

वार्षिक प्रतिवेदन

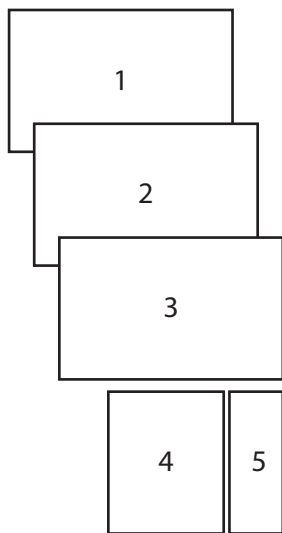
ANNUAL REPORT

2008-2009



CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
CHENNAI





Caption for Cover Photographs

1. CIBA campus
2. Bismi shrimp feed mill established with CIBA know-how
3. Launching of Bismi Shrimp Feed manufactured using CIBA technology
4. Feeding & Feed management using check tray
5. Rich harvest of Tiger Shrimp

वार्षिक प्रतिवेदन

Annual Report

2008 - 2009



केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद्)

75, सनथोम हाई रोड, राजा अण्णामलैपुरम, चेन्नई - 600 028



CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE

(Indian Council of Agricultural Research)

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PREFACE



The year 2008-09, the second year of the XI Five Year Plan period of 2007-12, has witnessed significant research outputs in brackishwater aquaculture. Considerable progress has been made during this year in the transfer of technologies through Public-Private-Partnership (PPP). Cost of feed is a major component of shrimp farming and it is increasing every year, while the price of shrimp is falling in the international market. In this scenario, it is imperative to cut-down the input cost by developing low-cost feed and CIBA has developed different grades (Starter, Grower and Finisher) of shrimp feed with indigenous feed technology. The shrimp feed technology was developed through formulation of several test feeds using indigenous ingredients to meet the dietary requirements of the tiger shrimp (*Penaeus monodon*). These were tested extensively in farmers ponds on a PPP mode. The feed technology was transferred to a progressive

farmer-cum-entrepreneur M/s Bismi Feeds Ltd., Perunthottam, Tamil Nadu. The entrepreneur established a new feed mill having indigenous machinery, with a production capacity of 1 tonne of shrimp feed per hour at a cost of Rs.1.5 crores and started producing and marketing the feed. The Bismi shrimp feed was officially launched by Dr. S. Ayyappan, Director General (Fy.), ICAR, New Delhi on 11-10-2008. The entrepreneur was highly impressed by the CIBA feed technology and upon his request, this consultancy was extended further.

Continuing the work on diversification of species in brackishwater aquaculture, now it is possible to produce seabass seed through out the year and spawning has been achieved at lower salinity of 14‰ through domestication and modification in management protocols. Improvement of nursery rearing of mudcrab with artificial hide-outs and formulated diets is another important achievement. Development of environmentally sustainable aquaculture technologies is a priority of the institute and commercialized the matrix for probiotic bacteria – *Lactobacillus* and *Bifido* to M/s ShrimpeX Biotech Services, Chennai.

The other achievements of the institute during the reporting period were, production of low input cost shrimp based on organic principles and zero water exchange technology at the farm facility of the institute at the Kakdwip Research Centre, periodic manual expulsion of spermatophore in shrimps to maintain male vitality, use of double stranded RNA (dsRNA) against White Spot Syndrome Virus (WSSV), linking disease spread with lack of biosecurity protocols in farms, adoption of Better Management Practices by farmers, establishing through analysis of remote sensing images that aquaculture development has not been at the cost of mangroves in reserve forest area, shrimp feeds for culture under different regimes of salinity, development of larval and nursery diets for seabass, identifying novel bacteria and genes of bioremediation importance, molecular biological characterization of chemolithoautotrophic nitrogen and sulphur oxidizing bacteria, quality assessments of the shrimps affected by WSSV and Loose Shell Syndrome (LSS), phage therapy for controlling *Vibrio harveyi*, white muscle disease in freshwater cultivable prawns, viral nervous necrosis in finfishes, evaluation of quality standards of commercially available probiotics, assessment of annual national loss due to diseases in shrimp farming export, role of aqua-consultants as service providers to the farmers, traditional shrimp farm organic certification requirements, development of a rational database management system, e-learning modules for Village Knowledge Centres and investigations on the marketing of the brackishwater aqua produces.

I am immensely thankful to Dr.Mangala Rai, Secretary, DARE and Director General, ICAR, Dr.S.Ayyappan, Deputy Director General (Fy), ICAR, and Dr.V.V.Sugunan, Assistant Director General (I.Fy) for their constant encouragement and support in guiding our research activities through out the year. I wish to express my gratitude to the Chairman and Members of the Research Advisory Committee for their valuable inputs in planning our research and allied activities. I also wish to thank all the scientists and staff members of the institute for their untiring efforts, as a team, in order to accomplish the mission aimed at achieving the targets.

A.G.Ponniah
Director

Executive Summary

The Central Institute of Brackishwater Aquaculture continued its research and development efforts, as in earlier years, to provide technological support for the sustainable development of the brackishwater aquaculture sector. The landmark achievement during the year 2008 - 09 was the launching of CIBA shrimp feed technology, which has been commercialised by an entrepreneur. For effective transfer of technologies, number of interaction meetings between the scientist and different stakeholders of the sector were organised in addition to method demonstrations, especially to women Self Help Groups as livelihood options. The following are the significant research accomplishments of the institute during 2008 - 09 presented as per the five thrust areas identified in the XI plan.

Environment friendly and cost effective brackishwater culture technologies with focus on techniques suitable for adoption by small scale farmers

- The CIBA shrimp feed technology (Starter, Grower and Finisher) has been successfully commercialized to M/s Bismi Feeds Ltd., Perunthottam, Tamil Nadu. CIBA shrimp feed is formulated with indigenous ingredients to meet the dietary requirements of *Penaeus monodon* and *Fenneropenaeus indicus*.



Dr. Mangala Rai, Secretary, DARE & DG, ICAR interacting with scientists of CIBA on 8th January 2009

- The final on-station trials of low-input, low-cost shrimp farming technology with organic inputs were carried out at Kakdwip Research Centre of CIBA. With tiger shrimp, *P. monodon*, an average production of 1289 kg/ha/crop and 1.28 FCR was achieved compared to 1121 kg/ha/crop and 1.36 FCR under conventional farming. There is substantial gain in production, better FCR and reduced cost of production.
- On-farm trial of modification in zero water exchange shrimp farming technology was carried out with a stocking density of 12 no./m². Average production of 3109 kg/ha/crop with 80 % survival was obtained in the experimental ponds with 7.95 % gain in terms of production, 6.96 % gain in survival rate and

10.24 % gain in FCR in comparison to the control ponds. This technology, developed in the institute ponds at Kakdwip is ready for on-farm demonstration and dissemination to farmers.

- The effect of salinity on growth and nutrient utilization was studied in the juveniles tiger shrimp *P. monodon* as part of our efforts to develop feeds that are specific for culture under low and high salinity conditions. Different physiological parameters indicate that *P. monodon* tolerates lower salinity better than higher salinities (50‰).
- In order to effectively utilize plant proteins in shrimp feed, eight potential ingredients were analysed for fibre and Non Starch Polysaccharide(NSP) content. Soluble NSP was maximum in rice bran and insoluble NSP was maximum in wheat bran, while there was not much variation of these in soybean meal, rape seed meal, sun flower meal and cotton seed meal. This data on NSP type content will help in determining the suitable enzyme mixture for improving the digestibility.
- The optimum levels for inclusion of sunflower cake, deoiled karanja cake, mango seed kernel and tamarind seed powder has been determined for preparing a low cost feed, that can be used in polyculture of *P. monodon* and *Mugil cephalus*.
- *In vitro* and *in vivo* experiments on the effects of steroidogenic hormones on vitellogenesis of *P. monodon* showed that 17 α hydroxy progesterone significantly accelerated vitellogenesis (Vg gene expression). The result reveals that any intervention to induce maturation by neutralizing the gonad inhibiting hormone is highly specific to the ovarian reproductive stage.
- Experimental work on male gamete quality in *P.monodon* indicated that the sperm quality can be maintained under captivity by periodic manual expulsion of the spermatophores.
- A simple prototype culture system, for the culture of tropical polychaete species, *Perineris nuntia*, which is an excellent maturation diet for shrimp broodstock, was developed. In 5-6 months, the males and females attained the size of 5-8 cm/ 0.4-0.9g and 6-14 cm/0.6-1.3 g respectively with a biomass production of 300 g/200 l tank.
- To identify microbes with novel properties and isolate novel genes such as salt tolerant genes, a total of 805 isolates of microbes (bacteria, actinomycetes, fungi, yeast isolates and *Archaeobacteria*) were isolated from different types of brackishwater eco-systems. Notable among the bacteria include a halophilic bacterium, *Bacillus* sp which has the ability to grow in 30% NaCl concentration. The gene responsible for the transport of glycine- betaine (osmolytes) has been identified in a *Bacillus* spp.
- The use of bagasse in shrimp ponds as a biostimulator for the removal of ammonia and nitrite has successfully been demonstrated in shrimp aquaculture. Enhanced nitrifying bacterial growth was observed on the bagasse which has been confirmed by molecular techniques including real-time PCR.
- Functional genes were targeted for molecular biological characterization of chemolithoautotrophic nitrifying, denitrifying, nitrogen fixing and sulfur oxidizing bacteria in coastal environment. Sequences of *amoA* (531 bp), *norB* (412 bp), *nirS* (873bp), *nosZ* (710bp), *soxB* (753bp, 483bp, 503bp, 239bp), *nifH* (407bp) genes have been submitted in the GenBank.
- Based on a questionnaire survey (n=112) it was found out that lack of bio-security measures such as disinfection and bird netting, use of un-tested seed, and non-uniformity in crop calendar were responsible for the incidence of diseases in shrimps.
- The adoption of commonly followed BMPs and partial implementation of bio-security BMPs was observed in both society and non-society farmers. The adoption rate was higher in non-society farmers because of the financial status of independent farmers compared to small and poor farmers in the society. There was not much significant difference with respect to over all water and soil quality in both category of ponds and all these parameters were in optimum range.

- The efficiency of probiotics to increase productivity was assessed based on information collected from farmers. The correlation analysis between production and use of probiotics for soil, water and feed indicates that these do play a role in increasing the productivity. The correlation coefficient value (r) between cost of water and soil probiotics and productivity was 0.68 and 0.52 respectively compared to r value of 0.91 for feed probiotics
- The documenting and evaluation of 60 Indigenous Technology Knowhow (ITK) in brackishwater farming systems of West Bengal has been completed along with experimental validation of some promising ITKS.
- In order to document and analyse the traditional brackishwater culture practices of West Bengal, a relational database management system (RDMS) has been developed. The Aquaculture Database System - Brackishwater is an application software that can retrieve information from the database created. The developed application software can be used for other culture systems also.

Comprehensive health management to address the existing and emerging diseases in shrimp and fish production systems

- Based on 110 samples collected from farms afflicted with slow growth in *P. monodon*, from the states of Andhra Pradesh, Tamil Nadu and Maharashtra, the presence of Monodon Slow Growth Syndrome has been confirmed and of these 76 % samples were found positive for Laem-Singh Virus.
- Asymptomatic iridovirus infection(42 % of 85 samples) has been detected in brackish and marine fishes from Kerala, Tamil Nadu, Andhra Pradesh, West Bengal and Puducherry. These have been confirmed through histopathology, electron microscopy and molecular methods.
- Screening for Viral Nervous Necrosis in marine and brackishwater fishes (n=168) from four coastal states, by (nested) RT-PCR assay optimized in the laboratory revealed 16% sub-clinical infection levels. Electron microscopy of brain tissues revealed multiple arrays of nodavirus like particles measuring around 35 nm in dimensions.
- Differences in occurrence of White Spot Syndrome Virus genotypes with respect to tandem repeats (VNTRs) across different geographical locations and difference between genotypes of wild and cultured crab and shrimp species, has been documented.
- To develop a phage therapy for controlling *Vibrio harveyi*, 42 isolates of luminescent *V. harveyi* were selected, based on phage typing and cluster analysis. The data on virulence factors, molecular characterization, phage typing and *in vivo* pathogenicity of these 42 isolates have indicated that phage typing could be useful in differentiating pathogenic and non pathogenic strains of *V. harveyi*.

High-health and high-growth shrimps through application of genetics and biotechnological tools

- The genetic work on selection for growth, survival and disease resistance in *P.monodon* has lead to an increased understanding of the genetic correlation with respect to harvest weight, pond survival, survival in challenge test and potential for selection for growth and disease resistance. The high correlation for growth between individual families' growth in two different geographic locations has indicated low genetic environmental interaction effect.
- The potential of double stranded RNA (dsRNA) to provide protection against White Spot Syndrome Virus (WSSV) was studied by injecting four types of dsRNA in experimentally infected *F. indicus* and *P. monodon*. The protection measured in terms of survival ranged from 80 to 98 % with the highest survival from ribonucleotide reductase gene (rr1).

- With regard to white muscle disease in freshwater prawn, five siRNAs based on RdRp gene of *MrNV* virus has been designed using computational approach. Cloning of a siRNA of RdRp gene of *MrNV* virus has been carried out in *E.coli* DH5 alpha competent cells. These would be evaluated for their effectiveness in controlling the disease in freshwater prawn under laboratory conditions.
- Under the work on functional genomics of *Penaeus monodon*, Toll receptor gene likely to influence immune defense and Tropomyosin gene which is responsible for the allergen in shrimp muscle proteins were cloned and expressed.

Diversification of species and systems for development of sustainable brackishwater aquaculture

- Successful spawning of F₄ generation seabass was observed at 14 ppt (during November – December) indicating that the domestication and improved broodstock management protocols have led to maturation of domesticated stock even in lower salinities. A total of 4.87 lakhs fry were produced, of which 2.0 lakhs fry were produced in December 2008 and January 2009 which were earlier considered as off season for seabass breeding.
- Survival of seabass hatchlings to 25 day old fry has increased to 32% with improved hatchery management techniques.
- Seabass larval rearing technology standardized by CIBA was validated in the facility of entrepreneur, M/s Periyar Hatchery Marakkanam and a survival rate of 58% was achieved. This success means that hatcheries meant for shrimp/scampi and mud crabs can be converted as seabass hatcheries with required modification.
- Seabass nursery rearing technique standardised by CIBA has been successfully transferred to farmers.
- Evaluation of optimal protein : fat (energy) required for seabass fingerlings indicated that they require a high protein and high energy diet for better growth and FCR. The fish can also perform equally well with low FCR at medium protein, if provided with a high lipid level.
- A micro diet with 45% protein and 12 % lipid was developed for nursery rearing of seabass. The feed was validated in farmer's ponds in Andhra Pradesh both in hapas and in nursery ponds . The CIBA nursery diet can be successfully used for large-scale nursery rearing of seabass fry for producing fingerlings and this technology is now ready for commercial scale production.
- Artificial hide-outs were found to significantly increase the survival rate in the nursery rearing of *Scylla tranquebarica*. The growth rate was significantly better in ponds with artificial hide-outs (0.27-0.35g/day) compared to the ponds with natural hide-outs (0.12-0.17g/day).
- Nursery reared crablets of *S. tranquebarica* (60 g) were transported from Chennai to Kakdwip and stocked at 0.75 no./m². They attained the size of 302 to 343g with 44 to 51% survival. This is the first culture trial of *S. tranquebarica* in West Bengal showing the potential for culture in the state.
- The apparent digestibility coefficient of dry matter (DM), crude protein(CP) and energy of sardine meal, *Acetes* meal, soya flour, wheat and rice bran in juvenile mudcrab *S. tranquebarica* was estimated. The results indicate that both animal and plant protein sources are very effectively utilized by the mudcrab.

Socio-economic analysis and policy support for sustainable brackishwater aquaculture development

- An evaluation on the impact of fisheries research in India revealed that yields are higher by 300 to 600 % in modern scientific farms of Tamil Nadu and Andhra Pradesh compared to traditional farms in Kerala

and West Bengal. However the increased number of crop failures indicate the need for research support to ensure availability of disease free *P. monodon* seed and implementation of Better Management Practices (BMPs) for health management.

- Based on a survey of 122 traditional shrimp farms (60 in Kerala and 62 in West Bengal) it was found out that the usage of wild caught seed in some traditional farms of West Bengal and supplemental feeding with pellet feeds in Kerala were the major deviations from organic certification standards.
- A study on the market opportunities for fisheries sector in India reveals that intermediaries take 42 to 58 % of consumer rupee as a marketing margin. Therefore efforts should be made to shorten the marketing channel to help maximise benefits to both producer and consumer. Domestic fish demand would further increase if the present consumer dissatisfaction on poor marketing infrastructure (72%) and unhygienic handling of fish (68%) in city markets is addressed.
- Shelf-life studies of the normal and disease affected shrimp *P. monodon* in cold storage (-20°C) was carried out based on the chemical indicators, microbial count and sensory evaluation studies. It was found that the Loose Shell Syndrome(LSS) affected samples had lesser shelf life compared to WSSV affected and healthy shrimp samples.
- The estimated annual national loss due to diseases in brackishwater aquaculture during the years 2005 to 2008 was assessed to be 48,717 t amounting to a loss of Rs. 1022.13 crores. In terms of farm level employment, annually 21.56 lakhs man days were lost due to shrimp diseases.
- The geographical and seasonal variations in the nutrient profiles of *P. monodon*, Indian white shrimp, *F. indicus*, *L. calcarifer* and *M. cephalus* from Andhra Pradesh, Kerala, Tamil Nadu and West Bengal have been documented.
- The carrying capacity(CC) assessment planning tool developed earlier was further refined with the addition of total suspended particles as one more input parameters in the model. The tool was further validated with a new type of source water body located near mangroves. It was found that the recommended area based on the CC was 275 and 96 ha on Vellar and Upanar Rivers, which is within the actual area that has been developed.
- Comparing the land use classes of 1987 and 2006, as determined from remote sensing images has clearly shown that reserve forest mangrove area was not used for aquaculture development. Most of the aquaculture development has taken place in the private owned areas outside reserve forest.
- Based on the information needs assessment of users of Village Knowledge Centres of Thangatchimadam, Ramanathapuram district, an e-Learning module on 'Soil and Water Management in Brackishwater Shrimp Aquaculture' has been designed and developed.
- Research Information System (RIS), an intranet-based application software has been developed to store and retrieve the information on all research papers, project proposals and reports and special publications of the Central Institute of Brackishwater Aquaculture (CIBA). The developed system can be used by any research institute.
- Analysis of data on five hundred and seven women farmers in six districts of Tamil Nadu revealed that women were involved in a wide spectrum of aquaculture activities like aqua business, small scale shrimp processing units, crab exports, crab fattening in cages and pens, crab hatchery, clam collection, shrimp hatchery, fish meal processing, preparation of value added products and sea bass farming.
- In order to diversify livelihoods among the women self help groups, the motivating factors for adoption of brackishwater aquaculture technologies were identified.

3. INTRODUCTION

The brackishwater aquaculture sector which was in its nascent stage in the early 1970s has grown by leaps and bounds to attain the present level of a commercial enterprise. By and large, shrimp farming is synonymous to the culture of tiger shrimp *Penaeus monodon* in our country. From a modest level activity as practiced during the 1970s, this sunrise sector expanded rapidly by the technological and promotional interventions of R&D institutions and other governmental agencies as well as by the entry of corporate sector during the late 1980s and early part of 1990s. The 8129 km long coastline of our country is rich with 3.9 million ha estuaries, 3.5 million ha coastal brackishwater area and 8 million ha salt affected areas. The country is blessed with 1.2 million ha brackishwater area and of which around 2,00,000 ha has already been developed for brackishwater aquaculture. Due to the recurring disease problem experienced by the farmers, the area under culture has come down to 108789 ha during 2008-09 with annual production of 75997 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, 45 Scientists, 29 Technical and 26 Administrative and 55 skilled support staff as on 31.3.2009.

MANDATE

- To conduct research for development of techno-economically viable and sustainable culture system 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

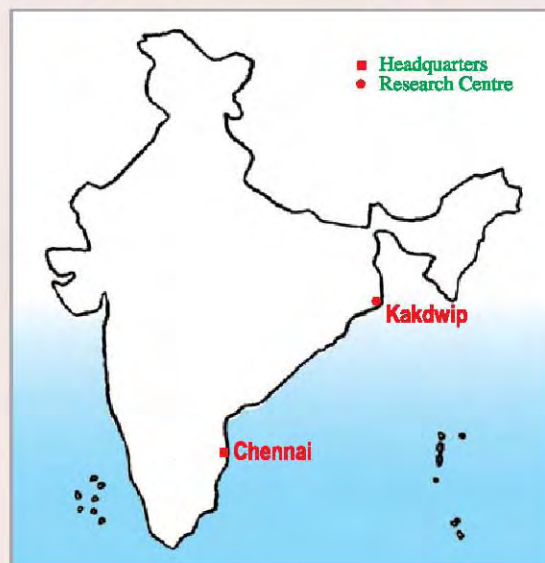
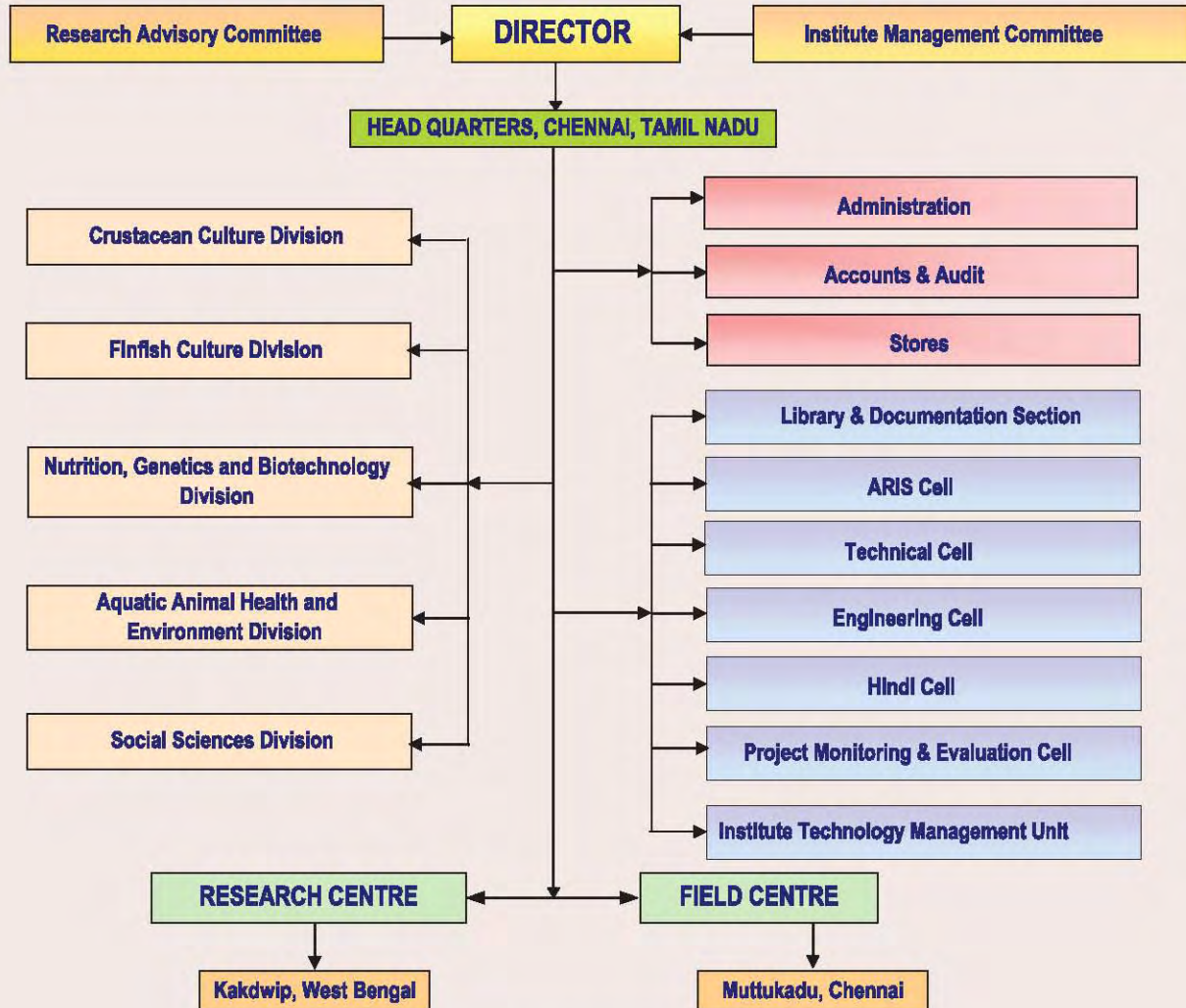
ORGANIZATIONAL SET-UP

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 11 in-house and 23 externally funded projects during 2009-10.

ORGANISATION CHART



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FINANCIAL STATEMENT

Sub-Head	BE	RE	Actual expenditure
NON-PLAN			
Establishment	395.00	645.00	622.41
O.T.A.	0.20	0.18	0.17
Traveling expenses	5.90	5.50	5.50
Other charges	55.90	86.00	86.00
Works	15.00	22.00	22.00
Total	472.00	758.00	736.08
PLAN			
Traveling expenses	12.00	12.00	11.99
HRD	5.00	5.00	4.99
Contingency	150.00	150.00	150.00
Works	120.00	120.00	120.00
Equipments	120.00	120.00	120.00
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	15.00	15.00
Total	450.00	450.00	449.98

REVENUE GENERATION

Year	Rs. in lakhs
2008-09	50.95

OFFICIAL LANGUAGE IMPLEMENTATION PROGRAMME

The implementation of Hindi for official use was reviewed by the officials from ICAR/DARE on two occasions in August and October 2008. The institute has nominated 15 staff members for various courses under Hindi teaching scheme. One staff underwent Hindi stenography course. The staff were given cash awards for successful completion of different Hindi courses and typing examinations. Hindi week was celebrated by organizing competitions like debate in Hindi and “*vad-vivad*” and the winners were given cash awards. A national Hindi Workshop on “Recent advances in aquaculture” was organized at CIBA, Chennai during 23-24 September 2008.



Hindi Workshop

STAFF POSITION

The details of the number of positions sanctioned, filled and remaining vacant as on 31.3.2009 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 Scientists	10	1	9
Scientists	52	44	8
Technical Assistant	30	29	1
Administrative Officer	1	1	0
Finance & Accounts Officer	1	1	0
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	55	5
Total	184	158	26

*including two support staff

4. RESEARCH ACHIEVEMENTS

IN-HOUSE PROJECTS

CRUSTACEAN CULTURE DIVISION

Title of the project **Sustainable shrimp production through domestication of *Penaeus monodon*, development of culture practice for *Marsupenaeus japonicus* and adoption of best management practices in farming**

Principal Investigator Dr.P.Ravichandran

Location of the project Chennai

Co-Investigators Dr.S.M.Pillai, Dr.C.Gopal, Dr.C.P.Balasubramanian, Dr.A.Panigrahi, Dr.M.Jayanthi, Dr.P.Nila Rekha, Dr.D.Deboral Vimala, Dr.K.Ponnusamy, Dr.M.Kumaran, Dr.M.Muralidhar, Dr.R.Saraswathy and Dr.J.Syama Dayal

Spermatophore and sperm quality characteristics of *Penaeus monodon* under captivity

Degeneration of reproductive tract and associated drop in reproductive quality is a recurring problem in captive male shrimps. Therefore, the primary focus of the shrimp maturation research programme during this year was to develop a management protocol to maintain male reproductive health/reproductive viability in hatchery systems. Experiments were carried out to understand the reproductive biology of male *P. monodon* under captivity.

Sperm quality (number and viability) in relation to life history traits (moulting) and captivity was evaluated. Base line values of male gamete quality characteristics from freshly collected inter moult individuals were: spermatophore weight, 0.19 ± 0.06 g; number of sperms, 3.2 ± 2.57 ; viability, 97%; number of abnormal sperms, 0.3%.

The effect of captivity on male reproductive quality was studied by two approaches: i) sperm quality at the beginning of the experiment was compared with variations in quality as a result of consecutive spermatophore

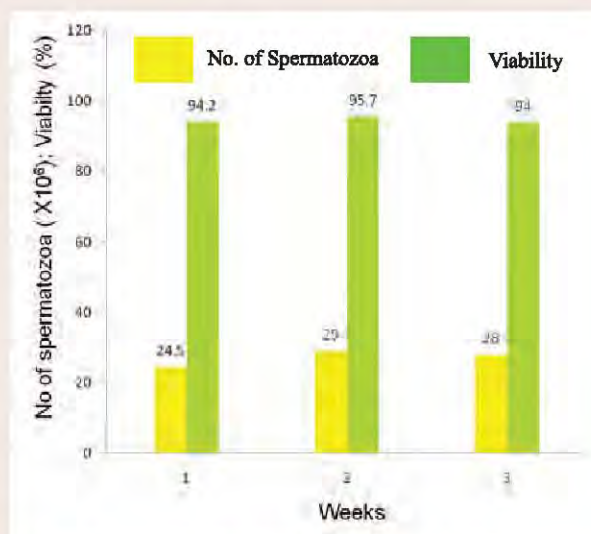


Fig. 1. Male gamete quality characteristics during captive rearing of *Penaeus monodon* during consecutive spermatophore regeneration.

regenerations (by expelling manually) and ii) sperm quality was evaluated after one month in captivity, without periodic collection of spermatozoa. In experiment (i) where the spermatophore was expelled manually, spermatophore weights of the individual shrimps decreased during the experimental period (0.29 g in the first week and 0.07 g in the third week); nevertheless, no significant difference was observed between the weekly values of spermatophore weight ($P>0.05$). On the contrary, sperm counts of individual shrimps increased slightly, although the values are not significantly different ($P>0.05$) (Fig.1).

