., Kathiravan, V., Natarajan, M., Kailasam, M., Pillai, S.M., 2010. Diversity of sulfur-oxidizing bacteria in green water system of coastal aquaculture. Appl.Biochem.Biotechnol. DOI 10.1007/s 12010-009-8886-3.

Krishnani, K.K., Shekhar, M.S., Gopikrishna, G., Gupta, B.P., 2009. Sequence similarity based identification of nitrifying bacteria in coastal aquaculture for bio-remediation predictability. Asian Fish.Sci. 22, 41-49.

Krishnani, K.K., Shekhar, M.S., Gopikrishna, G., Gupta, B.P., 2009. Molecular biological characterization and biostimulation of ammonia oxidizing bacteria in brackishwater aquaculture. J Environ Sci Health 44, 1598-1608.

Kumar, S., Chaturvedi, V.K., Kumar, B., Somarajan, S.R., Kumar, P., Gupta, P., Pandey, K.D., 2009. Standardization of the microtitre agglutination test for seromonitoring of haemorrhagic septicaemia vaccination. Journal of Immunology and Immunopathology 11, 63-67.

Mahalakshmi, P., Ganesan, K., 2009. Relative importance of evaluation criteria for predicting the optimal location in aquaculture – a pairwise comparison method approach. Indian J.Fish. 56, 313-316.

Panigrahi, A., Azad, I.S., Das, B.K., Das, G., Behera, S., Danpet, J., Mishra, S.S., 2010. Probiotic induced immunomodulation: investigation in to the cellular and molecular mechanism involved. Research Journal of Biotechnology 4, 7-13.

Panigrahi, A., Kiron, V., Satoh, S., Watanabe, T., 2010. Probiotic bacteria *Lactobacillus rhamnosus* influences the blood profile in rainbow trout *Oncorhynchus mykiss* (Walbaum). Fish Physiol Biochem DOI 10.1007/s10695-009-9375-x.

Panigrahi, A., Sundaray, J.K., Ghoshal, T.K., De, D., Ravichandran, P., 2009. Bio-secure zero water exchange system technology of shrimp farming for better monitoring of coastal ecosystem. J.Indian Soc.Coastal Agric.Res. 27, 50-53.

Ponnusamy, K., .Gupta, J., 2008. Information seeking behaviour of farmers in different coastal farming systems of Tamil Nadu. IASSI Quarterly 26, 64-74.

Ponnusamy, K., 2009. Livelihood contribution, prospects and problems of aquaculture in integrated farming systems. Indian J.Fish. 56, 317-322.

Ponnusamy, K., Gupta, J., Nagarajan, R., 2009. Indigenous Technical Knowledge (ITKs) in dairy enterprise in coastal Tamil Nadu. Indian Journal of Traditional Knowledge 8, 206-211.

Shekhar, M.S., Yuanan Lu, 2009. Application of nucleic-acid-based therapeutics for viral Infections in shrimp aquaculture. Mar Biotechnol. 11, 1-9.

Thawonsuwan, J., Kiron, V., Satoh, S., Panigrahi, A., Verlhac, V., 2009. Epigallocatechin-3-gallate (EGCG) affects the antioxidant and immune defense of the rainbow trout, *Oncorhynchus mykiss*. Fish Physiol Biochem Aug 2009. 10.1007/s10695-009-9344-4.

Wu, C.G., Tomy, S., Lee, M.F., Lee, Y.H., Yueh, W.S., Lin, C.J., Lau, E.L., Chang, C.F., 2010. Sex differentiation and sex change in the protandrous black porgy, *Acanthopagrus schlegeli*. Gen Comp Endocrinol. 167, 417-421.

POPULAR ARTICLES

Ayyappan, S., Kalaimani, N., Ponniah, A.G., 2010. Disease status in Indian shrimp aquaculture and research efforts for better health management. Fishing Chimes 29, 13-21.

Biswas, G., Thirunavukkarasu, A.R., Sundaray, J.K., Kailasam, M., 2009. Farming of asian seabass, *Lates calcarifer* in West Bengal- prospects and future challenges. Fishing Chimes 29, 19-21, 27.

Chandrasekaran, V.S., Shanthi, B., Kumaran, M., Krishnan, M., 2009. Shrimp farming practices in Goa. Fishing Chimes 29, 7-10.

Ghoshal, T.K., 2010. A report on brackishwater aquafarmers' meet 2009 of Kakdwip Research Centre of CIBA, Kakdwip. Fishing Chimes 29 (12), 67.

Krishnani, K.K., 2010. CIBA's initiative in the development of environmental technologies for aquaculture. Fishing Chimes 29, 41-42.

Kumaran, M., 2009. Group approach to shrimp farming: the key to sustainability. Aquaculture Asia 14, 18-21.

Ponniah, A.G., 2009. Central Institute of Brackishwater Aquaculture achievements. Fishing Chimes 29, 53-56.

Thirunavukkarasu, A.R., Kailasam, M., Sundaray, J.K., 2010. Success in hatchery development of seabass and its potential for commercial cage culture in India. Cage Culture of Seabass, CMFRI, Cochin 71-79.

Vimala, D.D., Ravisankar, T., Mahalakshmi, P., Kumaran, M., 2009. e-Sagu Aqua : An innovative information and communication technology model for transfer of technology for aquaculture. Aquaculture Asia 14, 23-25.

BOOK CHAPTERS

De.H.K., Kumaran, M., Saha, G.S., 2010. New initiatives in aquaculture extension. Narendra Publishing House, Delhi 206.

Jayanthi, M., 2009. Aquaculture development using RS and GIS. In: M.Thanikachalam (Ed.) Staff development programme on application of geometrics in digital Cartography.Vellammal Engineering college, pp. 124-131.

Kumaran, M., Ponnusamy, K., Vimala, D.D., 2010. Public private partnership in extension services for sustainable aquaculture. In: De, H.K, M.Kumaran and G.S.Saha (Eds.), New Initiatives in Aquaculture Extension, Narendra Publishing House, New Delhi, pp. 187-200.

Kumaran, M., Vimala, D.D., Ponnusamy, K., 2010. Research-extension-farmer linkage for sustainable aquaculture development. In: De, H.K, M.Kumaran and G.S.Saha (Eds.), New Initiatives in Aquaculture Extension, Narendra Publishing House, New Delhi, pp. 36-47.

Mahalakshmi, P., Krishnan, M., 2009. Development of an asynchronous e-Learning module for aquaculture development in an information and knowledge based society. In: C.U.Goswami.and D.Kumar (Eds.), Aquaculture Management, Narendra Publishing House, New Delhi, pp.371-381.

Mahalakshmi, P., 2010. Geographic information system. In: R.M.Prasad, B.S.Hansra and P.K.Jain (Eds.), Information and Communication Technology in Agriculture: Geographic Information System and Remote Sensing, RAE 004, IGNOU, New Delhi, pp.5-28.

Mahalakshmi, P., 2010. Information kiosk. In: R.M.Prasad, B.S.Hansra and P.K.Jain (Eds.), Information and Communication Technology in Agriculture: Computer Networking, RAE 004, IGNOU, New Delhi, pp. 28-47.

Mahalakshmi, P., 2010. Networking types. In: R.M.Prasad, B.S.Hansra and P.K.Jain (Eds.), Information and Communication Technology in Agriculture: Computer Networking, RAE 004, IGNOU, New Delhi, pp. 5-27.

Mahalakshmi, P., 2010. Remote sensing. In: R.M.Prasad, B.S.Hansra and P.K.Jain (Eds.), Information and Communication Technology in Agriculture: Geographic Information System and Remote Sensing, RAE 004, IGNOU, New Delhi, pp. 29-47.

Ponniah, A.G., Krishnani, K.K., 2009. Environment friendlytechnologies to address food safety and environmental concerns in brackishwater aquaculture. In: U.C.Goswami and Dilip Kumar (Eds.), 96th Indian Science Congress, Special Publication, Narendra Publishing House, New Delhi, pp. 115-128.

Ponnusamy, K., Kumaran, M., Vimala, D.D., 2010. Extension strategies for sustainable aquaculture development. In: De, H.K, M.Kumaran and G.S.Saha (Eds.), New Initiatives in Aquaculture Extension, Narendra Publishing House, New Delhi, pp. 133-147.

Vimala, D.D., Kumaran, M., Ponnusamy, K., 2009. Audio visual aids: an effective tool for technology transfer. In: De, H.K, M.Kumaran and G.S.Saha (Eds.), New Initiatives in Aquaculture Extension, Narendra Publishing House, New Delhi, pp. 79-101.

PROCEEDINGS

Ambasankar, K., Rajamohamed Kalanjiam, M., Rajendran, R., Ahamad Ali, S., Syama Dayal, J., 2009. Ontogeny and diurnal change of fibrolytic enzyme activity in the tiger shrimp *Penaeus monodon*. In: Proceedings of 13th Biennial Conference of Animal Nutrition Society of India, 2, 239p.

Ambasankar, K., Rajendran, R., Rajamohamed Kalanjiam, M., Ahamad Ali, S., Syama Dayal, J., 2009. Preliminary studies on fibrolytic enzyme activity in the tiger shrimp *Penaeus monodon*. In: Proceedings of 13th Biennial Conference of Animal Nutrition Society of India, 2, 238p.

Chakravarthy, N., Kalaimani, N., Alavandi, S.V., Poornima, M., Santiago, T.C., Raja, S., 2008. Quality of cultured tiger shrimp (*Penaeus monodon)* affected with LSS and WSSV. In: Jeyasekaran, G., Sukumar, D., Jeya Shakila, R.(Eds.), Proceedings of National seminar on Emerging issues in quality and safety of fish and shellfish, Fisheries College and Research Institute, TANUVAS, Thoothukudi, pp. 51-55.

Chandrasekaran, V.S., Ponnusamy, K., Ponniah, A.G., 2009. Emerging paradigms in public-private partnership in brackishwater aquaculture. In: Souvenir of National Workshop on Advances in Aquaculture and Fisheries, Prospects and Challenges, Academy of Science, Engineering and Technology, 3rd July 2009, pp. 48-50.

De, D., Ghoshal, T.K., Pramanik, A., Raja, A.R., 2009. Identification of potential cellulolytic bacteria isolated from gut of Asian seabass and milkfish. In: Proceedings of 13th Biennial Conference of animal Nutrition Society of India on Diversification of Animal Nutrition Research in Changing Scenario, NIANP, Bangalore, 2, pp. 188-189.

Ghoshal, T.K., Kumaran, M., 2009. Brackishwater fisheries based livelihoods in India. In: Proceedings of National Seminar on Fisheries based Livelihoods: Present Status, Problems and Prospects, The Livelihood School, Kolkata, pp. 12-18.

Krishnan, M., 2010. Forage fish and food security, problems and prospects. In: Books of Abstracts of Workshop on Role of Low Value Fish Species in Strengthening Food Security in India, KVAFSU, Bidar, College of Fisheries, Mangalore, pp. 6-7.

Krishnani, K.K., Ponniah, A.G., 2009. Prospects of microbial technologies in aquaculture. In: Proceedings of PFGF'Sir VII annual national meet 2009, pp. 45-50.

Muralidhar, M., Ponniah, A.G., 2009. Development of adaptation management strategies in response to climate change impacts on coldwater fisheries and aquaculture. In: Souvenir of National Workshop on, Impact of Climate Change on Coldwater Fisheries Resources: Perspectives, Framework & Priorities, Directorate of Coldwater Fisheries Research, Bhimtal, pp. 91-95.

Muralidhar, M., Kumaran, M., Ghoshal, T.K., Jayanthi, M., Gupta, B.P., Ponniah, A.G., 2010. Impact of Aila cyclone on brackishwater aquaculture in West Bengal, India – lessons to be learned for preparedness and adaptive measures. In: Proceedings of International Symposium on Remote Sensing and Fisheries Kochi, 105p.

Ponniah, A.G.,Sundaray, J.K., 2010. Strategy of promoting culture of small native fish species. In: Souvenir on the occasion of the Workshop on Small indigenous freshwater fish species: Their role in poverty alleviation, food security

and conservation of biodiversity by ICSF, Chennai and IFSI, Kolkata, CIFRI, Barrackpore, 85p.

Ravisankar, T., Krishnan, M., 2009. Background papers, National workshop on sampling design and methodology to socio-economic conditions of fishers & fish farmers in India, Central Institute of Brackishwater Aquaculture, Chennai, 22p.

Ravisankar, T., Krishnan, M., 2009. In: Proceedings of National workshop on sampling design and methodology to Survey socio-economic conditions of fishers & fish farmers in India. Central Institute of Brackishwater Aquaculture, Chennai, 35p.

Ravisankar, T., Kumaran, M., Ghoshal, T.K., Vimala, D.D., Mahalakshmi, P., 2010. Managing agri-food supply chain - issues in fish supply chains. In: National Conference on Managing Agri-Food Supply Chain, Indian Institute of Management, Lucknow, 11p.

Ravisankar, T., Ponniah, A.G., Agrawal, R.C., 2009. Heuristic evaluation of web sites of ICAR fisheries research institutions. Central Institute of Brackishwater Aquaculture, Chennai, 36p.

Rekha, N.P., Panigrahi, A., Ravichandran, P., 2009. Water resource management for sustainable aquaculture in coastal areas. In: Proceedings of Indo- US workshop on, Emerging Issues in Water Management for sustainable Agiculture in South Asia Region, Udhagamandalam, pp. 63-82.

Santiago, T.C., Chandrasekaran, V.S., 2010. Better web designing and content presentation. In: Ravisankar.T., A.G.Ponniah and R.C.Agarwal (Eds.), Proceedings of National Workshop on Heuristic evaluation of websites of ICAR Fisheries research institutions. Central Institute of Brackishwater Aquaculture, Chennai, pp. 3-10.

11

Consultancy and Commercialisation of Technology

- Extension of consultancy on CIBA shrimp feed technology to Bismi Feeds (P) Ltd., O.S.M. Nagar, Mayiladuthurai, Nagapattinam Dist., Tamil Nadu.
- Ring test was organised for harmonisation of PCR test by PCR labs at the request of MPEDA.
- Dr. M.Krishnan, Principal Scientist, CIBA and Dr. R.Narayanakumar, Senior Scientist, CMFRI, Kochi, got Personal Services Agreement Consultancy Project on Socio-economic dimensions of seaweed farming in India from Aquaculture Service, Fisheries & Aquaculture Resources Use and Conservation Division, FIRA, Fisheries and Aquaculture Department, FAO of UN.
- Micro-analysis kit for the estimation of ammonia and nitrite was commercialized to Shrimpex Biotech Services. The technology has successfully been scaled up from July 2008 and more than 1500 kits worth of Rs.6,75,000/- have been supplied in various parts of the country by the entrepreneur till date.
- A bacterial consortium has been commercialized for the development of bioaugmentor for ammonia removal.
- Salinity dependent pH and dissolved oxygen kits have been developed for accurate and sensitive detection of wide range of these important parameters in a variety of water samples (freshwater, brackishwater and coastal waters) in laboratory and field condition as well. Request has been received from an entrepreneur from Madhya Pradesh for technology transfer of pH and DO test kits.