In experiment (ii), where sperm quality was evaluated at the end of 30 day period without any manual expulsion of spermatophore, it was found that the mean sperm quality differed significantly between 0 day and 30th day (3.2×10^6 vs 0.1×10^6). The results of the two experiments indicated that the sperm quality can be maintained under captivity by periodical expulsion of the spermatophores.

Moulting in crustaceans involves mobilization of nutrients for the formation of new exoskeleton and has a strong influence in the maturation process of both males and females. Spermatophore and sperm quality were studied during different phases of moult cycles (post moult, inter moult and early pre moult stages) to evaluate the impact of moulting on male maturity. Post moult males failed to provide spermatophores. However, spermatophores could be collected from all the inter moult and pre moult males. No significant difference could be noticed in spermatophore weight and sperm quality between inter moult and pre moult males. Further, spermatogenesis occurs normally in inter moult and pre moult phases. However testis in the post moult phase contains more spermatogonial cells compared to inter moult and pre moult phases (Fig.2).

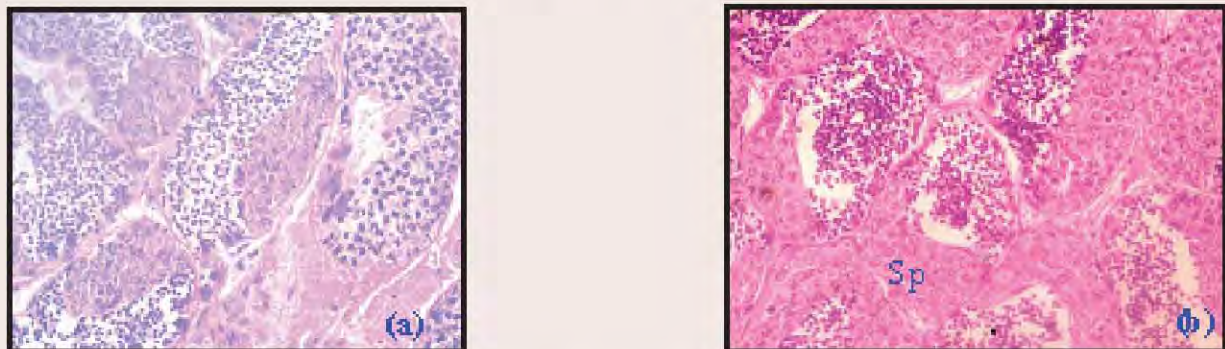


Fig. 2. Histological sections of testis of *Penaeus monodon*; intermoult(a) and post moult phases(b). Number of spermatogonial cells (Sp) are high in the post moult testis

Higher level of spermatogonial cells in the post moult phase clearly indicates that the moult cycle has a strong influence on the quality of male gametes. Post-moult and inter moult stage males will be performing better than pre-moult and newly moulted shrimps.

Effect of the rearing system on reproductive performance

Experiments were carried out to evaluate the effect of rearing system on the reproductive performance of *P. monodon*. Results showed that although spawning rate was comparable in water renewal system (60%) and recirculation system (40%), successful spawning was significantly higher in water renewal system (83%) than recirculation system (25%) (Fig.3). On the other hand, ammonia and nitrite concentration of the two systems

were found to be almost similar during the experimental period, and both metabolites were within the acceptable limits. The reduced reproductive performance in the recirculation system in comparison to renewal system needs further study.

Development of location specific better management practices (BMPs) in shrimp farming

For developing location specific better management practices (BMPs), studies were carried out in society and independent farms to determine the adoption rate of BMPs, water and soil quality differences and crop performance.

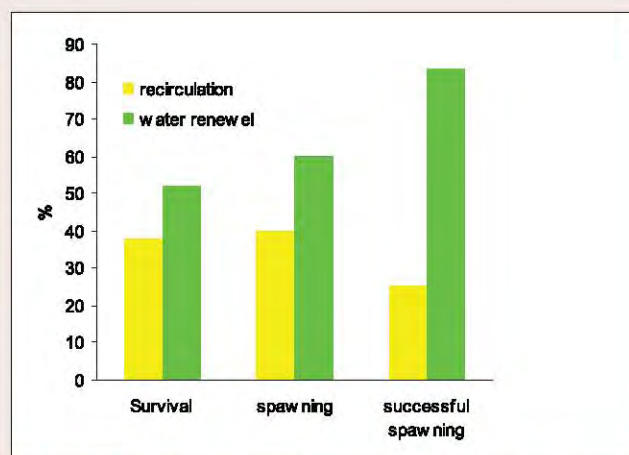


Fig. 3. Effect of recirculation system and water renewal system on reproductive performance of *Penaeus monodon*

Adoption rate of BMPs in society vs independent farms

Questionnaire survey of 20 farmers each for cluster/society and independent farmers group, (at each site with a total sample strength of 80), in Tamil Nadu and Andhra Pradesh was conducted to evaluate the adoption rate of BMPs. The temporal and spatial samplings to assess the soil and water quality and crop performance were carried out during 2008 summer crop in society ponds of National Centre for Sustainable Aquaculture (NaCSA) and in the independent farmer's ponds in Tamil Nadu (S1-C & S1-I, S2-C & S2-I) and Andhra Pradesh (S3-C & S3-I, S4-C & S4-I).

Analysis of both the crops revealed that adoption of commonly followed BMPs and partial implementation of bio-security BMPs were observed in both society and non-society farmers; however, the adoption rate (Fig. 4.)

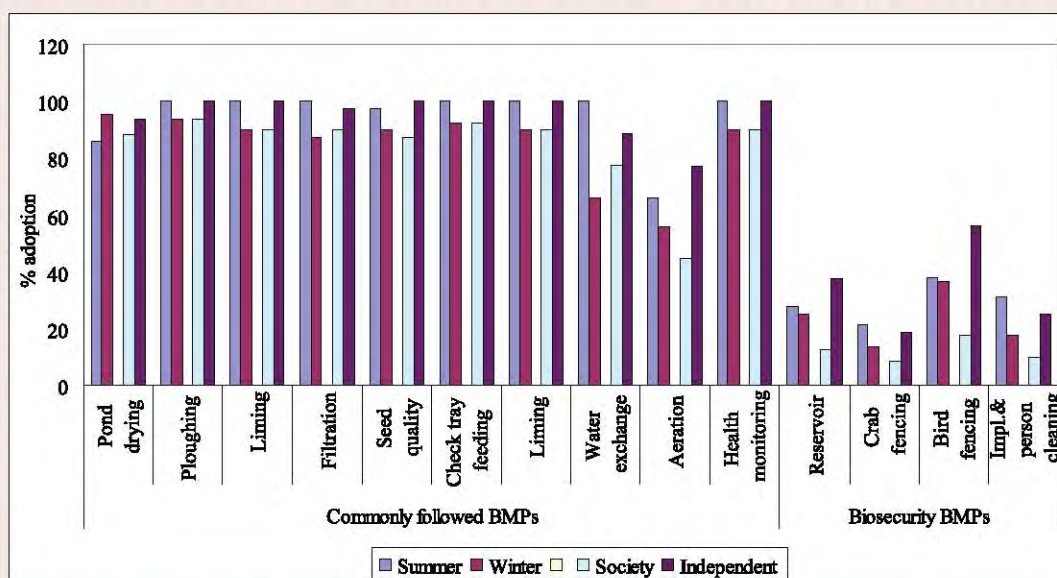


Fig. 4. Adoption rate for different BMPs during winter and summer crops in society and independent farmers ponds

was more in the ponds of independent farmers (commonly followed BMPs: 77- 100%, biosecurity BMPs: 19 -56%) than in ponds belonging to society farmers (commonly followed BMPs: 45-94%, biosecurity BMPs: 9-18%). This was attributed to the financial status of independent farmers compared to small and poor farmers in the society. With respect to crop season, the adoption rate was more in summer crop (commonly followed BMPs: 67 - 100%, biosecurity BMPs: 21-39%) compared to winter crop (commonly followed BMPs: 56-95%, biosecurity BMPs: 18-36%) which was due to a higher success rate in the summer crop as reported by the farmers.

Water and Soil quality

There was not much significant difference between society ponds and independent farmer's ponds with respect to over all water and soil quality and all the parameters were in optimum range. The soil cores in the study area were characterised and the average values from each site revealed more or less decrease in pH, electrical conductivity, calcium carbonate and organic carbon content with increase in depth (Fig.5).

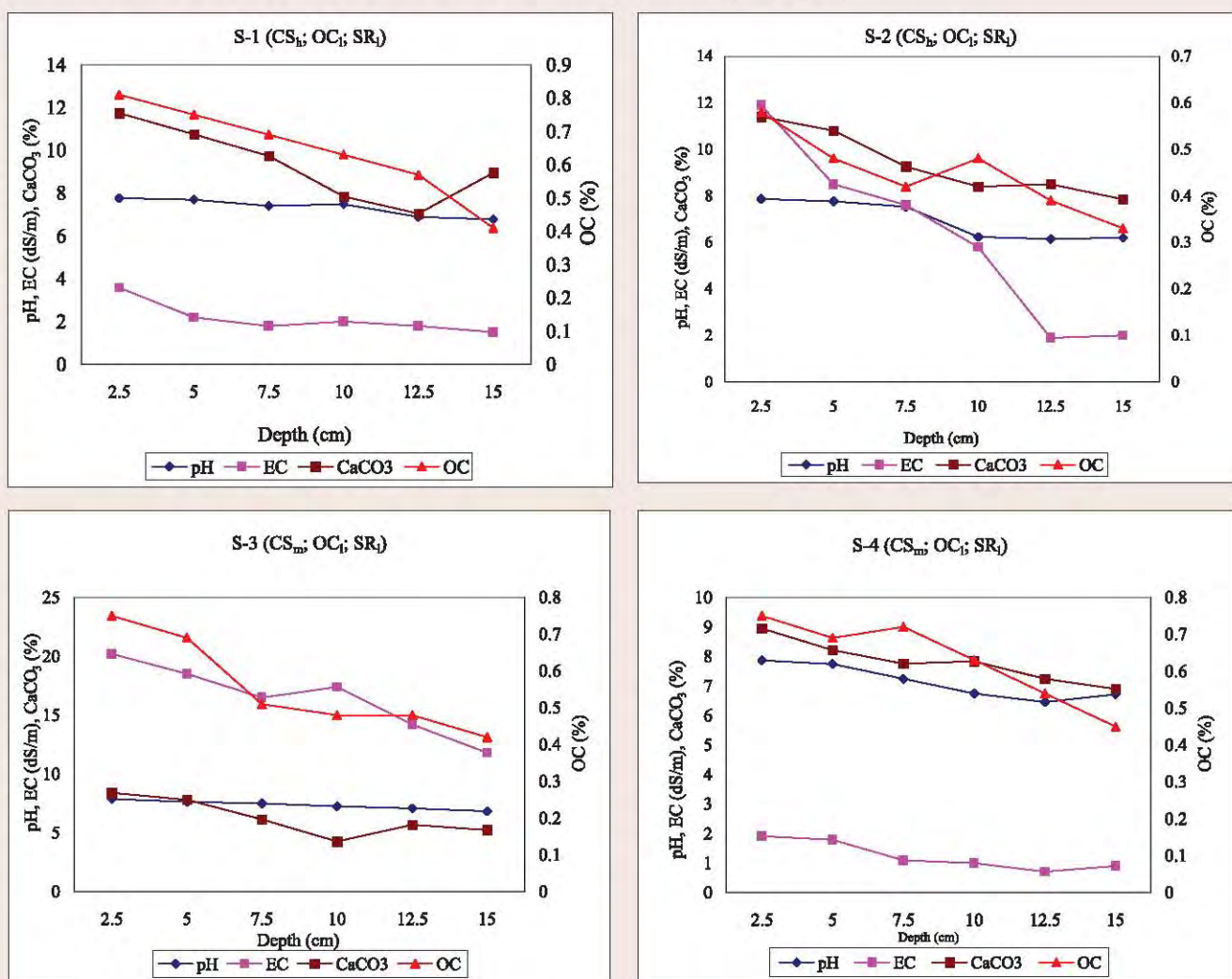


Fig. 5. Soil types at different sites showing decreasing values with depth. (S1 and S2 –sites in Tamil Nadu; S 3 and S4 – sites in Andhra Pradesh; CS – Calcareous sediment; OC – organic carbon; SR – sodium adsorption ratio; subscripts: h- high; m – medium; l – low)

The values within each site were similar while between sites it was highly variable. In view of the variation in the values of soil parameters, it is possible that the BMPs adopted in one type of soil can be extrapolated to the other areas having similar soil type. Categorization of soil based on the tested parameters will help in formulating the location specific BMPs.

Crop performance in society and independent farmers

The crop performance of the sampling ponds revealed that both society and independent farmers' ponds were affected with white spot disease. Few positive points observed in the society ponds, which may not be directly related to decrease in disease incidence were, creating awareness on BMPs among small and poor farmers, decrease in the use of chemicals/probiotic inputs that reduced the production cost by Rs.40/kg, discontinuing use of banned antibiotics, co-operation in buying high-quality farm inputs such as seed at competitive price, access to credit and increased co-operation in works such as deepening of source waters by removing aquatic weeds.

Scientific evaluation of farmer's practices – Specific experimental studies

Farmer's practices such as application of vermicompost during pond preparation as a nutrient supplement and fermentation products during culture period were evaluated in wet lab experiments using 25 ppt saline water in 100 l capacity FRP tanks in duplicate. Vermicompost (VC) was compared with traditional manures viz., cowdung (CD) and poultry manure (PM). Vermicompost was on par with other manures in supplementing nutrients (nitrate - 0.06-0.13, 0.07-0.12 and 0.05-0.13 ppm with VC, CD and PM respectively; phosphate - 0.03-0.08, 0.04-0.06 and 0.05-0.09 ppm with VC, CD and PM respectively) for enhancing primary productivity and it was better than poultry manure in maintaining good pond bottom condition as revealed by low levels of metabolites load in water (20 days after treatment - total ammonia N was 0.06, 0.08 and 0.12 ppm with VC, CD and PM respectively; nitrite- N was 0.11, 0.32 and 0.46 ppm with VC, CD and PM respectively) and organic carbon content in soil (VC- 0.21%, CD-0.63%, PM-0.33%). Fermentation of vermi compost was done in brackishwater and low saline water separately, simulating the farmers practice and the filtrate obtained after filtration was characterised for the presence of microbial density. Yard experiments in FRP tanks with soil, water and shrimps under brackishwater (BW- 25 ppt) and low saline water (LSW- 5 ppt) environments separately revealed that fermented filtrate prepared in low saline water was more effective as revealed by the shrimp growth (percentage increase in weight was 30 and 27 in LSW and BW respectively after 18 days) and environmental conditions (TAN – 0.02 to 0.46 ppm in LSW and 0.12 to 0.76 ppm in BW; Nitrite N – 0.02 to 0.38 ppm in LSW and 0.05 to 0.22 ppm in BW).

Studies on horizontal spread of white spot disease in relation to the bio-security conditions in the farms

Bio-security protocols followed in shrimp aquaculture farms and their adoption rate, white spot disease incidence and the horizontal spread of disease were studied in Kancheepuram, Thiruvallur and Nagapattinam Districts of Tamil Nadu and Krishna and West Godavari Districts of Andhra Pradesh. Based on a questionnaire survey (n=112) it was found out that lack of bio-security measures such as disinfection and bird netting, use of un-tested seed, and non-uniformity in crop calendar were responsible for the incidence of disease. Letting out of water for emergency harvesting during disease outbreak without prior intimation to neighborhood farmers was observed to be the main reason for rapid spread of the disease.

The spread of disease was through water and birds, but primarily through the water at the time of exchange during the culture period. Zero water exchange showed no disease incidence in the farms but resulted in poor growth. Transmission of the virus through birds was noticed more in the farms without bird fence. The distance between the farms affected with the disease ranged from 0.5 to 5 km (Fig.6). Generally, it takes 1 to 20 days for the spread of disease from the first farm to other farms. The disease remained in areas for a maximum of two months.

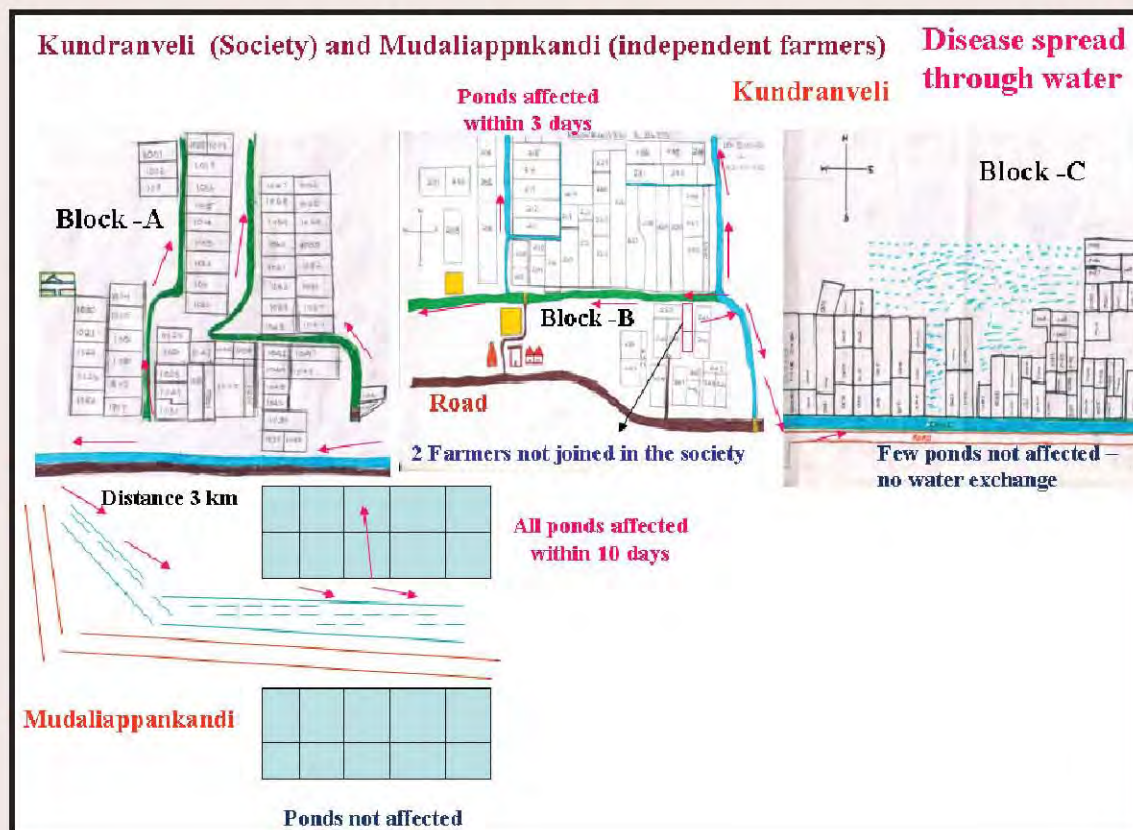


Fig. 6. Lay-out of the study sites in Tamil Nadu indicating the pattern of horizontal transmission of WSSV through water (red arrows show direction of disease spread)

On-farm testing of biosecured zero water exchange system

Biosecured zero water exchange system technology (BZEST) developed at Kakdwip Research Centre (KRC) was further evaluated and modified for the culture of *P. monodon*, with the objective of prevention of viral diseases with strict biosecurity and at the same time incorporating zero-tolerance for antibiotics and other chemicals usage. Use of beneficial microorganisms (*Lactobacillus*, *Bacillus*, *Pseudomonas* and probiotic yeast *Saccharomyces*) for controlling the pathogenic microorganisms and maintaining the water quality was one of the major interventions in the technology. On-farm trial of the technology was carried out with a stocking density of 12 no./m² and an average production of 3109 kg/ha with 80 % survival was obtained in the experimental ponds with 7.95 % gain in terms of production, 6.96 % gain in survival rate and 10.24 % gain in FCR in comparison to the control ponds. The modified BZEST technology developed in the institute ponds at KRC is ready for on-farm demonstration and dissemination to farmers.

Diversification into other species of shrimps *Marsupenaeus japonicus* and *Fenneropenaeus merguensis*

Domestication of *M. japonicus* and *F. merguensis* has been achieved and captive stock of domesticated shrimps are being maintained over a number of generations. Culture technology has been developed and on farm trials in West Bengal are in progress. The growth rate and production levels of both the species are low at about 1 tonne/ha in 5-6 months. As an alternate species to *P. monodon*, *F. merguensis* does not attract the attention of the farmers because of their low export-price and slow growth. But the technology is being developed for the west coast since the species can tolerate low temperature. *M. japonicus* could fetch a very high price if exported live to Japan and the species is a good candidate species for sea-water based sandy farm areas.

Culture of polychaetes

Culture trials of polychaetes, *Perineris nuntia* and *Marphysa graveyly* were carried out in yard experiments. Brood sac of *M. graveyly* collected from MES lagoon was stocked in 200 l tank with substratum and after 5 months the larvae had attained the size of 4-12 cm/0.14-1.1 g. These were stocked in tanks for further rearing. A total biomass of 350 g (42 nos.) were produced at the end of 4 months, indicating the possibility of mass culture of the species. 1500 larvae of *P. nuntia* were cultured with sand substratum in a tank for 11 months and a total biomass of 150.69 g (172 nos.) was obtained. Scaling-up of culture in larger tanks is in progress.



Culture of polychaetes in tanks

Title of the project Development of packages for nursery rearing and grow-out culture of mudcrabs (*Scylla* spp)

Principal Investigator Dr.S.Kulasekarapandian

Location of the project Chennai and Kakdwip

Co-Investigators Shri M. Kathirvel, Dr.C.P.Balasubramanian, Dr.K.K.Krishnani, Dr.Ezhil Praveena, Dr.A.Panigrahi and Dr.T.K.Ghoshal

Nursery rearing of mudcrab *Scylla tranquebarica*

Technology package for the nursery rearing of hatchery produced megalopa larvae has been standardized in two phases. Phase I is for rearing megalopa larvae to 3 g crablets and Phase II is for rearing 3 g size to stockable size of 30-40 g. After a series of trials of Phase I in indoor tanks, open ponds, in hapas inside pond and hapas in open backwater, it was established that rearing directly in open ponds was the best, based on the growth and survival of the larvae. Further experiments to confirm the findings was also carried out.

Experiments on Phase I nursery rearing

In Experiment (i), megalopa larvae of size 1.4 mm /0.005 g was stocked in five 100 m² ponds at a stocking density of 60 no./m² with sea weed (*Gracilaria verrucosa*) as hide-out in four ponds while in one pond bunches of nylon thread was used. Reduced stocking density of 30 no./m² was used in another pond with artificial hide-out. The survival was higher in ponds with natural hide-out (37-42%) compared to the ponds with artificial hide-outs irrespective of the stocking density (22-23%). The growth rate was significantly better in ponds with artificial hide-outs (0.27-0.35g/day) while compared to the ponds with natural hide-outs (0.12-0.17g/day). The negative correlation observed between the growth rate and the number of surviving crablets present at the time of harvest irrespective of the stocking density and nature of hide-out indicates that the higher growth rate was not solely due to the artificial hide-out.

In experiment (ii), rearing of megalopa larvae was taken up in six hapas in open backwaters at a uniform stocking density of 50 no./m² with natural and artificial hide-outs. There is no significant differences among the survival rate obtained between natural hide-out (23-54%) and artificial hide-out (29-50%). But the growth rate was poor in all cases ranging between 0.02 to 0.04 g/day.

Comparison of data from experiment (i) and (ii) indicates that the larvae require soil base and natural hide-out for better growth and survival. Considering the objective of Phase I rearing is to grow the megalopa to 3 g size in one month and in view of the lack of wide difference in average survival for open pond (32%) and hapas (37%), it could be concluded that Phase I nursery rearing in ponds with natural hide-outs is the best option.

Experiments on nursery phase II

Phase II of nursery rearing was for rearing the juvenile crablets of 3-5 g to crablets of stockable size (30-50g) in 60-75 days rearing. Earlier studies have indicated rearing in ponds as the viable option and further evaluation was carried out at stocking densities of 13-17 no./m² in six ponds of 100 m² area. The details of the results are presented in Table 1.

The data indicated that there is no significant difference in the growth rates among the different stocking densities and the nature of the hide-outs. But higher survival was obtained at the lowest density of 13 no./m². Further experiments to standardize the stocking density is required. Considering the cost involved in transplanting natural sea weed, the durability of artificial hide-out designed and the lack of difference in growth and survival with the different treatments, it could be concluded that for phase II nursery rearing artificial hide-outs could be used without compromising the growth or survival.

Table 1. Effect of two different hide-outs on growth and survival of crablets of *Scylla tranquebarica* under nursery rearing

Sl.No.	Stocking density (no./m ²)	Culture days	Growth rate (g/day)	Survival (%)
With sea weed as hide-out				
1	16	77	0.8	25.1
2	16	77	1.0	17.3
3	17	73	1.1	19.0
4	17	50	1.3	21.5
With bunches of nylon thread as hide-out				
5	13	50	0.8	34.9
6	16	55	1.1	19.2



Artificial hide-out for nursery rearing of mudcrab (a) Juveniles among nylon threads (b) Nursery pond with nylon thread hide-out

Evaluation of pellet feed for Phase II nursery rearing

Experiments (in triplicate) were carried out to study the effect of pellet feed on growth and survival of early juvenile crabs during second phase of nursery rearing with clam meat as control feed. The results indicated that the survival was better with clam meat (93%) than the pellet feed (87%), but the growth rate was higher in crabs fed with pellet feed (0.24 g/day) than control crabs (0.18 g/day). Since the overall survival is higher in both the treatments it could be concluded that clam meat can be replaced with pellet feed in nursery phase II rearing. Further experiments are required to standardize the feeding rates and to evaluate the cost-benefit ratio.

Grow-out culture of *Scylla tranquebarica*

In experiment (i), three ponds were stocked with crablets of 75-100g at 3-4 no./m² and reared for 124 days with trash fish as feed (10% biomass). Despite heavy rains and flooding of ponds during the course of culture, recovery of 12.58 to 41.67 % was obtained. The crabs had grown to a size range of 255 to 316 g and production level of 1.26 to 2.82 t/ha/124 days was obtained. The results have indicated for the first time, the high potential production levels of pond culture of the species.

In experiment (ii), nursery reared crablets of *S. tranquebarica* of 60 g size were transported from Chennai to Kakdwip and stocked in two ponds (A,B) (Table 2) with equal numbers of male and female at a stocking density of 0.75 no./m². In four months the crabs have attained the size of 302 to 343 g with survival rate of 44 to 51%. CIBA pellet feed was used and the FCR obtained was 2.46. This is the first trial of culture of *Scylla tranquebarica* in West Bengal and it has shown positive indication for culture of the species in West Bengal where low salinity regime prevails. Further experiments to standardize the stocking density is being planned. The results show that grow-out culture of *S. tranquebarica* can be propagated as a profitable venture for farmers of West Bengal region.



Pond culture of *Scylla tranquebarica* in West Bengal

Table 2. Pond based culture trials with *Scylla tranquebarica* in West Bengal

Pond No.	Initial carapace width (mm)	Initial body weight (g)	Final carapace width (mm)	Final body weight (g)	Survival (%)	Crab yield (kg /ha)
A	74 ± 4.8	60 ± 6.8	103 ± 13.8 (M) 115 ± 18.0 (F)	308 ± 97.3(M) 343 ± 144.7(F)	44 %	1073
B	74 ± 4.8	60 ± 6.8	107± 13.7(M) 111± 13.2(F)	302±111.8(M) 325 ± 92.4(F)	51 %	1158

Grow-out culture of *Scylla serrata*

Culture of *S. serrata*, was undertaken during post-monsoon and winter season, at a stocking density of 1 no./m² in two ponds (C, D) for five months (Table 3) The crabs have registered final size of 139-167 g with 35-40% survival in 5 months rearing. An average production of 582 kg/ ha/5 months was obtained with FCR of 4.4. The low salinity coupled with low temperature was found unsuitable for the species.

Table 3. Pond based culture trials with *S. serrata* in West Bengal

Pond No.	Initial carapace width (mm)	Initial body weight (g)	Final carapace width (mm)	Final body weight (g)	Survival (%)	Crab yield (kg / ha)
C	69 ± 1.4(M)	76 ± 0.002	90 ± 7.3 (F)	167 ± 2.8(M) 139 + 27.3(F)	40.6 %	601
D	62 ± 1.5(M) 64 ± 53.3(F)	49 ± 1.7	91 ± 4.8(M) 95 ± 6.0(F)	157 ± 8.8(M) 139 ± 20.7(F)	36.7 %	562.5

Title of the project Aquaculture farm appraisal and impact assessment using remote sensing and GIS

Principal Investigator Dr.M.Jayanthi

Location of the project Chennai

Co-Investigators Dr.P.Ravichandran, Dr.P.Nila Rekha and Dr.M.Muralidhar

Mapping of existing aquaculture farms and monitoring aquaculture development close to ecologically important areas are important for planning the development of sustainable aquaculture. To evaluate the potential application of remote sensing techniques for the automated extraction of aquaculture farms in larger areas and to assess the impact of aquaculture development on selected ecologically sensitive coastal areas, remote sensing techniques, Geographical Information System (GIS) and modeling techniques were used. The project had the following three objectives: (i) to assess the impact of aquaculture on mangroves and agricultural lands; (ii) to develop the methodology for the estimation of aquaculture farms in larger areas using remote sensing techniques; (iii) to assess the impact of shrimp farming on coastal aquifer.

Assessment of impact of aquaculture on Coringa mangrove

Coringa mangrove is situated south of Kakinada Bay and named after the river Corangi. It is second largest mangrove formation in India after Sunderban mangroves. The wetland consists of three reserve forests (RF) in the northern side of the Nilarevu River namely Corangi, Corangi Extn, and Bhairavapalem. The other six reserve forests situated in the southern side of the Nilarevu River are Rathialava, Masanitippa, Matalatippa, Balustippa, Kothapalem and Kandikuppa, To assess the impact of aquaculture development in and around the Coringa mangrove region, remote sensing IRS P6 Linear Imaging Self scanning Sensor (LISS) III satellite data of 2006 and Landsat Thematic mapper (TM) of 1987 were used, in this study.

Reserve forest boundaries and ground control points were delineated from the Survey of India topographic maps. The land use pattern was derived from the satellite data using ERDAS Imagine 9.1 and Arc GIS 9.2. In the geo-referenced remote sensing (RS) images, the smooth bright red colour indicates the dense mangrove forests. The variation in the mangrove appearance (different red tone in TM and LISS III data) was due to variation in sensors capability. The small creeks and drainage system are clearly seen in the imagery. Regular square or rectangular shaped blocks in dark blue or bluish grey are aquaculture farms. The wide spread red color in landward side are agriculture lands (Fig.7a,b). From the RS images it was possible to delineate different land classes such as mangroves, agriculture, aquaculture, mudflats, saltpans, settlements, coastal vegetation and sand. Yellow line indicates the reserve forest boundary (Fig.7c,d).

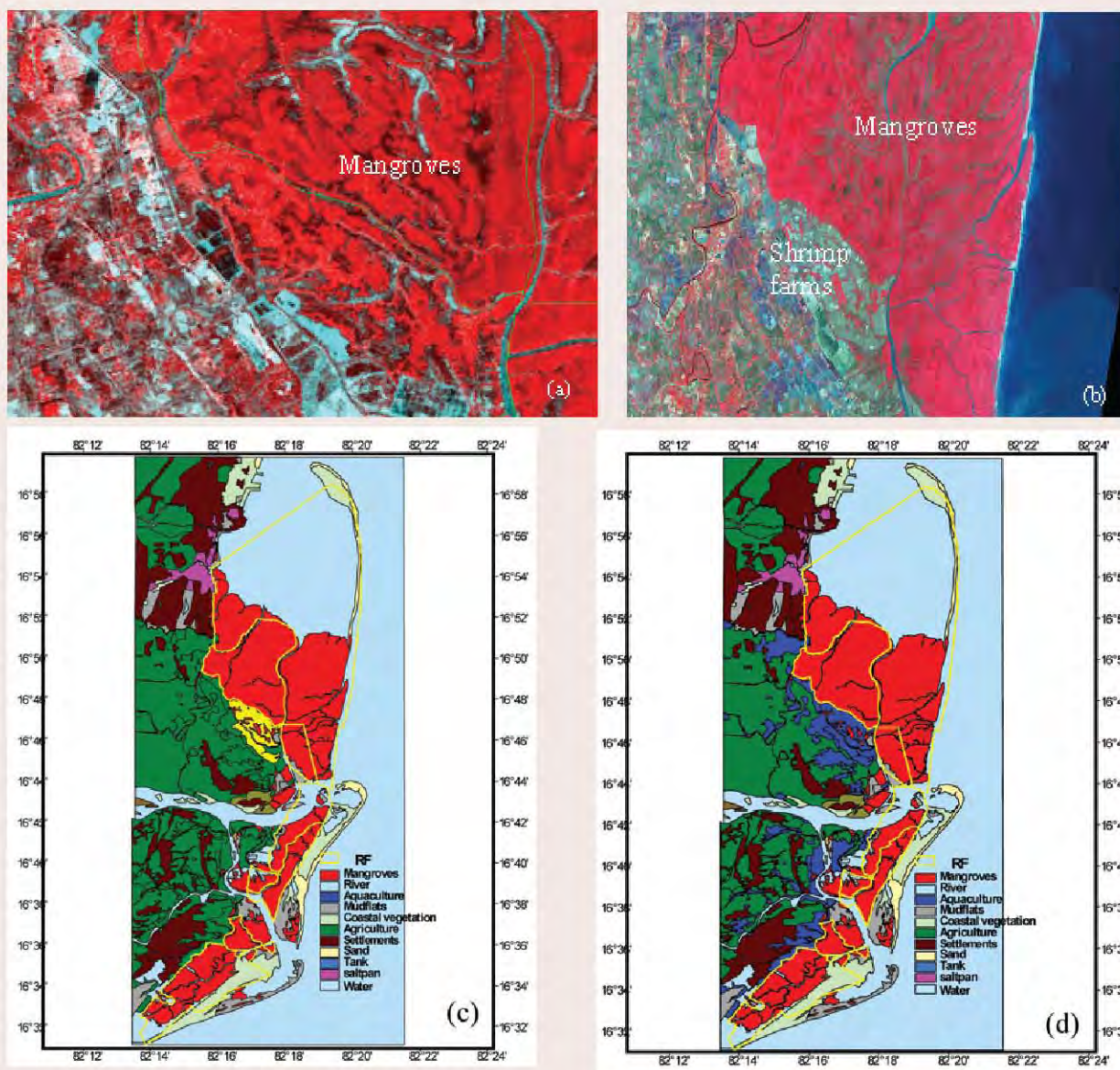


Fig. 7. Landuse pattern in 2006 and 1987 in and around Coringa mangroves. (a) Landsat TM images of Coringa mangroves in 1987. (b) IRS P6 images of Coringa Mangroves in 2006. (c) Land use pattern in and around Coringa mangroves derived from Landsat TM 1987 data (d) Land use pattern in and around Coringa mangroves derived from IRS P6 2006 data.

Avicennia marina and *Excoecaria agallocha* are the dominant species in the dense forests while *Acanthus ilicifolius*, *Sueada Maritima*, *Sueada mudifora* and *Salicornia brachiata* are commonly found in degraded areas and elevated places respectively. GIS analysis indicated that the estimated 14960 ha of mangroves in 1987 includes mangroves in reserve forests and those in private lands. Of these, 13364 ha mangrove had remained unchanged until 2006. This may be due to the dense mangrove vegetation cover without any human interference.

Mangrove of 1596 ha were converted to other categories such as aquaculture and mudflats after 2006. The aquaculture farms have grown to an extent of 5869 ha. Aquaculture farms of 762 ha (13 %) have been developed outside the reserve forest boundary (Fig.7 D) in earlier mangroves areas, but owned by private people.

The study indicated that the reserve forest mangrove area was not used for aquaculture development. Most of the aquaculture development has taken place in the private owned areas outside reserve forest.

Development of methodology for the estimation of aquaculture farms in larger area using remote sensing techniques

Delineation of brackishwater aquaculture farms by automated classification is difficult and may not be accurate as the digital number values of shallow water bodies and aquaculture farms were not found to vary much. Hence, there was a need for the methodology to delineate aquaculture farms automatically so that it can be applied for larger areas in less time.

Methodology was earlier developed using high resolution (4 m) multi spectral IKONOS data to delineate aquaculture farms. This methodology of mapping water class as vector layer and removing water class from the satellite images using image processing model was applied to IRS P6 LISS III data of 23.5 m resolution. LISS III data was used to assess the possibility of delineation capacity compared to high resolution data. The LISS III data and IKONOS data were merged together (Fig.8) to assess the capability of different resolution in delineating aquaculture farms. The images were selected in such a way that it consists of water class, aquaculture farms and agriculture. The vector layer was created for water bodies by digitizing water class features in the digital image. The model was developed and applied to mask the water classes from the image. The masking of water layer was carried out in the digital image by applying different function through ERDAS Imagine 9.1. The digital image without water class was obtained and the supervised classification was applied to delineate different land use pattern. From this output, aquaculture ponds were not distinct and merged with other classes. This is mainly due to the low resolution of data in which the classes are not separable automatically. Using this methodology, the automatic delineation of aquaculture farms was possible only with high resolution data. Visual digitization can be used to delineate aquaculture farms using low resolution data.

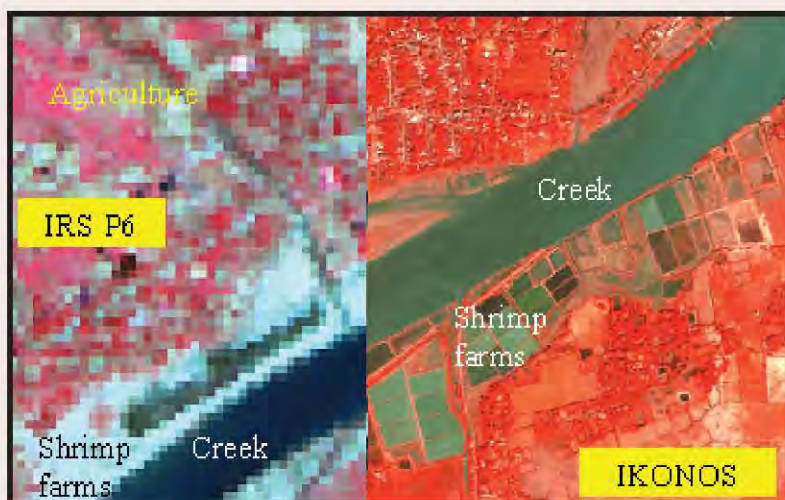


Fig. 8. Comparison of low resolution data (IRS P6) with high resolution data (IKONOS)

Delineation of aquaculture farms using image processing techniques have given better results in high resolution data. Considering the cost and availability involved in the high resolution data, it can be applied to studies, which demands very high accuracy information.

Impact of shrimp farming on coastal aquifer

To assess the impact of shrimp farming on salinisation of coastal aquifer, the brackishwater shrimp farming area in Cuddalore District was selected. Two crops were undertaken by the farmers from February to June and August to December. The total area developed for shrimp farming in 2008 was 400 ha under two clusters in

Chidambaram block and one in Cuddalore block. About 70% of the farms were less than 2 ha. The groundwater samples were collected from identified locations ranging from 50 m to 2 km from the shrimp farms during June 2008 and January 2009. The groundwater samples were analysed for pH, electrical conductivity (EC), total dissolved solids (TDS) and chloride ion content. The pH ranged between 7.0 to 7.7. The EC and the TDS value varied between 0.77 to 2.65 dS/m and 530 to 1870 mg/l respectively. The chloride ion in the shallow aquifer was found in the range of 93 to 733 mg/l. The average value of the parameter are depicted in Fig. 9.

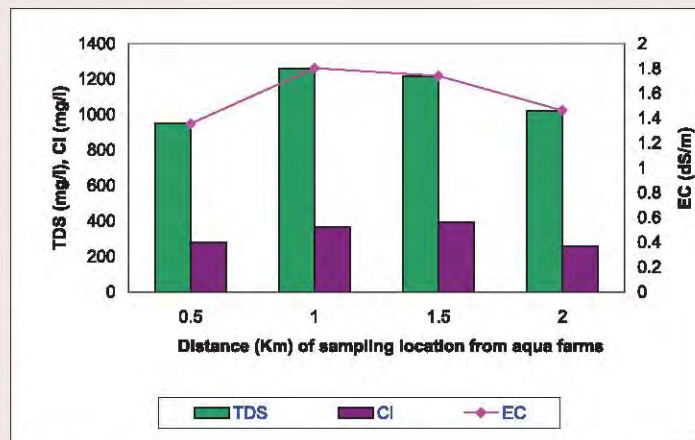


Fig. 9. Water quality trend in shallow aquifer as a function of distance from shrimp farm

To assess the spatial spread of salinization, the cadastral map and the block level map from Land and Survey Records/ Taluk Office were used. The location of the shrimp farms along with their survey numbers were identified and same has been digitized. The village boundary and other details were also digitized in the scale 1: 5000. The farm location, the name of the owner, the farm area etc. and other information has been incorporated and a spatial data base has been developed. The spatial analysis carried out so far did not reveal any pattern of salinisation and further studies are in progress.

FINFISH CULTURE DIVISION

Title of the project Seed production technology for commercially important brackishwater fishes

Principal Investigator Dr. A.R. Thirunavukkarasu

Location of the project Chennai

Co-Investigators Dr.C.P.Rangaswamy, Dr.M.Natarajan, Dr.P.Shiranee, Dr.M.Kailasam, Dr.J.K.Sundaray, Dr.N.Kalaimani, Dr.Krishna Sukumaran, Dr.K.Ambasankar and Shri G.Biswas

Broodstock development and captive maturation of seabass

An impressive number of broodstock (120 nos.) of Asian seabass *Lates calcarifer* which includes F_1 , F_2 , F_3 and F_4 generations developed over the years is being maintained in three 100 t RCC tanks @ 1.0 kg/m^3 . Feeding, water quality and health management like parasitic control were carried out following the protocols standardized over the years. Matured males with oozing milt were noticed from April 2008 and matured females with mean oocyte diameter of above $450 \mu\text{m}$ from June 2008. F_4 generation fishes were in the size of 2.0 kg. Mature male and female fishes from RCC holding tanks were selected for breeding trials from March to October 2008, when the salinity ranged from 27-32 ppt. From the 100 t RCC outdoor broodstock tanks, brood fishes were shifted to 10 t circular broodstock tanks in the re-circulation facility and maintained the biomass @ 10.0 kg/m^3 . In the

outdoor 100 t broodstock tanks, no mature fish were observed during November 2008. However, broodstock were maintained within the recirculation facility during the off season (November to March) to ensure the availability of mature fishes. Successful spawning and hatching were observed even at 17 ppt salinity. During the initial years, the minimum salinity requirement for successful spawning was 27 ppt and resorption of ovary occurred in lower salinities. However, over the years, salinity requirement for maturation has come down and successful spawning occurred even at 14 ppt (during November – December), indicating that seabass can be matured by domestication and following improved broodstock management protocols even in lower salinities.

In order to explore the possibility of reducing the requirements of male broodstock and using cryopreserved milt for large scale larval production, trials were carried out for standardizing the protocol for cryopreservation of *L. calcarifer* milt. Cryodiluents tested were 5% sucrose with 20% glycerol and or 10% DMSO or modified Fish Ringer with 20% glycerol with a two stage freezing. Sea water of the activating solution was used. Based on post thaw percentage of motile spermatozoa, vigor of motility and duration of active sperm movement, 5% sucrose with 20% glycerol was found to be relatively better cryodiluent.

Spawning and larval rearing of seabass

A total of 39 spawnings (24 natural; 15 induced) could be achieved. In natural spawning, number of eggs varied from 0.05 to 12 lakh eggs/spawning. Average fertilization rate recorded was 65% and in some cases there was no fertilization. In the case of induced spawning, the number of eggs varied from 0.15 to 6.0 lakhs/spawning with average fertilization rate of 68%.

The hatching and larval rearing were carried out following the protocols standardized over the earlier years. In larval rearing upto 25 days, the survival rate varied from 2 to 56% with average of 32%, compared to the 24.4% in the previous year. This could be attributed to improved hatchery management strategies. A total of 4.87 lakhs fry were produced, of which 2.0 lakh fry were obtained in the months of December 2008 and January 2009.



Larval rearing tank of seabass with skimmer



Seabass larval rearing undertaken by a private hatchery

Larval rearing technology under controlled conditions, standardized by CIBA was validated in the facility of an entrepreneur, M/s Periyar Hatchery Marakkanam. Survival rate of 58% was achieved in the larval rearing phase. This success indicated that hatcheries meant for shrimp/scampi and mudcrabs can be converted as seabass

hatcheries with required modification. The demand from farmers for hatchery reared seabass seed is increasing and no private seabass hatchery has been set up so far. The difficulty of converting shrimp hatcheries for seabass seed production units is directly related to broodstock availability. However, it is possible that the existing shrimp hatcheries can take up the rearing of newly hatched larvae (hatchlings) and early fry (10-15 day old) produced by CIBA. These can be reared to fry of 1.0 cm size in the hatchery itself as first phase of rearing with live feed rotifer and *Artemia* nauplii. During the second phase of rearing, the hatcheries which are technically competent for rearing of 15 day old early fry to 35 day old fry, could carry out the same in the hatchery by feeding *Artemia* nauplii/weaning formulated diet and then sell them to farmers. If more private shrimp hatcheries come up to adopt the seed production technology developed by CIBA (without having to maintain broodstocks), then the total output from CIBA seabass hatchery can be considerably enhanced.

Nursery rearing of seabass

Nursery rearing of seabass in the hatchery facility was validated in private hatcheries following the protocols developed by CIBA. Fry of 1.0 cm size were reared to 3.0 cm with 90% survival rate.

Nursery rearing was successfully demonstrated in a farmer's site in Peddapallekurupalam, near Bapatla in Andhra Pradesh in hapas (n=60) installed in a 1.0 ha pond stocked @ 750 nos./m³ and achieved 90% survival rate after three weeks rearing by feeding initially with artificial diet and later with minced fish meat.

At KRC, nursery rearing of seabass fry (26±0.3 mm/ 204±4.6 mg) was performed in 12 double-layered mosquito net hapas in triplicate (1.2 x 1 x 1 m) with four different feeding frequencies (1,2,3 and 4 times/ day). Fry were fed with imported larval feed @ 10-8% body weight daily for 35 days. Of the feeding frequencies tested, feeding three times daily has resulted in maximum growth (46±0.3 mm/ 1204±4.6 mg), survival (76±4.2%) and better feed conversion (2.2±0.12). Based on the present and earlier experiments as well as the follow up of the nursery practices in farmer's sites, it is found that better survival and faster growth are dependent on frequent feeding, grading and ensuring free flow of water in the hapas.

Controlled breeding of grey mullet *Mugil cephalus*

Presently a total of 48 males and 73 adult females are being maintained along with 70 pond reared juveniles in two RCC tanks at Muttukadu. Juveniles from the successful spawning in 2007, were reared in indoor cement tanks and on reaching 250 – 300 g size, the four surviving juveniles were tagged with Passive Integrated Transponder (PIT) and transferred to outdoor broodstock tank.



Hatchery bred mullet juvenile

Fifty three *M. cephalus* broodstock were tagged with PIT tags for individual identification. Feeding, water quality management and parasitic control were based on protocols standardized over the years. A total of 11 maturing non-oozing males were implanted in mid September 2008 with α -methyl testosterone (MT) pellets in the dorsal musculature. Thereafter spermiation was checked at regular intervals and 75 to 80 % of the captive males were freely oozing milt during November and December. Oozing males were recorded till January 2009. Starting from September 2008, booster doses of carp pituitary extract (5 mg/kg) were administered intramuscularly for maturing females to sustain ovarian development and these females were catheterized and checked for ova development. Vitellogenic ova were observed from mid October to November (227 – 496 μ). By the end of November and early December,

30 % of the captive females attained advanced stages of maturity and one female attained ova diameter of 608 μ which is the maximum recorded in the captive stocks at Muttukadu. Eight induced breeding trials were conducted using three sets of females (Table 4) having ova diameters from 422 to 609 μ . Various hormone protocols were tested based on the initial ova diameter of female spawner; single or split hormonal doses, with dopamine inhibitor (Table.4). One female spawned spontaneously after hormone induction but males did not respond, resulting in unfertilized eggs. Fecundity was 6 lakhs and the ovulated egg size was 828 μ . Stripping of the remaining eggs and dry fertilization was not successful. Based on the earlier and present trial it has been decided that in future only stripping of eggs will be tried. In case of non synchronized spawning, cryopreserved milt will be used. Adopting the earlier developed protocols, milt from MT implanted and non-treated captive males were collected and cryopreserved.

Table. 4. Hormone induction protocols adopted for induced breeding of *Mugil cephalus*

Set	Female spawner weight (g)	Initial ova diameter (μ)	Carp Pituitary extract (mg/kg)	Resolving hormone		Remarks
				LHRHa (μ g/kg)	Metoclopramide (mg/kg)	
I	1530	609	20	200	1.0	No spawning
	2000	538	20	200	1.0	Release of calcium deposits and bulging anterior part of the abdomen
II	1880	510	20	100	0.5	Spontaneous spawning 21 h after resolving hormone injection
	1430	536	20	100	0.5	No spawning
	1390	522	20	100	0.5	No spawning
	1450	423	20	100	0.5	Resolving dosage given for 2 days. No spawning
III	1400	422	10	-	-	Priming dosage given for 4 days. No improvement in ova diameter.
	1510	481	10	-	-	Priming dosage given for 4 days. No improvement in ova diameter.

Broodstock development and induced breeding of milkfish *Chanos chanos* and Andaman tilapia *Oreochromis urolepis*

To achieve diversification in brackishwater aquaculture, other than seabass and mullet, CIBA is working on two more finfish species, milkfish *Chanos chanos* and Andaman tilapia *Oreochromis urolepis*. Broodstock of milk fish has been developed from 2004 onwards and four year old stock (32 nos.) are maintained in the holding facilities. Broodstock were fed with formulated feed. Maturation of male milk fish with oozing milt was observed in the captive broodstock for a prolonged period from April 2008 – February 2009. This is reported for the first time in India. In the previous year, the milting was observed only for a very short duration. On regular screening no ovarian development was observed.



Milkfish broodstock being screened to check ovarian development

The Andaman tilapia *Oreochromis urolepis* is being evaluated as a candidate species for culture in abandoned shrimp ponds and as a first step seed production and growth comparison with established exotic *O. mossambicus* was carried out. A total of 49 *O. urolepis* (26-38 g) with the mean weight of 32 g were brought from Andamans. Fishes were stocked in 10 t FRP tank and fed with formulated commercial feed daily @ 3-5 % body weight. Females (2-120 g) were able to breed almost every month and growth rate recorded was only 6% higher than the *O. mossambicus*. The results are not encouraging and few more trials are planned in order to evaluate *O. urolepis* as a candidate species for diversification.

Broodstock development and induced breeding of moon fish and spotted scat

The development of seed production technology for two brackishwater ornamental fish species, moon fish *Monodactylus argenteus* and Spotted scat *Scatophagus argus* is being attempted. A total of 10 nos of *M. argenteus* are being maintained in 500 l FRP tanks. In the coming year the broodstock number will be increased.

A stock of 50 nos scats *S. argus* in the size range of 35- 162 g was maintained in RCC tanks, FRP tanks and hapas fixed in pond. Fishes were fed with formulated commercial feed daily @ 3-5% body weight. In the RCC tanks salinity was maintained between 17 to 25 ppt. Parasitic infection mainly by *Caligus spp* was noticed and sudden dip in fresh water was found to be effective to get rid of parasites from the body surface. Scats of 47 to 68 g were found to be males with oozing milt. One male released 0.05 to 0.1 ml milt, which is milky and watery and very active sperm motility could be noticed under the microscope. Three females weighing 132 to 162 g showed mean oocytes diameter in the range of 240-436 μm . Two female fishes (162 and 157 g) with mean oocyte diameter (436 and 396 μm) were selected for induction of spawning and administered priming dose of HCG @ 1000 IU/kg body weight which was followed by a resolving dose of LHRHa @ 100 $\mu\text{g/kg}$ body weight, 24 hrs later. After the administration of hormones, two males (of which one was oozing) and one female were maintained together in 400 l spawning tank in 22 ppt salinity. The water temperature varied from 26.5 to 29.0°C. The fish spawned 48 h after receiving the resolving dose. There was no fertilization, since the male did not respond. The spawned egg had a mean oocyte diameter of $770 \pm 8 \mu\text{m}$. Attempts will be made to strengthen the broodstock in order to get more mature fishes under captivity and induced breeding trials will be carried out in different salinities.

Title of the project Culture of commercially important brackishwater fishes

Principal Investigator Dr. M. Natarajan

Location of the project Chennai and Kakdwip

Co-Investigators Dr.A.R.Thirunavukkarasu, Dr.C.P.Rangaswamy, Dr.P.Shiranee,
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Polyculture of Asian seabass in farmers' pond

In terms of species with which seabass is grown under polyculture and the feeding protocols followed, farmers are making their own modifications. Polyculture of seabass with carps and tilapia was carried out by a farmer. Hatchery produced seabass seed were nursery reared to 60-80 g by the farmer in Ganapapuram, Andhra Pradesh. A total of 1200 nursery reared fishes were stocked in a 1.2 ha pond. Feeding was done with trash fish like tilapia and after 320 days culture period, 90.25% survival was achieved with recovery of 1083 seabass along with 1450, 70 and 576 nos of rohu, catla and tilapia respectively. Total yield of 3120 kg /ha with gross profit of Rs.2.35 lakhs was achieved.



Seabass harvest from the farmer pond in Ganapapuram, Andhra Pradesh

Grow-out pond culture technology of *Mugil cephalus* and *Chanos chanos*

Polyculture of mullets, *M. cephalus* and shrimps, *M. japonicus* was conducted at Muttukadu. *M. cephalus* fingerlings (12 g / 11 cm) stocked at low density of 1600 nos./ha along with kuruma shrimp. Though the production achieved was low due to low stocking density, the results (Table 5) indicate that *M. japonicus* performs better under polyculture with *M. cephalus*.

Table 5. Comparison of culture of *Marsupenaeus japonicus* singly and in combination with *Mugil cephalus*

Parameters	Monoculture	Polyculture	
	<i>M. japonicus</i>	<i>M. japonicus</i>	<i>M. cephalus</i>
Survival (%)	31	43	100
Average body weight at harvest (g)	11.26	9.55	108.3
Production (kg/ha)	361.8	506.3	173.0

Polyculture trials of *M. cephalus* with either Indian major carps or tilapia were conducted in two backyard ponds (0.07 and 0.135 ha) of farmers at Kakdwip, West Bengal. At the end of 11 month culture, with carps the final yield was 351 kg/ha, out of which 61 % was contributed by mullets (24.2 cm/156.2 g). With tilapia the total yield was 417 kg/ha with 83% of the harvest coming from mullets (27.5 cm/213 g). The total income obtained per hectare from mullet-carp culture was Rs.34,000 and Rs.45,000 from mullet-tilapia farming. Mullet being a relatively high value food fish is highly suitable for polyculture using low cost inputs and even at low salinity conditions. Further its bottom browsing activity might improve the pond conditions, which is advantageous for shrimp farming.

Nursery rearing of wild collected milkfish fry (30.38 ± 2.46 mm/ 0.2 ± 0.04 g) was carried out in a 0.09 ha pond @ 35,500/ha. The fry were fed daily with powder feed mixture prepared from wheat flour, fish meal, mustard oil cake, rice bran, soybean meal supplemented with vitamin-mineral premix at 5% body weight. In 35-days of rearing the fingerlings grew to 8.13 ± 1.38 g with 90.63% survival. Nursery rearing is an important step to produce milk fish fingerlings for grow-out culture.

Grow-out culture of *Etroplus suratensis*

Monoculture of pearlspot *E. suratensis* (36.7 mm/1.2 g) in a tide fed pond at KRC of CIBA yielded a production of 455.8 kg/ha. The average size at harvest was 43 ± 6.1 g (105 ± 21.1 mm) with 70.7% survival in 240 days of culture. *E. suratensis* seed collected from various sites of Kerala were transported to Kakdwip and 150 seed were released in a pond to raise them as a new stock. In 200 days, they have attained average size of 14.2 cm/87 g.

Polyculture of pearlspot undertaken in three farmer's backyard ponds in combination with Indian major carps yielded total production of 1080, 1666 and 2048 kg/ha. The fishes attained size of 126 mm/45.4 g, 125 mm/48.5 g and 128 mm/50.6 g respectively in 14 months culture. The contribution of pearlspot in the total harvest ranged between 4.8 to 11.2%. The trial indicated that pearlspot is suitable for polyculture with carps.

AQUATIC ANIMAL HEALTH AND ENVIRONMENT DIVISION

Title of the project **Investigations on epidemiology of infectious diseases of fish and shellfish and development of diagnostics and prophylactics**

Principal Investigator Dr. T.C.Santiago

Location of the project Chennai and Kochi

Co-Investigators

CIBA Dr.N.Kalaimani, Dr.K.P.Jithendran, Dr.S.V.Alavandi, Dr.M.Poornima, Dr.R.Ananda Raja, Dr.M.Shashi Shekhar, Dr.Ezhil Praveena and Dr.S.Kannappan

CIFT Dr.M.K.Mukundan and Dr.K.Ashok Kumar

Genotyping of WSSV

There are reports that variable numbers of tandem repeats (VNTRs) in White Spot Syndrome Virus (WSSV) serve as potential markers for the identification of the virulence factors and can be useful in epidemiological and

virulence studies since in WSSV, VNTRs are located in ORF 75, ORF 94 and ORF 125. In order to verify the above as a beginning, (genotyping based on ORF 94 region) baseline genetic profiles of 30 WSSV isolates from cultured shrimp (7), wild shrimp (2), cultured mudcrab (13), and wild crabs (8) collected from Andhra Pradesh, Tamil Nadu, Kerala and West Bengal were determined. Genotypes with 4 and 9 repeat units (RUs) (amplicon sizes, 640 and 910 bp respectively) were found in cultured crabs and shrimps. Genotypes with 9 and 12 repeats (amplicon sizes 910 and 1072) were in wild shrimp and genotype with 14 repeats (amplicon size 1180 bp) (Fig. 10) in wild crab were noticed. The preliminary study revealed difference in occurrence of genotypes across different geographical locations and difference in genotypes of wild and cultured crab and shrimp species.