Patents filled

- Krishnani, K.K. and Kathiravan, V. 2010. Nucleic acid based multiplex method for detection of bacteria implicted in biotransformation of potent greenhouse gases and nitrogenous fluxes. Application No. 1119/DEL/2010.
- Krishnani, K.K. 2010. Quantitative method for detecting a microbial pollutant. Application No. 741/DEL/2010.

12

RAC, IMC, SRC and IJSC Meetings

RESEARCH ADVISORY COMMITTEE (RAC)

The Research Advisory Committee of CIBA was constituted by ICAR (Council's order F.No.18-2/2004-ASR-I dated 25 July 2007) for a period of three years from 25 July 2007 with the following.

Dr.P.Natarajan — Chairman
Professor, Rajiv Gandhi Chair, School of Environmental Studies
Cochin University of Science & Technology
Thrikkakara Campus
Kochi 682 022, Kerala

Dr.Apurba Ghosh — Member
Ex-Principal Scientist & Project Coordinator
All India Coordinated Project
23, Gora Chand Road
Kolkata 700 014

Dr.H.C.Joshi — Member
Professor, Department of Environmental Science
Indian Agricultural Research Institute
Pusa, New Delhi 110 012

Dr.Madan Mohan — Member
ADG (M.Fy.)
Indian Council of Agricultural Research
Pusa, New Delhi 110 012

Dr.A.G.Ponniah — Member
Director
Central Institute of Brackishwater Aquaculture
Chennai 600 028

Dr.S.M.Pillai — Member Secretary
Principal Scientist & OIC, Technical Cell
Central Institute of Brackishwater Aquaculture
Chennai 600 028

The 15th Meeting of the Research Advisory Committee was held on 23 February 2010 and the major recommendations are:

- To focus on hormonal and genetic control of shrimp maturation in captivity.
- With regard to the newly introduced *Litopenaeus vannamei* to undertake monitoring of environmental and culture practices.
- The factor which is responsible for higher production in organic shrimp farming has to be identified. Yard experiments are to be conducted to validate the usage of inputs for organic farming.
- Seed production and farming technologies for *Mugil cephalus,* and *Etroplus suratensis* are to be given top most priority by the institute for the benefit of stakeholders and in this regard taking into consideration the broodstock facilities, the work programme to be completely reoriented.
- To ensure reduction on cost of seabass feed, to strengthen the work on plant ingredients for partial replacement fishmeal and development of extruder feed technology.
- To standardize cost-effective feeds for all the cultivable brackishwater species of fish and shrimp especially that of mullet and pearlspot.
- To strengthen the work on WSSV with respect to biosecurity epidemiology and pathogenesis.
- Analysis of the weather data collected has to be completed to understand the impacts of climate change on brackishwater culture systems.
- For seabass in order to promote its culture, take up studies on marketing and farm level economics.
- To collate the information to help district level planning of coastal districts.
- Strengthen the link with KVKs and explore setting up of one KVK in Andhra Pradesh.

Research Advisory Council Meeting on 23 February 2010

STAFF RESEARCH COUNCIL

The Staff Research Council (SRC) of CIBA has the following composition. The 23rd SRC meeting was held during 23-24 March 2010 respectively.

Dr.A.G.Ponniah Director, CIBA	Chairman
Assistant Director General (M.Fy.) ICAR, New Delhi	Member
Dr.A.R.Thirunavukkarasu Head, Finfish Culture Division	Member
Dr.P.Ravichandran Head, Crustacean Culture Division	Member
Dr.T.C.Santiago, Principal Scientist & SIC, Aquatic Animal Health and Environment Division	Member
Dr.S.A.Ali, Principal Scientist & SIC, Nutrition, Genetics and Biotechnology Division	Member
Dr.M.Krishnan, Principal Scientist & SIC, Social Sciences Division	Member
Dr.B.P.Gupta, Principal Scientist & SIC, Environmental Group	Member
Dr.G.Gopikrishna, Principal Scientist & SIC, Genetics and Biotechnology Division	Member
Principal Investigators of all the projects	Member
Dr.S.M.Pillai, Principal Scientist & OIC, Technical Cell	Member Secretary

The salient recommendations of the SRC meeting were:

- ITK and certification should be included as activities under the new project.
- The work on taxonomy of *S. serrata* and *S. tranquebarica* will be continued with observations on large number of collections. Geographical location of the species collected and genetic data should be correlated for the final nomenclature of each species.
- The impact of aquaculture on mangroves in Orissa is to be included and also examine the studies already conducted in Sundarbans, West Bengal.

- Milkfish broodstock maintained under captivity are maturing, efforts should be made to achieve breeding and seed production in the coming season.
- Breeding of seabass during high saline period in summer months may be attempted by reducing the salinity to 18 ppt, since seabass has already been bred and seed produced at this salinity level so that a technology package can be developed.
- The production of mullet and pearlspot under culture is low and strategies should be evolved to enhance their production to make it attractive for farmers to take up culture of these species.

23rd SRC Meeting at Institute Head Quarters

- An assessment of damage due to nodavirus in grow-out culture of seabass in other countries is to be completed to understand the significance of this disease.
- Survey has revealed that WSSV recurrence is more pronounced in certain areas in Andhra Pradesh and it is necessary to document the frequency of WSSV occurrence to understand the possible reasons for such phenomenon.
- Information on the additives used by farmers in ponds is to be collected to understand the various products available in the market and their usefulness.
- With regard to feed development for shrimps cultured under low and high saline conditions, the role of calcium and phosphorous in feed is to be studied under yard and field conditions at different inclusion levels under varied salinity conditions.
- The virulence of the shrimps collected from WSSV affected farm which subsequently matured and spawned is to be measured with real time PCR.
- Secondary data is to be collected from districts about the extent of area under high and low saline shrimp culture and the prevalence of WSSV. The role of salinity stress on induction of WSSV is to be included as an activity under the in house project.
- The output of the focus group discussions is to be uploaded on the intranet / ciba website for use by all the scientists.
- The accuracy of database generated out of the Agro-Web project is to be evaluated and continued as an activity under institute project.
- With large volume of *L. vannamei* expected to be produced in the country, to find out whether it will find way in the domestic market and will compete with of *F. indicus*.
- Geographic focus on Kerala has to be included in the project and the market potential of mullets should be covered in the study.
- The market study of seabass under NFDB project should not be restricted to CIBA technology alone, but should have also competitors to our technology package with focus on the adoption of these technologies by the farmers to have a clear understanding of the popularity of each one.

- The studies proposed on probiotics have to be directed towards our understanding of the mechanism of action of probiotics, rather than production of probiotics.
- Based on the experience of seabass culture at Danti, Gujarat under IDP/GUJ/1 project, the calendar for seabass culture has to be modified to circumvent the impact of winter.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

Institute Management Committee has following composition

Director CIBA, Chennai	Chairman
Assistant Director General (M.Fy.) Indian Council of Agricultural Research, New Delhi	Member
Director of Fisheries Government of Tamil Nadu, Chennai	Member
Director of Fisheries Govt. of Andhra Pradesh, Tank Bund Road, Hyderabad	Member
Dean Fisheries College and Research Institute Tamil Nadu Veterinary and Animal Science University Tuticorin, Tamil Nadu	Member
Shri Ajitsinha Bajirao Patil H-6, Haliopolis, 58 Colaba, Mumbai	Member
Shri Chidipothu Murali Chellemma Thota, Tangutur Post & Mandal Prakasam Dist., Andhra Pradesh	Member
Dr.K.V.Rajendran, Principal Scientist Central Institute of Fisheries Education, Mumbai	Member
Dr.E.Vivekanandan, Principal Scientist Central Marine Fisheries Research Institute, Kochi	Member
Dr.M.Srinath, Principal Scientist Directorate of Research for Women in Agriculture Bhubaneswar	Member

Dr.G.Gopakumar, Principal Scientist Central Marine Fisheries Research Institute, Mandapam	Member
Shri Balabrahmaiah, Senior Finance & Accounts Officer Central Marine Fisheries Research Institute, Kochi	Member
Administrative Officer CIBA, Chennai	Member Secretary

The 34th and 35th meetings of the Institute Management Committee were held on 27th June and 4th December 2009 respectively. The major decisions taken during the meetings are:

- Approval for new major works amounting Rs.420 lakhs during 2009-10
- Clearance for procurement of equipments worth Rs.5.0 lakhs
- Approval for condemnation of department vehicles
- Recommended for expenditure security contract
- Recommended in procurement of vehicles

Institute Management Committe Meeting held on 4th December 2009

QUINQUENNIAL REVIEW TEAM

Council vide order F.No.6(27)/2003-IA-VI dated 15th December 2008 has constituted the Quinquennial Review Team (QRT) to review the work done by the institute for the period 1st April 2004 to 31st March 2009. The composition of the QRT is as under:

Dr.T.J.Pandian — Chairman
Former National Professor (ICAR)
C/o School of Biological Sciences
Madurai Kamaraj University
Madurai 625 021

Dr.T.Balasubramanian — Member
Director
CAS in Marine Biology
Annamalai University
Parangipettai
Tamil Nadu 608 502

Dr.George John Member
Advisor
Department of Biotechnology
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Dr.(Mrs.)Indrani Karunasagar Member
Professor & Head
Department of Microbiology
College of Fisheries (KVAFSU)
Mangalore 575 002

Dr.Ramesh Chand Member
National Professor
NCAP
Pusa
New Delhi 110 012

Dr.S.M.Pillai Member Secretary
Principal Scientist
CIBA
Chennai 600 028

Interactions with QRT Team

The planning meeting of the QRT was held at New Delhi on 6th April 2009. The Chairman, Director, CIBA and Member Secretary attended this meeting convened by the Deputy Director General wherein the schedule of visits and meetings of the QRT were finalized. The team reviewed the progress of research and other developmental activities undertaken by the institute at its headquarters in Chennai, field centre at Muttukadu, research centre at Kakdwip, collaborating centre at Navsari. The team also had interaction with officials at Kerala Agricultural University Research Station at Kumarakam to identify potential areas of collaborative research as well as with Annamalai University. The QRT also interacted with the stakeholders at Chennai. The QRT submitted the report to Council on 21st July 2010. The major research recommendations of the QRT are:

- Increased focus on pond microbial ecology and role of microbes in crustacean seed production and culture
- Monitor chemicals and drugs use and evaluate and increase the efficiency of effluent treatment Pond

- Use of newly identified microbes and nanotechnology in bioremediation
- Antibacterial strategies using 'alternates to antibiotics'
- Diversification of species and systems
- Culture system specific feeds with focus on salinity and intensification and modification of *L. vannamei* culture practices to suit levels of input
- Document important brackishwater biological resources
- Domestic market with farmer linkages
- Technology modifications and policy interventions based on farm level economics and studies on infrastructure and regulations affecting production and export
- Publish more papers in reputed journals and prepare monographs
- Strengthen linkages with Kerala Agricultural University, Center for Advanced Studies in Marine Biology, Annamalai University and National Institute of Ocean Technology.

INSTITUTE JOINT STAFF COUNCIL (IJSC)

The composition of the Institute Joint Staff Council (reconstituted by CIBA for a period of three years with effect from 24.11.2009, vide Office Order F.No.13-1/2009-Admn. dated 3rd December 2009) was as follows. During the year, one meeting was held on 24 November 2009.

Meeting of Institute Joint Staff Council members

Director, CIBA	Chairman
Dr.A.R.Thirunavukkarasu, Head, FCD	Member
Dr.P.Ravichandran, Head, CCD	Member
Dr.T.C.Santiago, Principal Scientist	Member
Dr.S.A.Ali, Principal Scientist	Member
Finance & Accounts Officer	Member
Administrative Officer	Secretary

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Shri R.Subburaj, Technical Assistant (T-4)	Member
Shri R.Balakumaran, Technical Assistant (T-2)	Member

Shri B.Palanivelmurugan, LDC	Member
Shri C.Saravanan, SSS	Member
Shri M.Pichandi, SSS	Member
Shri A.Manoharan, UDC	Secretary

Shri R.Subburaj, Member, IJSC was also a Member of CJSC of ICAR.

GRIEVANCE COMMITTEE

The composition of the Institute Grievance Committee (reconstituted by CIBA for a period of two years with effect from 01.02.2010, vide Office Order F.No.6 (2)/2007-Admn. dated 28 January 2010) was as follows:

Director, CIBA	Chairman

Co-opted

Dr.P.Ravichandran, Head, CCD	Member
Finance & Accounts Officer	Member
Administrative Officer	Member
Shri.R.G.Ramesh, AAO	Member Secretary

Elected members

Dr.A.R.Thirunavukkarasu, Head, FCD	Scientific Member
Shri K.Paranthaman, T-2	Technical Member
Shri.K.Nandhini, JAO	Administrative Member
Shri. K.Nithyanandan, SSS	Staff Member

13

Participation in Conferences, Meetings, Workshops and Symposia

Particulars	Organizers	Duration	Participants
1. Planning meeting of QRT of CIBA at Fisheries Division of ICAR	ICAR, New Delhi	April 6, 2009	Dr.A.G.Ponniah
2. Workshop on building capacity for sustainable governance in South Asian Fisheries: poverty, well being and deliberate policy networks, funded by NERC-ESRC-Dfid Ecosystem Servies and Policy Alleviation Programme (ESPA)	Institute of Ocean Management, Anna University	April 7, 2009	Dr.M.Krishnan
3. Ph.D. Viva-Voce at Cochin University of Science and Technology, Kochi	CUSAT, Kochi	April 13, 2009	Dr.A.G.Ponniah
4. Visit to farmers' site at Saphale, Mumbai, for launching seabass seed under NFDB Project on demonstration of Asian seabass farming in Pond culture system	NFDB, Hyderabad	April 15-16, 2009	Dr.A.G.Ponniah
5. Brainstorming session at Mandapam Regional Centre of CMFRI to deliberate future strengthening of priority areas of research and infrastructure development at Mandapam Regional Centre	CMFRI, Kochi	April 18, 2009	Dr.A.G.Ponniah
6. Review meeting on Internet connectivity and related issues with Assistant Director General (ARIS) & ERNET at CIBA, Chennai	CIBA , Chennai	April 24, 2009	Dr.A.G.Ponniah