Future studies would focus on genotyping of WSSV isolates based on two other ORF regions viz. ORF 75 and ORF 125 in addition to ORF 94 using more sample size.

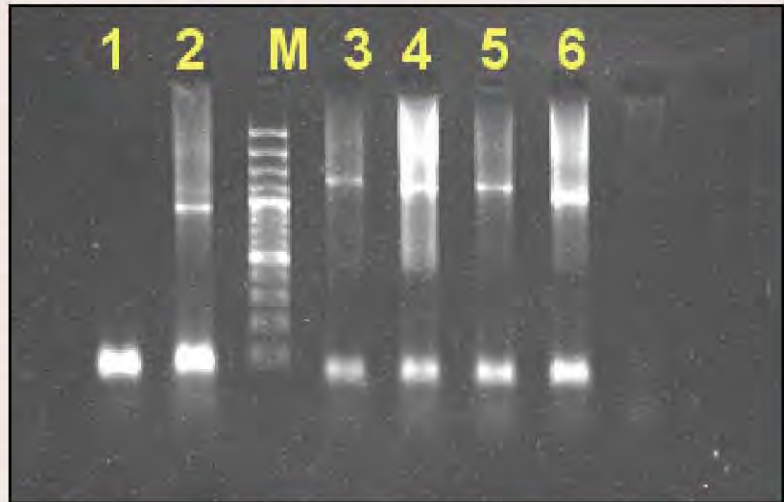


Fig.10. Genotyping of WSSV isolates from wild crabs and shrimp (lane M : 100 base pair marker; lane 1: negative control, lane 2 : positive control [farmed shrimp sample, genotype 9 RUs], lane 3 : WSSV isolates from wild crab [genotype with 14 RUs], lane 4&5 : WSSV isolates from wild shrimp [genotype with 12 RUs], lane 6 : WSSV isolates from wild shrimp [genotype with 9 RUs])

Screening for emerging diseases - Monodon Slow Growth Syndrome (MSGS)

During the last few years unusual retarded growth in cultivated *P. monodon* has been reported by shrimp farmers in Andhra Pradesh (AP) and Tamil Nadu (TN) and the presence of Monodon Slow Growth Syndrome (MSGS) in India was suspected. The preliminary investigation conducted on the MSGS problem reported from 12 farms in



Farmed *P. monodon* showing signs of Monodon Slow Growth Syndrome (MSGS)



Fig.11. Detection of Laem-Singh Virus in MSGS samples (lane 1 : 100 base pair marker, lane 2-5 : sample positive for LSNV, lane 7-8: samples negative for LSNV)

AP, TN and Maharashtra revealed the severe growth retardation and wide size variation after 3–4 months of culture and the farmers experienced economic loss due to decrease in yield. Seven of these farms reported extended culture period and growth retardation. Samples from 22 ponds (50, 25 and 35 samples respectively from AP, TN and Maharashtra) of the farms with the history of extended culture period and growth retardation were screened for Laem-Singh Virus (LSNV) by nested PCR. 83 out (75.45 %) of the 110 samples collected (from farms with slow growth) were found positive for LSNV (Fig. 11) . Screening of samples for co-infection showed positive for IHNV (26%), WSSV (13%) and PvNV (3 %) by PCR. Though LSNV has been reported from India, this is the first report based on an extensive survey. The future research aims at improved diagnostics for detection of LSNV. Although LSNV is implicated in MSGS, its exact etiology needs further confirmation based on metagenomic research approach.

Epidemiology of Iridovirus in fish

Iridoviruses are one of the major threats for the aquaculture industry causing mortality in fishes and amphibians from many of the aquaculture countries. In India, iridovirus infections in fish have not been reported so far. A case of mortality was observed in a commercial seabass cage culture facility in Andhra Pradesh during the summer months of 2008 when the salinity increased from 8 to 14 ppt and temperature from 28 to 32°C. Two lots of live seabass fingerlings brought from different locations for experimental purpose from Andhra Pradesh also suffered severe mortality in the wet laboratory of CIBA at Muttukadu. Sudden onset of disease with dark coloration of the body, preference to settle in the bottom or float at the surface and subsequent gradual mortality occurred over a period of two weeks. Moribund or dead seabass were analysed by histopathology, EM and molecular methods, while the apparently healthy wild fishes were analysed only by molecular methods.



Comparison of healthy (top) and Iridovirus infected (middle and bottom) seabass of same age group



Moribund seabass with highly reduced visceral organs and pale gills

Areas of necrosis or damage in liver and haematopoietic tissues of the spleen were consistent. Enlarged cell nucleus and translucent cytoplasm were consistent in brain tissues of diseased fishes. Electron microscopy of selected suspected brain samples showed numerous hexagonal virus-like particles of 120 nm with multilayered capsid and an electron dense core (Fig. 12).



Fig.12 Electron microscopic photograph showing Iridovirus (120 nm) in brain tissue of sea bass (100000 X)

Optimisation of PCR assay for detection of Iridovirus

A DNA based PCR assay for the detection of both symptomatic and asymptomatic infection was developed based on published primers. The assay produced an amplicon of 250 bp or 1.2 kbp product with two different sets of primers (Fig.13). Surveys conducted in four coastal states (Kerala, Tamil Nadu, Andhra Pradesh and West Bengal) and Union Territory of Puducherry during the year 2008 revealed that iridovirus infection in fish is widely distributed sub-clinically along the east coast of India among many species of brackishwater and marine fishes (Table 6). The expected band was visible only in nested reaction (generating 248 bp product) when used primer set 1 and even in 1st PCR (generating 1.2 kbp product) with primer set 2. Partial sequences of the genome of fish iridovirus from India which showed similarity to other known iridoviruses were submitted to GenBank (FJ485600, FJ655188, FJ655189, FJ655190 and FJ655191). This is the first report describing the existence of iridovirus in clinical and sub-clinical form among farmed and wild marine / brackishwater fishes in India.

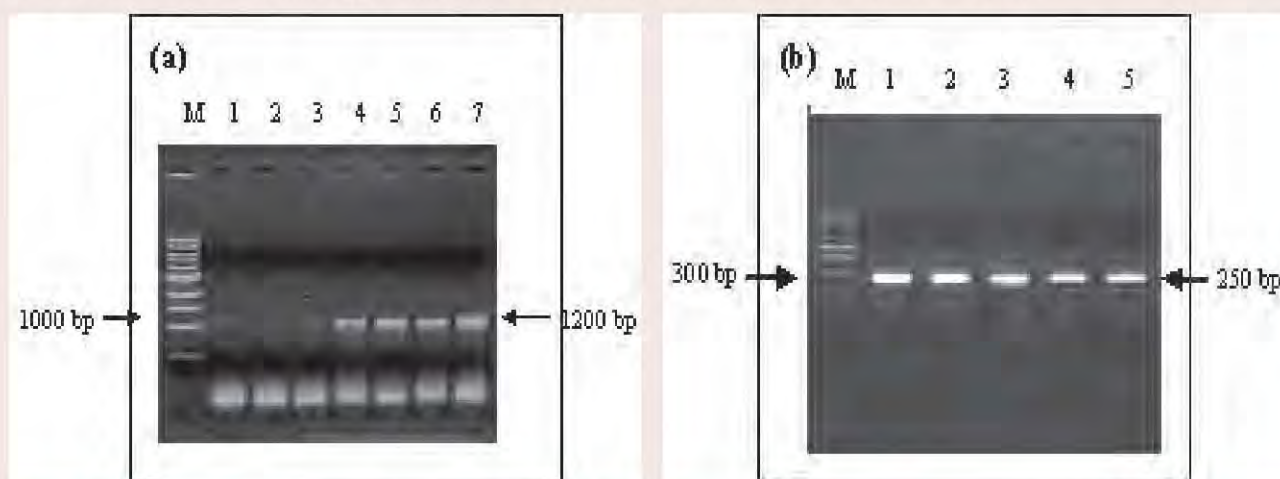


Fig.13. Agarose gel electrophoresis showing Iridovirus specific amplicon of approximately 1200 bp by first step PCR and (b) 250 bp by nested PCR (For a. Lane M: 1kb marker and Lane 1-7: Test fish samples; for b. Lane M: 100 bp ladder and Lane 1-5: Test fish samples).

Table 6. Iridovirus infection in brackishwater fishes from different states

Species	Location (n)	PCR positive fishes (%)
<i>Lates calcarifer</i>	Andhra Pradesh (27)	21 (77)**
	Puducherry (6)	6 (100)**
	West Bengal (3)	0
<i>Mugil cephalus</i>	Kerala (10)	0
	West Bengal (3)	1(33.3)
<i>Chanos chanos</i>	Tamil Nadu (2)	0
	West Bengal (6)	1 (16.6)
Other fishes*	Tamil Nadu (23)	5 (8.7)
	West Bengal (5)	2 (40)
Total	85	36 (42.4)

* *Liza parsia* (2), *Liza tade* (3), *Thriassocles dussumieri* (1), *Therapon jarbua* (4), *Synodus indicus* (8), *Leiognathus splendens* (1), *Amblygaster clupeioides* (3), *Nemipterus* sp. (6)** Observed clinical symptoms

Antioxidant status of LSS infected *Penaeus monodon* fed with and without vitamin C supplementation

With a view to evaluate if vitamin C as an antioxidant would help mitigate LSS in shrimp, antioxidant status of LSS infected and healthy *P. monodon* (130±10mm; 17±2g) have been evaluated after feeding with and without vitamin C supplementation. The experiments were carried out in 100l FRP tanks at 32 ppt salinity with five shrimps in each tank with triplicates. The control shrimps were fed with pellet feed whereas the experimental ones were fed with pellet feed mixed with vitamin C at a fixed ratio @ 5% of total biomass initially for 10 days. After 10 days of feeding, LSS infection was induced and the feeding was continued for 23 days. Then two shrimps were taken from each tank and muscle and hepatopancreas tissues were analysed for antioxidants and antioxidant enzymes activity. The results revealed that vitamin C had significant effect in increasing both the enzymes and antioxidants, indicating the possible use of vitamin C as a therapeutic for LSS.

Development of immunodiagnostic test for detection of WSSV

As, an approach to develop simple and rapid immunodiagnostic test for detection of WSSV, VP 28 gene encoding the envelope protein of white spot syndrome virus was cloned into expression vector in the previous study. The purified recombinant protein of 39.9 kDa size was used for polyclonal antibody production. Specific immune reactivity of the rabbit anti rVP28 antiserum to the recombinant viral antigen was confirmed by western blot. Polyclonal antibodies could detect the purified WSSV VP 28 recombinant protein at 1:20,000 dilution in dot immunoassay. The polyclonal antibodies will be used for detection of WSSV in the infected field samples of shrimps by immuno-dot blot assay.

Detection of WSSV latency in disease resistant shrimps

Shrimps surviving the WSSV challenge test and field outbreak of WSSV have been screened for virus latency in order to study host pathogen interactions at molecular level. Primers based on reported latency associated WSSV ORF's 151, 366 and 427 were used for screening the shrimp samples by PCR for latency. An amplified PCR product of 210 bp associated with ORF 366 was found consistent in seven WSSV challenged and five field WSSV outbreak surviving shrimp samples. These shrimp samples harbouring WSSV latency associated genes would be analysed for genes associated with immune response at host level.

Evaluation of quorum sensing (luminescence) inhibitors from marine resources

With the objective of evaluating marine bacteria and algal compounds for controlling quorum sensing luminescence, *Vibrio harveyi* were cultured with *Tetragenococcus halophilus* (a marine halophilic bacteria) (Fig.14). The later was able to control luminescence process and inhibit *V. harveyi*. Furanone, a halogen based macro algal compound controlled luminescence against post larvae (PL) of *P. monodon* in the tanks. PL of 150 numbers were stocked in plastic tanks (5 l) containing 8 ppt water and 5 ml of 10^9 level of *V. harveyi* was inoculated with 1mg/ml

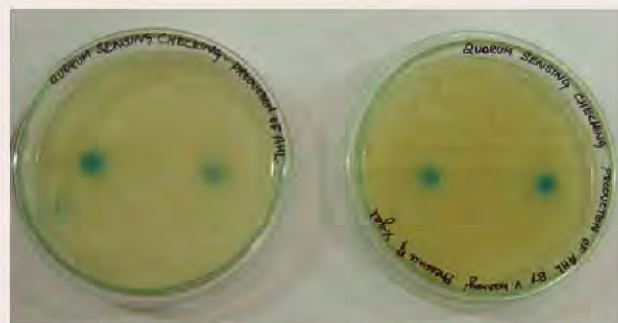


Fig.14. Detection of quorum sensing luminescence by *Vibrio harveyi* in TSA medium

of furanone. PL from the furanone tank survived more than 45 days whereas in control 100% mortality was observed in 10 days. Marine bacteria which has AiiA protein and enzymes for inactivating AHL compounds in *V. harveyi* will be screened further.

Title of the project Shrimp pond soil and water management practices and products that mitigate environmental impact and increase productivity

Principal Investigator Dr.B.P.Gupta

Location of the project Chennai

Co-Investigators Dr.K.K.Krishnani, Dr.M.Muralidhar, Dr.R.Saraswathy, Dr.Sujeet Kumar, Dr.M.Krishnan, Dr.M.Jayanthi, Dr.M.Kailasam, Dr.A.Panigrahi and Dr.K.Ponnusamy

Evaluation of bagasse as biostimulator under field conditions

Accumulation of toxic nitrogenous metabolites in shrimp farming can adversely affect productivity. Development of environment friendly products from agricultural wastes for coastal aquaculture is the objective of this project. In order to determine the efficacy of bagasse as biostimulator to remove ammonia and nitrate, yard experiments were carried out (for 35 days, replicated twice) at Kakdwip Research Centre of CIBA. Significant reduction in ammonia level was observed in treatment groups compared to control. One field trial in a shrimp pond (Kattur, Tamil Nadu) was conducted for three weeks in zero water exchange system with *P. monodon*, with erection of biostimulators prepared from bagasse (Fig.15a,b) using Kadappa stones. The SEM image of biostimulator (Fig.15b) revealed high surface area for biofilm formation and there was no surface deformation during the process of preparation of biostimulator from raw bagasse.

In the three weeks field experiment, decrease in ammonia level from the initial concentration of 0.25 mg/l to 0.12 mg/l (52%) was observed till harvest. Enhanced nitrifying bacterial growth was observed on the bagasse, which has been confirmed by molecular techniques including real-time PCR. The use of bagasse as a biostimulator for removal of ammonia and nitrite has successfully been demonstrated in shrimp aquaculture. This technology is available for adoption by farmers.

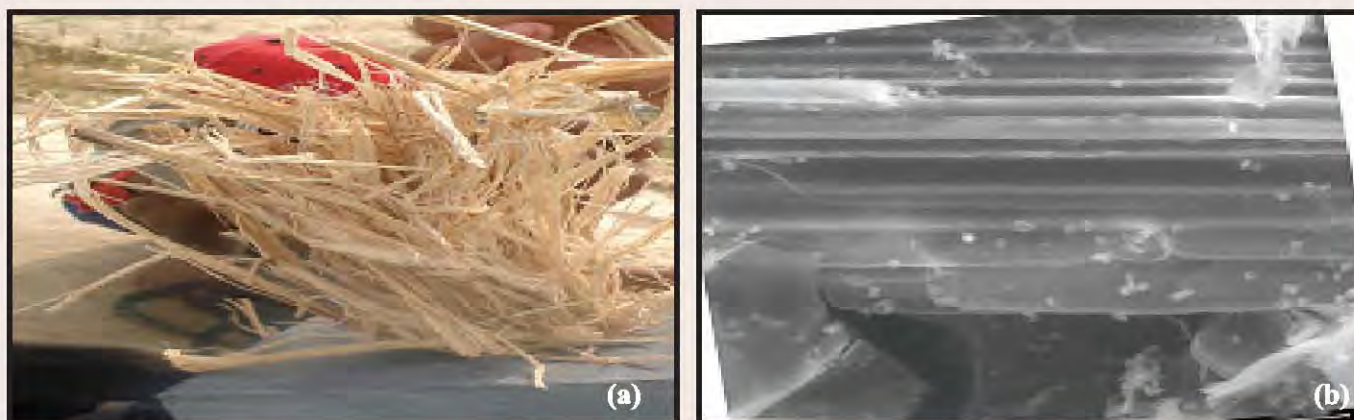


Fig.15. Bagasse used as biostimulator (a). Bagasse on kaddappa stone (b). SEM image of bagasse

Diversity of autotrophic bacteria

Understanding of microbial ecology is required to predict aquatic fluxes and to analyze the fate of metabolites, which helps to optimize bioremedial measures. Nucleic acid methods based on sequencing of clone libraries provide sequence and the phylogenetic information of individual clone. Diversity of chemolithoautotrophic bacteria has been examined in coastal aquaculture by creation of metagenomic clone libraries for functional genes such as ammonia monooxygenase gene (*amoA*), nitrite oxido-reductase (*norB*), nitrous oxide reductase gene (*nosZ*), nitrite reductase (*nirS*) and *nifH* gene (Fig.16). Sequences obtained were released in the GenBank; *amoA* (531bp; EU886370-EU886371), *norB* (412bp; EU839894-EU839895), *nosZ* (710bp; FJ403222), *nirS* (873bp; EU83989), *nifH* (407bp; EU856740-EU856741). The *amoA* gene sequences exhibited 81-82% identity to *Nitrosomonas europaea*, *Nitrosococcus mobilis* and *Nitrosomonas eutropha* which were also similar to particulate methane monooxygenase (*pmoA*) gene sequences. The *norB* genes are closely affiliated with *Nitrobacter* sp. especially *Nitrobacter winogradskyi* and other uncultured beta-proteobacteria available in the GenBank. The levels of nucleotide similarity with uncultured bacteria bearing *norB*, *nirS* and *soxB* ranged from 78-82%, 79-82%, 77-82%, whereas amino acid similarity were 79-87%, 80-88%, 76-86% respectively. A total of 151 of 290 amino acid residues were conserved in *nirS* sequences. The *soxB* gene sequences of four members of sulfur oxidizing bacterial community exhibited identity to *Rhodovulum sulfidophilum*, *Allochromatium vinosum*, *Marinobacter* sp. and *Dinoroseobacter shibae*. The level of conservation of the *soxB* amino acid sequences ranged from 23 to 30%. Based on this study, a molecular tool has been developed for the detection of chemolithoautotrophic bacteria and is being offered to private entrepreneurs for commercialization.

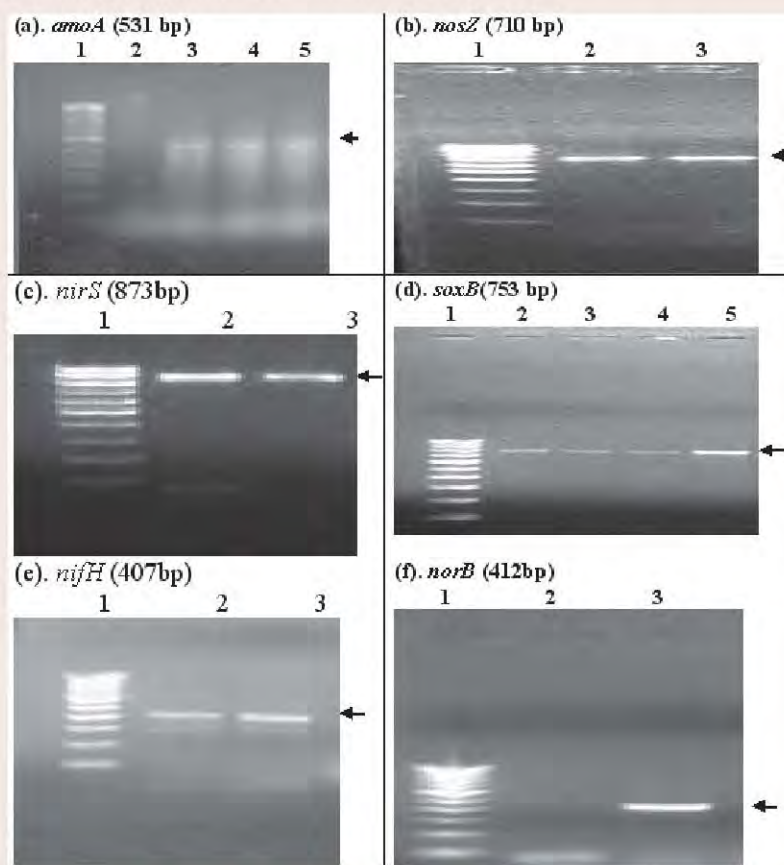


Fig.16. Detection of autotrophic bacteria in different coastal soil samples using PCR amplification of functional genes. (Lane-1: 100-1000 bp Marker, other lanes: functional genes in different coastal soil samples)

Nutrient dynamics during fallow and culture periods in shrimp ponds

To understand the productivity and nutrient dynamics under different stocking densities during culture period and nutrients' transformation during fallow period, studies were continued in 2008 in shrimp farms near Mahabalipuram, Kancheepuram District, Tamil Nadu. During fallow period, as compared to the end of culture period, there was a decrease in organic carbon content (from 0.38 % to 0.24% in five months from January to May, 2008) and increase in available nitrogen (from 109 to 122

ppm) and phosphorus content (from 8.7 ppm to 9.1 ppm) was noticed due to mineralization. On comparison of 2007 and 2008 data, it is observed that mineralization rate increased during 2008, where both scraping and ploughing were carried out as compared to scraping only during 2007. During culture period under high stocking density, organic carbon accumulation was more as compared to fallow period (Fig. 17). Dissolved oxygen, pH and phytoplankton

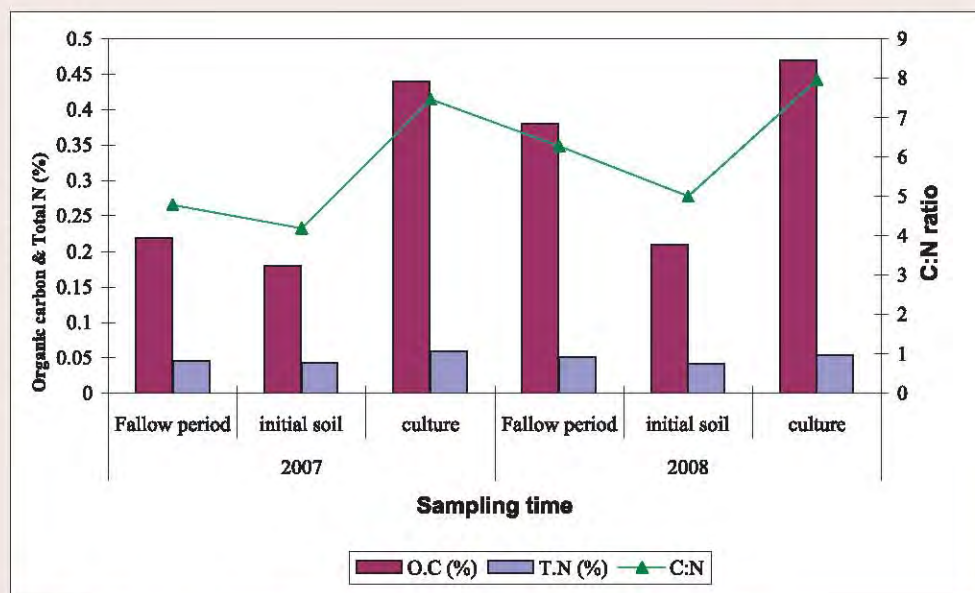


Fig.17. Changes in soil parameters under different culture practices

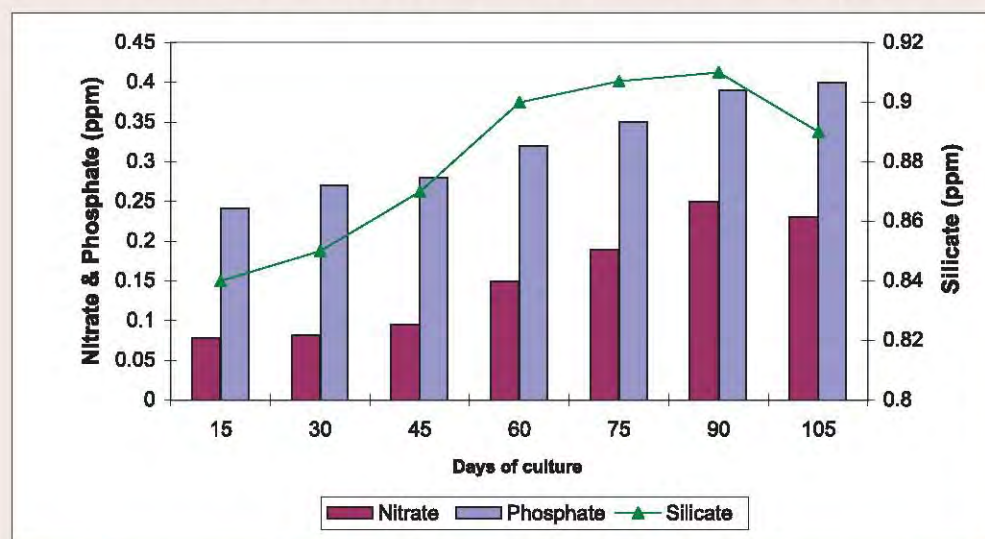


Fig 18. Changes in nutrient concentration in pond water during culture period

to aeration and application of probiotics though the values were more compared to low stocking density ponds.

varied with depth at surface and subsurface levels, during the culture period. Nutrient concentration in water increased with days of culture (Fig. 18) and did not vary with the depth. Silicate concentration was more than the required level for natural productivity. Production obtained for low and high stocking density was 1.6 t/ha and 2.13 t/ha respectively. All the water parameters were within the permissible limits in high stocking density ponds due

Diurnal studies

To understand the diurnal variation in nutrients and chlorophyll at surface and sub-surface levels, water quality parameters were analysed during culture period on a monthly basis. Samples were collected using a modified sub-surface water sampler for four months (August to November, 2008) during culture period as compared to the 5-day continuous study during 2007 to understand the variation in nutrient content, natural productivity and potential stressors during the course of the day and at surface and sub-surface

levels. Nutrient concentrations (nitrate, phosphate and silicate) varied throughout the day (Fig.19). Maximum chlorophyll a content was observed at dawn at surface level. With increase in light intensity during the day, there is an increase in vertical movement of plankters, which resulted in an increase in chlorophyll a content at sub-surface level. It can be concluded that monthly water sampling at different depths will provide vital information to take suitable decisions.

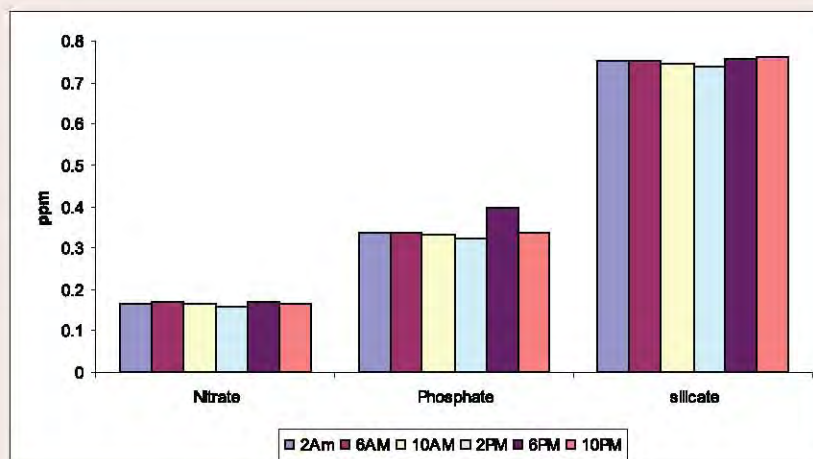


Fig.19. Diurnal variation of nutrients concentration

Estimation of carrying capacity of source water located near mangroves

In order to plan the development of maximum area under shrimp farming that is environmentally compatible and sustainable with respect to a particular water body, the carrying capacity (CC) assessment studies carried out earlier were continued, with a new type of water source body located near mangroves. In CC assessment, both assimilation capacity which is the actual nutrient loading and flushing/ dilution rates and supportive capacities are considered (Table 7). The CC model developed is based on the water quality (actual loading into the water body) and flushing /dilution rates. Studies were initiated during September 2007 on Vellar and Upanar Rivers, located adjacent to Pichavaram mangroves in Tamil Nadu. The monthly collection of water samples from the fixed sampling stations (GPS markings) and discharge points of shrimp farms was continued upto August 2008. The area under culture compared to the developed area during 2008 summer crop (21% on Vellar and 40% on Upanar) was much less than 2007 winter crop (85% on Vellar and 78% on Upanar). The total area developed was determined using remote sensing and GIS tools. Besides nutrients loading (total N and P) from shrimp farms, total suspended solids (TSS) concentration has also been included, in the model from this year for the assessment of CC of water bodies and for estimation of maximum allowable area for shrimp farming. All the parameters were in optimum range prescribed for shrimp farming. Nutrients and TSS loading in the critical month from the cultured area was much less for Vellar River with maximum load for N, P and TSS as 176, 36 and 7710 kg/day respectively compared to carrying capacity of 3903, 952 and 247518 kg/day respectively which is due to good flushing rates. For Upanar River, these were only slightly less with maximum load of N, P and TSS at 73, 12 and 2230 kg/day compared to carrying capacity of 117, 29 and 7440 kg/day respectively. Nitrogen loading was the critical parameter for the CC based recommended area in both the rivers (Fig.20). The recommended area based on the CC was 275 and 96 ha on Vellar and Upanar Rivers, respectively and this is within the actual area that has already been developed (Table 7). The present and previous case studies on CC at different sites revealed that there is no need for sampling every month in the study area with shrimp farming as the only major activity for the assessment of CC and the sampling in the critical months is sufficient after analysing the systems in the study area.

Table 7. Area recommendations based on carrying capacity assessment

Source water	Total area developed (ha)	Area (ha) recommendation based on		Remarks
		Assimilation capacity	Carrying capacity	
Vellar River	275	3030	275	High dilution and flushing rates; but no supportive capacity. No further development is possible.
Upanar River	87	96	96	Further area can be developed based on the guidelines of CAA and CRZ rules.

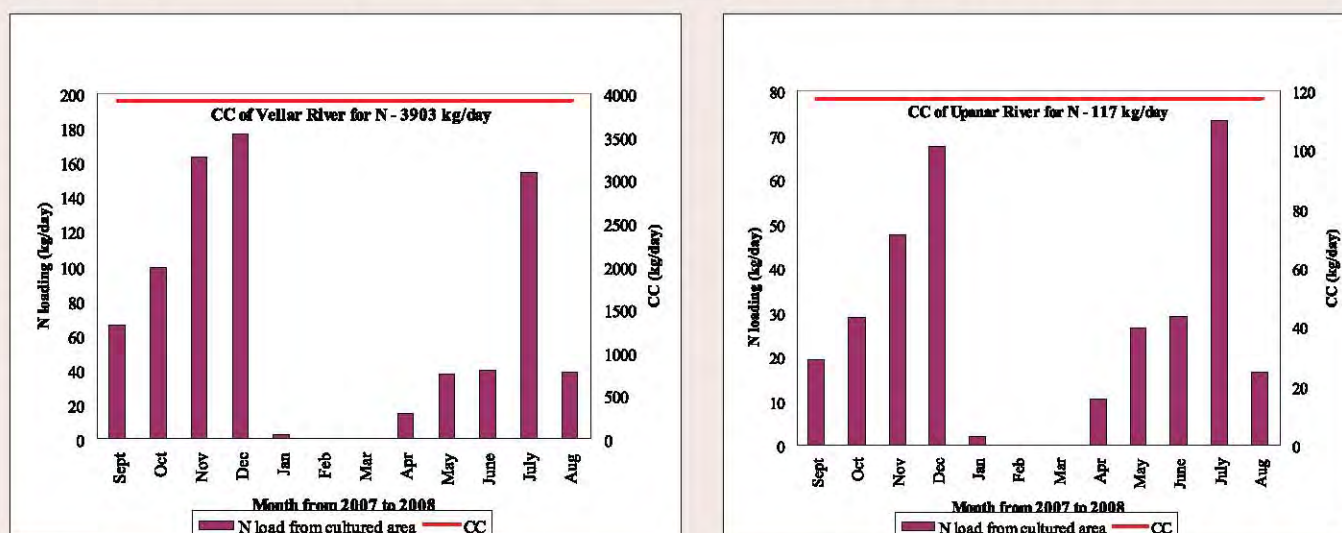


Fig.20 Nitrogen loading from shrimp farms vs. carrying capacity of Vellar and Upanar Rivers (shown by red line)

Impact of shrimp farm discharge water on the water body

Collection and analysis of water samples once in a quarter coinciding with the harvest time from the water body and discharge water samples from the shrimp ponds (GPS markings) were continued during 2008 summer on Paminiyar River, one of the six distributaries of Cauvery near Muthupet mangroves, in order to assess the impact of shrimp farm discharge water on the quality of receiving water body. The area under culture for 2008 summer crop was less compared to previous years. All the parameters in shrimp farm discharge water and receiving water body are in optimum range as per the standards prescribed for the discharge of wastewater.

Understanding the impact of extreme climatic conditions

Communication of weekly weather watch information to ICAR and advisory services to the farmers based on the changes in temperature and rainfall related to brackishwater shrimp aquaculture was continued. This service was hosted on the Institute web site and is being updated every week.

‘Nisha’ Cyclone in November 2008 destroyed 1000 acres of shrimp farms in coastal Tamil Nadu. As per preliminary assessment reported in news, more than 1500 tonnes of mature shrimp was washed away and infrastructure including

farm equipment damaged accounted for a total loss of around 326 million rupees. Many farms were affected with diseases after heavy rains and flooding, due to entry of pathogens into aquaculture systems; pond preparation for the next summer crop was delayed due to high water level in the ponds for a prolonged period.

The assessment of damage to shrimp aquaculture due to extreme climatic events will be continued, in order to create awareness among the policy makers about the extent of damage and to get sufficient relief to aquaculture on par with agriculture. These studies are also being carried out to understand long term impact of climate change on the increasing frequency/ intensity of extreme climatic changes.



Damage to shrimp pond bunds due to Nisha

Impact of probiotics use in shrimp farming

Farmers are investing significant amount of money in probiotics, however their positive impact on increasing production and maintaining water quality has not been established. As a first step to understand the impact on productivity, a questionnaire survey (n=34) was carried out in four districts viz., South 24 Parganas in West Bengal, Nellore and West Godavari in Andhra Pradesh and Tiruvallur in Tamil Nadu with the objective of assessing the proportionate cost of probiotics used to the total cost of production and their use in influencing the productivity of shrimp. Analysis of the survey data revealed that about 82 % of respondents used probiotics only based on the technician's advice and the rest based on fellow farmer's advice. Farmers are applying three types of probiotics viz., soil, water and feed probiotics which cost in the range of Rs. 600 to 1000/ kg, Rs. 170 to 600 / kg and Rs. 800 to 3000 / kg respectively. The average total cost incurred probiotics for by farmers was Rs. 26598 / ha, that including Rs. 12472/- for soil probiotics, Rs. 5741/- for water probiotics and Rs. 8385/- for feed probiotics. The share of probiotics in the total production cost was estimated district wise 5 % in Tiruvallur, 4.3 % in Nellore, 8.9% in West Godavari and 8.8% in 24 South Parganas (Fig.21).

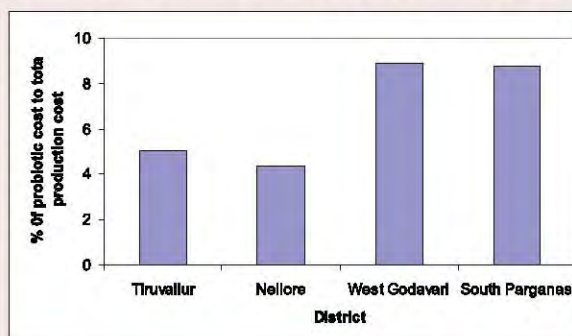


Fig.21. Percentage of probiotics cost to total shrimp production cost in four coastal districts

It was observed that early application of probiotics (<20 days) resulted in significant increase in productivity ($P < 0.01$) without significantly increasing total cost of production. The correlation analysis between production and other factors indicated that all the three probiotics could play a role in increasing the productivity. The correlation coefficient value (r) between cost of water and soil probiotics and productivity was 0.68 and 0.52 respectively compared to r value of 0.91 for feed probiotics. The study has brought out the need for more scientific investigations on the efficiency of water and soil probiotics in increasing productivity and their role in maintaining pond water quality and on shrimp farm discharge water.

NUTRITION, GENETICS AND BIOTECHNOLOGY DIVISION

Title of the project **Development and demonstration of balanced feeds for Asian seabass, crabs and improvement of shrimp feeds**

Principal Investigator Dr. S.A. Ali

Location of the project Chennai and Kakdwip

Co-Investigators Dr.S.Kannappan, Dr.K.Ambasankar, Dr.J.Syama Dayal, Dr.K.Ponnusamy, Dr.Debasis De and Dr.T.K.Ghoshal

Effect of salinity on growth, digestibility, osmolality and nitrogen metabolism in tiger shrimp *Penaeus monodon*

The effect of salinity on growth and nutrient utilization was studied in juvenile tiger shrimp *Penaeus monodon* to develop feeds that are specific for culture under low and high salinity conditions. The experiment was conducted with 2 g size shrimps at six salinities of 3, 10, 20, 30, 40 and 50 ‰. The animals were fed with CIBA–Shrimp feed containing 39% crude protein and 8.6% ether extract throughout the experimental period. The growth cum digestibility study was conducted for 6 weeks. The haemolymph osmolality was measured with the Flaske micro-osmometer model 210 (USA). The experimental results (Table 8) indicate that best growth ($151 \% \pm 3.8$) and FCR were recorded at 20‰ salinity.

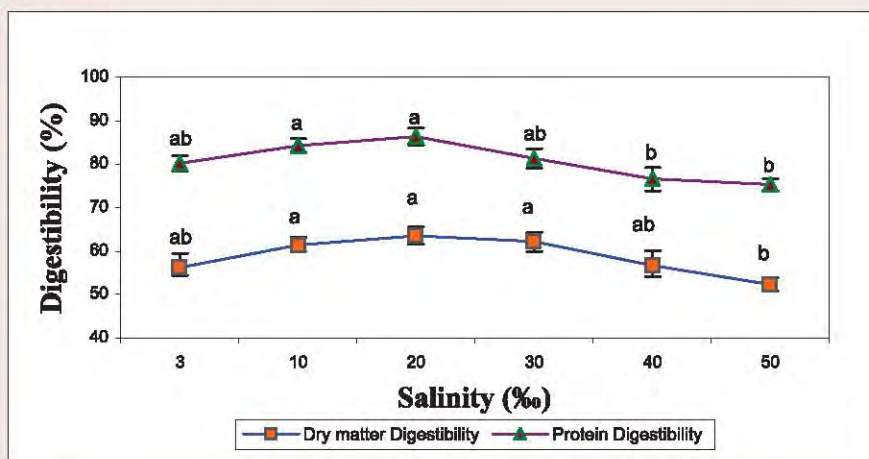


Fig.22 Effect of salinity on dry matter and protein digestibility in *Penaeus monodon* (Means with different superscripts are significantly different)

Table 8. Effect of salinity on weight gain, FCR and survival of *Penaeus monodon* juveniles

	Salinity (‰)					
	3	10	20	30	40	50
Weight gain (%)	108.7 ^b ± 4.59	136.8 ^a ± 3.25	151.3 ^a ± 3.79	138.6 ^a ± 5.25	95.4 ^c ± 3.06	71.3 ^d ± 5.16
FCR	2.1 ^a ± 0.12	2.1 ^a ± 0.07	2.0 ^a ± 0.06	2.3 ^a ± 0.02	2.4 ^a ± 0.33	3.2 ^b ± 0.18
Survival (%)	80.0 ^{ab} ± 3.85	93.3 ^a ± 3.84	91.1 ^{ab} ± 2.22	93. ^a ± 3.85	73.3 ^{bc} ± 7.69	60.0 ^c ± 6.66

Mean values with different superscripts are significantly different in the same row

The dry matter and protein digestibility were also significantly ($P<0.05$) highest at 20‰ compared to other salinities and lowest at 50‰ (Fig. 22). The iso-osmotic point of haemolymph osmolality was between 20-30‰. Hepatopancreas trypsin activity was highest at low salinity (13.48 U/mg protein) compared to high salinity (11.58 U/mg protein). The analysis of haemolymph free amino acids (FAA) indicated that glycine, proline, taurine and alanine were the predominant non essential amino acids and their values were lowest at low salinity and highest at 30 ‰. Among the essential amino acids, arginine was predominant, followed by leucine. In the muscle, non essential amino acids increased with salinity and essential amino acids were highest at 20‰. It was found that salinity has influence on nitrogen metabolism. The haemolymph ammonia N and urea N increased with increase in salinity and urea N increase was more pronounced (0.22 to 2.54 $\mu\text{moles /ml}$). The ammonia N excretion decreased with increase in salinity (14.22 to 3.22 $\mu\text{g /g/h}$). The environmental salinity stress has significantly reduced nutrient reserves in the hepatopancreas as indicated by its high moisture contents. The FAA levels of essential amino acids of haemolymph and muscle are highest at 17-23%. The hepatopancreas moisture levels increased under salinity stress and the muscle moisture level is inversely proportional to the salinity. Based on the results it is concluded that tiger shrimp, *P. monodon* appears to tolerate lower salinity better than higher salinities (50‰).

Effect of dietary supplementation of crystalline amino acid coated with different binders in Tiger shrimp *Penaeus monodon*

Crystalline amino acids were pre-coated with different binders like carboxymethyl cellulose (CMC), gelatin, carragenan, starch, agar and wheat gluten with the objective of supplementing them in shrimp diets to improve amino acid balance. The pre-coated amino acids were incorporated in shrimp feed and were tested with juvenile tiger shrimp (3-4 g). The feeds were tested for leaching of amino acids. The results indicated that all binders significantly reduced leaching of crystalline amino acids, among them, CMC binder coating resulted in the least leaching ($2.96\% \pm 0.18$) when tested for 30 minutes, and maximum leaching of $5.08\% \pm 0.14$ was observed in control with no binder coating. The results of the six week feeding trial with test feeds on juveniles *Penaeus monodon* indicated (Table 9) that CMC, starch, wheat gluten and gelatin are better binders for coating amino acids compared to agar and carrageen and the best growth and FCR were obtained with CMC and starch.

Postprandial free amino acid (FAA) profiles of haemolymph and muscle of shrimp were analyzed. The haemolymph FAA profiles indicated that the supplemented amino acid levels increased within half an hour of feeding. The high levels were maintained upto two hours. The muscle FAA increased after three hours of feeding indicating that the amino acids supplemented in feed are quickly absorbed into the haemolymph.

Table 9. Effect of dietary supplementation of coated amino acids on growth, FCR and survival in *Penaeus monodon* juveniles

Parameters	Control		Gelatin	Carragenan	CMC	Starch	Agar	Wheat gluten
	without amino acids	Un-coated amino acid						
Weight gain (%)	97.2 ^a $\pm$ 3.04	112.1 ^b $\pm$ 1.01	124.87 ^{ce} $\pm$ 1.6	121.2 ^e $\pm$ 2.73	140.9 ^d $\pm$ 0.63	139.8 ^d $\pm$ 0.81	119.6 ^e $\pm$ 2.08	129.6 ^e $\pm$ 0.80
FCR	2.3 ^a $\pm$ 0.012	2.3 ^b $\pm$ 0.010	2.1 ^a $\pm$ 0.006	2.2 ^b $\pm$ 0.010	2.0 ^d $\pm$ 0.012	2.0 ^d $\pm$ 0.006	2.2 ^e $\pm$ 0.015	2.1 ^f $\pm$ 0.006
Survival (%)	84.4 $\pm$ 4.44	86.7 $\pm$ 3.85	82.2 $\pm$ 2.2	88.9 $\pm$ 2.22	88.9 $\pm$ 4.44	82.2 $\pm$ 2.22	80.0 $\pm$ 3.85	91.1 $\pm$ 2.22

Effect of low fish meal shrimp feed on *Penaeus monodon* production, hemolymph and muscle free amino acids in pond grow-out trial

A low fish meal shrimp feed was formulated by replacing 40% fish meal and 28% other marine protein sources with plant protein sources. The ratio of protein contributed from different sources (fish meal: other marine protein sources: plant protein sources) is 38: 35: 27 in control feed and 23: 24: 53 in low fish meal feed. Both the control and low fish meal shrimp feeds were produced at CIBA's Muttukadu feed mill and tested with *P. monodon* in grow-out ponds at KRC at a stocking density of 6 nos./m². Average production of 1289 kg/ha and 1.28 FCR was recorded in ponds fed with lower fish meal (15 %) feed, compared to 1121 kg/ha and 1.36 FCR under control. The shrimp hemolymph and muscle free amino acids are similar in the treatments. The values of arginine and lysine are 89.72, 84.33; 38.79, 42.88 nmoles/ml in haemolymph and 51.23, 56.44; 9.87, 10.23 μ moles/g in muscle, respectively in shrimps fed with low fish meal and control feed. The marginal decrease in production, FCR and hemolymph and muscle free amino acids indicate that the low fish meal shrimp feed developed can be effectively used in *P. monodon* culture.

Evaluating digestibility of potential feed ingredients in mud crab

Feed trials were conducted to determine the apparent digestibility coefficient of dry matter, protein and energy of five ingredients namely sardine fish meal, *acetes* meal, soy flour, wheat and rice with juvenile mudcrab *Scylla tranquebarica* (83.40 $\pm$ 3.43g) for inclusion in mudcrab diet formulations. The apparent digestibility of nutrients in feed ingredients was determined using a reference diet (a standard diet used for feeding crabs) with chromic oxide as external indicator. The diet consisted of 70% reference diet and 30% test ingredient to be tested were used.

The feeding trials were carried out in completely randomized design using six replicates for each treatment. A total of 30 crabs were stocked individually in oval 100 l FRP tanks. All the crabs were first fed with the reference diet for three weeks to determine the digestibility of reference diet and then fed with respective test diets for three weeks for determining the digestibility of test ingredients.

After a week of acclimatisation, faeces were collected by siphoning continuously for 4-5 hours after feeding. The apparent dry matter digestibility coefficient (%) of dry matter (ADMD), crude protein (ACPD) and energy (AED) are given in Table 10.

Apparent energy digestibility was highest in fishmeal and acetes meal (about 95%) among animal ingredients. The plant protein source, soybean meal also had high apparent digestibility (92%). However, the digestibility of rice and wheat was lower than that of the animal ingredients.

Table 10. The apparent digestibility coefficient (%) of dry matter (ADMD), crude protein (ACPD) and energy of test diets in *Scylla tranquebarica*

Test diet	ADMD (%)	ACPD (%)	AED (%)
Sardine fish meal	85.71	91.54	95.43
<i>Acetes</i> meal	91.61	94.47	95.19
Soyabean meal	88.32	95.23	92.17
Wheat flour	75.13	80.12	78.85
Rice flour	78.42	82.49	81.54

Calcium requirement of mud crab

The dietary requirement of calcium for mud crab *Scylla tranquebarica* was determined using juvenile mud crabs of 48.5 $\pm$ 1.79g. Five (A,B,C,D,E) semi purified diets (Table 11) containing 0,1,2,3 and 4% calcium, obtained by supplementing calcium carbonate as the source were prepared. In order to balance the increase in weight due to calcium carbonate, different amounts of cellulose were added. The ingredient composition of experimental diets is given Table 11.

Feeding trials with test diets was carried out by stocking individual crabs in 100 l FRP tanks in a completely randomized design with four replicates for each treatment. Freshly moulted crabs (M^0) were weighed and fed the experimental diets @ 3% body weight in two equally divided doses until they moulted again (M^1) and the inter-moult period in each case was recorded.

Table 11. Ingredient composition ($g \cdot 100g^{-1}$) of five test diets

Ingredient (%)	Test diets and dietary calcium level (%)				
	A	B	C	D	E
	0	1	2	3	4
Casein	45	45	45	45	45
Albumen (egg)	5	5	5	5	5
Gelatin	5	5	5	5	5
Bread flour	20	20	20	20	20
Fish oil	5	5	5	5	5
Lecithin	3	3	3	3	3
Cholesterol	0.5	0.5	0.5	0.5	0.5
Vitamin mixture	0.5	0.5	0.5	0.5	0.5
Mineral mixture without calcium	3	3	3	3	3
Cellulose	11.5	9.3	7.05	4.83	2.6
Guar gum	3	3	3	3	3
Calcium carbonate	0.0	2.5	5.0	7.5	10.0

Crabs fed with 1- 4% calcium containing diets did not show much variation in carapace width and weight gain and lowest weight gain was in diet with 0% calcium (Table 12). FCR among different treatment groups did not vary much and ranged from 4.19 to 4.34. There was no mortality of crabs. Inter-moult period among different treatments ranged from 56-61 days, with maximum in the groups fed with 0% calcium. The results indicate that diets containing 1-4% calcium showed better weight gain and minimal inter-moult duration (61 days to 56 days).

Table 12. Effect of varying levels of dietary calcium on increase in carapace width, final body weight, FCR and inter-moult duration in *Scylla tranquebarica*

Dietary calcium level (%)	Increase in carapace width (%)	Weight gain (%)	FCR	Survival (%)	Intermoult duration (days)
0	22.4±0.58	89.1±4.16	4.24±0.06	100	61±1.58
1	22.7±0.56	106.3±6.85	4.19±0.06	100	58±1.29
2	22.1±0.61	111.4±5.07	4.21±0.07	100	57±1.29
3	21.4±0.65	107.3±6.15	4.34±0.07	100	56±1.31
4	22.9±0.53	110.8±2.95	4.27±0.12	100	57±1.22

Phosphorus requirement in the diet of mud crab

Dietary requirement of phosphorus in the diet of mud crab *Scylla tranquebarica* was determined using juvenile mud crab weighing $51.29 \pm 2.79\text{g}$. Five semi purified diets (A,B,C,D,E) (Table 13) containing 0, 0.5, 1.0, 1.5, 2.0 and 2.5% phosphorus, achieved by using sodium dihydrogen orthophosphate as the source were prepared for feeding the mud crabs. In order to balance the increase in weight due to sodium dihydrogen orthophosphate, cellulose was added in different proportions.

Table 13. Ingredient composition of six test diets used for dietary phosphorus determination in *Scylla tranquebarica*

Ingredient (%)	Diet number & Phosphorus levels (%)					
	A	B	C	D	E	F
	0	0.5	1.0	1.5	2.0	2.5
Casein	43.5	43.5	43.5	43.5	43.5	43.5
Albumen (egg)	5	5	5	5	5	5
Gelatin	5	5	5	5	5	5
Bread flour	20	20	20	20	20	20
Fish oil	5	5	5	5	5	5
Lecithin	3	3	3	3	3	3
Cholesterol	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin mixture	0.5	0.5	0.5	0.5	0.5	0.5
Mineral mixture with out Phosphorus	3	3	3	3	3	3
Cellulose	11.5	9.3	7.05	4.83	2.6	0.37
Guar gum	3	3	3	3	3	3
Monosodium dihydrogen orthophosphate	0	2.2	4.45	6.67	8.90	11.13

Feeding trials with test diets were conducted with individual crabs in 100 l FRP tanks in a completely randomized design with four replicates for each treatment. The crabs were maintained on standard CIBA crab pellet feed until moulting (M^0). The moulted crabs were weighed and fed the experimental diets @ 3% of body weight in two equally divided doses till the next moulting (M^1) when the experiment was terminated.

Table 14. Effect of dietary phosphorus level on carapace width, final body weight, FCR and intermoult duration in *Scylla tranquebarica*

Dietary phosphorus level (%)	Increase in carapace width (%)	Weight gain (%)	FCR	Survival (%)	Intermoult duration (days)
0	19.9 ± 0.56	73.9 ± 5.46	4.56 ± 0.08	100	66 ± 2.88
0.5	22.7 ± 0.62	91.2 ± 5.66	4.34 ± 0.08	100	59 ± 1.68
1.0	24.4 ± 0.61	108.3 ± 4.48	4.12 ± 0.11	100	51 ± 1.79
1.5	25.1 ± 0.58	109.1 ± 4.54	4.23 ± 0.06	100	54 ± 1.73
2.0	26.0 ± 0.63	106.5 ± 4.59	4.19 ± 0.15	100	53 ± 1.70
2.5	25.9 ± 0.55	108.7 ± 4.03	4.24 ± 0.10	100	52 ± 2.12

Experimental results (Table 14) revealed that better weight gain was observed in crabs fed with 1.0% and above phosphorus levels. Crabs fed with diet without phosphorus showed poor weight gain and increase in carapace width. The results indicate that diets containing 1.0-2.5% phosphorus showed better weight gain and increase in carapace width with minimal inter moult period (66 days to 52 days).

Pool trial of grow-out mudcrab feed

Formulated pellet feed developed by CIBA for mud crabs was tested in grow-out ponds at Kakadwip Research Centre. Nursery reared *S. tranquebarica* juveniles were stocked in two ponds (initial body weight 60 ± 6.8 g @ 0.75/m²). In 4 months of culture, the male and female crabs attained an average weight of 305 g and 334 g respectively. An average production of 1116 kg/ha with 51 % survival was obtained. This pellet feed showed good acceptability and obtained the FCR of 2.46.

Assessment of fish meal plants in Karnataka, Kerala and Tamil Nadu

Twelve fish meal plants (8 in Karnataka, 2 in Tamil Nadu and 2 in Kerala) were randomly chosen and data were collected through semi-structured interview schedule. The installed production capacity of fish meal plants varied from 20 to 350 tonnes of raw material handling per day. All the plants produce only two products namely, fish meal and fish oil. Among the different species as raw material source, oil sardine constitutes 95-97 % followed by other species. The maximum availability of oil sardine is during September to January (Rs. 800-850/t) and medium availability is during February to May (Rs.600 to 700/t). Normally, 20 % fish meal and around 5 to 8 % oil are derived from the raw material. The fish meal produced has specifications of 60 % protein, 2 % silica, 10 % moisture and 3 % salt and that of fish oil was 5% free fatty acid, 2 % moisture and impurities and 14% iodine. Fishmeal is sold at Rs 40 to 50 per kg and fish oil at Rs 50-55 per kg.

Title of the project Genetic studies and application of molecular techniques in brackishwater shellfish breeding programmes

Principal Investigator Dr. G. Gopikrishna

Location of the project Chennai

Co-Investigators Dr.C.Gopal, Dr.M.Shashi Shekhar, Dr.S.Kannappan and
Dr. K. Vinay Kumar

This project aimed at exploring the amenability of kuruma shrimp to genetic selection for growth and white spot virus (WSSV) disease resistance using eight wild and two inbred families. Analyses of harvest data revealed that the differences between sexes with respect to harvest weight were highly significant and hence further analysis was done sex-wise. A statistical model having sex as a fixed effect and family as a random effect was run. The corrected means of harvest weight was 29.5 ± 0.68 g in females and 21.8 ± 0.78 g in males. The heritability of harvest weight was estimated to be 0.8 ± 0.36 in males and 0.3 ± 0.23 in females. The estimates indicate that growth as a trait in kuruma shrimp is amenable to selection and substantial response could be obtained. The challenge test carried out on wild and inbred families earlier indicated that there was no difference to WSSV.

From the harvested shrimps, three families were produced. The larviculture in hapas revealed low survival, indicating that hapa rearing may not be a viable proposition for kuruma shrimp. Surviving shrimps from three families were tagged with visible implant elastomer tags and stocked in a pond for monitoring growth. However, in early December, severe attack of WSSV disease affected the families and no survivors could be retrieved.

SOCIAL SCIENCES DIVISION

Title of the project Studies in resource use efficiencies and development strategies in coastal aquaculture

Principal Investigator	Dr. M. Krishnan
Location of the project	Chennai
Co-Investigators	Dr.V.S.Chandrasekaran, Dr.T.Ravisankar, Dr.(Mrs.)B.Shanthi, Dr.(Mrs.)D.Deboral Vimala, Dr.K.Ponnusamy, Dr.M.Kumaran and Mrs.P.Mahalakshmi

Manpower planning for brackishwater fisheries development in Tamil Nadu

Manpower planning is essential for increasing productivity in all agriculture sectors and this is more important for brackishwater aquaculture production in view of the specialized technical knowledge required for implementing brackishwater aquaculture development schemes. The analysis of secondary data from two professional fisheries institutions in Tamil Nadu (Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, Chidambaram and Fisheries College, Thoothukudi) on number of fisheries graduates passing out during 1999 to 2008, and levels of unemployment was carried out. The analysis of annual absorption and size of unemployment of fisheries graduates indicated that 21 graduates are yet to be fully employed in the year 2008. A mathematical model was developed based on year wise output of these institutions and the employment of these graduates over the years to predict the output and levels of unemployment over the years. If the current trends of graduates output and employment generation of Tamil Nadu fishery graduates continues, and taking the year 2005 as base year, it is projected that by 2019-20, 252 fresh fisheries graduates would be available. It is expected that by 2009, no fishery graduate belonging to 2005 batch would be unemployed; the number of unemployed fisheries graduates at the end of 2009 would be those who passed out in the years 2006 and 2007. The study has indicated that unless effective manpower planning is carried out, technical manpower generated will not be effectively utilized.

Information, infrastructure and ICT for aquaculture development

Based on the information needs assessment of users of Village Resource Centre and Village Knowledge Centres of Thangatchimadam in Ramanathapuram District, an e-Learning module on 'Soil and Water Management in Brackishwater Shrimp Aquaculture' was designed and developed in English with flash presenter and navigation controls (Fig.23).

The opinion of 75 users of Village Knowledge Centres, Pudhucherry, on effectiveness of e-learning module on Mud Crab Fattening (*Scylla tranquebarica*), which was developed earlier were obtained by means of a survey questionnaire. The feedback obtained was with respect to 26 broad categories, grouped under nature of contents, attractiveness of presentation, interactivity features, visual design, easy accessibility, user friendliness, incentives to return to the module and potential for field application. The results of the study revealed that the module produced conforms to the requirements by users of VKCs in terms of contents, learning strategies, the learning presentation and its design. Overall 85% of the respondents have the intention to use it in the future, 100% of them would recommend it to other learners.

Research Information System (RIS), an intranet-based application software was developed to store and retrieve the information on all research papers, project proposals and report and special publications of the Central Institute of Brackishwater Aquaculture (CIBA). This intranet-based application software would help in easy retrieval of scientific information generated by any research institution and would help in strengthening the process of Project Monitoring and Evaluation (PME) and in the development of project proposals.