7. Brainstorming session on alternative livelihood options for fisherfolk of Sunderban	Dhamakhali, West Bengal	April 24, 2009	Dr.T.K.Ghoshal, Dr.R.Ananda Raja
8. Meeting of the Quinquenniel Review Team (QRT)	CIBA , Chennai	April 30-May 2, 2009	Dr.A.G.Ponniah
9. Sensitization meeting and discussion on monitoring and evaluation of NAIP mega project Bioprospecting of genes and allele mining for abiotic stress tolerance under the chairmanship of DG, ICAR	ICAR, New Delhi	May 5-6, 2009	Dr.A.G.Ponniah
10. Selection Committee Meeting for the post of Scientist –F & Scientist – D of NIOT	NIOT, Chennai	May 8, 2009	Dr.A.G.Ponniah
11. Selection committee meeting for the post of Senior Scientist (as DG's nominee)	ASRB, New Delhi	May 14-15, 2009	Dr.A.G.Ponniah
12. Meeting convened to review the progress of the establishment of the aquatic quarantine facility for *L.vannamei* at Chennai, under the chairmanship of Joint Secretary (Fisheries), at Krishi Bhavan, New Delhi	DAHD&Fy., Min. of Agriculture, New Delhi	May 18, 2009	Dr.A.G.Ponniah
13. Meeting of expert group for review of standard conditions for sanitary import of various fish and fishery products at the NIFPHT&T	CIFT, Kochi	May 19, 2009	Dr.N.Kalaimani
14. Visit to Kakdwip Research Centre of CIBA along with the QRT of CIBA	CIBA, Chennai	May 22-24, 2009	Dr.A.G.Ponniah
15. DBT-NOFIMA Indo-Norwegian collaborative project review meeting	CIFRI, Barrackpore	May 27, 2009	Dr.G.Gopikrishna
16. Workshop on conservation and wise use of natural resources in Chilka lagoon	Chilka Development Agency, Orissa	May 28, 2009	Dr.C.P.Balasubramanian

17. Women aquafarmers meet 2009 organized at Kattur and Thonirevu villages, Pallaverkadu of Tiruvallur District, under the DBT Project	CIBA, Chennai	May 29, 2009	Dr.A.G.Ponniah, Dr.M.Krishnan, Dr.V.S.Chandrasekaran, Dr.K.Ponnusamy
18. Meeting convened to finalize the Standard Operating Procedures (SOP) for Aquatic Quarantine Facility at CIBA, Chennai	CIBA, Chennai	May 30, 2009	Dr.A.G.Ponniah
19. Participated in shrimp diseases and introduction of western white shrimp *L.vannamei*	Navsari, Gujarat	June 2, 2009	Dr.V.S.Chandrasekaran
20. Farmer-scientist interaction meet at Marakannam, Villipuram District, T.N. on the occasion of World Environment Day	CIBA, Chennai	June 5, 2009	Dr.A.G.Ponniah, Dr.A.R.Thirunavukkarasu, Dr.R.Saraswathi
21. Workshop meeting on Consortium of e-Resources in Agriculture (CeRA)	CIBA, Chennai	June 6 & October 21, 2009	Dr. M.Natarajan
22. 7th Governing Council Meeting of NaCSA at MPEDA, Kochi	NaCSA, Kakinada	June 9, 2009	Dr.A.G.Ponniah
23. On farm training programme on brackishwater aquaculture to students of B.F.Sc at W.B.U.A.F.S	KRC of CIBA, Kakdwip	June 9-24, 2009	Dr.A.R.Thirunavukkarasu
24. Review meeting on the on-going seabass demonstration project at CIBA, Chennai	NFDB, Hyderabad	June 18, 2009	Dr.A.G.Ponniah
25. Midterm appraisal meeting of NFDB funded project demonstration of Asian seabass, *Lates calcarifer* farming in pond culture system	CIBA, Chennai	June 18, 2009	Dr.A.R.Thirunavukkarasu, Dr.M.Muralidhar
26. Scientific Advisory Committee of KVK	Tirur, Tiruvallur	June 19, 2009	Dr.K.Ponnusamy

27. Stakeholders meeting to discuss the Standard Operating Procedures (SOP) for aquatic quarantine of SPF *Litopenaeus vannamei* broodstock	CAA, Chennai	June 22, 2009	Dr.A.G.Ponniah
28. 64th Meeting of the Board of Management of TANUVAS, at Madras Veterinary College, Chennai	TANUVAS, Chennai	June 24, 2009	Dr.A.G.Ponniah
29. Final meeting of QRT	CIBA, Chennai	June 26-27, 2009	Dr.A.G.Ponniah
30. 34th Meeting of Institute Management Committee at CIBA, Chennai	CIBA, Chennai	June 27, 2009 (Forenoon)	Dr.A.G.Ponniah
31. Interaction meeting of QRT with the stakeholders	CIBA, Chennai	June 27, 2009 (Afternoon)	Dr.A.G.Ponniah
32. Brainstorming workshop on partnership with aquaconsultants for on-farm research and extension outreach	CIBA, Chennai	July 1, 2009	Dr.A.G.Ponniah, Dr.M.Muralidhar, Dr.J.Syama Dayal
33. ILDEX India 2009: National workshop on advances in aquaculture and fisheries : prospects and challenges at ITPO, Pragati Maidan, New Delhi	Academy of Science Engineering and Technology, Bhopal in collaboration with ICAR, New Delhi	July 3, 2009	Dr.A.G.Ponniah, Dr.K.Ponnusamy
34. National conference of state fisheries ministers at Bhubaneswar	CIFA, Bhubaneswar	July 4-5, 2009	Dr.A.G.Ponniah, Dr. A. Panigrahi
35. Meeting on inauguration of biochemistry association	Ramakrishna Mission Vivekananda College, Chennai	July 6, 2009	Dr.K.K.Krishnani

36. UGC sponsored National seminar on current scenario in molecular biotechnology	St. Peter's College, Kolenchery.	July 8-9, 2009	Dr.K.K.Krishnani
37. 8th Meeting of the DBT Task Force at Biotechnology Department, University of Madras, Chennai	DBT, New Delhi	July 9-10, 2009	Dr.A.G.Ponniah, Dr.K.P.Jithendran
38. Hindi workshop on fish and fisheries science	CIFE, Kolkata Centre, Salt Lake City	July 10, 2009	Dr.T.K.Ghoshal , Dr. Sujeet Kumar
39. Indian Fish Festival 2009	NFDB, Hyderabad	July 10-13, 2009	Dr.A.R.Thirunavukkarasu
40. INFISH 2009	NFDB, Hyderabad	July 12, 2009	Dr.A.G.Ponniah
41. Workshop on sustainable coastal livelihoods for various stakeholders for community and govt.officials	Coastal System Research, M.S.Swaminathan Research Foundation, Chidambaram	July 15, 2009 & July 21, 2009	Dr.V.S.Chandrasekaran
42. ICAR Foundation Day	ICAR, New Delhi	July 16, 2009	Dr.A.G.Ponniah
43. National seminar on agricultural marketing	State Agricultural Marketing Board & Orissa University for Agriculture and Technology, Bhabuneswar	July 18-19, 2009	Dr.M.Krishnan
44. QRT meeting	CIBA, Chennai	July 20-21, 2009	Dr.A.G.Ponniah
45. National consultation on evaluation and valuation of fish genetics resources	NBFGR, Lucknow	July 24-25, 2009	Dr.M.Krishnan
46. Demonstration of carrying capacity software	Andhra Pradesh State Fisheries Department at SIFT, Kakinada	July 27, 2009	Dr.M.Muralidhar

47. Meeting to discuss on convergence workshop for convergence of NREGA at Unnati, Krishi Bhawan	Ministry of Rural Development, Department of Rural Development, Govt. of India, New Delhi	July 29, 2009	Dr.A.G.Ponniah
48. Brainstorming workshop on environmental sustainability of brackishwater aquaculture on the occasion of ICAR – CIBA Foundation Day	CIBA, Chennai	July 30, 2009	Dr.A.G.Ponniah, Dr.M.Krishnan, Dr.K.P.Jithendran, Dr.M.Muralidhar, Dr.(Mrs.) M.Jayanthi, Dr.J.K.Sundaray, Dr.M.Kumaran, Mrs. P.Mahalakshmi
49. Visit to Annamalai University, Parangipettai in connection with the signing of MoU between CIBA and CAS in Marine Biology	Annamalai University, Parangipettai	August 3, 2009	Dr.A.G.Ponniah
50. Workshop on carrying capacity of creek in coastal aquaculture	Gujarat State Fisheries Department, Navsari	August 6, 2009	Dr.M.Muralidhar
51. Meeting of the aquaculture sub-committee to finalize the draft standards for organic aquaculture	MPEDA, New Delhi	August 7, 2009	Dr.A.G.Ponniah
52. Workshop on livelihood opportunities for Aila affected families in sunderbans	Kolkata	August 7, 2009	Dr. A. Panigrahi
53. PMAC meeting of ADDSIAR Project	New Delhi	August 11, 2009	Dr.T.Ravisankar
54. Twenty second meeting of the Coastal Aquaculture Authority at MPEDA, Kochi	CAA, Chennai	August 12, 2009	Dr.A.G.Ponniah
55. Delivered lecture in the NFDB sponsored training programme on finfish cage culture in brackish water and backyard hatchery seed production of *Etroplus suratensis*	BFDA, Kerala	August 13, 2009.	Dr.A.R.Thirunavukkarasu
56. Interview board of Tamil Nadu Veterinary and Animal Sciences University at Chennai	TANUVAS, Chennai	August 17, 2009	Dr.A.G.Ponniah

57. National level training cum workshop on DNA-The Decisive Evidence	Andhra Pradesh Police Academy, Hyderabad	August 17-19, 2009	Dr.K.K.Krishnani
58. Workshop on application of ML and REM methods by employing AsReml in fisheries research data analysis	CIFE, Mumbai	August 17-18, 2009	Dr.G.Gopikrishna, Dr.K.Vinaya Kumar
59. 65th Special meeting of the Board of Management of TANUVAS at Madras Veterinary College, Chennai	TANUVAS, Chennai	August 18, 2009 (FN)	Dr.A.G.Ponniah
60. Meeting of the chairs of QRT and RAC and Directors of fisheries research institutes	SMD, ICAR, New Delhi	August 20, 2009	Dr.A.G.Ponniah
61. National level brainstorming session on Nanogeoscience	Department of Marine Science, Bharathidasan University, Tiruchirapalli	August 20-21, 2009	Dr.R.Saraswathi
62. National seminar on enhancing agricultural productivity and profitability at CMFRI, Kochi	CMFRI, Kochi	August 29-30, 2009	Dr.A.G.Ponniah
63. Indo-French seminar on recent advances in aquaculture	CIFA, Bhubaneswar	August 30-31, 2009	Dr.S.A.Ali, Dr.G.Gopikrishna
64. Special interactive workshop on administrative and financial matters at NAARM, Hyderabad	ICAR, New Delhi	September 10-11, 2009	Dr.A.G.Ponniah
65. National hindi workshop on prospects of aquaculture in Chhatisgad	CIFE, Mumbai at Raipur	September 12-13, 2009	Dr.K.K.Krishnani
66. Meeting of chemists	Chemistry department, Ravishankar University at Raipur	September 12, 2009	Dr.K.K.Krishnani
67. Expert committee meeting on access & benefit sharing for processing the applications received by NBA	NBA, Chennai	September 16, 2009	Dr.A.G.Ponniah

68. Brainstorming session as part of the NFDB sponsored training programme on BMPs of shrimp farming and crab culture	CIBA, Chennai	September 19, 2009	Dr.A.G.Ponniah, Dr.M.Kumaran
69. Review workshop on Agroweb project monitoring by PMAC	NASC complex, New Delhi	September 19-20, 2009	Dr.T.Ravisankar
70. Hindi Day	Kakdwip research Centre, Kakdwip	September 23, 2009	Dr.K.P.Jithendran
71. Workshop on farm-made aqua feed	CIBA, Chennai	September 29, 2009	Dr.A.G.Ponniah, Dr.J.Syama Dayal
72. Awareness cum practical experience workshop on farm-made aqua feeds	Thonirevu Village, Pulicat, Tiruvallur District Tamil Nadu	September 29-30, 2009	Dr.(Mrs.) B.Shanthi, Dr. K. Ambasankar
73. 179th Board Meeting of Tamil Nadu Fisheries Development Corporation Limited	TNFDC, Chennai	September 30, 2009	Dr.A.G.Ponniah
74. Eighth Governing Council Meeting and third AGM meeting of National Centre for Sustainable Aquaculture	NaCSA at MPEDA, Kochi.	September 30, 2009	Dr.M.Muralidhar
75. Farmers' Meet – cum – harvest of shrimp at Danti Farm of Navsari Agricultural University under CIBA-NAU Collaborative Project on brackishwater aquaculture	NAU, Gujarat	October 3, 2009	Dr.A.G.Ponniah, Dr.S.M.Pillai
76. 3rd Meeting of the Sub-Committee on organic aquaculture	MPEDA, New Dehli	October 5, 2009	Dr.A.G.Ponniah
77. Meeting of the Expert committee on preparing guidelines for taking up ameliorative measures for biodiversity rich areas threatened by overuse, abuse (or) neglect	NBA, Chennai	October 9, 2009	Dr.A.G.Ponniah

78. Training programme on technical consultancy	Consultancy Development Centre, Ministry of Science and Technology, Bangalore	October 9, 2009	Dr.K.K.Krishnani
79. Nutrition, Biochemistry and Physiology in Fisheries and Researches	National Institute of Animal Nutrition and Physiology, Bangalore	October 19, 2009	Dr.S.A.Ali, Dr. K. Ambasankar, Dr.J.Syama Dayal
80. Organized farmers meet	Satapada, Puri, Orissa	October 22, 2009	Dr.(Mrs.) B.Shanthi Mrs. P.Mahalakshmi
81. Delivered lecture in the ICAR sponsored short course on gender analysis: a methodology for sensitization and action	Directorate of Research on Women in Agriculture, Bhubaneswar, Orissa	October 23, 2009	Dr.(Mrs.) B.Shanthi Mrs. P.Mahalakshmi
82. Consultative workshop for the management planning of Chilka lake –A Ramsar site	Chilka Development Agency, Orissa	October 23-24, 2009	Dr.C.P.Balasubramanian, Dr. A. Panigrahi
83. User awareness program by M/s. Informatics (India) Limited, Bangalore on JCCC (J-Gate Custom Content for Consortia) for CeRA (Consortium for e-Resources in Agriculture)	CIBA, Chennai	October 28, 2009	Dr. M.Natarajan
84. UGC sponsored refresher course on life sciences for college teachers	Pondicherry University, Pondicherry	October 28, 2009	Dr.K.K.Krishnani
85. 4th Meeting of the sub-committee on organic aquaculture	MPEDA, New Delhi	October 28, 2009	Dr.A.G.Ponniah, Dr.P.Ravichandran, Dr. A. Panigrahi

86. Review meeting of Indo-Norwegian DBT – NRC research project improved disease resistance of tiger shrimp and rohu carp farmed in India : developing and implementing advanced molecular methods and streamlining access to and use of genetic resources	CIBA, Chennai	November 3, 2009	Dr.A.G.Ponniah, Dr.G.Gopikrishna, Dr.M.Shashi Shekhar, Dr.S.Kannappan, Dr.Sherly Tomy, Dr.K.Vinaya Kumar
87. Good laboratory practices compliance in biotechnology	Department of Biotechnology	November 3-5, 2009	Dr.K.P.Jithendran
88. Norman Borlaug International workshop on food safety and food security	Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hissar, Haryana and Iowa State University, USA	November 3-4, 2009	Dr.(Mrs.)P.Nila Rekha
89. Second workshop of Indo-Norwegian DBT project	CIFA, Bhubaneswar	November 5-7, 2009	Dr.G.Gopikrishna, Dr.M.Shashi Shekhar, Dr.K.Vinaya Kumar
90. 36th Foundation Day celebration of ASRB	Agricultural Scientists Recruitment Board, ICAR	November 9, 2009	Dr.A.G.Ponniah
91. Presented guest lecture in the ICAR sponsored winter school on application of molecular and serological tools in fish disease diagnosis and delivered training on cytokine network and health assessment in fish and cellular Immune response in Penaeid shrimp	CIFA, Bhubaneswar	November 9-29, 2009	Dr. A. Panigrahi
92. Seminar on role of Self Help Groups in women empowerment	TNAU, Coimbatore	November 10-11, 2009	Dr. (Mrs.) B. Shanthi
93. INDO-US workshop on nanotechnology: applications and implications	IICT, Hyderabad	November 10-12, 2009	Dr. (Mrs.) R. Saraswathi