Evaluation of an e - extension aquaculture technology model

Among the few existing agriculture extension models in India, an innovative ICT model- e Sagu Aqua has been implemented in West

Godavari District of Andhra Pradesh for freshwater aquaculture. In order to evaluate the effectiveness of the model as an extension tool, a survey was carried out to evaluate technology transfer modalities, components of the model and information and communication system along with its data strengths and limitations. The survey covered forty seven aqua farmers. The opinion of two fishery experts, four village co-coordinators and one computer programmer was also obtained. The strengths perceived by the respondent were: quick deployment of services during the time of crisis (100 %), accountable advice (100 %), significant reduction of lag period from lab to land (96 %), cost effective methods (94%), vehicle to reach the remote places (43 %), rapid exchange of information among the major stakeholders (40%) were the strengths of the e Sagu model. Limited financial resources and limited coverage of subjects were the major weaknesses as reported by 100% and 56% of the respondents respectively.



Fig. 23. Front page of soil and water management in brackishwater shrimp aquaculture e-learning module

Requirements for organic certification of traditional farms

Organically produced shrimps fetch premium price at international market and also in Indian super markets. MPEDA has a project on certifying the traditional shrimp farms under organic shrimp farming. A survey of 122 traditional farms (60 in Kerala and 62 in West Bengal) was carried out to study the current status of productivity and the present practices adopted that are not compatible with organic farming standards and remunerative for the price offered. The net shrimp yield from traditional farms ranged from 350 to 450 kg/ha which is well within the accepted norms. The usage of wild caught seed in some traditional farms of West Bengal and supplemental feeding with pellet feeds in Kerala which were the major deviations identified and have to be addressed if they are to be declared as organic farms (Table 15).

The reduced income from low average yield of shrimp of 300 to 400 kg/ha is partly compensated by increased price (15% to 25% higher) realized for the lower count per kg produced in these traditional farms when compared with price realization by scientific farms. Traditional shrimp farming can be easily converted into organic farming with suitable modifications of local farming practices.

Profile analysis of aqua consultants

Private aqua consultants play a lead role in providing first line extension services to the farming community. Thirty three independent aqua-consultants were interviewed to categorize them based on their occupational structure and their requirements for capacity building as well as to evolve a mechanism to get ground level feedback from them on regular basis. It was found that 30% of them were full time consultants and 33% of them had their own farms in addition to consultancy. Seventy percent of them were post graduates with M.Sc in Marine Biology/Aquaculture or Fisheries. Most of them (90%) had more than five years of consultancy experience and majority (67%) of them had above five years of pre-consultancy experience in aquaculture as farm technicians and/or an input company representative. They (65%) updated themselves mainly through learning by doing and interaction with fellow consultants and aqua professionals. Mutual sharing of information and experiences through mobile phones (100%), annual workshops or meetings of consultants (70%) and news letters (60%) were the preferred mechanisms of interactions by which research institutions could get field feedback from them on regular basis. Aqua-consultants could be the potential collaborators for research and extension considering their experience, qualification and influence. Therefore, it is suggested that government should initiate measures to register qualified consultants, improve their competency and collaborate with them for on-farm validation of research findings and extension service.

Table 15. Major contravening practices from organic standards in traditional shrimp farms

Sl.No	State	Existing contravening practices (% of farms)	Support required
1	West Bengal	Wild caught seeds (85)	Organically certified hatchery seeds
2.	Kerala	Use of supplementary feeds of non organic nature (70)	Organically certified feeds

Participation of women in brackishwater aquaculture sector

Based on the analysis of data collected on five hundred and seven women farmers in six districts of Tamil Nadu, it was found that women were involved in a wide spectrum of aquaculture activities like aqua business, small scale shrimp processing units, crab exports, crab fattening in cages and pens, crab hatchery, clam collection, shrimp hatchery, fish meal processing, preparation of value added products and seabass farming (Fig. 24). Maximum number of women (178 out of 507) involved in brackishwater aquaculture were observed in Kancheepuram District. In this seven women SHGs are engaged in crab fattening.

In order to understand the nature of ownership and motivation among the women entrepreneurs, twelve case studies were analysed. It was observed that 50 % of the women entrepreneurs had taken aquaculture as traditional occupation with own investment indicating that these women are confident in taking up aquaculture with their own funds. The two major motivating factors were, the desire to take up aquaculture (100%) and the need for economic independence (92%). The three major perceptions with regard to technology adoption by these women entrepreneurs were the possibility of increasing production (100%), potential for increasing income (83%) and the desire to exhibit entrepreneurship (83%). The analysis of the women entrepreneurs in aquaculture indicated that women have potential to take up brackishwater aquaculture as an enterprise with the availability of adequate funds and the support of their family.



Fig. 24 Participation of women in different aquaculture sectors in coastal villages of Tamil Nadu.

KAKDWIP RESEARCH CENTRE

Title of the project **Refinement of traditional brackishwater aquaculture systems for sustainable production of shrimp and fishes**

Principal Investigator Dr. A.Panigrahi

Location of the project Kakdwip

Co-Investigators Dr.T.K.Ghoshal, Dr.Debasis De, Mr.G.Biswas, Dr.R.Ananda Raja, Dr.M.Jayanthi, Dr.M.Kumaran, Dr.R.Saraswathy, Mrs.P.Mahalakshmi, Mrs.Shyne Anand and Dr.Sujeet Kumar

Development of organic farming technology

Organic farming of *P. monodon* was carried out in two ponds, A and B (Table 16), stocked @ 6 nos./m² and for comparison conventional farming was done in two other ponds, C and D (Table 16) with the same stocking density. Low fish meal feed was applied in the organic ponds along with yeast based organic preparations and vermicompost as other organic inputs. The shrimp produced were healthy and free from WSV, IHHNV, YHV and GAV diseases. Substantial gain in the production level (15%) and improvement in size at harvest (10 %) with better FCR (6.57 %) by following organic principles was achieved. By fine tuning last year's organic shrimp farming method same production level with better FCR was achieved with lower stocking density.



Harvest of organic shrimp at KRC



Organic shrimp culture pond

Table 16. Performance of shrimps in organic farming system

Treatment	Pond area (m ²)	Average body weight (g)	Yield (kg)	FCR	Survival (%)	Productivity (kg/ha/crop)	
						Pond	Treatment
Organic	A (1840)	33.12	227	1.31	62.08	1233.7	1289.4 ± 55.65
	B (1000)	32.29	134.5	1.24	69.42	1345	
Conventional	C (1620)	26.90	177.1	1.37	67.74	1093	1120.5 ± 27.50
	D (1000)	32.56	114.8	1.36	58.76	1148	

Microbial dynamics of organic shrimp farming

In order to understand the microbial dynamics of organic shrimp farming, total heterotrophic bacterial and *Vibrio* counts of pond water were estimated throughout the culture period at fortnightly interval (Fig. 25). It was observed that both counts significantly decreased after disinfection and increased towards the progress of the culture. After 135 days of culture, significant reduction in bacterial population was observed. Moreover it revealed that the total heterotrophic bacterial and *Vibrio* counts in ponds fed with low fish meal diet was lesser than the ponds fed with conventional feed throughout the culture. In zero water exchange ponds, it was found that the bacterial load was lesser in probiotic fed ponds throughout the culture than control ponds. From the results obtained, it was concluded that total bacterial population and *Vibrio* count in organic and zero water exchange system was lesser with good production than those of the conventional culture system.

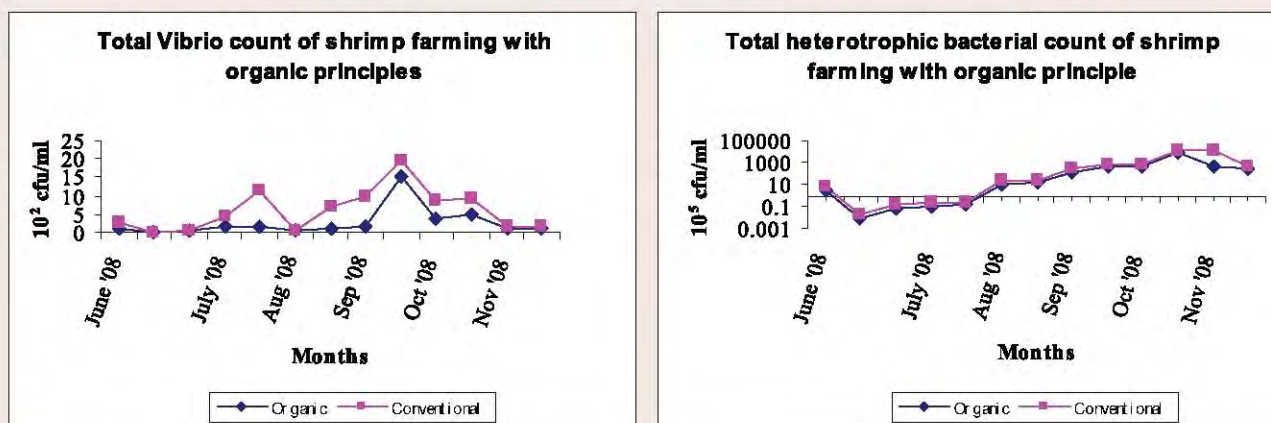


Fig. 25. Total heterotrophic bacterial and *Vibrio* count in organic and conventional ponds

Gross primary productivity in low input organic system

Gross primary productivity (GPP) and phytoplankton diversity in organic shrimp farming and other production systems were studied over the culture period for a better understanding of the phytoplankton dynamics and to manage it for improving productivity. There was a positive relation between water nutrient levels and GPP. Average GPP value in organic ponds was 275 mgC /m³/h. The nutrient input via feed and stocking density affected the phytoplankton density and its composition over culture period. A total of 33 genera of phytoplankton and 4 genera of zooplankton were identified in these shrimp ponds, Bacillariophyceae being the largest group was represented by 14 genera, contributing to 42 % followed by nine *Chlorophyta* genera (27%), seven *Cyanophyta* genera (21%) and dinoflagellates which were the smallest group represented by only two genera (6 %) (Fig. 26).

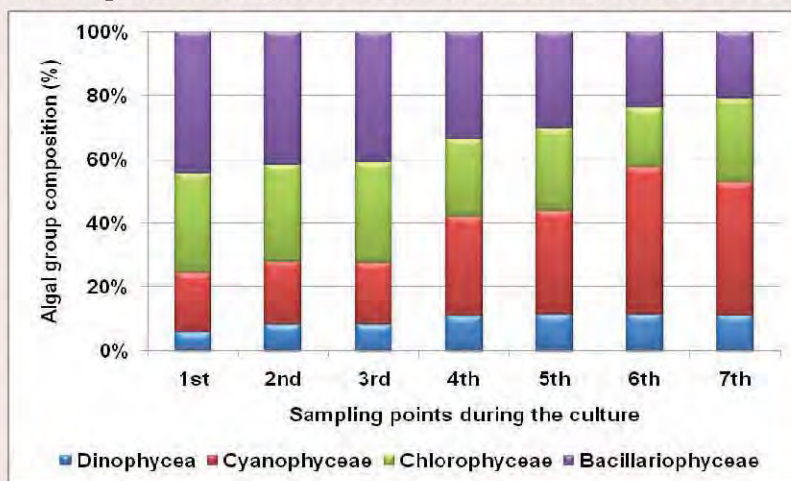


Fig. 26. Percentage of algal classes in organic shrimp pond system

The commonly found phytoplankton species in the ponds were diatom *Navicula sp.*, *Nitzschia sp.*, *Microcystis sp.*, *Anabaena sp.*, filamentous green algae *Chaetomorpha sp.* and *Chlorella sp.* The average plankton density was higher in the low stocking density ponds compared to that of natural bheries. The occurrence of algal bloom was higher in higher stocking biosecured zero water exchange system ponds to that of the low density organic ponds. Algal blooms were not recorded in extensive bheries systems.

Formulation of organic shrimp feeds

Four types of low fish meal (Fish meal-20%, CP-33% and EE-7%) based shrimp diet were prepared with inclusion of soyabean cake, mustard oil cake, sesame cake and azolla in different proportions as vegetable protein source and named as T-I, T-II, T-III and T-IV feeds (Table 17). Feeding experiments were carried out in triplicates for each feed in 100 l tanks containing 20 juvenile *Penaeus monodon* for 45 days. The results showed that all the four feeds were equally effective (Table 17) in terms of growth and FCR.

Table 17. Performance of shrimps with organic feeds

Parameter	T-I	T-II	T-III	T-IV	P value
Initial body weight (g)	1.3 ± 0.02	1.3 ± 0.08	1.3 ± 0.01	1.3 ± 0.05	0.96
Final body weight (g)	2.0 ± 0.01	2.1 ± 0.08	2.1 ± 0.03	2.1 ± 0.04	0.85
Average daily gain (mg)	16.3 ± 0.41	17.9 ± 0.27	17.3 ± 0.71	17.6 ± 0.39	0.19
Specific growth rate (% day ⁻¹)	1.0 ± 0.03	1.1 ± 0.06	1.0 ± 0.04	1.1 ± 0.05	0.46
FCR	2.7 ± 0.02	2.7 ± 0.01	2.7 ± 0.04	2.7 ± 0.05	0.76

Polyculture of brackishwater finfish

Polyculture was conducted in two ponds with two different species combination. The species combination followed in the first group (T-I), was mullet (*Mugil cephalus* - 4500 nos./ha, *Liza tade*-1500 nos./ha, *L. parsia* - 2000 nos./ha) and *Penaeus monodon* (20,000 nos./ha) and in the second group (T-II), *C. chanos* (8000 nos./ha) and *P. monodon* (20,000 nos./ha). Low cost pellet feed prepared from locally available feed ingredients was given as supplementary feed @ 5-2% body weight twice daily. The feed was given in feed trays for fish and broadcasted for shrimp. In the feed tray the quantity was given in two split



Harvested mullets and shrimp from polyculture pond

doses at one hour interval to meet the requirement of the different sizes of the fishes. After 170 days of culture, total biomass production obtained was 687.44 ± 27.64 and 717.08 ± 43.75 kg/ha with FCR of 1.74 ± 0.02 and 1.99 ± 0.25 in T-I and T-II, respectively. Water samples were collected periodically from the polyculture ponds for estimation of bacterial load to understand the best species combination with respect to the total heterotrophic bacterial and *Vibrio* populations. Total heterotrophic bacterial and *Vibrio* count showed an increasing trend in both the treatments with the advancement of culture, however, both the counts were found to be less in treatment II, without any significant effect on the production.

Evaluation of locally available feed ingredients

For formulation of low cost feed for polyculture, yard experiment was conducted to determine the inclusion level of sunflower cake (SFC), deoiled karanja cake (DOKC), mango seed kernel (MSK) and tamarind seed powder (TSP) in diets of *P. monodon* and *M. cephalus* (Table 18). It was found that SFC can be incorporated upto 10 % level in diet of both the species. DOKC can be included at 2.5 % and 7.5 % level in diet of *P. monodon* and *M. cephalus*, respectively, without affecting survival, growth and digestibility. MSK and TSP can be added at 7.5 % and 2.5 % level in diet of both the species, respectively.

Table 18. Effect of different inclusion levels of ingredients in the diet of *Mugil cephalus* and *Penaeus monodon*

Ingredient		<i>M. cephalus</i>			<i>P. monodon</i>		
	%	Wt. gain(g)	FCR	SGR (%)	Wt. gain(g)	FCR	SGR (%)
SFC	0	0.4 ± 0.00	3.9 ± 0.04	3.6 ± 0.07	0.2 ± 0.03	3.4 ± 0.49	3.1 ± 0.44
	5	0.3 ± 0.02	4.1 ± 0.20	3.3 ± 0.06	0.2 ± 0.01	3.8 ± 0.25	2.7 ± 0.10
	10	0.4 ± 0.02	3.7 ± 0.16	3.7 ± 0.17	0.2 ± 0.01	3.8 ± 0.18	2.9 ± 0.14
	15	0.3 ± 0.02	4.7 ± 0.39	3.2 ± 0.19	0.2 ± 0.02	4.2 ± 0.65	2.5 ± 0.26
DOKC	0	1.0 ± 0.20	3.4 ± 0.04	0.8 ± 0.15	0.3 ± 0.00	2.8 ± 0.09	6.1 ± 0.42
	2.5	0.9 ± 0.36	3.8 ± 0.18	0.7 ± 0.27	0.3 ± 0.00	2.7 ± 0.25	5.8 ± 0.43
	5	0.8 ± 0.07	3.6 ± 0.15	0.6 ± 0.07	0.2 ± 0.01	3.2 ± 0.12	5.2 ± 0.25
	7.5	1.4 ± 0.05	3.6 ± 0.07	1.1 ± 0.04	0.2 ± 0.01	3.1 ± 0.51	4.4 ± 0.28
MSK	0	0.5 ± 0.04	3.3 ± 0.17	3.1 ± 0.17	0.3 ± 0.01	3.5 ± 0.19	2.4 ± 0.08
	2.5	0.5 ± 0.06	3.7 ± 0.42	2.8 ± 0.26	0.4 ± 0.08	2.9 ± 0.49	2.6 ± 0.27
	5	0.6 ± 0.04	2.8 ± 0.18	3.4 ± 0.09	0.4 ± 0.03	2.9 ± 0.23	2.7 ± 0.27
	7.5	0.79 ± 0.11	2.1 ± 0.29	4.1 ± 0.41	0.4 ± 0.02	2.5 ± 0.09	2.9 ± 0.07
TSP	0	1.22 ± 0.03	2.3 ± 0.38	3.5 ± 0.13	0.9 ± 0.08	4.9 ± 0.49	3.1 ± 0.20
	2.5	1.25 ± 0.05	2.3 ± 0.09	3.7 ± 0.14	0.9 ± 0.03	4.4 ± 0.39	3.0 ± 0.08
	5	0.81 ± 0.01	3.1 ± 0.10	2.7 ± 0.01	0.7 ± 0.08	5.9 ± 0.71	2.6 ± 0.21
	7.5	0.82 ± 0.07	3.3 ± 0.35	2.7 ± 0.08	0.5 ± 0.04	7.5 ± 0.42	1.9 ± 0.12

Culture practices of traditional brackishwater aquaculture systems vs zero water exchange system

One hundred and ninety farms have been surveyed during 2008-09 in three coastal districts of West Bengal and many aspects of the existing and evolving culture practices were documented along with other socio-economic information. Ninety percent of shrimp farmers of East Midnapur District are practicing zero water exchange system while traditional shrimp culture practices are followed in North 24 Parganas. Both the culture systems are followed in South 24 Parganas District and based on an evaluation of culture practices adopted, a comparison has been given in the Table 19. This is part of the efforts in identifying entry points for improving productivity of these systems. In North 24 Parganas District, majority of farmers residing in the bank of Ichhamati River are practicing paddy-cum-fish culture with fish/shrimp/prawn production of 1325 kg/ha/yr and a profit of Rs.81525 /ha/yr from paddy and fish produce.



Paddy-cum-fish culture

Table.19 Comparison of culture practices of bheries and zero water exchange shrimp monoculture

Parameter	Bheries	Zero water exchange monoculture
Fallow period drying	One month	6 months
Chemicals and probiotics use	Occasionally used	Extensively used
Species cultured	<i>P. monodon</i> , <i>M. rosenbergii</i> , <i>L. calcarifer</i> , <i>O. mossambicus</i> , <i>L. parsia</i> , Indian major carps (IMC), <i>M. cephalus</i> and <i>M. gulio</i>	<i>P. monodon</i>
Stocking density/ m ²	Auto-stocking or 0.03 to 0.45 for different species with IMC at 0.75	15 - 25
Pond size (ha)	0.1 to 100	0.05 to 1
Salinity (ppt)	0-18	3-15
Disease prevalence (%)	Bacterial (44.4), WSD (38.9), Black gill disease (16.7), and LSS (5.6)	Bacterial (15.5), Black gill disease (11.3), WSD (5.6), and LSS (2.8)
Production (t/ha)	1.0 to 1.5	3.0 to 7.0
Production cost (Rs. Per kg)	75/-	180 - 200/-
Av. net income (Rs. Per ha)	56,625/-	1,82,410/-

Disease prevalence in bheries and zero water exchange shrimp monoculture

Since information of disease prevalence in bheries and zero water exchange shrimp monoculture is lacking and for giving management advice, a survey was undertaken. Shrimp samples (15 postlarvae, 16 juveniles and 78 adults) were collected from 34 traditional and 75 semi-intensive shrimp farms. Higher prevalence of bacterial diseases followed by white spot viral disease was found in both systems. All the samples were found to be negative by PCR for IHHNV, YHV and GAV. Among the preserved samples, the shrimp exhibiting gross lesions and PCR II step positive for WSSV were also processed for standard histological examination and photomicrography. Out of 109 samples, only three samples (2.75%) showed typical clinical signs and gross lesions of white spot viral disease. These were PCR I step positive and had led to the failure of crop. Eight samples (7.34%) were only PCR II step positive for WSSV with no failure of the crop. Histopathological changes in the tissues of shrimps with gross lesions were more severe than the same tissues from asymptotically infected shrimps. Those changes were characterized by hypertrophied nuclei with intranuclear inclusion bodies and chromatin margination in gill tissues. Hepatopancreas showed the cowdry-A type-like intranuclear inclusions, cellular disintegration and multifocal necrosis characterized by vacuolization. The WSSV prevalence was estimated to be 20.59% in traditional bheries and 5.33% in zero water exchange system, indicating the lack of biosecurity measures in traditional culture system and reduced practice of stocking WSSV tested seed.

From the organic and traditional culture ponds, shrimp samples were collected at fortnightly intervals and screened. All samples were found negative for viral infections such as WSSV, IHHNV, YHV and GAV.

Documentation of brackishwater culture practices and traditional knowledge of West Bengal

In order to document and analyse the traditional brackishwater culture practices of West Bengal, a relational database management system (RDMS) has been developed. The Aquaculture Database System - Brackishwater (Version 1.0) (ADS - BW) developed is an application software used to create database and search / retrieve information from the database created using ADS – BW (Fig.27). This database system can be used for other culture systems with some modifications and the modified version will be released in the coming year.

The documenting and evaluation of 60 Indigenous Technology Knowledge (ITK) in brackish water farming systems have been completed along with experimental validation of some promising ITKs. A publication on these ITKs is underway and it would be the first of its kind from India.

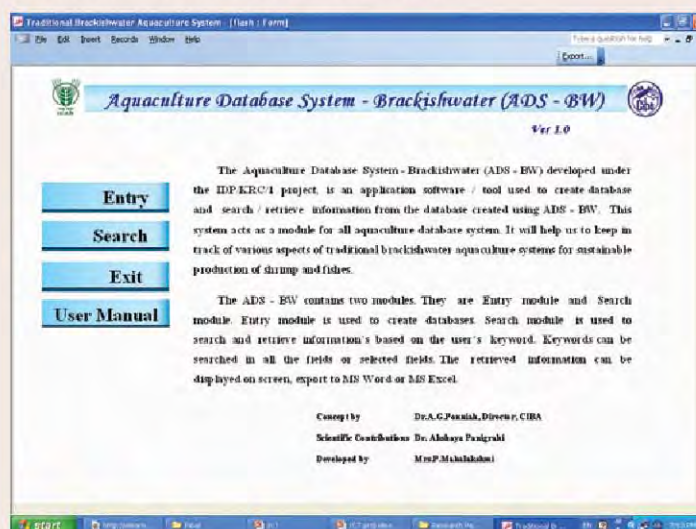


Fig. 27. Main page of the Aquaculture Database System – Brackishwater



Herbal medicinal plants for ITK validation

EXTERNALLY FUNDED PROJECTS

Indo-Norwegian

Title of the project **Genetic improvement of *Penaeus monodon* (tiger shrimp) through selective breeding for growth and white spot disease resistance**

Principal Investigator Dr.P.Ravichandran

Location of the project Chennai

Co-Investigators Dr.G.Gopikrishna, Dr.C.Gopal, Dr.S.M.Pillai, Dr. S.V.Alavandi,
Dr.M.Shashi Shekhar, Dr.C.P.Balasubramanian, Dr.R.Saraswathy and
Dr.S.Kannappan

Maturation of genetic stocks

The tiger shrimp, *P.monodon* tagged during December 2006, were reared in a pond for 14 months and 58 adult broodstock (32 males and 26 females) were collected in February 2008. The average size of females was 110 g and males 75 g. The adult shrimps were shifted to cement tanks, segregated sex wise and maintained. One female matured and spawned 2.25 lakhs eggs and the hatching rate was 55%. Newly moulted females were placed with the selected male for single-pair mating. At the inter-moult stage, unilateral eye-stalk ablation was carried to induce maturity. It was observed that majority of the adult females spawned, yielding eggs ranging from 6,600 to 5,89,400. But in all the cases, the eggs were unfertilized. The reproductive quality of males under captivity was the major problem encountered in this study.

In the second set, 23 families were procured in January-February 2008 (11 families from Tamil Nadu and 12 mixed families from Andamans) and reared to juveniles. These juveniles were tagged with VIE tags in April 2008 and subjected to challenge test with WSSV through consumption of infected meat. The time to death of these shrimps was recorded. The second set of tagged shrimps were stocked in a pond and reared for 6 months in order to obtain growth parameters of the different families. At harvest, the wet weight of the shrimps were recorded, eye-ring tagged and re-stocked in another pond to raise them as brood stock for the next 8 months.

Potential for selection for growth, survival and disease resistance

During the course of the project, the following methodology and protocols were standardized for: family and individual tagging, controlled challenge tests with WSSV and rearing of individual families and genetic stocks in tanks and ponds. The data also revealed strong sexual dimorphism in growth. The analysed data have increased understanding with respect to harvest weight, pond survival, survival in challenge test, and genetic correlation with respect to the above and potential for selection for growth and disease resistance. With reference to the Chennai data, the effect of stock was significant ($P<0.01$), with least-squares means of 8.64 g and 7.71 g for TN and Andamans respectively. The estimates of heritability were 0.72 and 0.45 in Kakinada and Chennai families

respectively. The high correlation for growth between individual families' growth in two different geographic locations, indicated low GxE effect. These estimates should be treated with caution, as particularly in the case of the Chennai data as they will include the individual tank effect which is confounded with the family effect. Nevertheless, the estimates do indicate considerable genetic variations for stocking weight.

The estimates of heritability were between 0.26 and 0.30 indicating that growth rate was substantially influenced by additive gene action and selection would be effective in eliciting response for this trait. The estimates of heritability for pond survival ranged from 0.18 to 0.56 and suggests additive gene action which would ultimately translate into genetic gain on selection.

The estimate of heritability of time to death in WSSV challenge was between 0.08 and 0.23. Even though the standard errors were large, the heritability estimate is greater than zero. Further fine-tuning of challenge tests might render reliable estimates of heritability for this trait.

Correlation between family breeding values for the three traits from different models were calculated and found to be high for harvest length and harvest weight, but negative between pond survival in the two locations and between survival and harvest weight. Correlations between breeding values for hours to death and weight were positive. Positive correlations indicate the positive association between two traits, whereas negative correlations indicate the decline of one trait for increase in the other.

Title of the 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

Project Co-ordinator (National)	Dr. S. Ayyappan
Project Co-ordinator (CIBA)	Dr. A.G.Ponniah
Principal Investigator	Dr.G.Gopikrishna
Lead Centre	CIBA, Chennai and CIFA, Bhubaneswar
Location of the project	Chennai
Co-Investigators	Dr. P.Ravichandran, Dr. C. Gopal, Dr. M.S. Shekhar, Dr. S.Kannappan, Dr. K. Vinaya Kumar

The Department of Biotechnology (DBT)-Norwegian Research Council (NRC)-ICAR collaborative project with CIBA, Chennai and CIFA, Bhubaneswar as the Indian partners was initiated on 9th January 2009. The first component of the project entails the challenge of tiger shrimp with White Spot Syndrome virus, collection and sequencing of the early dying and surviving shrimps, followed by detection of QTLs, if any. The second component involves streamlining access to use of genetic resources especially in the light of IPR issues. An inception workshop of project was held in January 2009 at CIBA, Chennai and the detailed actionable points for the project work plans were formulated.

ICAR AP Cess

Title of the project Investigation on loose shell syndrome among farmed tiger shrimp *Penaeus monodon*

Principal Investigator Dr.S.V.Alavandi

Location of the project Chennai

Co-Investigator Dr.T.C.Santiago

The objective of the project is to understand the causative factors involved in the onset of Loose Shell Syndrome in *P. monodon* and to develop management interventions for its control. Investigations on the causative factors of LSS in black tiger shrimp indicated the involvement of a filterable viral-like agent of about 13-24 nm size, which was purified from LSS affected shrimp using sucrose gradient ultracentrifugation technique. Transmission electron microscopic examination of the purified putative agent showed enveloped oval to elliptical shaped structures with a central dense core (Fig.28). Similar agents could be also observed in the nucleus of the hepatopancreatocytes of LSS affected shrimp. Experiments on the disease transmission indicated that LSS could be induced in healthy tiger shrimp by experimental challenge using purified virus-like agent and homogenates of hepatopancreas and muscle of LSS affected shrimp. LSS affected shrimp were also examined for the bacterial infections and it was observed that secondary bacterial infections caused by *Vibrio sp.* were common among these shrimps. Experiments carried out to mitigate LSS with the commercial products / compounds suggested that tested products could not mitigate the disease either in terms of prophylactic or control measures. One of the environmental interactions with incidence of LSS, was the frequent algal crashes noticed in the LSS-affected ponds. However in terms of microalgal diversity during the crop, it was noticed that the diatoms were predominant in both LSS-affected and unaffected shrimp culture ponds. Further research would focus on understanding the nucleic acid of the putative aetiologic agent, to enable the development of a rapid diagnostic tool.