94. Workshop on sampling design and methodology to survey socio-economic condition of fishers and fish farmers in India	Fisheries Division, ICAR, New Delhi & CIBA, Chennai	November 13, 2009	Dr.A.G.Ponniah, Dr.M.Krishnan, Dr.V.S.Chandrasekaran, Dr.T.Ravisankar, Dr.(Mrs.)D.Deboral Vimala, Dr.M.Kumaran, Mrs. P.Mahalakshmi
95. ADDSIAR meeting	NAARM, Hyderabad	November 13-14, 2009	Dr.T.Ravisankar
96. Farmers' meet	Kakdwip Research Centre of CIBA, Kakdwip	November 17, 2009	Dr.A.G.Ponniah, Dr.A.R.Thirunavukkarasu
97. Aquafarmers meet	ICAR Complex, Goa	November 25, 2009	Dr.S.M.Pillai , Dr.V.S.Chandrasekaran
98. Workshop on organic aquaculture production and product marketing	INFOFISH, Kaulalampur, Malayasia and MPEDA, Cochin	November 25, 2009	Dr. A. Panigrahi
99. NACA project meeting at Indonesia	NACA	November 26, 2009	Dr.P.Ravichandran
100. Seminar on building market linkages for the value added fish food products developed by coastal women Self Help Groups (SHGs) at CIBA, Chennai	CIBA, Chennai	November 27, 2009	Dr.A.G.Ponniah, Dr.M.Krishnan, Dr.V.S.Chandrasekaran, Dr.(Mrs.)B.Shanthi,
101. National seminar on fisheries based livelihoods: present status, problems and prospects	The Livelihood School, Kolkata	November 28-29, 2009	Dr.T.K.Ghoshal
102. Meeting of expert committee on preparing guidelines for taking up ameliorative measures for biodiversity rich areas threatened by overuse, abuse or neglect, constituted by NBA	NBA, Chennai	November 30, 2009	Dr.A.G.Ponniah

103. Focus group discussion meetings perception of climate change impacts on small-scale shrimp farmers	Gullalamoda and Chinnapuram in Krishna District, Andhra Pradesh	December 3, 2009	Dr.M.Muralidhar, Dr.J.Syama Dayal, Dr.M.Kumaran, Mrs. P.Mahalakshmi
104. Seabass feed production	MPEDA, Chennai	December 3, 2009	Dr. K. Ambasankar
105. Institute Management Committee meeting of CIBA	CIBA, Chennai	December 4, 2009	Dr.A.G.Ponniah
106. Presented the state of art on organic shrimp farming technology in the IMC meeting	CIBA, Chennai	December 4, 2009	Dr. A. Panigrahi
107. International stakeholders workshop on impact of climate change on shrimp farming	Vijayawada, Andhra Pradesh	December 4, 2009	Dr.M.Muralidhar, Dr. J.Syama Dayal, Dr. M.Kumaran, Mrs. P. Mahalakshmi
108. All India official language conference at Orissa	Bhartiya RajBhasha Parishad, New Delhi,	December 9-11, 2009	Dr. R. Ananda Raja
109. Indo- US workshop on emerging issues in water management for sustainable agriculture in South Asia	Central Soil and Water Conservation Research & Training Institute and Michigan State University, USA	December 10-12, 2009	Dr. (Mrs.) P.Nila Rekha
110. Seminar on marine resources – sustainable utilization & conservation	St.Mary's College, Tuticorin	December 11, 2009	Dr. A.G. Ponniah
111. Fifth NIAS-DST workshop on nanotechnology: dimensions of nanoscience, nanotechnology & society for women scientists & technologists	National Institute of Advanced Studies, Bangalore.	December 14-18, 2009	Dr. (Mrs.) R. Saraswathi
112. Twenty fourth meeting of the Coastal Aquaculture Authority	Coastal Aquaculture Authority, Chennai	December 16, 2009	Dr.A.G.Ponniah
113. Indo-Us workshop on epigenetic regulation and genome control: emphasis on RNAi and micro RNA	Centre for cellular and molecular Biology, Hyderabad	December 16-18, 2009	Dr.M.Shashi Shekhar, Dr.Sherly Tomy

114. Delivered lecture on success in hatchery development of sea bass and its potential for commercial cage culture in India in the occasion of National level training on cage culture of seabass	Central Marine Fisheries Research Institute	December 21, 2009	Dr.A.R.Thirunavukkarasu
115. National seminar on Indian marine fisheries – sustainability at cross roads and delivered lecture on coastal aquaculture in India – present and path ahead	College of Fisheries, Mangalore	December 22-23, 2009	Dr.A.R.Thirunavukkarasu
116. Inaugural function of the International conference on recent advances in lobster biology, aquaculture and management, RALBAM 2010	National Institute of Ocean Technology, Chennai	January 5, 2010	Dr.A.G.Ponniah
117. International workshop on research in chicken coccidiosis – an update and national cocci alert network	Madras Veterinary College, Chennai	January 7, 2010	Dr.K.P.Jithendran
118. Inaugural function of INDAQUARIA 2010 at YMCA, Vepery, Chennai	Marine Products Development Authority, Cochin	January 8, 2010	Dr.A.G.Ponniah, Dr.M.Kailasam
119. 5th Meeting of the aquaculture sub-committee on organic aquaculture	MPEDA, New Delhi	January 11-12, 2010	Dr.A.G.Ponniah, Dr. A. Panigrahi
120. Interaction meet of CIAE scientists and engineering scientists of fisheries institutes	CIAE, Bhopal	January 11-12, 2010	Dr.(Mrs.) M.Jayanthi, Dr.(Mrs.)P.Nila Rekha
121. Brainstorming workshop on bioinformatics application in fish/ shellfish genomics – recent development in bioinformatic tool in genomics	CIFA, Bhubaneswar	January 12-13, 2010	Dr.Sherly Tomy , Dr.K.Vinaya Kumar
122. Inaugural function of national seminar on integrated management of water resources with reference to biodiversity & livelihood	Academy of Science, Engineering and Technology, Bhopal	January 16, 2010	Dr.A.G.Ponniah, Dr.V.S.Chandrasekaran
123. Financial management review meeting	NASC complex, New Delhi	January 20, 2010	Dr.T.Ravisankar
124. CHEM BLAZE 2010	Women's Christian College, Chennai	January 20, 2010	Dr.K.K.Krishnani

125. Technical meet on strategies for sustainable shrimp aquaculture	Lotus Hall, GRT Convention Centre, Chennai	January 26, 2010	Dr.V.S.Chandrasekaran
126. DBT-NOFIMA project review meeting	ICAR, New Delhi	January 29, 2010	Dr.G.Gopikrishna
127. Meeting to review the foreign-aided projects in fisheries division on 29.1.2010 and meeting convened by Secretary, DARE and Director General, ICAR, on Institute's activities	SMD, ICAR, New Delhi & ICAR, New Delhi	January 29-30, 2010	Dr.A.G.Ponniah
128. Training workshop on sensitization on networking and web hosting	NAARM, Hyderabad	February 2-3, 2010	Dr.T.Ravisankar, Mrs. P.Mahalakshmi
129. Workshop on PMAC meeting	NAARM, Hyderabad	February 2-4, 2010	Dr.T.Ravisankar, Mrs. P.Mahalakshmi
130. Awareness programme on biosecurity protocols at Thiruvallur District	CIBA, Chennai	February 3, 2010	Dr.A.G.Ponniah, Dr.C.Gopal, Dr.M.Muralidhar
131. Chennai Science Festival-2010	Periyar Science and Technology Centre, Chennai	February 3-7, 2010	Dr.M.Kumaran
132. 25th Meeting of the Coastal Aquaculture Authority	Coastal Aquaculture Authority, Chennai	February 9, 2010	Dr.A.G.Ponniah
133. Indo-European workshop on waste management in aquaculture and fisheries	Cochin University of Science and Technology (CUSAT) in association with Universita Del Salento, Italy, National Institute of Oceanography, Goa and Food and Agricultural Organization, Italy	February 10-11, 2010	Dr.A.G.Ponniah, Dr.K.K.Krishnani, Dr. Sujeet Kumar

134. Second Consortium Advisory Committee (CAC) meeting of NAIP project on export oriented marine value chain for farmed seafood production using Cobia (*Rachycentron canadum*) through rural entrepreneurship	Fisheries College Research Institute, Tuticorin	February 11, 2010	Dr.A.R.Thirunavukkarasu
135. DBT taskforce meeting of aquaculture and marine biotechnology	Goa University	February 15, 2010	Dr.K.P.Jithendran, Dr.R.Ananda Raja
136. Directors' Conference during 15-16 February 2010 and SAU Vice-Chancellors' Conference	ICAR, New Delhi	February 15-17, 2010	Dr.A.G.Ponniah
137. International symposium on remote sensing and fisheries	SAFARI, Canada and CIFT, Kochi	February 15-17, 2010	Dr.M.Muralidhar, Dr.(Mrs.) M.Jayanthi, Dr.K.Ponnusamy
138. National seminar on climate change and rain fed agriculture	CRIDA and Indian Society of Dry land Agriculture, Hyderabad	February 18-20, 2010	Dr.M.Muralidhar
139. Interaction meet and demonstration of Asian seabass *Lates calcarifer* farming in the pond culture system, at Ramudupalem, Nellore	CIBA and National Fisheries Development Board, Hyderabad	February 19, 2010	Dr.A.G.Ponniah, Dr.A.R.Thirunavukkarasu
140. India International seafood show	MPEDA, Chennai Trade Centre, Chennai	February 19-21, 2010	Dr. V.S. Chandrasekaran , Dr. (Mrs.) D.Deboral Vimala, Mrs. P.Mahalakshmi
141. Stakeholders interaction meeting to discuss the steps to be adopted in strengthening sustainable development among the coastal women Self-Help Group beneficiaries	CIBA, Chennai	February 20, 2010	Dr.A.G.Ponniah, Dr.M.Krishnan, Dr.(Mrs.) B.Shanthi, Dr.C.P.Balasubramanian, Dr. K. Ambasankar

142. Research Advisory Committee Meeting	CIBA, Chennai	February 23, 2010	Dr.A.G.Ponniah
143. Workshop on small indigenous freshwater fish species: their role in poverty alleviation food security and conservation of biodiversity	Central Inland Fisheries Research Institute, Barrackpore	February 25, 2010	Dr.A.G.Ponniah, Dr.J.K.Sundaray
144. NAIP sub-projects to familiarize with procurement related matters and financial management	New Delhi	February 25-26, 2010	Dr.Debasis De
145. 14th Scientific Advisory Committee of KVK	Kattuppakkam	February 26, 2010	Dr.V.S.Chandrasekaran
146. National Symposium on laboratory safety and waste management	Biotechnology Department, IIT, Chennai	February 27, 2010	Dr.K.K.Krishnani
147. Meeting on implementation of various fisheries development schemes	CIFE, Mumbai	March 2, 2010	Dr.S.M.Pillai
148. 181st Meeting of Board of Directors of Tamil Nadu Fisheries Development Corporation Limited	TNFDC Ltd., Chennai	March 3, 2010	Dr.A.G.Ponniah
149. Research Council meeting of Tamilnadu Agricultural University (TNAU)	Coimbatore	March 4, 2010	Dr.N.Kalaimani
150. Workshop on organic aquaculture standards consultation meeting	MPEDA, New Delhi	March 5, 2010	Dr. A. Panigrahi
151. Review meeting of outreach programmes of icar fisheries division	ICAR, New Delhi	March 5-6, 2010	Dr.A.G.Ponniah, Dr. S. A. Ali Dr.G.Gopikrishna, Dr. K. Ambasankar
152. TANSA 2009 Expert Advisory Committee Meeting for selection of awardee in biological sciences, at Tamil Nadu State Council of Science and Technology	Tamil Nadu State Council of Science and Technology, Chennai	March 8, 2010	Dr.A.G.Ponniah

153. Field Experience Training (FET) for the 89th Foundation Course for Agriculture Research Service (FOCARS) training	CIBA, Chennai	March 12, 2010	Dr.A.G.Ponniah
154. Meeting-cum-workshop on ICAR zonal technology management and business planning and development	CIFT, Cochin	March 12-13, 2010	Dr.S.M.Pillai, Dr.S.A.Ali, Dr.N.Kalaimani Dr.K.K.Krishnani
155. Training workshop on distributed ownership of institutional websites for content management and update	CIBA, Chennai	March 16, 2010 (FN)	Dr.A.G.Ponniah, Dr.A.R.Thirunavukkarasu, Dr.M.Krishnan, Dr.T.Ravisankar, Dr.(Mrs.)D.Deboral Vimala, Dr.J.K.Sundaray, Dr.R.Saraswathi, Mrs. P.Mahalakshmi
156. Field Experience Training (FET) for the 89th Foundation Course for Agriculture Research Service (FOCARS) training	CIBA, Chennai	March 16, 2010 (AN)	Dr.A.G.Ponniah
157. National Workshop on ICT initiates of the NAIP	New Delhi	March 19, 2010	Dr.T.Ravisankar
158. Staff Research Council Meeting	CIBA, Chennai	March 23-24, 2010	Dr.A.G.Ponniah
159. NFDB–FAO mission consultative meeting on development of fisheries sector in india	NFDB, Hyderabad	March 23-25, 2010	Dr.M.Muralidhar
160. Workshop on fisheries resource management	IFAD assisted PTSLP of Tamil Nadu Corporation for Development of Women Ltd., Chennai	March 24, 2010	Dr.(Mrs.) B.Shanthi
161. Consultative meeting to develop a full project document, under FAO assistance for development of fisheries	FAO in collaboration with NFDB, Hyderabad	March 25, 2010	Dr.A.G.Ponniah

162. Workshop on role of low value fish species in strengthening food security in india	KVAFSU, Bidar, College of Fisheries, Mangalore	March 25-26, 2010	Dr.M.Krishnan
163. 1st IFIP International conference on bioinformatics	SVNIT, Surat	March 25-28, 2010	Mrs. P.Mahalakshmi , Dr.K.Vinay Kumar
164. Launching workshop of the NAIP Project	CSSRI, RRS, Canning	March 28, 2010	Dr.T.K.Ghoshal , Dr.Debasis De, Mr. G. Biswas, Dr.R.Ananda Raja, Dr. Sujeet Kumar