Fig.28. Identification of causative agent for LSS in *Penaeus monodon* (a) Purification of viral-like agent by sucrose density gradient ultracentrifugation and (b) electron micrograph of viral-like agent showing oval to elliptical viral-like structures (arrows)

Title of the project Molecular characterization and analysis of virulence factors in pathogenic *Vibrio harveyi* isolates from shrimp larviculture systems

Principal Investigator Dr.S.V.Alavandi

Location of the project Chennai

Co-Investigator Dr.T.C.Santiago

The project objective was to build a stock of luminescent bacteria (LB), characterize them and develop methods to differentiate pathogenic and non-pathogenic strains of *Vibrio harveyi*. The work is based on 395 cultures of *V. harveyi* isolated and characterized from three commercial shrimp hatcheries earlier. *V. harveyi* was found to be the predominant LB in the hatchery systems, and other species such as *V. splendidus*, *V. logei*, *V. fisheri* and *Photobacterium sp.* were also occasionally found. The shrimp brooders in the hatchery were found to be the main source of LB. The isolates, phenotypically identified as *V. harveyi* were further confirmed by polymerase chain reaction (PCR) using the primer designed by Oakey in 2003 (Fig.29).

Virulence factors of 150 isolates of *V. harveyi* were tested and all the isolates produced proteases and siderophores, whereas, haemolysins and phospholipases were produced by 92% and 82% of the isolates respectively. Molecular characterisation of 42 isolates of *V. harveyi* was carried out using Pulsed Field Gel Electrophoresis (PFGE) by digesting the bacterial DNA with Not I. The results suggested that *V. harveyi* was a genetically highly divergent group of bacteria.

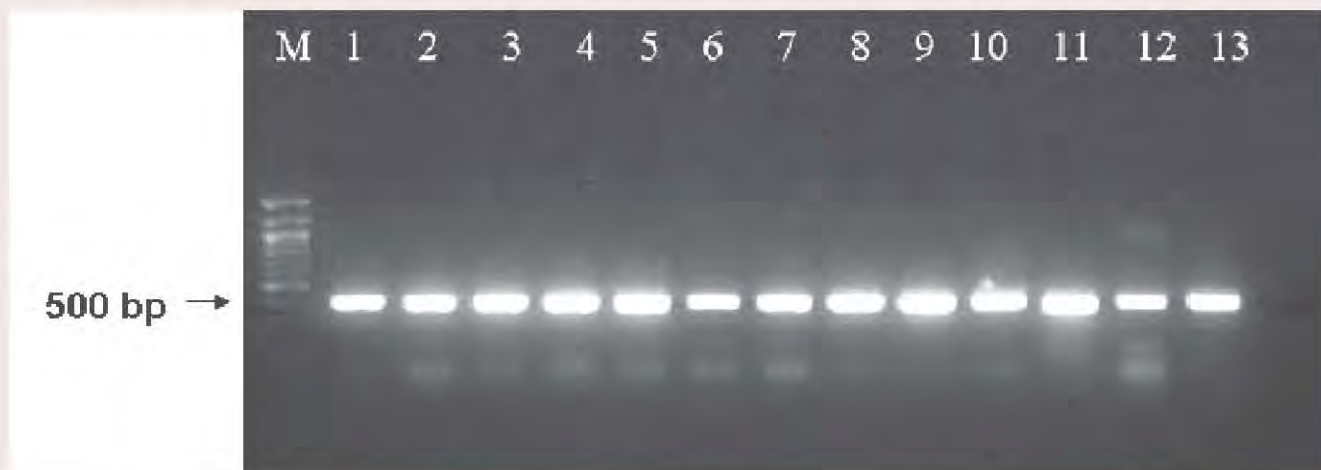


Fig.29 . Gel showing amplification of 413 bp product specific for *Vibrio harveyi* (lane M –marker; lanes 1-3 different *V. harveyi* isolates)

From hatchery ecosystem, a total of 77 bacteriophages were isolated on 27 hosts of *V. harveyi*. These phages were subjected to degenerate primed PCR for further differentiation. Phylogenetic analysis based on degenerate primed PCR revealed the occurrence of 13 major clusters at 30% hierarchical level. *V. harveyi* isolates were subjected to phage typing using 76 bacteriophages. Data of phage typing analyzed using Phylip phylogeny inference package revealed 39 clusters at 80% hierarchical level.

Investigation on the association of *V. harveyi* myovirus like (VHML) bacteriophage with pathogenic isolates was carried out by VHML specific PCR and the study indicated that the VHML was not associated with pathogenic isolates. Further investigations need to be carried for the involvement of other bacteriophages similar to VHML in imparting virulence to *V. harveyi* isolates in this geographic region.

Title of the project The assessment of losses in shrimps in brackishwater aquaculture due to diseases

Principal Investigator Dr.N.Kalaimani

Location of the project Chennai

Co-Investigator Dr. T. Ravisankar

Losses in shrimp aquaculture due to diseases

Aquatic animal health problems in pond culture and their impacts on yield are well known, but are not often quantified due to the difficulties in collecting accurate and reliable quantitative information. This project was initiated in July 2005 and the survey was conducted for a continuous period of three years to collect extensive primary data from farmers as well as secondary data from state fisheries departments, MPEDA, CAA, etc. The survey covered an area of 7263 acres in nine coastal states covering 5779 ponds belonging to 1142 farmers (Fig. 30). The area surveyed in different districts of these states with their respective geographic locations (38 numbers) are depicted in the map (Fig.30). A total of eighteen parameters were analysed with reference to year, state, coast, farmer category, CAA approval, owned / leased, season, different water sources and different types of farming using SPSS 17.0 version.

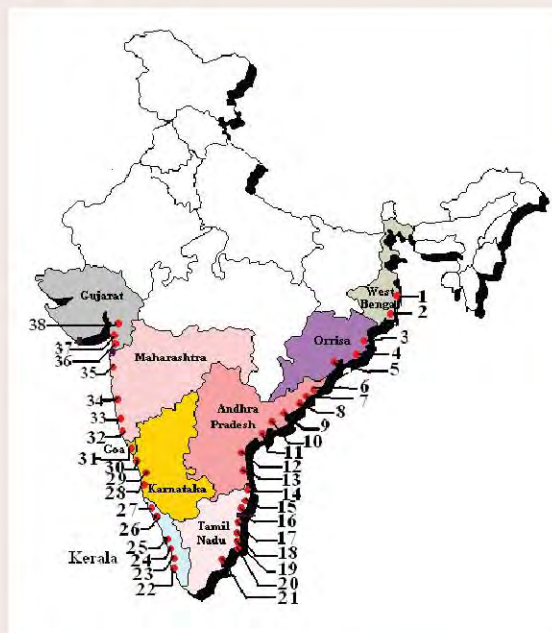


Fig. 30. Areas covered under the survey to assess losses in shrimp aquaculture due to diseases (geographic locations are serially numbered)

The gross national loss estimated due to diseases are: i) 48,717 metric tonnes of product which is about 30 per cent of present shrimp production ii) an amount of Rs. 1022.17 crores in terms of national income and iii) 21.56 lakh man days in terms of farm level employment. Epidemic seriousness among the diseases was observed to be WSSV, LSS, White Gut and Slow Growth Syndrome and a combination of WSSV and LSS, in that order, at the national level.

Frozen storage studies of WSSV and LSS affected shrimp

Studies on changes in sensory quality of diseased and healthy *Penaeus monodon* showed that LSS infected samples were significantly inferior in scoring with respect to appearance, odour, firmness and fibrousness compared to WSSV infected and healthy frozen shrimps. The chemical indicators, microbial count and sensory evaluation studies in shrimp under storage at -20° C revealed that the LSS affected samples had lesser shelf life compared to WSSV and healthy shrimp samples.

Predictive factors for disease occurrence

Predictive factors for disease occurrence were assessed using multiple regression analysis. The most important risk factors for LSS are farming experience, water spread area of the farm, type of farming, stocking rate, culture duration, presence of pollution, and amount of chlorine applied. Among these, stocking rate, pollution and absence of chlorination in reservoir pond were observed to be the strong risk factors. It is observed that there is a 22 fold increased risk, when stocking rate is more than 12/ m² when compared to 6-8/ m² and a 13 fold increased risk, when there is farm pollution when compared to pollution free pond.

Department of Biotechnology

Title of the project : Gene expression in *Penaeus monodon* and *Penaeus indicus* in relation to microbial infection and environmental stress

Principal Investigator : Dr.T.C.Santiago

Location of the project : Chennai

Cloning and expression of Toll like receptors

Invertebrates rely completely on their innate immune system for protection against pathogens. This non-self-recognition is activated by microbial cell wall components with uniquely conserved molecular patterns. Pathogen-associated molecular patterns (PAMPs) are recognized by pattern recognition receptors (PRRs). Shrimp possess at least one Toll receptor that might be involved in immune defense. In this study a full length sequence of the Toll receptor gene was cloned and expressed using RLM-RACE kit (Invitrogen) from a gill tissue of the giant tiger shrimp, *Penaeus monodon*.

Cloning and expression of Tropomyosin gene

Shellfish are a common cause of adverse food reactions in hypersensitive individuals and shrimp is one of the most frequently reported cause for allergic reactions. The protein, tropomyosin, first identified as a 36-kDa allergen in

shrimp muscle proteins (Fig.31a) responsible for IgE-mediated food allergies is the main research goal in seafood allergy. Tropomyosin gene was cloned into an *E. coli* expression vector, pET32a (Novagen). The gel-purified PCR product was restricted, digested and cloned into the pET32a vector at the BamHI and EcoRI sites. The ligated product was transformed into an *E. coli* strain XL-1Blue. The positive clones were screened by using T7 promoter primer. The expression of recombinant tropomyosin was analysed by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) (Fig.31b).

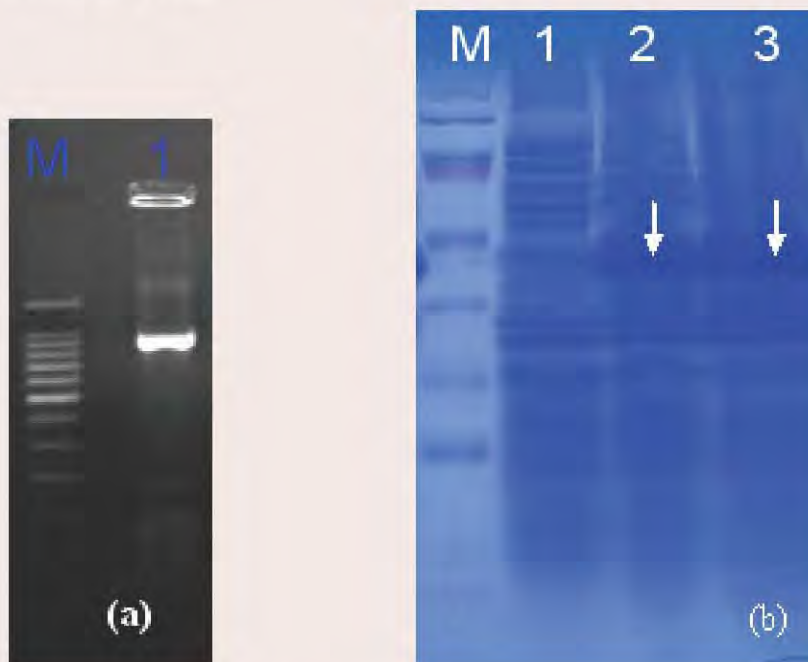


Fig. 31. (a) Amplification and (b) expression of the recombinant tropomyosin. (a. lane M.-marker [100bp], lane 1. - Tropomyosin from *P. monodon*; b. Tropomyosin Protein expression in SDS-PAGE gel, lane M -Protein marker, lane 1 -BL21-before IPTG Induction, lane 2 - 1hour after IPTG Induction, lane 3 - 2hour after IPTG Induction)

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

Principal Investigator : Dr.K.P.Jithendran
Co-operating Centre : C.Abdul Hakeem College, Melvisharam
Location of the project : Chennai
Co-Investigators : Dr.M.Shashi Shekhar and Dr.M.Poornima

Characterization of Betanodavirus

Viral Nervous Necrosis (VNN) caused by Betanodavirus, of the family Nodaviridae, is the causative agent of this highly destructive disease common in hatchery reared larvae and juveniles of several varieties of marine fin fish across the world. In India, the outbreak of this disease was observed in the larvae of seabass in hatchery facilities causing concern as this is due to the vertical transmission of the virus. Studies conducted in four coastal states

(Kerala, Tamil Nadu, Andhra Pradesh and West Bengal) and Union Territory of Puducherry during the year revealed that Betanodavirus is widely distributed sub-clinically along the east coast of India in the target species as well as in low value fishes (Table 20). About 16% of the total analysed fishes (n=168) gave positive results for the virus by (nested) RT-PCR assay using different combinations of published primers, optimised in the laboratory. Of these, species wise percentage of positive samples were: *Lates calcarifer* 8.5% (n=71), *Mugil cephalus* 8.3% (n=36) and trash fishes 29.5% (n= 61) with most of the samples being apparently healthy without any clinical symptoms. Custom designed primers based on the partial nucleotide sequences of Indian strains were also evaluated for their efficiency in detecting the virus (Fig.32). Samples found positive with any of these primers were further processed for confirmatory analysis by cell culture inoculation, nucleotide sequencing, histopathology and electron microscopy. Electron microscopy of brain tissues from sub-clinically infected fish revealed multiple arrays of nodavirus like particles measuring around 35 nm in dimensions (Fig. 33).

Partial nucleotide sequences of the PCR products were submitted to GenBank (FJ 655182, FJ 655183, FJ 655184, FJ 655185, FJ 655186 and FJ 655187) and this is the first such submission on VNN from the country. The data confirmed the origin and identity of the sequences to



Fig. 33. Nodavirus like particle detected by TEM in the brain tissue of asymptomatic fish. (1,00,000 X).

Table. 20 Viral nervous necrosis positive samples from survey of four coastal states

Species positive	No.	Source	No. RT-PCR positive (%)
<i>Lates calcarifer</i>	71	Wild/ farm/ hatchery	6 (8.5)
<i>Mugil cephalus</i>	36	Wild	3 (8.3)
Other low value fishes	61	Wild/farm	18 (29.5)
Total	168		27 (16.0)

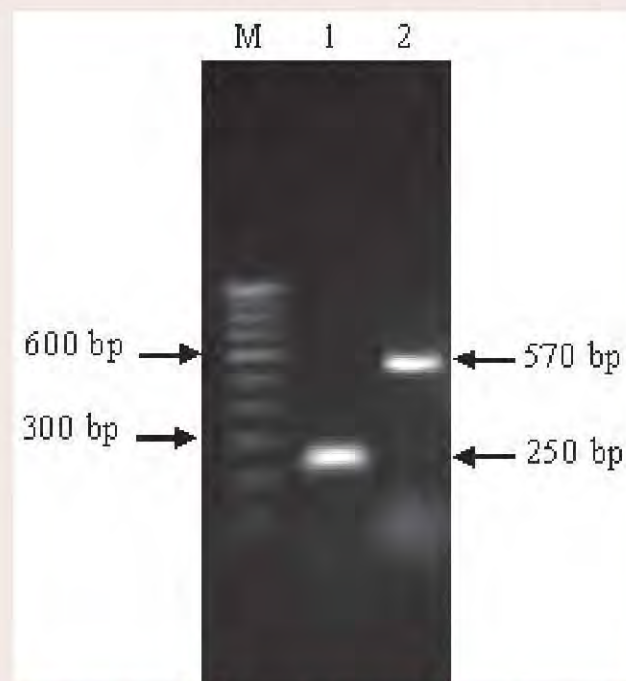


Fig. 32. Detection of subclinical infection with nodavirus with custom designed primers (lane M: 100 bp ladder, lane 1 : 250 bp amplicon with custom designed primer, lane 2 : 570 bp amplicon with degenerate primer)

betanodavirus by NCBI BLAST. For the characterization of the virus at genomic level, segments of coat protein gene was amplified and sequenced directly from the fish tissues. The nucleotide sequence data revealed considerable variation in their total length. Similarity scores among the sequences were estimated to be 91-99%. In the multiple alignment data performed using *MEGA* version 4, single point deletions were observed at multiple sites. In another analysis, complete coat protein gene sequences available so far from NCBI Genbank were retrieved and aligned along with our partial sequences to

construct a phylogenetic tree. The result showed that the Indian strains can be grouped into a distinct single cluster and there are altogether seven clusters with subgroups within them.

Development of diagnostics for VNN

Based on the sequence data, three primer sets were designed and are being used for the development of genome based diagnostics for betanodavirus in fishes. The nested (RT) PCR protocol optimised in the laboratory is being used for this purpose and some of the primers are proven to be effective. They are being analyzed in various combinations to develop a highly sensitive diagnostic PCR assay for the detection of betanodaviruses in low numbers so that it would benefit screening of carrier animals.

Title of the project : Development of substrate specific fibrolytic enzymes for enhancing nutrient utilization in shrimp

Principal Investigator : Dr.K.Ambasankar
Location of the project : Chennai
Co-Investigators : Dr.S.A.Ali and Dr.J.Syamadayal

The main objectives of the project were to: (i) test the presence of fibrolytic enzyme activity, its ontogeny and diurnal variations in the gut of the shrimp *P.monodon* (ii) determine optimal inclusion levels of various fibrolytic/ Non Starch Polysaccharide (NSP) degrading enzymes for improving the nutritive value of fibre/NSP rich feed ingredients and (iii) assess the cost benefit ratio of enzyme supplementation. Earlier studies carried out on fibrolytic enzyme activity in the shrimp *P.monodon* revealed the presence of cellulase, xylanase, pectinase and chitinase. The main aim for the current year was to ascertain the source of the fibrolytic enzymes, its diurnal changes and effect of feeding on enzyme activity. In order to find out the optimal inclusion level of various fibrolytic enzymes, the type and content of fibre and NSP has to be documented. To achieve this, potential ingredients were selected and subjected to analysis of fibre and NSP content.

Ascertaining the source of fibrolytic enzymes

Since the activity of the fibrolytic enzymes were established in the shrimp, an attempt was made to ascertain if the source of the enzymes were exogenous or endogenous in nature. Juveniles of *P.monodon* having average size of 15.67 ± 0.98 g/ 11.93 ± 0.27 cm were divided into two groups each with three replicates. Control group was fed with CIBA shrimp feed and the test group was fed with CIBA shrimp feed supplemented with 100 ppm tetracycline, for seven days. Shrimps were sacrificed at the end of the period and the enzyme activity was estimated in the hepatopancreas and the results obtained are depicted in the Fig. 34.

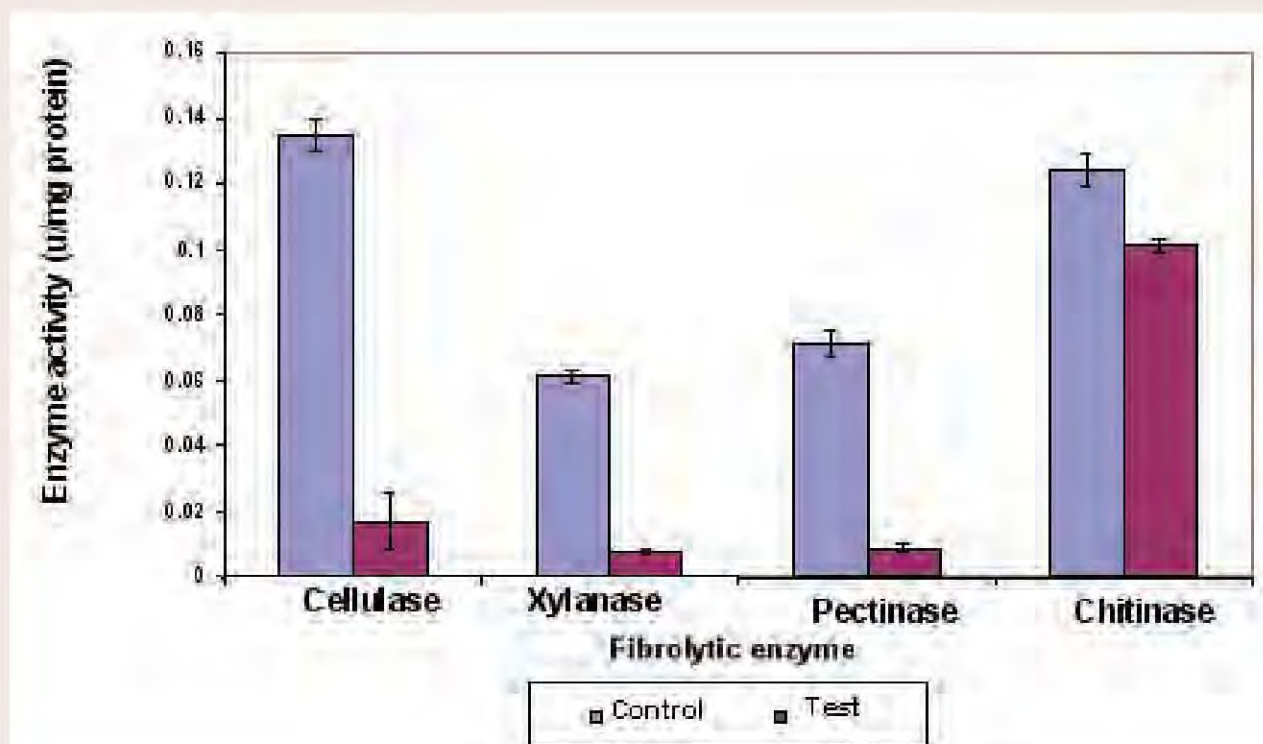


Fig.34. Enzymes activity in hepatopancreas in *Penaeus monodon*

Tetracycline, a broad spectrum antibiotic was included in the diet to eliminate the microbial population of gut. The results indicate that cellulase, xylanase and pectinase activity were significantly reduced in the test group. However, chitinase enzyme showed marginal decrease in activity in the test group. The drastic reduction in cellulase, xylanase and pectinase activity shows that these enzymes may be secreted from the microbes present in the gut. This result confirms that chitinase is the only endogenous fibrolytic enzyme secreted by hepatopancreas and other fibrolytic enzymes are exogenous in nature and probably secreted by gut microbes.

Diurnal changes in the fibrolytic enzyme activity

Diurnal change in the fibrolytic enzyme activity was studied in juvenile (10.3 ± 0.43 g) shrimp to develop the feeding regime based on enzyme activity. Enzyme activities were studied at four hourly intervals in a day and the samples were screened for three consecutive days. Effect of diurnal variations on fibrolytic enzyme activity is presented in Table 21.

Table 21. Diurnal changes observed in the fibrolytic enzyme activity of the shrimp *Penaeus monodon*

Time of sampling	Maximum Activity (U/mg protein) (Mean $\pm$ SD)			
	Cellulase	Xylanase	Pectinase	Chitinase
2 am	0.14 $\pm$ 0.004	0.06 $\pm$ 0.002	0.07 $\pm$ 0.003	0.09 $\pm$ 0.003
6 am	0.12 $\pm$ 0.005	0.08 $\pm$ 0.004	0.09 $\pm$ 0.003	0.14 $\pm$ 0.005
10 am	0.09 $\pm$ 0.001	0.12 $\pm$ 0.004	0.06 $\pm$ 0.002	0.10 $\pm$ 0.002
2 pm	0.12 $\pm$ 0.005	0.05 $\pm$ 0.002	0.06 $\pm$ 0.002	0.07 $\pm$ 0.006
6 pm	0.10 $\pm$ 0.001	0.05 $\pm$ 0.003	0.06 $\pm$ 0.002	0.10 $\pm$ 0.002
10 pm	0.16 $\pm$ 0.001	0.11 $\pm$ 0.004	0.07 $\pm$ 0.003	0.11 $\pm$ 0.004

The fibrolytic enzyme activity study related to circadian rhythm showed that cellulase activity was maximum during night and it showed a variable activity during day. Xylanase, pectinase and chitinase activity revealed no definite pattern with day and night indicating that these enzyme activities are not influenced by circadian rhythm and there is no significant difference in enzyme activity during day and night. These enzymes seem to be continuously produced by endogenous or exogenous source.

Effect of feeding on fibrolytic enzyme activity in the shrimp

To study the effect of feeding influence on fibrolytic enzyme activity, an experiment was conducted with *P. monodon* juveniles having average size of 14.69 ± 1.56 g/ 11.9 ± 0.18 cm. The shrimps were divided in two groups and were starved for 12 hours. The test group was fed with feed at 12 hours and the control group was continuously starved. In the test group, immediately after feeding, the enzyme activity was studied and it was recorded as 0 hour after feeding. The enzyme activity was measured at 0, 2, 4, 8 and 12 hours in both control and test groups. All the four fibrolytic enzymes were present in the test as well as control groups. Although differences in activity of these enzymes were observed in the test and control group, there was no trend to suggest that feeding influences the fibrolytic enzyme activity. However, the test group showed a marginally higher activity than the control group. In the test group, enzyme activities were found to vary between individuals whereas there was not much variation among the individuals in the control group. Further, this study indicates continuous fibrolytic enzyme production, even though the activity was very low (0.05 ± 0.002 u/mg of protein).

Collection of NSP/fibre rich feed ingredients and their chemical analysis

Eighteen different fibre/NSP rich feed ingredients were collected from important feed producing and raw material processing localities and subjected to nutrient analysis. Based on the nutrient content (more than 25% crude protein for plant protein sources and more than 2000 Kcal of GE /kg for energy byproducts with crude fibre between 10-20 %), availability (more than one million tonne) and cost (less than Rs. 25/kg for plant protein sources and less than Rs. 10/kg for energy byproducts).

Eight potential ingredients were selected for further analysis for fibre fraction and NSP content. Potential ingredients viz., soybean meal, rape seed meal, ground nut cake, cotton seed cake, sunflower cake meal, copra cake, wheat bran and rice bran were subjected for fibre and NSP fractions. Fibre fractions in terms of Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF), cellulose, hemicellulose, and lignin and NSP fractions in terms of soluble, insoluble and total were determined. Results revealed that cellulose content is comparatively higher than the hemicellulose in soybean meal, rape seed meal, sunflower meal, where as hemicellulose is the dominant fibre fraction in byproducts like rice bran and wheat bran. Total NSP content varied from a low of 16.30 ± 0.026 % in soybean meal to a high of 38.24 ± 0.266 % in wheat bran. Soluble NSP was maximum in rice bran (12.96 ± 1.143 %) and insoluble NSP was maximum in wheat bran (12.96 ± 1.235 %). There was not much variation in soluble and insoluble NSP content of soybean meal, rape seed meal, sun flower meal and cotton seed meal. This data on type content of NSP will help in determining the suitable enzyme mixture for improving the digestibility.

Title of the project : Development and application of CMG family recombinant hormones, their antagonists and RNAi technique for induced maturation and spawning of *Penaeus monodon*

Lead Centre : Central Marine Fisheries Research Institute, Kochi

Co-Principal Investigator : Dr.C.P.Balasubramanian

Location of the project : Chennai

Expression of vitellogenin/vitellin during ovarian development

Vitellogenin/vitellin (Vg/Vn), the reproductive marker protein in the oviparous animals, was characterized in female *P.monodon* and its profile in the reproductive tissues (ovary, hepatopancreas and hemolymph) during the ovarian development was investigated. During the natural reproductive cycle, vitellogenin specific polypeptide was observed in all the reproductive tissues examined. Whilst hepatopancreas showed only one Vg/Vn specific polypeptide, hemolymph showed three Vn specific polypeptides. In the eyestalk of ablated females SDS PAGE profile was found to be similar to normally maturing females. In general, contribution of the hepatopancreas appeared to be less in the production of vitellin/vitellogenin.

Expression of Vg mRNA in hepatopancreas and ovary was analyzed by RT PCR cDNA fragment of expected 389 bp was detected in the ovary and hepatopancreas of all the vitellogenic stages. Vg was primarily expressed in ovary, and its expression level was generally found to increase through various vitellogenic stages. On the contrary, Vg mRNA expression was found to be low in hepatopancreas throughout the gametogenic cycle. Further, Vg mRNA expression profile in hepatopancreas and ovary was similar in eyestalk ablated as well as naturally maturing females. This observation was contrary to the earlier studies carried out in *Marsupenaeus japonicus* where Vg mRNA was not found to be expressed in hepatopancreas of eye stalk ablated females.

In vitro and *in vivo* experiments were conducted to study the effects of steroidogenic hormones on vitellogenesis of *P. monodon*. *In vitro* experiments showed that 17 α hydroxy progesterone significantly accelerated vitellogenesis (Vg gene expression) in *P. monodon*. Among the two experiments conducted to study the *in vivo* effects (one set with eye ablated and other with un-ablated females), it was observed that only eyestalk ablated females matured. These results indicate that the effect of GIH should be blocked or neutralized to achieve maturation (vitellogenesis).

Characterisation and expression of vitellogenin inhibiting hormone(VIH)/gonad inhibiting hormone(GIH) and its messenger RNA during ovarian development

The full length coding sequence of VIH/GIH in *P. monodon* was determined by RT-PCR (Fig.35). It was noted that it is composed of 633 nt and encodes a precursor of 205 amino acid sequence. The phylogenetic tree based on GIH amino acid sequence using neighbour joining method is shown in the Fig.36. The tree was estimated by maximum likelihood and updated with GIH data sets. In this phylogeny, GIH appears to have a close similarity with MIH.