14

Services in Committees

Dr.A.G.Ponniah, Director

- Member, Executive Committee and Governing Body, Rajiv Gandhi Centre for Aquaculture (MPEDA), Mayiladuthurai
- Member, National Committee to oversee and regulate introduction of exotic aquatic species, Min. of Agriculture, Govt. of India
- Member, Coastal Aquaculture Authority, Ministry of Agriculture, Govt. of India
- Member, General Body of Orissa Shrimp Seed Production Supply and Research Centre (OSSPARC), Orissa
- Member, ICAR Regional Committee No.VIII
- Member, Task Force Committee on Fisheries Development Mission – Tamil Nadu. State Fisheries Department
- Member, Scientific Advisory Committee for Dr.Perumal Krishi Vigyan Kendra
- Director - Board of Directors of Tamil Nadu Fisheries Development Corporation Limited, Chennai
- Expert Member – Tamil Nadu Fisheries Research Council
- Member, Task Force Committee on Aquaculture and Marine Biotechnology of Department of Biotechnology
- Member, Working group on Fisheries for the Eleventh Five Year Plan (2007-2012)
- Member, National Centre for Sustainable Aquaculture (NaCSA)
- Member, Committee for protection of fish germplasm through registration and documentation, constituted by ICAR
- Member, Sub-Committee for studying the potential and viability of culturing endemic and exotic species, constituted by DAHD&Fy., Ministry of Agriculture
- Member, Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur
- Member, Broad Subject Matter Area Committee for assisting National Core Group for restructuring of Masters' and Doctorate Course Curricula & Syllabi

- Member, Committee to study various aquaculture standards for inclusion in National Programme for Organic Production (NPOP), constituted by National Steering Committee for Organic Products, MPEDA
- Member, Sub-Committee to formulate guidelines for farming of *L.vannamei* and norms for setting up of multiplication centres for production and supply of *L.Vannamei*
- Chairman – Sub-committee to frame guidelines for registration of PCR laboratories, Feed manufactures/ suppliers and dealers, constituted by CAA
- Member, Fisheries Institute of Technology and Training (FITT), Chennai
- Member, Sub-committee to finalize the guidelines for import of Ornamental fishes, constituted by Ministry of Agriculture, DAHD&Fy
- Member, Sub-Group on Fisheries constituted by Ministry of Agriculture, Department of Animal Husbandry, Dairying & Fisheries, Govt. of India, New Delhi
- Member, Board of Management of Tamil Nadu Veterinary and Animal Sciences University, Chennai
- Member, Expert Committee to prepare Rules for management and conservation of Biodiversity Heritage sites, constituted by National Biodiversity Authority, Chennai
- Member, Expert Committee to evaluate the access, patent, transfer of research results and material transfer applications, constituted by National Biodiversity Authority, Chennai
- Member, Expert Committee on preparing guidelines on ameliorative measures for Biodiversity rich areas threatened by overuse, abuse or neglect, constituted by NBA, Chennai
- Member, Expert Committee on Access and Benefit sharing for processing the applications received by NBA, constituted by National Biodiversity Authority, Chennai
- Member, Selection Committee for selection of Deans and Directors of various faculties of TANUVAS (As ICAR representative)
- Member, Selection Committee constituted for the selection of an Awardee in the discipline of Biological Sciences, constituted by Tamil Nadu State Council for Science & Technology
- Member, State Level Committee on Animal Genetic Resources (SLCAnGR), constituted by Animal Husbandry & Veterinary Services, Chennai
- Member, National Organizing Committee of the National Workshop on Advances in Aquaculture and Fisheries : Perspectives, Prospects and Challenges, organized by Academy of Science Engineering and Technology, Bhopal in collaboration with Ministry of Agriculture, GOI and M/s.PIXIE on 2nd July 2009 at New Delhi
- Member, Panel of Experts for the Technical Session on Brackishwater Aquaculture and Mariculture: Potentials and Issues in Brackishwater Aquaculture, organized on the occasion of INFISH 2009 during 11-13 July 2009 at Hyderabad

- Member, National Advisory Committee of the National Seminar on Integrated Management of Water Resources with Reference to Biodiversity and Livelihood, organized by Academy of Science Engineering & Technology, from 21-22 November 2009 at Bhopal

- Member, Organizing Committee of the National Seminar on Conservation and Sustainability of Coastal Living Resources of India in association with Central Institute of Fisheries Technology, Cochin, Centre for Ocean Environmental Studies, New Delhi, Central Marine Fisheries Research Institute, Cochin and National Institute of Oceanography, Goa, held during 2-3 December 2009

- Member, Advisory Committee of the National Seminar on Indian Marine Fisheries – Sustainability at Cross Road, organized by the College of Fisheries and Alumni Association of College of Fisheries, Mangalore, during 22-23 December 2009 at Mangalore

- Member, National Organizing Committee for International Symposium on Remote Sensing and Fisheries, in collaboration with SAFARI, IOCCG and other International organizations during 15-17, February 2010 at Kochi

- Member, Advisory Council of the Indian Aqua-Invest Congress and Expo-2010 organized by Pillay Aquaculture Foundation at Central Institute of Fisheries Education, Mumbai from 22-24 April 2010

- Member, Advisory Council of 8th Symposium on Diseases in Asian Aquaculture (8th DAA), organized by College of Fisheries, Mangalore during 21-25 November 2011

Dr.A.R.Thirunavukkarasu, Head, FCD

- Member, Board of studies of Botany and Zoology (PG) at University of Madras, Chennai

- Member, External Technical Committee for the Government of Tamil Nadu for marine finfish hatchery

- Member, Non-Academia Member in the Board of Studies in Zoology (G&P) of University of Madras for 3 years from 5.1.2006

- Member, Peer Review Committee, ICMAM, NIOT

- Member, Board of Directors, Centre for Aquaculture Research & Development, Govt. of Tamil Nadu

- Member, Advisory Committee, Fisheries Institute of Technology & Training, Govt. of Tamil Nadu

- Member, Implementation of SGSY Special programme of Fisheries, Govt. of Tamil Nadu

Dr. M. Natarajan, Principal Scientist

- Chairman of the Best Thesis Award Committee of Professional Fisheries Graduates Forum (PFGF), Mumbai

Dr. M.Krishnan, Principal Scientist

- Member, IMC, CMFRI, Kochi, 23 July 2009 & 30 March 2010

Dr. K.P.Jithendran, Principal Scientist

- Panel member for evaluation of research project proposal under the Young investigators programme in biotechnology (Yipb)' of the Kerala State Council for Science, Technology and Environment (KSCSTE), Trivandrum

Dr. V.S.Chandrasekaran, Principal Scientist

- Member, Committee for approval of purchase of CD/DVD Server for the MVC Library of the Tamil Nadu Veterinary and Animal Sciences University

Dr. T.Ravisankar, Senior Scientist

- Peer reviewer for e-learning course, Livestock economics and marketing for BVSc & AH of TANUVAS NAIP

Dr.M.Muralidhar, Senior Scientist

- Nodal officer from CIBA for weather watch and to provide measures to be undertaken in the context of constant climate and weather changes

Dr. M. Jayanthi, Senior Scientist

- Member, Technical committee of GIS, Department of Animal Husbandry, Dairying & Fisheries (DAHDF), Ministry of Agriculture, Govt. of India, New Delhi

Dr.K.Ambasankar, Senior Scientist

- Co- teacher for developing the e–course content of the course ANN 222, Applied Animal nutrition (2+1) in association and co ordination of the course content developer of TANUVAS under NAIP scheme

Dr.K.Ponnusamy, Senior Scientist

- Executive member of Fisheries Technocrats Forum, Chennai

15

Workshops, Seminars and Meetings

WORKSHOPS

Workshop on environmental sustainability of brackishwater aquaculture

A workshop on 'Environmental sustainability of brackishwater aquaculture' was held at CIBA, Chennai on 30th July 2009 on the occasion of ICAR Day and the CIBA Foundation Day. The workshop was attended by Dr.R.Paulraj, Member Secretary, Coastal Aquaculture Authority, Government of India, Ministry of Agriculture, Shri. Thillai Govindan, Joint Director of Fisheries (Research), Department of Fisheries, Govt. of Tamil Nadu. A total of 110 participants representing scientists, officials and farming sector attended. Three technical sessions were conducted *viz*., ecosystem carrying capacity assessment and integration of aquaculture into Integrated Coastal Zone Management (ICZM), discharge water treatment of brackishwater aquaculture farms and environmental monitoring of coastal water bodies. The discussions were focused on the actual influence of discharges of shrimp farming and other activities on the coastal water quality, and monitoring of receiving water quality. Decision support software on 'Estimation of carrying capacity of water body for shrimp farming' developed by the institute was released during the workshop.

Workshop on sampling design and methodology to survey socio economic conditions of fishers & fish farmers in India

A National workshop on Sampling design and methodology to survey socio economic conditions of fishers & fish farmers in India was conducted on 13th November 2009. Twenty six participants from ICAR institutions, Madras Institute of Development Studies (MIDS) and Tamil Nadu Agricultural University participated in the deliberations. Dr. S.Ayyappan, DDG (Fy.) inaugurated the workshop. Dr. Madan Mohan, ADG (M.Fy), Dr.A.G.Ponniah, Director CIBA, Dr.V.K.Bhatia, Director, IASRI, Dr. B.C.Barah, Director, NCAP, Dr. M.Saleth, Director, MIDS participated in the discussions.

International workshop on impact of climate change on shrimp farming

A stakeholder workshop was organized on 4th December 2009 in Vijayawada to understand the perception of different stakeholders towards impacts of climate change on shrimp farming and adaptive measures. The workshop was attended by 90 participants including farmers, scientists and officials from different organizations. The workshop addressed issues of policy adaptive measures to mitigate the impact.

Workshop on distributed ownership of institutional websites for content management and update

An in-house training workshop for scientists and officers of CIBA was organised on 16th March 2010 to familiarize the team with JOOMLA open source web applications and web content management in a distributed manner with individual login and password system in the Institute web site. A total number of 35 participants including experts from IIT Chennai, NIC Chennai, NAARM Hyderabad, Fisheries College, Tutucorin and MSSRF Chennai participated in the training workshop.

FARMERS MEETS

Women aquafarmers meet

Women aquafarmers meet was organised on 29th May 2009 at Kattur and Thonirevu villages, Tiruvallur District, Tamil Nadu. During this meet the crab fattening pens, farm model aquafeed unit and value added fish products development units were inaugurated by Dr. M.Sakthivel, President, Aquaculture Foundation of India, Shri.Thillai Govindan, Joint Director of Fisheries (Research), Department of Fisheries, Govt. of Tamil Nadu and Dr.A.G.Ponniah, Director, CIBA.

Interaction meeting at Navsari, Gujarat

A farmers meet was organised during the harvest of tiger shrimp at the Danti farm in Navsari District of Gujarat on 3rd October 2009 under the collaborative project between CIBA and Navsari Agricultural University.

Interaction meeting in Orissa

Farmer's meet on empowerment of women through sustainable brackishwater aquaculture' was organized on 22nd October 2009 at Satapada, Puri, Orissa in collaboration with Directorate of Women in Agriculture, Bhubaneswar. Thirty women Self Help Group members and 15 aquafarmers from Mahensa, Barakpur Panchayat, Berhampur Post, Naupada, Puri, participated in this meet.

Brackishwater aquafarmers meet at Kakdwip

Kakdwip Research Centre of CIBA organised a brackishwater aquafarmers meet on 17th November 2009. The meet provided a platform for interaction/ exchange of ideas between the farmers and scientists. The meeting reviewed the development and new trends in brackishwater aquaculture in West Bengal, popularised the technologies developed by CIBA. About 150 farmers from four coastal blocks, *viz.,* Sagar, Namkhana, Kakdwip and Pathar Pratima under Kakdwip Sub-Division, South 24 Parganas District participated in this meet.

Interaction meeting in Goa

In order to create awareness among the aquafarmers regarding the potential of diversification of species for aquaculture and to popularize the latest technologies already developed in brackishwater aquaculture, an aqua farmers meet was organized by the institute in collaboration with ICAR Research Complex for Goa and Brackishwater Fish Farmers Development Agency (BFDA), Goa at the ICAR Research Complex, Old Goa on 25th November 2009. About 100 farmers, scientists from CIBA and ICAR Research Complex for Goa, officials from Brackishwater Fish Farmers Development Agency, Goa, MPEDA and NACSA participated in the meeting.

Interaction meet on bio-security protocols

An awareness programme on biosecurity protocols for shrimp farm biosecurity was organised on 3rd February 2010 at Ponneri Taluk, Thiruvallur district of Tamil Nadu. The programme was attended by 54 farmers from 8 villages of Thiruvalluvar district. The importance of biosecurity protocols *viz*., maintenance of reservoir ponds, screens and filters at the water inlet points, seed quality, PCR testing of seeds, prescribed stocking density, bird netting, crab fencing and disinfection of implements and machineries were emphasised to minimize the disease risk and various means of horizontal transmission of the viral pathogens and the methods to prevent such transmission were discussed.

Interaction meeting of demonstration on Asian seabass farming

Interaction meeting of NFDB funded project demonstration of Asian seabass, *Lates calcarifer* farming in pond culture system was organised on 19th February 2010 at Nellore and Ramudupalem. 220 stakeholders including farmers, bankers, fish/shrimp feed company representatives, officials from MPEDA, NFDB, Department of Fisheries, Govt. of Andhra Pradesh participated. Awareness has been generated through print and electronic media about prospects of seabass farming in India.

STAKEHOLDER MEETINGS

- Meeting to finalize SOP standards for AQF at CIBA, Chennai on 30th May 2009.
- Midterm appraisal meeting of NFDB funded project .

The mid-term appraisal meeting of NFDB funded project on 'Demonstration of Asian seabass, *Lates calcarifer* farming in pond culture system' was conducted on 18th June 2009 at CIBA, Chennai, wherein participants including farmers, entrepreneurs, fish hatchery owners and feed companies attended.

- Public - private partnership with aquaconsultants for on-farm research and extension outreach meeting on 1st July 2009 at Ongole.
- Meeting with stakeholders on aquafarm made feed at CIBA, Chennai during 29-30 September 2009.
- Co-ordination meeting of fisheries group under the NAIP Project Bioprospecting of genes and allele mining for abiotic stress tolerance at CIBA, Chennai on 5th October 2009.

- Review meeting of the Indo-Norwegian DBT-NOFIMA-CIFA-CIBA Collaborative project Improved disease resistance of rohu carp and tiger shrimp farmed in India: Developing and implementing advanced molecular methods, and streamlining access to and use of genetic resources at CIBA, Chennai on 3rd November 2009.

- Mid-term review meeting on Nutrient profiling and evaluation of fish as a dietary component project at CIBA, Chennai on 19th November 2009.

- Focus Group discussion meetings on Perceptions of farmers towards impact of climate change on shrimp farming at Gullalamoda and Chinnapuram, Krishna District, Andhra Pradesh on 3rd December 2009.

- A brackishwater aquafarmers meet was organized on the occasion of World Environment Day on 5th June 2009 at Marakanam in Villupuram district of Tamil Nadu. Eco-friendly brackishwater technologies developed by the institute were discussed in the workshop.

Puppet Show

A 'Puppet Show' was organized at Thonirevu village, Tiruvallur District, on 29th May 2009 to create awareness among the coastal women SHGs and the villagers on the importance of brackishwater aquaculture production in the current scenario of dwindling marine catch, diversification of livelihoods and contingency measures to be taken during natural disasters like cyclone, tsunami, etc. in coastal areas. The show was witnessed by 75 villagers.

Field Experience Training (FET)

CIBA co-ordinated Field Experience Training (FET) for 8 ARS probationers of 89th FOCARS deputed by NAARM for 21 days during 2-22 March 2010. The probationers carried out PRA exercises at Kattur Village in Tiruvallur District for first 14 days and later underwent industrial attachment training at shrimp hatchery and sugar factory.

EXHIBITIONS

The institute participated in the following exhibitions:

- ILDEX India 2009 at Pragati Maidan, New Delhi during 2-4 July 2009

- National conference of State Fisheries Ministers, Bhubaneswar at Swati Plaza during 4-5 July 2009

- Indian Fish Festival organized by National Fisheries Development Board, Hyderabad at People's Plaza, Hyderabad during10 – 12 July 2009

- National seminar on integrated management of aquatic water resources with reference to biodiversity and livelihood organized by the Academy of Science, Engineering and Technology, Bhopal at Regional Museum of Natural History, Bhopal during 16-17 January 2010

- Chennai Science Festival at Science City Campus organized by Tamil Nadu State Council for Science and Technology at Chennai during 3-7 February 2010

- International symposium on Remote Sensing and Fisheries at Kochi organised by Society of Fisheries Technologists, India and CIFT at Abad Plaza, Kochi during 15 – 17 February 2010
- Indian International Seafood Show, hosted by MPEDA at Chennai Trade Centre, Chennai, during 19-21 February, 2010
- Panchayat and Rural Development Week at Pratapaditya Gram Panchayata, Kakdwip during 17-19 December 2009
- Golden Jubilee Celebration of Sri Ramakrishna Ashram at Nimpeeth, South 24 Parganas, West Bengal during 20-25 January 2010
- Krishi Mela-2010 hosted by FIAC ATMA Patharpratima at Patharpratima, South 24 Pgs during 12-14 February 2010

CIBA exhibition stall at Patharpratima

CIBA exhibition stall at Ramakrishna Ashram, Nimpith KVK

CIBA exhibition stall at Chennai Science Festival

CIBA exhibition stall at India International Seafood Show

16

Visitors

The following dignitaries visited the institute:

SCIENTISTS /DIGNITARIES

Name of the Scientist/Dignitary	Date of Visit
Dr.T.P.Trivedi, Assistant Director General (ARIS), ICAR and Mr.Mohan Ram, Executive Director, ERNET	24 April 2009
Prof.T.J.Pandian, Dr. Balasubramanian T. Director, Centre for Advanced Study in Marine Biology, Annamalai University, Parangipettai, Dr. (Mrs.) Indrani Karunasagar, Professor and Head, Department of Microbiology, College of Fisheries, Mangalore, Dr. George John, Advisor, Department of Biotechnology, Dr. Ramesh Chand, National Professor, National Centre for Agricultural Economics and Policy Research	30 April 2009
Dr.P.Krishnaiah, IAS, Chairman, NFDB	18 June.2009
Prof.N.Rajendran, Visiting Professor, Graduate School of Engineering, Yokohama National University, Yokahama, Japan	29 June 2009
Dr.Catherine Chesnutt & Mr.Amit Aradhey of USDA	11 September 2009
Mr.Karl Iver Dahl – Madson, President, Danish Aquaculture & Former Head of DHI Ecology & Water Quality Centre, and Mr.Ajay Pradhan, Managing Director, DHI (India) Water & Environmental (P) Ltd., New Delhi	15 October 2009
Dr.P.V.S.M.Gouri, Advisor (Organic Products), MPEDA, New Delhi, Shri.B.Vishnu Bhat, Director, MPEDA	28 October 2009
Dr.S.Ayyappan, Deputy Director General (Fy.), ICAR, Delhi, Dr.George John, Advisor, Department of Biotechnology, Delhi, Dr.Ambekar Eshwar Eknath, Director, Central Institute of Freshwater Aquaculture, Bhubaneswar and Norwegian Scientists	3 November 2009

Mr.Le Anh Tuan, Head of Department, NHA Trang University, Faculty of Aquaculture, Department of Fish Nutrition and Feeds, Vietnam, Dr.Egil Lien, Senior Scientist, SINTEF Fisheries and Aquaculture, Norway, Dr.Niels Svennevig, Marine Biologist and Scientist, Head of Tropical Centre, SINTEF Fisheries & Aquaculture, Norway with Dr.M.Sakthivel, President, Aquaculture Foundation of India.	8 December 2009
Dr. K. C. Tyagi, Member, ASRB, New Delhi	16 December 2010
Dr. Arvind Kumar, DDG (Education) and DDG (Fy.) (Additional charge)	11 February 2010

Dr. Arvind Kumar, DDG (Education) and DDG (Fy.) (Additional charge)

Dr. K. C. Tyagi, Member, ASRB

17

Personnel

Managerial Personnel

Director: Dr.A.G.Ponniah

Headquarters

Scientific Personnel

Head of Division

Dr. A.R.Thirunavukkarasu, Finfish Culture Division
Dr. P.Ravichandran, Crustacean Culture Division

Principal Scientist

Dr. S.Kulasekarapandian
Dr. S.M.Pillai
Dr. T.C.Santiago
Dr. Syed Ahmed Ali
Dr.B.P.Gupta (Superannuation on 28.2.2010)
Dr. N.Kalaimani
Dr. M.Natarajan
Dr. M.Krishnan
Dr. G.Gopikrishna (promoted on 27.7.2006)
Dr. K.P.Jithendran
Dr. C.Gopal
Dr. V.S.Chandrasekaran

Senior Scientist

Dr. T.Ravisankar
Dr. (Mrs.) Shiranee Pereira
Dr. K.K.Krishnani
Dr. M.Muralidhar
Dr. (Mrs.) M.Jayanthi
Dr. (Mrs.) B.Shanthi
Dr. S.V.Alavandi
Dr. C.P.Balasubramanian
Dr. M.Kailasam
Dr. (Mrs.) D.DeboralVimala
Dr. M.Shashi Shekhar
Dr. S.Kannappan
Dr. K.Ponnusamy
Dr. J.K.Sundaray
Dr. (Mrs.) P.Nila Rekha
Dr. K.Ambasankar
Dr. Syama Dayal
Dr. M.Kumaran
Dr. (Mrs.) M.Poornima (CAS promoted on 5.10.2007)
Dr. (Mrs.) R.Saraswathy (CAS promoted on 26.12.2007
Dr. P.K. Patil
Dr. S.K. Otta
Dr. (Mrs.) Sherly Tomy

Scientist (Senior Scale)

Mrs.P.Mahalakshmi

Scientist

Dr. K.Vinaya Kumar
Dr (Mrs.) Krishna Sukumaran
Dr. (Mrs.) Ezhil Praveena
Dr. (Mrs.) Bhubaneswari

Technical Officer

T (7 – 8)

Shri R.Elankovan

(T – 6)

Dr. S.Sivagnanam

Shri D.Raja Babu

Shri M.Shenbagakumar

Shri V.R.Senthil Kumar

Shri R.Puthiyavan (promoted on 1.1.2008)

(T – 5)

Shri M.G.Subramani (Driver) (Superannuation on 30.11.2009)

Shri M.Gopinathan Nair (Driver)

Shri S.Rajamanickam

Shri S.Rajukumar

Shri Joseph Sahayarajan

Shri S.Nagarajan (promoted on 3.1.2007)

Shri S.Stanline (promoted on 17.2.2007)

Dr. A.Nagavel (promoted on 21.8.2007)

Shri R.Subburaj (promoted on 21.8.2007)

(T – 4)

Shri R.Rajashekaran

Technical Assistant

(T – 3)

Shri N.Ramesh

Shri S.Saminathan

Shri R.Balakumaran (Driver)

(T – II – 3)

Shri N.Jagan Mohan Raj

Shri D.M.Ramesh Babu

Shri G.Thiagarajan

(T - 2)

Shri C.Anandanarayanan

Shri K.Paranthaman (Driver)

Shri K.Karaian

(T – 1)

Shri. K.V.Delli Rao

Administration and Finance

Administrative Officer

Shri A.Muthuraman

Finance & Accounts Officer

Shri S.Krishnaswamy
(Superannuation on 30.6.2009)

Assistant Administrative Officer

Shri R.G.Ramesh

Junior Accounts Officer

Mrs. K.Nandhini

Assistants

Shri R.Kandamani

Mrs. V.Usharani

Personal Assistant

Mrs.S.Nalini

Shri. K.G.Gopala Krishna Murthy

Stenographer, Grade – III

Mrs. K.Hemalatha

Mrs. K.Subhashini

Upper Division Clerks

Shri S.Pari

Mrs. E.Amudhavalli

Shri A.Manoharan

Shri A.Sekar

Mrs. E.Mary Desouza

Lower Division Clerks

Shri P.Srikanth

Mrs.R.Vetrichelvi

Shri B.Palanivelmurugan

Mrs.M.Mathuramuthu Bala

Mrs.B.Prasanna Devi

Shri R.Kumarasen

Shri A.Paul peter

Skilled Support Staff

Shri P.Arumugam (Superannuation on 31.10.2009)

Shri M.Santhosam

Shri N.Harinathan

Shri V.Jeevanantham

Shri K.Mariyappan

Shri K.Nithyanandam

Shri V.M.Dhanapal

Shri M.Subramani

Shri V.Kumar

Shri C.Saravanan

Shri S.Kuppan

Shri M.Pichandi

Shri S.Selvababu

Shri D.Senthilkumaran

Shri C.Raghu

Shri P.G.Samuvel

Shri M.Sakthivel

Shri R.Mathivanan

Shri R.Indra Kumar

Shri G.Dayalan

Shri Kanaka Prasad

Smt. S.Premavathi

Shri M.Sampath Kumar

Shri J.Murugan

Supporting Staff

S.S.Gr.II

Smt. S.Shanthi
(obtained VRS on 24.8.2009)

S.S.Gr.I

Shri E.Manoharan

Kakdwip Research Centre

Scientific Personnel

Senior Scientists

Dr. T.K.Ghoshal, Officer-in-Charge

Dr. Akshaya Panigrahi

Dr. Debasis De
(CAS promoted on 23.11.2007)

Scientists

Dr. R.Ananda Raja

Shri Gouranga Biswas

Dr. Sujeet Kumar

Ms. Shyne Anand

Technical Personnel

(T – 2)

Shri P S.Samanta

Mrs. Chanda Mazumder

Administrative Staff

Personal Assistant

Shri S.K.Halder

Assistants

Shri S.K.Bindu

Shri P.K.Roy

Upper Division Clerks

Mrs. Arati Rani Panigrahi

Skilled Support Staff

Shri N.N.Mondal (Superannuation on 31.3.2010)

Shri N.C.Samanta

Shri Rash Behari Das

Shri Gour Hari Jana

Shri Sasadhar Betal

Shri Kalipada Mondal

Shri Pranesh Chandra Saha (Superannuation on 30.4.2009)

Shri Phani Gharami

Shri Patit Paban Halder

Shri Abhimanyu Naskar

Shri R.K.Roy

Shri Narendra Nath Jana

Shri Amar Gharami

Shri Krishna Pada Naskar

Shri B.C.Paik

Smt Lakshmi Rani Bhuiya

Shri Uttam Kumar Santra

Shri Bholalal Dhanuk

Shri Purna Chandra Das

REDEPLOYED TO CIFA, BHUBANESWAR

Technical Assistant

T – 2

Shri P.C.Mohanty (Driver)

Skilled Support Staff

Shri Balaram Das (superannuation on 31.1.2009)

Shri Baman Jally

Shri M.C.Behera

Shri Sudarsan Naik

Shri Bijoy Bhoi

Shri K.C.Samal

Shri Maharaja Majhi

Shri Premananda Bisoi

18

Infrastructure Development

The major works carried out during the year are listed below:

CIBA Headquarters, Chennai

- Construction of Aquatic health testing and wet lab independent modules
- Construction of trainee's hostel

Muttukadu Experimental Station of CIBA, Muttukadu

- Providing extension of crab hatchery with A.C sheet roof
- Construction of effluent treatment pond with pump house and remodeling of drainage canals in main building side
- Construction of wet lab for environmental experiment

Kakdwip Research Centre of CIBA, Kakdwip

- Construction of hatchery shed and water distribution sysyetm
- Construction of Type-IV quarters-1 No. (Vertical expansion)
- Construction of boundary wall/PVC coated chain link fencing and security cabin for sector C

Foundation stone laying for aquatic health testing laboratory and trainees hostel by Dr.Mangala Rai, Sectretary DARE & DG, ICAR and Dr.S.Ayyappan, DDG (Fy.) on 5th September 2009

19

Library and Documentation

Library holdings

The CIBA Library acquired 40 new books and subscribed to an additional 24 foreign journals and 31 Indian journals for the Headquarters and another 26 Indian journals for KRC library during this period. The Library has a total holding of 2, 265 books, 1,553 journal back volumes, 675 reprints/ photocopies, 2,000 reports / bulletins and 4,280 miscellaneous publications as of March 2010.

For better dissemination of scientific information, the following facilities have been made in the library:

- Online access to the following journals

  Aquaculture International
  Aquaculture Nutrition
  ASFA Online Search
  Diseases of Aquatic Organisms
  Fish and Fisheries
  Fish Physiology and Biochemistry
  Fisheries Science
  Journal of Fish Diseases
  Journal of Marine Science and Technology
  The Biological Bulletin
  Journal of Applied Ichthyology
  Journal of the World Aquaculture Society

- Online connectivity to the Consortium for Electronic Resources in Agriculture (CeRA) journals subscribed by NAIP (available both at headquarters and Kakdwip Research Centre).

- Foreign journals subscribed at headquarters are made available to Kakdwip Research Centre in pdf format.

- Newsletters of NACA and other important publications of FAO etc. are being made available individually to all the Scientists of CIBA in pdf format and they are also made available through the local site of CIBA.

Exchange services

The Library maintained an exchange relationship with National and International Organizations of mutual interest. The library maintained the free mailing of the institute's Annual Report and other publications to various research organizations, universities and other agencies.

Information services

The Library section extended information service to the scientific personnel of research organizations, university / college students, research scholars and other agencies / individuals through reference of books and journals in the library.

Utilization of funds

During this year a total of Rs.15.00 lakhs under plan budget and Rs. 2.00 lakhs under ITMU budget were utilized towards renewal of subscription to journals and procurement of new books for the libraries at the headquarters and Kakdwip Research Center.

Other facilities

Many new facilities have been created in the library for the better dissemination of scientific information for the advantage of its users.

Document delivery system

As per the direction from PI, CeRA the library section supplied the photocopies of journal articles requested by various ICAR institutes, scientists and research fellows under CeRA - Document Delivery Request (DDR).

The library also provides reprographic service to its users when needed. In addition to the Institute's scientists and staff, research scholars and students from several universities / colleges / research institutes, farmers and members from NGOs who visit the institute for reference work.

Dr. H. Chandraseharan, Principal Investigator, CeRA project addressing the scientists on 21.10.09

20

कार्यकारी संक्षेप

वर्तमान वर्ष में केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान का पूरा ध्यान, छोटे स्तर के किसानों के लिए पर्यावरणानुकूल एवं लागत प्रभावी पालन प्रौद्योगिकियों का विकास करने, प्रजातियों एवं व्यवस्थाओं के वैविध्यीकरण में तथा एक बृहत् स्वास्थ्य प्रबंधन व्यवस्था के विकास में केन्द्रित रहा है। QRT ने सीबा की उपलब्धियों को छह महत्त्वपूर्ण क्षेत्रों में विभाजित किया है :

पर्यावरणानुकूल एवं लागत प्रभावी पालन प्रौद्योगिकियाँ

- टाइगर झींगों के लिए बंधक स्थिति में प्रजनन प्रौद्योगिकी के विकास कार्यक्रम के एक भाग के रूप में ब्रूडस्टॉक के संतुलित आहार में परीक्षण किए गए। एक परिपक्व संतुलित आहार के साथ सफल परिपक्वन, अंडे एवं अंडों के फूटने के परिणाम प्राप्त हुए, जिसमें उत्तम एवं ताज़े खाद्य पदार्थ की पद्धति के 50% भाग को एक कृत्रिम नमी युक्त संतुलित आहार से प्रतिस्थापित किया गया।

- कार्य–स्थल परीक्षणों से यह स्पष्ट होता है कि खाद्य पदार्थ में 38% से लेकर 32% के बीच में प्रोटीन के साथ उत्पादन का स्तर वही स्तर बनाए रख सकते हैं तथा प्रोटीन स्तर को 32% से कम किए जाने पर झींगा उत्पादन की लागत में रु. 4–5 रुपए कमी देखी जा सकती है।

- झींगे से संबंधित स्थल विशिष्ट पालन आवश्यकताओं को समझने के लिए गुजरात के नवसारी कृषि विश्वविद्यालय के सहयोग में एक परियोजना शुरू किया गया है। इस कार्यक्रम के एक भाग के रूप में दन्ती–उम्भट केन्द्र के खारा पानी खेत में विकसित टाइगर झींगा पालन का अध्ययन किया गया।

- उच्च लवणता स्थिति में विशिष्ट टाइगर झींगा खाद्य पदार्थों का विकास करने के लिए प्रयासों से यह स्पष्ट होता है कि प्रयोग किए गए संतुलित आहार के निम्न स्तरीय प्रोटीन स्तरों की तुलना में प्रयुक्त अपक्व प्रोटीन संतुलित आहार के 40 एवं 33.5 प्रतिशत स्तरों में अत्यधिक वृद्धि पाई गई। उच्च लवणता (40%) में बेहतरीन प्रोटीन क्षमता अनुपात एवं वास्तविक प्रोटीन उपयोग के आधार पर यह स्पष्ट हुआ कि संतुलित आहार के 33.5% प्रोटीन स्तर में बेहतरीन प्रोटीन क्षमता के उपयोग के परिणाम प्राप्त हुए।

- निम्न स्तरीय लवणता (7-10 ppt) स्थिति में टाइगर झींगे के लिए संतुलित आहार के कैल्शियम एवं फॉस्फोरस, लवणता के संपर्क में आते हैं तथा उनकी वृद्धि को प्रभावित करते हैं। यार्ड परीक्षणों से यह स्पष्ट होता है कि Ca एवं P के निम्न स्तरों की तुलना में 3% Ca के साथ के 2% P डालने पर Ca एवं P के पचन में अधिक वृद्धि के साथ उनकी वज़न में भी बढ़ोतरी देखी जाती है।

- इसमें वृद्धि, जीवंतता, एवं प्रोटीन क्षमता अनुपात काफी अधिक पाए गए तथा नियंत्रित आहार की तुलना में सजीव सेल्युलोलाइटिक सूक्ष्मजीवी खिलाए गए झींगों में FCR काफी कम पाया गया।

- शून्य पानी विनिमय झींगा तालाबों में अमोनिया को कम करने के लिए बैगास–जैव–उत्तेजक का प्रयोग सफलतापूर्वक निरूपित किया गया तथा इस पद्धति से अमोनिया में 29-38% कमी पाई गई।

- यार्ड परीक्षणों में सूक्ष्मजीवी एवं जैव–फ्लॉक के उत्पादन की गतिकी पर कॉर्बन एवं नाइट्रोजन का प्रभाव निर्धारित किया गया। साथ ही, अमोनिया को काफी हद तक निकाला गया तथा तरुण टाइगर झींगों ने जैव–फ्लॉक को खाद्य पदार्थ के रूप में स्वीकार किया, जिससे कि वृद्धि में बढ़ोतरी पाई गई।

बृहत् स्वास्थ्य प्रबंधन

- जैव सुरक्षा पद्धतियों को अपनाने से एकल रूप में तथा झींगा खेतों के साथ में अपनाई गई पद्धति को सफेद दाग के रोग के साथ सहसंबद्धता स्थापित करने पर यह पाया गया कि रिज़र्वॉयर तालाब के इस्तेमाल से रोग के फैलने में काफी कमी पाई गई।

- वर्ष 2007–2010 की अवधि में पश्चिमी बंगाल के तीन तटवर्ती प्रदेशों के जिले के झींगों के एकल–पालन एवं परंपरागत भेरियों में रोग के 198 खेतों के सर्वेक्षण से यह स्पष्ट होता है कि PCR परीक्षण के बिना स्टॉक किए गए बीजों में सफेद दाग के रोग (WSD) काफी अधिक पाये गये ।

- लेयम–सिंह वायरस (LSNV) के RdRp जीन को लक्षित करते हुए निर्धारित डिज़ाइन प्राइमरों से युक्त एक बेहतरीन डॉयग्नॉस्टिक नेस्टेड RT- PCR का विकास किया गया जो मोनोडॉन निम्नस्तरीय वृद्धि सिंड्रोम (MSGS) में प्रभावी है। इस सुधारे गए डॉयग्नॉस्टिक PCR के प्रयोग से खेत में पैदा किए गए तथा जंगली ब्रूडस्टॉक सैम्पलों का स्क्रीनिंग से LSNV की अत्यधिक उपस्थिति पाई गई। ब्रूडस्टॉक में इसकी अत्यधिक उपस्थिति से वायरस के वर्टिकल फैलाव देखा जा सकता है।

- बृहत् स्तर पर मरक–विज्ञान स्क्रीनिंग के लिए झींगों में WSSV की जल्द पहचान के लिए PCR संवेदनशीलता की पहली स्तर के समतुल्य पहचान के साथ WSSV के लिए ''सीबा इम्यूनो ब्लॉट परीक्षण'' का विकास किया गया।

जैव प्रौद्योगिकी अनुप्रयोगों के माध्यम से 'उत्तम स्वस्थता' एवं 'अत्यधिक वृद्धि'

- ईएसटी डेटाबेस के निर्माण करने के प्रयासों के एक भाग के रूप में एनसीबीआई में सूक्ष्म जैविक दूषण एवं पर्यावरण पर प्रभाव के संबंध में टाइगर झींगे क्रमों के कुल 1500 ईएसटी जमा किए गए।

- पेइनाइड एलर्जिक जीन, एर्जिनाइन कीनेज़, सेर्कोप्लास्मिक कैल्शियम जोड़नेवाली प्रोटीन, मयोसिन हल्का चैन एवं ट्रोपोपिन नामक चार और पहलुओं की पहचान की गई तथा उनकी विशेषताओं की पहचान की गई।

- WSSV दूषणों के दौरान अभिव्यक्त जीनों को समझने के लिए WSSV दूषित टाइगर झींगा *पी.मोनोडॉन* से cDNA जानकारी स्रोत का निर्माण किया गया एवं पांच जीनों की पहचान की गई जो रोग चिकित्सा के विकास करने में सहायक होंगे।

- WSSV दूषित टाइगर झींगों में वायरस प्रतिरोधक के लिए जिम्मेदार इम्यून संबंधी जीनों की पहचान करने के लिए एक प्रतिरोधक घटाव संकरण जानकारी स्रोत तैयार की गई तथा 20 से भी अधिक प्यूटेटिव जीनों की पहचान की गई और उन्हें इम्यून से संबंधित होने की बात पर विचार किया गया। इनमें से तीन महत्त्वपूर्ण जीन क्रस्टिन, कैपेज़ 3 तथा ऐन्टिवायरल जीन (PmAV) को क्लोन करके अभिव्यक्त किया गया।

- सीआईएफए के सहयोग में एक संयुक्त परियोजना के एक भाग के रूप में इम्यूनोमॉड्युलेशन के परीक्षणों में प्रयोग करने के लिए स्वच्छ पानी झींगा नोडावायरस के कैप्सिड एवं B2 जीनों को अभिव्यक्त किया गया तथा उन्हें परिष्कृत किया गया।

- भारतीय–नॉर्वे सहयोग परियोजना के अंतर्गत टाइगर झींगों में रोग फैलने से रोकने के लिए मार्कर सहायता प्राप्त चयन

की पद्धति को समर्थ बनाने के लिए, अद्यतन परमाण्विक पद्धतियों के विकास के कार्य जारी हैं तथा cDNA जानकारी स्रोत तैयार करने के लिए जंगली टाइगर झींगों के RNA सार युक्त नमूनों की प्रक्रिया जारी है, जिन्हें SNP चिपों को बनाने के लिए प्रयोग किया जाएगा।

- जीनों के जैव–संभावना के प्रयास कार्यों के एक भाग के रूप में तथा अजैव पदार्थों दबाव के प्रति एल्लेल माइनिंग के लिए लवणता दबाव नियमित जीनों के लिए cDNA खंड जानकारी स्रोत तैयार किया गया।

प्रजाति एवं व्यवस्थाओं का वैविध्यीकरण

- आन्ध्र प्रदेश, तमिलनाडु एवं महाराष्ट्र स्थित किसानों के तालाबों में राष्ट्रीय मात्स्यिकी विकास बोर्ड, हैदराबाद के निधि समर्थन से सीबा द्वारा विकसित आहार के आधार पर सीबॉस नर्सरी एवं उसके ग्रोआऊट का प्रथम निरूपण सफलतापूर्वक किया गया।

- हापा–तालाब व्यवस्था के लिए सीबा द्वारा विकसित सीबॉस नर्सरी प्रौद्योगिकी के आधार पर, भीमावरम का एक किसान, 95% जीवंतता दर तथा 1.73 लाख लाभ के साथ स्वच्छ पानी तालाब के स्टॉक करने लायक आकार के बीज तैयार कर पाया है।

- सीबॉस नर्सरी पालन प्रौद्योगिकी का विकास, टैंक आधारित व्यवस्था के लिए किया गया था तथा इनके इनपुट के तुलनात्मक विश्लेषण एवं 300 से लेकर 4000 संख्या / m^3 के बीच की श्रेणी में स्टॉकिंग सघनता के लिए प्राप्त लागत से यह पता चलता है कि व्यावहारिक वाणिज्यिक प्रचालनों के लिए बंद टैंक नर्सरी पालन व्यवस्था में इष्टतम सघनता 1000 संख्या / m^3 होगी।

- गुजरात में इस सीबॉस पालन को प्रोत्साहन देने के लिए नवसारी कृषि विश्वविद्यालय के विकसित खेत में सीवॉस पालन निरूपित किया गया।

- पश्चिमी बंगाल के किसानों के तालाबों में फोरेज मत्स्य के रूप में ऐशियाई सीबॉस के साथ बहु–खेती की तकनीकी–आर्थिक व्यावहारिकता को निरूपित किया गया।

- सीबॉस में चार स्तरों में 0 से लेकर 15% की श्रेणी में विशिष्ट विटामिन एवं धात्विक मिश्रणों का परीक्षण किया गया। आहार में दोनों मिश्रणों के 0.5 % स्तर पर डालने से उनके वज़न में, प्रोटीन क्षमता अनुपात एवं प्रोटीन के वास्तविक उपयोग अत्यधिक वद्धि देखी जाती है।

- सीबॉस के लिए सक्षम आहार पदार्थों के रूप में तीन तेल–केकों के पौष्टिक पचन के मूल्यांकन से यह प्रतीत होता है कि तिल एवं सूर्यमुखी के तेल–केकों की तुलना में सरसों के तेल–केक के पौष्टिक तत्त्वों का पचन बेहतर पाया गया।

- मल्लेट के लिए नर्सरी पालन प्रौद्योगिकी का विकास करने के लिए कार्य–स्थल तालाबों में दो स्टॉकिंग सघनता एवं आहार एवं उर्वरण आधारित दो तालाब व्यवस्थाओं में किए गए परीक्षणों का मूल्यांकन किया गया। यद्यपि दोनों व्यवस्थाओं के लिए प्रचालन की लागतें समान रही हैं, उर्वरण आधारित व्यवस्था में अत्यधिक जीवंतता के स्तर देखे जाते हैं।

- पश्चिमी बंगाल में खारापानी मत्स्य खेती की संभावनाओं की पहचान करने के लिए एक किसान के तालाब में आर्थिक रूप से व्यावहारिक दुधिया मत्स्य एकल–पालन निरूपित किया गया।

- यद्यपि खारापानी के लिए पर्लस्पॉट स्थान विशेष नहीं है, सीबा द्वारा आपूर्तित ब्रूड मत्स्य द्वारा किसानों ने साज सज्जे के

लिए मिट्टी के छोटे मटकों में पर्लस्पॉट बीज का उत्पादन करना शुरू कर दिया है। साथ ही एक किसान को इससे 200 m^2 के क्षेत्र से 21,000 रुपयों का लाभ प्राप्त हुआ।

- मिट्टी के कंकड़े के नर्सरी पालन प्रौद्योगिकी के अधिक परिष्करण के लिए निम्न लागत के मिट्टी नर्सरी व्यवस्था में मेगालोपा की 50 nos/m^2 की इष्टतम स्टॉकिंग सघनता निर्धारित की गई।

- मिट्टी के केंकड़े के ग्रोआऊट पालन में पूर्ण स्त्री पालन की तुलना में लिंग मिश्रित पालन में अत्यधिक उत्पादन देखा गया। लिंग मिश्रित पालन के अंतर्गत अत्यधि कवज़न की प्राप्ति के परिणामस्वरूप ही उत्पादन में वद्धि पाई गई।

- मत्स्य भोजन को कम करने के लिए केंकड़े के आहार में सस्ते पौधे पदार्थों के मूल्यांकन से यह पता चलता है कि 87% तथा 88% से भी अधिक प्रोटीन पचन के परिणाम से इनका प्रयोग बहुत अच्छा सिद्ध हुआ।

- अकार्बनिक झींगा आहार का विकास करने के एक भाग के रूप में 5 % स्तर पर अज़ोला को उसमें सम्मिलित किए जानेवाले पदार्थ के रूप में मूल्यांकित किया गया तथा इस आहार के साथ मत्स्य भोजन को कम करने के साथ साथ उच्च वद्धि भी प्राप्त की जा सकती है।

आर्थिक रूप से महत्त्वपूर्ण खारापानी सूक्ष्म जीवाणु

- मेटाजीनॉमिकों का प्रयोग करते हुए तटवर्ती प्रदेशों के हरित पानी व्यवस्थाओं में विविध प्रकार के नाइट्रिफाइंग, नाइट्रोजन फिक्सिंग, मीथेनोट्रॉपिक एवं सल्फर ऑक्सीडाइज़िंग सुक्ष्मजीवी पाए गए। हरित पानी व्यवस्थाओं में नाइट्राइट ऑक्सीडाइज़िंग, नाइट्राइट कम करनेवाले, सल्फर ऑक्सीडाइज़िंग तथा नाइट्रोजन फिक्स करनेवाले सूक्ष्मजीवी अत्यधिक मात्रा में पाए गए। सात प्रकार्यात्मक जीनों के लिए मेटाजीनॉमिक क्लोनल जानकारी स्रोत तैयार किये गये है तथा प्राप्त अनोखे क्लोनों को सीक्वेन्स करने के पश्चात् जीन बैंक में जमा किए गए।

- प्रभावशाली हरित गैस एवं अन्य नाइट्रोजनस फ्लक्सों के जैव–रूपांतरण में होनेवाले सूक्ष्मजीवियों का पता लगाने तथा उनकी पहचान करने के लिए मल्टिप्लेक्स PCR का विकास किया गया।

- जैव–रासायनिक परीक्षण, वसा अम्ल मीथाइल एस्टर विश्लेषण (FAME), 16S rRNA तथा प्रकार्यात्मक जीन पद्धतियों का प्रयोग करते हुए हेटरोट्रॉपिक सूक्ष्मजीवियों की पहचान करने के बाद उन्हें जीन बैंक में जमा किया गया।

- सात अमोनिया ऑक्सीडाइज़िंग ऑर्केइया सूक्ष्मजीवी को समृद्ध करके उन्हें खारापानी नमूनों से अलग किया गया तथा इनमें से चार को PCR के माध्यम से अलग करने से यह पता चला कि उनमें अमोए जीन उपस्थित है।

- वर्तमान वर्ष के दौरान 130 सूक्ष्म जीवाणुओं को पहचानने के साथ 112 सूक्ष्मजीवी, 15 ऐक्टिनोमइसाइट्स एवं 3 कवकों को अलग किया गया तथा उन्हें कृषि के लिए महत्त्वपूर्ण सूक्ष्म जीवाणु राष्ट्रीय ब्यूरो के पालन इकत्रीकरण बैंक में जमा किया गया।

- कुल 40 सूक्ष्मजीवियों के 16S rRNA प्रजाति स्तर पर वाणिज्यिक रूप से महत्त्वपूर्ण जीनों की पहचान करने के लिए उन्हें परिवर्धित एवं सीक्वेन्स किया गया। इन ग्रुपों में से कृषि एवं वाणिज्यिक रूप से महत्त्वपूर्ण सूक्ष्मजीवी पैदा करनेवाले ऐन्ज़ाइमों (जत्राइलनेज़, पेक्टिनेज़, अगरेज़, सेल्युलेज़, चिटिनेज़, प्रोटियेज़ तथा लाइपेज़) को अलग करके, उनकी पहचान करके उन्हें कैरेक्टराईज़ किया गया। वाणिज्यिक रूप से महत्त्वपूर्ण जीनों जैसे कैटलेज़, चिटिनेज़, लाइपेज़, कोलाइन डिहाइड्रोजनेज़ तथा बिटैन अल्डिहाइड डिहाइड्रोजनेज़ को क्लोन करके उनकी अभिव्यक्ति प्राप्त की गई।

- **16S rRNA** जीन के आधार पर कुल 15 ऐक्टिनोमइसाइटों को पहचाना गया। इनमें से सात सूक्ष्म जीवाणु प्रतिरोधी पैदा करते हैं।

- दो रंजक सूक्ष्मजीवियों से जैव रूप से सक्रिय मिश्रणों को पहचाना गया तथा उन्हें कैरेक्टराईज़ किया गया। इनके एथेनॉल सार से मानवीय पैथोजन सूक्ष्मजीवी के स्ट्रेनों के प्रति प्रतिरोधी क्रिया पायी गयी।

- *स्युडोमोनॉस* **प्रतिरोधात्मक सूक्ष्मजीवी से जैव रूप से सक्रिय मिश्रित योंगिको को निकाला गया तथा उनमें झींगो में निहित पैथोजनिक सूक्ष्मजीवी** *विब्रियो हार्वेई* के खिलाफ प्रतिरोधी क्रिया पायी गयी।

जलजीव पालन के लिए सामाजिक–आर्थिक एवं नीतिगत समर्थन

- गुजरात में विस्तार संबंधी आवश्यकताओं का समाधान करने के लिए गुजराती भाषा में विस्तार सामग्री के रूप में 11 पोस्टर बनाए गए जिन्हें नवश्री कृषि विश्वविद्यालय में प्रदर्शित किए गए हैं तथा उन्हें किसान बैठक एवं प्रदर्शनों में प्रदर्शित करने के लिए रखे गए हैं। वर्तमान फसल पद्धतियाँ, तथा तकनीकी, सामाजिक एवं सांस्थानिक समस्याओं को समझने के लिए वल्साड, नवश्री, सूरत एवं भरूच के जिले में झींगा पालन पद्धतियों का विश्लेषण किया गया।

- महिला स्वयं सेवक दलों में आम रोज़गार में विविधता लाने के लिए केंकड़ा मोटा करने की खेती, खेत में तैयार किए गए आहार तथा मूल्यवान मत्स्य उत्पाद विकास की तीन खारापानी जलजीव पालन एवं संबंधित प्रौद्योगिकियाँ सफल रूप से हस्तांतरित किए गए। इन उत्पादों के लिए विभिन्न अंतः संबंधित कार्यों के माध्यम से मार्केट संपर्क स्थापित किए गए।

- कृषि में महिलाओं पर अनुसंधान निदेशालय (DRWA), भुवनेश्वर के साथ उड़ीसा में अंतःसंबद्ध संस्थान कार्यक्रम के अंतर्गत उचित खारापानी जलजीव पालन के माध्यम से लिंग आधारित शक्तियाँ प्रदान करने के लिए कार्यनीतियों का विकास करने के लिए उड़ीसा के एसएचजी दलों द्वारा किए गए केंकड़ा मोटा करने के कार्यों का मूल्यांकन किया गया। इस मूल्यांकन से यह स्पष्ट होता है कि समुदाय से समर्थन, परिवार, गैर सरकारी संगठन एवं अनुसंधान संस्थान तथा खारापानी जलजीव पालन प्रौद्योगिकियों को अपनाने के प्रति सकारात्मक भावना ही इन एसएचजी दलों के महिलाओं की सफलता का मुख्य कारण है।

- एक विस्तृत परामर्श एवं पणधारियों के लिए आयोजित कार्यशाला के आधार पर, जलजीव पालन विस्तार सेवाओं के लिए एक जलजीव परामर्शदाताओं के साथ सार्वजनिक–निजी साझेदारी PPP पर एक संकल्पनात्मक रूपरेखा तैयार की गई है तथा इस PPP पद्धति को कार्यान्वित करने के विभिन्न पहलुओं की पहचान की गई।

- वर्तमान में प्रचलित जलजीव पालन के स्रोत तथा भविष्य में उनकी संभावनाओं को शामिल करते हुए जिला स्तर पर एक योजना दस्तावेज़ तैयार किया गया है जो वर्तमान समस्याओं का पता करने तथा समस्याओं का समाधान प्राप्त करने की योजना प्रदान करता है और ये जलजीव पालन के दीर्घकालिक विकास के लिए अत्यंत आवश्यक हैं। नागपट्टिनम जिले के लिए विभिन्न स्रोतों से डेटा शामिल करते हुए एक और दस्तावेज़ तैयार किया गया है।

- रिमोट संवेदी एवं जीआईएस का प्रयोग करते हुए गुजरात में वर्ष 2009 में 3210 ha के क्षेत्र में वायुशिफों को छोड़कर वर्तमान व्यर्थ भूमि पर स्थित झींगा खेतों को दिखाने की पद्धति का विकास किया गया। इससे यह पता चलता है कि तमिलनाडु एवं आन्ध्र प्रदेश में जलजीव पालन का विकास वायुशिफों से नहीं है।

- झींगा खेती को समर्थन प्रदान करने के लिए पानी स्रोत को वहन करने की क्षमता का परिकलन करने के संदर्भ में वेट्टार नदी का अध्ययन किया गया तथा अध्ययन के परिणामों से पता चलता है कि पिछले महीनों की महत्त्वपूर्ण अवधि में पानी के अधिकतम निष्कासन के सैम्प्लिंग से संपूर्ण पालन अवधि में नियमित सैम्प्लिंग करने के बजाय संपूर्ण क्षेत्र में वहन करने की क्षमता का परिकलन किया जा सकता है। इस टूल के प्रयोग को योजना तैयार करनेवालों में प्रोत्साहन देने के लिए एक निर्णय समर्थन सॉफ्टवेयर का विमोचन किया गया तथा उसे आन्ध्र प्रदेश एवं गुजरात के राज्य मात्स्यिकी विभाग अधिकारियों के सामने निरूपित किया गया।

- मौसम परिवर्तन एवं विपरीत घटनाओं संबंधी कार्यों के एक भाग के रूप में अइला भवंडर एवं कृष्णा नदी में बाढ़ के कारण

हुए नुकसान का विश्लेषण करने के लिए पश्चिमी बंगाल एवं आन्ध्र प्रदेश क्षेत्रों में सर्वेघण किया गया। राज्य सरकारों द्वारा प्रस्तुत डेटा की तुलना में सर्वेक्षण की सूचना अत्यंत वास्तविक पाई गई। प्राप्त जानकारी को कंप्यूट किया गया। साथ ही इन समस्याओं के समाधान के रूप में अपनाई जानेवाली कार्यनीतियों का विकास किया गया।

- ऐशिया–पैसिफ जलजीव पालन केन्द्र नेटवर्क (NACA) सहयोग परियोजना के अंतर्गत मूल चर्चा एवं पणधारियों के लिए आयोजित कार्यशाला के माध्यम से स्रोत–गरीब, छोटे स्तर पर कार्यरत जलजीव पालन खेती के किसान, किसानों के विचार और मान्यताओं तथा अपनाई जानेवाली क्षमताओं में मौसम के परिवर्तनों के प्रभाव से लेकर आत्मसात् करनेवाली कार्यनीतियों तक विभिन्न पहलुओं पर प्रकाश डाला गया।

- प्रकाशम, गुंटूर एवं नेल्लूर जिलाओं में कम सघनता युक्त क्षेत्रों के लिए लंबी फसल अवधि के लिए बृहत् आकार के विशिष्ट फसल के लिए मौका युक्त मार्केट में विश्व झींगा दरों के प्रभाव का मूल्यांकन किया गया।

- जलजीव पालन के दीर्घकालिक विकास के लिए उस क्षेत्र में उपलब्ध मौकों को मूल्यांकित करने के लिए विभिन्न बिन्दुओं से निर्यात से स्वदेश में निहित मार्केट की दरों से लेकर हावड़ा मार्केट के ग्राहक तक पहुँचनेवाली श्रृंखला में बदलाव को इकट्ठा किया गया। इस विश्लेषण से यह स्पष्ट हुआ कि हिल्सा, सीबॉस एवं झींगे की तुलना में कम दर के मत्स्यों के लिए किसानों को ग्राहकों से प्राप्त होनेवाली रकम में से बहुत कम मिलता है। इसमें बीच में आनेवाले ठेकेदार काफी लाभ ले लेते हैं।

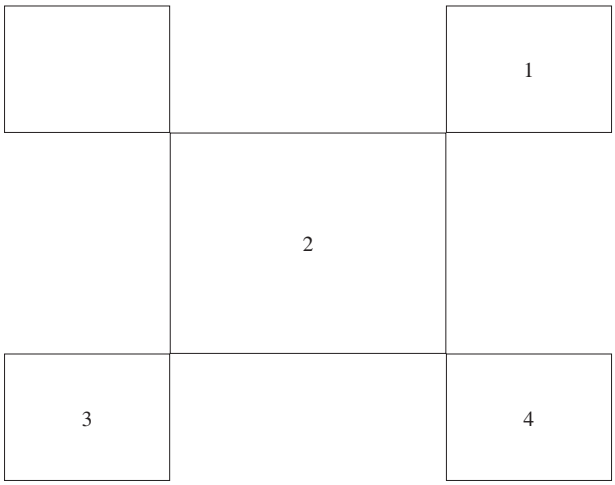
- सीबॉस एवं झींगा खेती में खेती स्तर की उत्पादन आर्थिकी के तुलनात्मक अध्ययन में 10 सालों की अवधि की योजना क्षितिज में झींगा में परिकलित प्रतिशत 0.49 की फसल असफलता की संभावना को शामिल करते हुए, सीबॉस के लिए एक आंतरिक दर वापसी (IRR) 29% तथा 24% शामिल करते हुए उनका तुलनात्मक अध्ययन किया गया। यह अत्यंत दिलचस्प बात है कि यदि राजस्व में 10% की बढ़ोतरी होती है या लागत में 10% की कमी होती है जिससे कि सीबॉस एवं झींगा पालन 40% से अधिक स्तर पर आईआईआर मूल्यों में वापस आते हैं।

सामान्य

वर्तमान वर्ष के दौरान 13 बाह्य विस्तारित निधि प्राप्त परियोजनाओं के अतिरिक्त, सीबा ने 2 से 3 सालों की अवधि के कुल 519 लाख की 9 अतिरिक्त निधि परियोजनाए निधि एजेसियो जैसे की जैव–प्रौद्योगिकी विभाग, राष्ट्रीय मात्स्यिकी विकास बोर्ड, राष्ट्रीय कृषि नवप्रवर्तन, पशु कृषि दूध एवं मात्स्यिकी विभाग तथा राष्ट्रीय कृषि ग्रामीण विकास बैंक से प्राप्त की हैं।

इस वर्ष के दौरान प्रकाशित 64 अनुसंधान पत्रों में से, 24 विश्व विख्यात अनुसंधान पत्रिकाओं में प्रकाशित हुए हैं जिनका औसतन प्रभाव 5.38 (NAAS) है।

संस्थान ने 7 किसान मिलाप, एवं विचार विनिमय हेतु पणधारियों के साथ 9 बैठकें आयोजित कीं, साथ ही 13 प्रशिक्षण कार्यक्रम आयोजित किए गए तथा केन्द्र ने 10 प्रदर्शनों में भाग लिया। इसके अलावा संस्थान ने 4 कार्यशालाएँ भी आयोजित कीं है।



Caption

1. Stocking of water crabs in the ponds by the women Self Help Group, Orissa.
2. Dr. S. Ayyappan, DG - ICAR, visiting the crab fattening site at Kattur, Tamil Nadu.
3. Hygienic packing of value-added fish products by the women Self Help Group, Royapuram, Chennai.
4. Drying of crab pellets in the fish feed dryer by the women Self Help Group, Pulicat, Tamil Nadu.


CRAB FATTENING & FEED TRIALS
PROJECT SITE
KATTUR