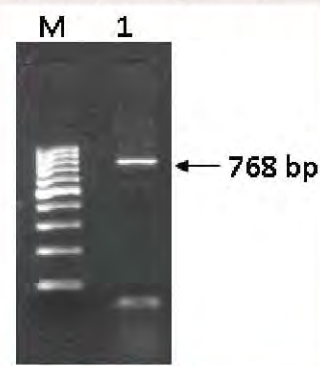


Fig 35. RT-PCR of Gonad Inhibiting Hormone from eye stalk of pre-vitellogenic female

In order to find the expression of GIH during different phases of reproductive cycle in *P. monodon*, females were characterized into four major stages of maturation using light/electron microscopy (Fig.37a,b,c). Eyestalk of shrimps with different stages of maturation showed that GIH was expressed in all stages of maturation, although the expression of GIH mRNA changed during the different stages of vitellogenesis. In shrimps with immature ovary (ovaries with hundred percent oogonial cells and where it was difficult to discern from the adjacent somatic tissue), the quantity of GIH was found to be less and it peaked in the previtellogenic phase and diminished in subsequent phases. This indicates that GIH mRNA abundance is regulated during the previtellogenic phases. This result is particularly interesting as it reveals that any intervention to induce maturation by neutralizing the GIH hormone is highly specific to the ovarian reproductive stage.

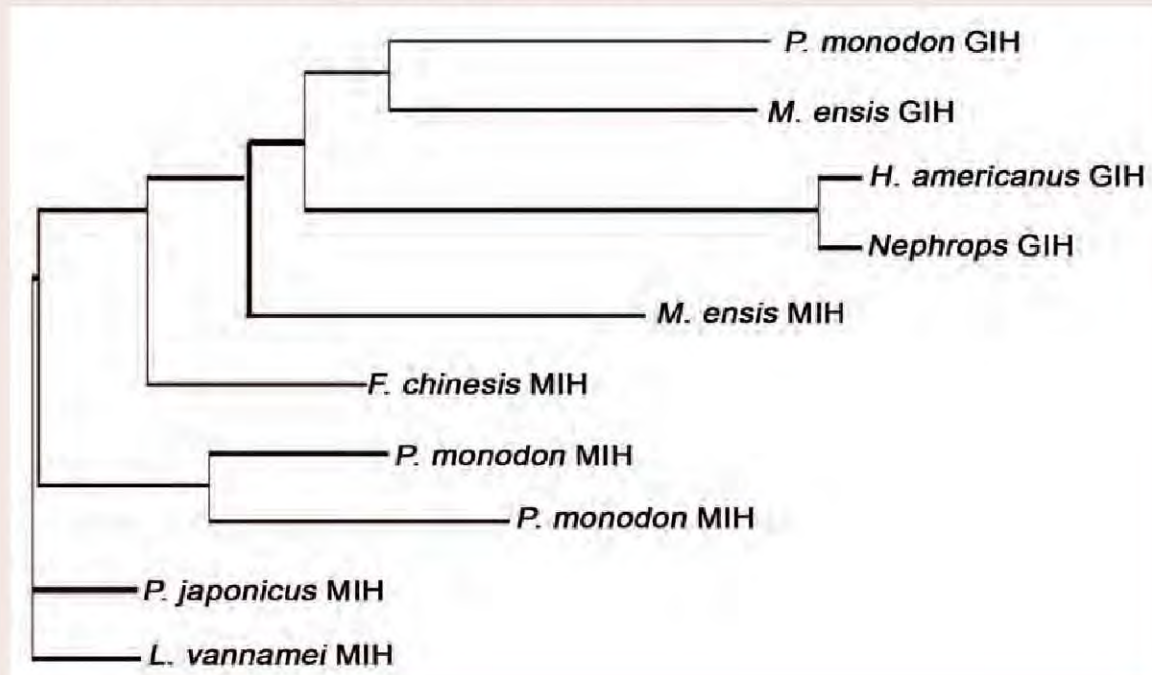


Fig. 36. Phylogenetic tree obtained by amino acid sequence comparison of gonad inhibiting hormone and moulting inhibiting hormone of different decapods

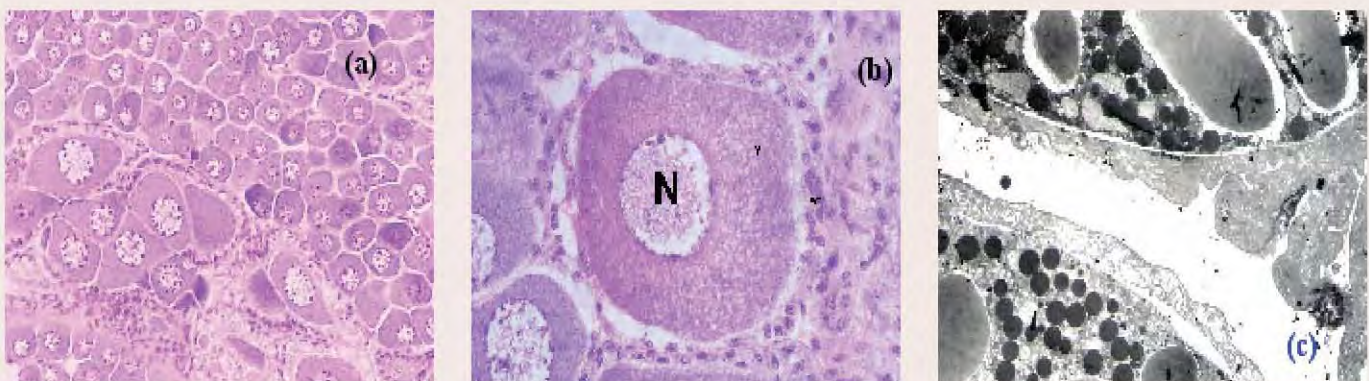


Fig. 37. Gametogenic phases of female *Penaeus monodon*: (a) previtellogenic phase, (b) vitellogenic phase, (c) ripe stage

Title of the project : Enrichment of aquafeed with cellulolytic and amylolytic microbes isolated from digestive tract of brackishwater fishes

Principal Investigator : Dr. Debasis De

Location of the project : Kakdwip

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

Isolation and enumeration of gut microbiota of brackishwater fishes

The objective of the project was to identify candidate cellulolytic and amylolytic digestive tract microbial species that can be used to enrich feeds for brackishwater species. Test fish species with different feeding habits, namely, seabass, *Lates calcarifer* (LC); milkfish, *Chanos chanos* (CC); grey mullet, *Mugil cephalus* (MC) and pearlspot, *Etroplus suratensis* (ES) (average body weight: 90 ± 38.4 g for seabass, 700 ± 5.8 g for grey mullet, 93 ± 2.0 g for milk fish and 112 ± 7.3 g for pearlspot) were starved for 48 hours and dissected aseptically within laminar air flow on ice for analysis of aerobic digestive tract microbiota. The total bacteria (60.19×10^5 CFUg⁻¹ of digestive tract) and proteolytic (6.32×10^4) bacterial population were significantly higher ($P < 0.01$) in *L. calcarifer*, amylolytic (51.66×10^3) and lipolytic (3.99×10^3) population was more ($P < 0.01$) in *C. chanos*, and cellulolytic (25.33×10^3) population was higher ($P < 0.01$) in *E. suratensis* (Fig. 38).

To know the site of adherence of cellulolytic and amylolytic microbiota in the gut, analysis of microbiota from different portions of the digestive tract of fishes was done and it revealed that, the total bacterial population was higher ($P < 0.01$) in mid gut of *L. calcarifer*, fore gut of *C. chanos* and hind gut of *E. suratensis*. Amylolytic bacterial population was higher ($P < 0.01$) in hind gut of all the three fish species (Fig. 39).

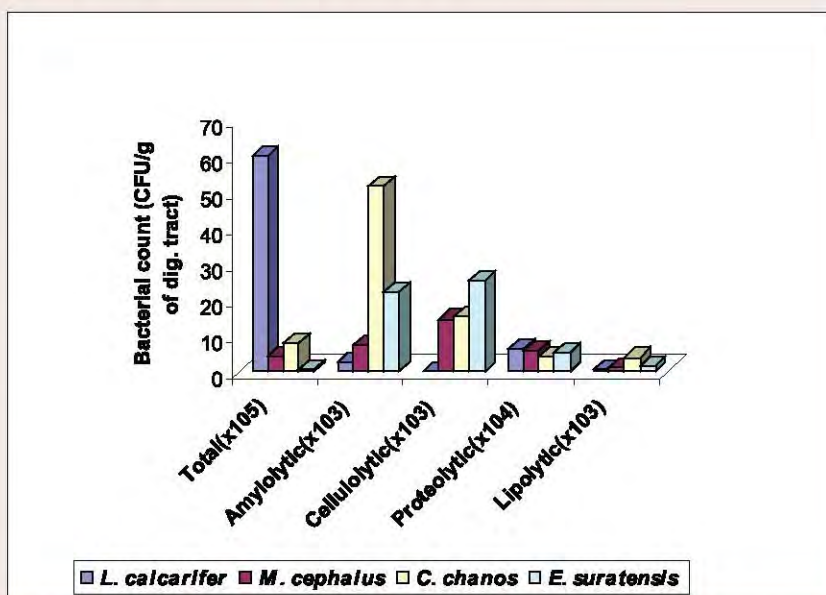


Fig.38. Aerobic bacterial count of different brackishwater fish species.

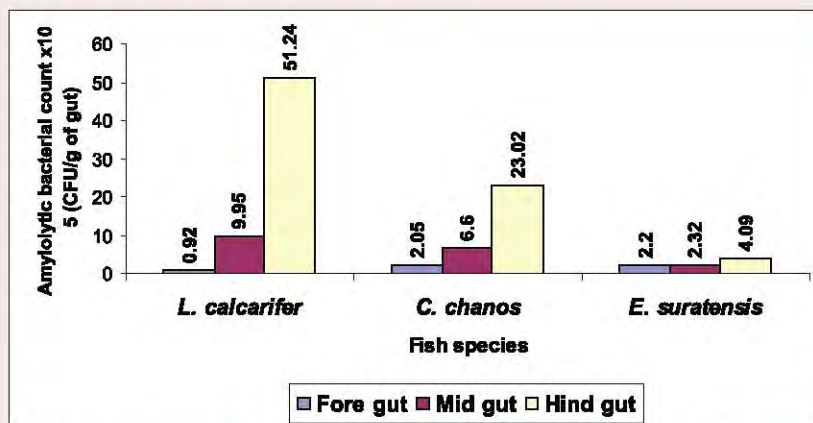


Fig. 39. Amylolytic bacterial population in different portions of gut

In *L. calcarifer* and *E. suratensis* cellulolytic bacterial population was higher ($P<0.01$) in the hind gut but in *C. chanos*, it was higher ($P<0.01$) in mid gut. In *L. calcarifer* and *E. suratensis* proteolytic bacterial population was higher ($P<0.01$) in the mid gut but in *C. chanos*, it was higher in hind gut.

Identification and characterization of isolated gut bacteria

Twelve bacterial isolates from the intestinal tract of *L. calcarifer*, ten from *M. cephalus*, nine from *C. chanos* and five from *E. suratensis* were identified according to descriptions in Bergey's Manual of Systematic Bacteriology. Among them, eight types from *L. calcarifer*, one from *M. cephalus* and two from *C. chanos* were characterised on the basis of their morphological, physiological and biochemical characteristics (Table 22). For biochemical characterization a number of biochemical tests e.g. gas production in the broth by Durham's tube (Fig. 40a) indole production test (Fig. 40b), nitrate reduction test (Fig. 40c) etc. were done.

Gram positive cocci were prevalent in all the species except *L. calcarifer* where gram positive rods are predominant. Most of the isolated gram positive bacilli were endospore producers and non motile except three isolates from *L. calcarifer* (LC1, LC2 and LC8). Most of the gram positive cocci were non-motile and could not produce endospore except three isolates from *C. chanos* (CC1, CC2 and CC3). All isolates could tolerate temperature range of 15° to 40 °C and pH range of 5-10.

Table 22. Identified bacterial isolates in digestive tract of brackishwater fishes

Fish species	Bacterial isolates	Name of isolates
<i>Lates calcarifer</i>	LC1	<i>Bacillus laterosporus</i>
	LC2	<i>B. bravis</i>
	LC3	<i>B. megaterium</i>
	LC5	<i>B. megaterium</i>
	LC6	<i>B. subtilis</i>
	LC7	<i>B. larvae</i>
	LC8	<i>B. macerans</i>
	LCp	<i>B. licheniformis</i>
<i>Mugil cephalus</i>	MC3	<i>B. megaterium</i>
<i>Chanos chanos</i>	CC4	<i>B. larvae</i>
	CCx	<i>B. licheniformis</i>



(a) Left: -ve; Right: +ve



(b) Left: -ve; Right: +ve



(c) Left: -ve; Right: +ve

Fig. 40. Biochemical tests for bacterial identification (a) gas production in GP broth, (b) Indole test (c) Nitrate reduction test

Estimation of total digestive enzymes in different portions of gut

Both endogenous and microbial secretory enzymes constitute the total digestive enzyme in the gut of brackishwater fishes. In order to find out the total cellulase and amylase status in the gut of fish in wild condition, the enzyme activities were determined in the whole gut of these brackishwater fishes collected from the wild. Higher ($P<0.01$) specific amylase activity was observed in *C. chanos* and *E. suratensis* when compared to that of *M. cephalus* and

L. calcarifer. Specific cellulase activity was higher ($P<0.01$) in *E. suratensis* followed by *C. chanos*, *M. cephalus* and *L. calcarifer*.

Extracellular enzyme activity of different bacterial isolates from fish gut

The intensity of extracellular enzyme production by bacterial isolates was assayed qualitatively. Among thirty six aerobic isolates obtained from the gut of *L.calcarifer*, *M. cephalus*, *C.chanos* and *E. suratensis*, extracellular amylase activity was shown by twenty six isolates, extracellular cellulase activity was exhibited by twenty seven isolates and protease activity by all isoates.

In order to identify the most promising isolate, the specific amylase, cellulase and protease activity of all selected isolates was determined. Among all the promising isolates, LC8 (*Bacillus macerans*) isolated from the gut of *L.calcarifer* showed maximum ($P<0.01$) specific cellulase activity (54.63 ± 0.04 μ g of glucose liberated / mg of protein / min.) and CCx (*B.licheniformis*) isolated from the gut of *C. chanos* showed maximum ($P<0.01$) specific amylase activity (26.16 ± 0.04 μ g of maltose liberated / mg of protein / min.) and protease activity (8.03 ± 0.02 μ g of tyrosine liberated / mg of protein / min) (Fig.41). Hence, *B.macerans* was identified as the potent cellulase producer and *B. licheniformis* was identified as the potent amylase and protease producer.

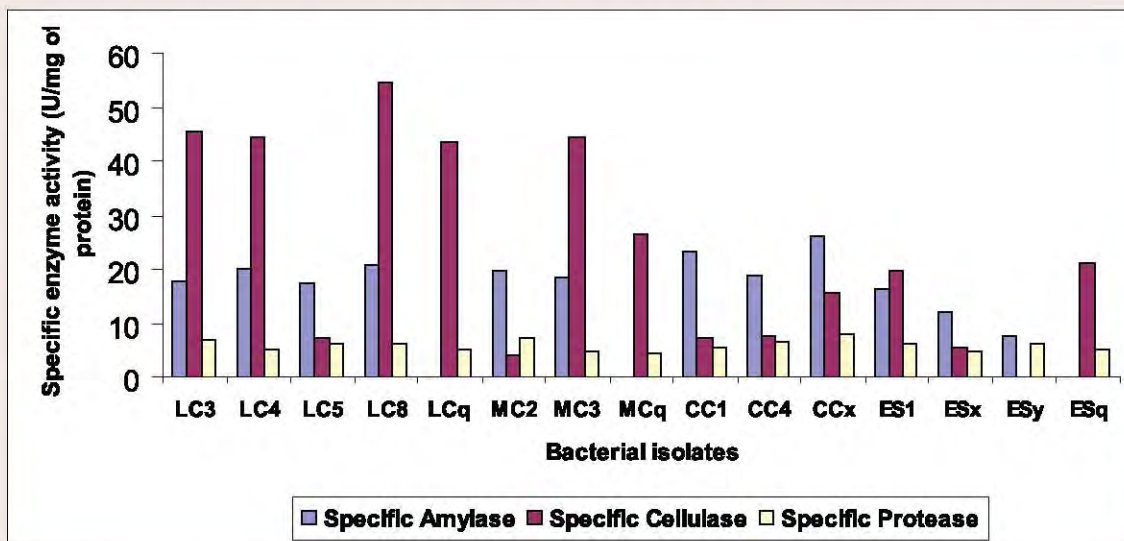


Fig. 41. Specific amylase, cellulase and protease enzyme profile of different promising isolates

Title of the project : Development of antiviral therapy using double stranded RNA (dsRNA) against shrimp viruses, WSSV, MBV and HPV

Principal Investigator : Dr.T.C.Santiago
 Co-operating Centre : C.Abdul Hakeem College, Melvisharam
 Location of the project : Chennai
 Co-Investigators : Dr.N.Kalaimani and Dr.M.Poornima

RNA interference is a mechanism that inhibits gene expression at the stage of translation or by hindering the transcription of specific genes. Application of RNAi for viral clearance from the WSSV infected animals was investigated. Genes expressed early in the WSSV life cycle, W230, W474, W169, W02, W339 were selected as suitable candidate genes. The WSSV genes corresponding to W230 and W474 were amplified and cloned in pLitmus28i vector. The corresponding dsRNA was synthesized by *in vitro* transcription. WSSV challenge experiments were carried out in *P. monodon* injected with *in vitro* synthesized dsRNA. It was observed that there was a delayed mortality in groups that were administered dsRNA in comparison to the positive control group that were exposed to only WSSV (Fig. 42). No mortality was observed in the negative control which was not administered dsRNA or exposed to WSSV.

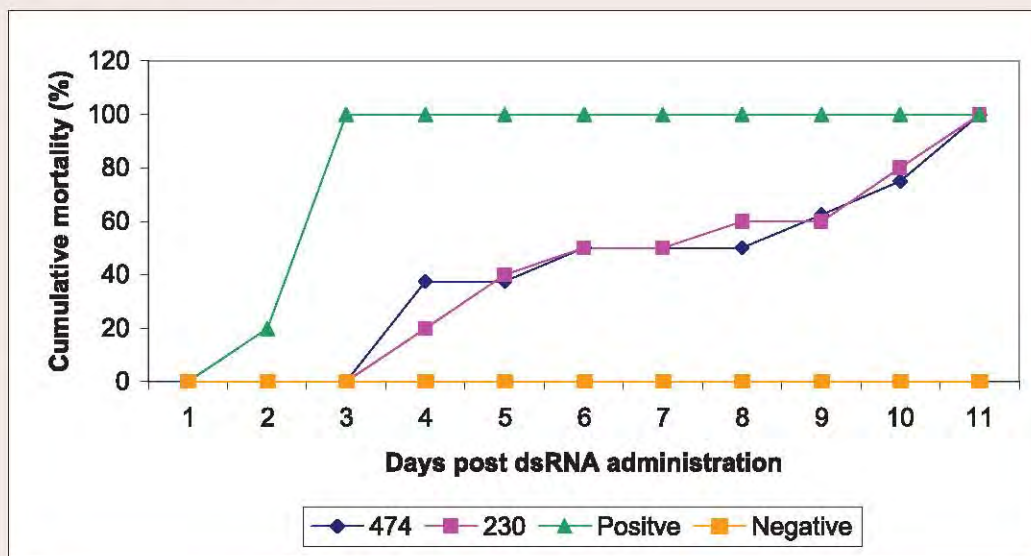


Fig.42. Cumulative mortality (%) of *Penaeus monodon* experimentally infected with WSSV, post dsRNA (W230, W474)

Title of the project : Diversification of livelihoods among women SHGs through coastal aquaculture technologies

Principal Investigator : Dr.B.Shanthi

Location of the project : Chennai

Co-Investigators : Dr.M.Krishnan, Dr.V.S.Chandrasekaran, Dr.C.P.Balasubramaniam, Dr.S.Kannappan and Dr.K.Ambashankar

Motivating factors for adoption of brackishwater aquaculture technologies

In order to understand the motivating factors for the adoption of brackishwater aquaculture technologies, extension tools like 'Development Context Tool kit', Stakeholders Priorities for Development Tool kit' and 'Livelihood Analysis Tool kit' were used. Socio-economic factors that motivated the beneficiaries to adopt the brackishwater aquaculture technologies (Table 23) were determined. It was found that 'economic necessity' was given the maximum score by the participants.

Facilitating factors (Fig. 43) that led the beneficiaries to adopt brackishwater aquaculture technologies were 'the aquaculture activities are well known', followed by 'being a women self help group member', 'friends and family members in the same job' and 'satisfaction in looking after own business'.

Table 23. Motivating factors for adoption of brackishwater aquaculture technologies by women

S. No	Motivating Factors	Percent	Weighted score	Rank
1.	Economic necessity	78	48.98	1
2.	Resource depletion in the sea	29	29.23	4
3.	To occupy time usefully	38	25.80	6
4.	Participate in a new avenue	29	28.57	5
5.	Raise the standard of living	35	30.39	3
6.	Dislike for households work	34	22.89	7
7.	Economic independence	48	33.82	2

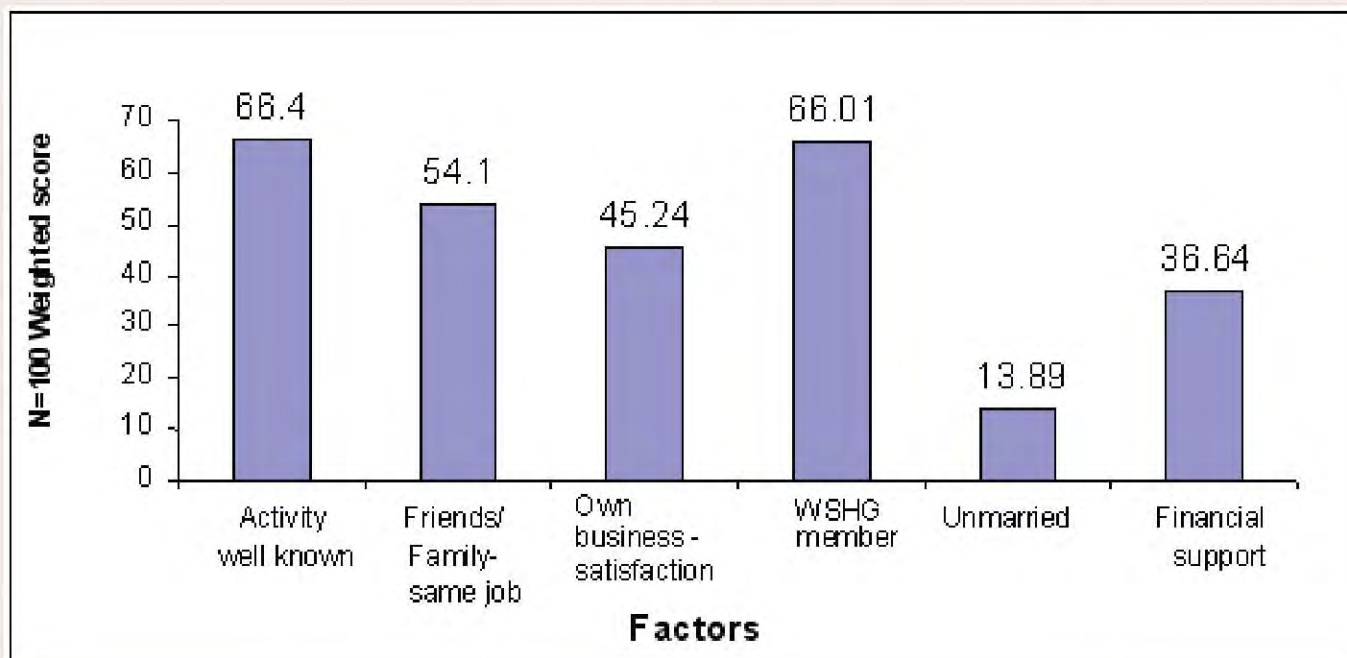


Fig.43. Facilitating factors encouraging brackishwater aquaculture in WSHG

Training and demonstration programmes to WSHGs on brackishwater aquaculture technologies

The following training and demonstration programmes on brackishwater aquaculture technologies were conducted:

- Three demonstration programmes on 'Value-added fish food products development' and 'Crab feed development' were conducted during 5-11 June 2008 for the WSHGs of Thonirevu village, Kattur village and Light House Kuppam of Tiruvallur District and Kadapakkam village of Kancheepuram District, Tamil Nadu.
- Three demonstration programmes on 'Crab feed development', 'Value-added fish food products development' and 'Crab fattening' were conducted during 18-27 February 2009 for the WSHGs beneficiaries of Thonirevu

Kattur and Light House Kuppam and Kadapakkam.

- Six crab fattening trails in the floating FRP cages were conducted during July-Sept 2008 at Thonirevu, Kattur and Kadapakkam.
- Installation of pens for crab fattening was done in Thonirevu and Kattur during March – April 2009.
- An awareness campaign was conducted for the beneficiaries of the project at Kadapakkam of on 24th December 2008. The programme was conducted to create market linkages between the beneficiaries of the project with the crab suppliers, fish feed suppliers and fish products marketing agents. The local NGO and the officials from the banks also participated in the programme.



Crab feed demonstration



Fish food products development



Field demonstrations on crab fattening



Title of the project : Immunomodulation studies in freshwater prawn *Macrobrachium rosenbergii* using recombinant proteins of *Macrobrachium rosenbergii* nodavirus

Lead Centre : CIFA, Bhubaneswar
Co-Principal Investigator : Dr.M.Shashi Shekhar
Location of the project : Chennai

Cloning, expression and purification of *Macrobrachium* nodavirus RNA dependent RNA polymerase gene

White tail disease is a recently reported disease of the giant freshwater prawn, *Macrobrachium rosenbergii* associated with *Macrobrachium rosenbergii* nodavirus (MrNV). In an earlier study, the amplification and sequence analysis of RNA dependent RNA polymerase (RdRp) gene of MrNV of an Indian isolate was reported, which confirmed the nodavirus infection in *M. rosenbergii* from India. For further investigations on the pathogenesis and molecular characterization of MrNV, a joint collaborative project has been initiated with CIFA, Bhubaneswar. A 738 bp PCR amplified product of RdRp gene of MrNV specific to RNA-1, was cloned and expressed as fusion recombinant protein in *Escherichia coli*. Expression of recombinant protein (44.5 kDa) was visualized by imidazole-SDS-zinc reverse staining and purified by electro-elution. The purified RdRp recombinant protein will be used for immunomodulation studies in *Macrobrachium rosenbergii* at CIFA.

Designing and cloning of MrNV siRNA's:

As an approach to develop antiviral therapeutics against MrNV, five gene specific and control siRNA's were designed based on MrNV RdRp gene (GenBank accession no. DQ146969). The oligonucleotides were annealed and ligated into pSilencer 4.1-CMV puro for each target gene. Transformation of the ligated mixture was carried out in DH5α competent cells. The positive clones were confirmed by PCR and sequencing reaction for the presence of siRNA inserts. The cloned siRNA's of MrNV will be analysed by *in vitro* antiviral studies at CIFA.

Title of the project : Development and evaluation of green water technology for aquatic bioremediation in coastal aquaculture

Principal Investigator : Dr.K.K.Krishnani
Co-operating Centre : CMFRI, Kochi
Location of the project : Chennai
Co-Investigators : Dr.M.Kailasam

The culture of shrimps in aquaculture system results in adverse environmental conditions such as low DO, high nutrient/ organic/ metabolic loads and pathogens which ultimately reach the environment through the drained waste. The objective of the project was to develop and evaluate greenwater technology in zero exchange and recirculation systems in coastal aquaculture for bioremediation of organic, inorganic and microbial loads.

Isolation of environmentally important bacteria from coastal aquaculture green water system

Environmentally important bacteria have been isolated from greenwater systems in coastal aquaculture and characterized using 16S rRNA gene approach and the sequences have been submitted in the GenBank (Table 24). Bacterial isolates are being screened for the development of microbial product, bioaugmentor and probiotics for chemical and microbial decontamination.

Diversity of functional genes trough metagenomic clone libraries

Diversity of chemolithoautotrophs has been examined in greenwater systems in coastal aquaculture through creation of metagenomic clone libraries of functional genes. Sequences submitted in the GenBank are given in Table 25. Adoption of molecular techniques led to the realization that microbial populations relevant to coastal aquaculture are much more diverse than previously thought using traditional culture methods. Nitrite oxidizing, nitrate reducing, sulfur oxidizing and nitrogen fixing bacteria were found abundantly in greenwater systems.

Development of Multiplex PCR and Real-time PCR methods for detection of environmentally important bacteria

Multiplex PCR technique has been developed for the detection of bacteria implicated in potent greenhouse gases and nitrogenous fluxes. In this connection, 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. The invention also relates to methods of identifying microorganisms capable of biotransformation. This can be applied to get a more accurate understanding of aquatic fluxes in aquatic and related environment.

Real-time PCR method has been developed for highly sensitive and specific fluorescence detection of ammonia oxidizing bacteria (AOB) in samples. In the present invention, based on *amoA* gene sequences, a pair of nucleic acid molecules and a nucleic-acid-binding entity have been developed. One of the clones obtained through creation of metagenomic clone library serves as a standard for obtaining the calibration curve and was also used as the positive control for real-time assay of AOB.

Table 24. 16S rRNA GenBank Accession of environmentally important bacteria

GenBank Accession No.	Isolate
FJ976651	<i>Pseudomonas aeruginosa</i> strain
GQ214397	<i>Achromobacter</i> sp.
GQ214399	<i>Achromobacter</i> sp.
GQ214401	<i>Alcaligenes</i> sp.
FJ842652	<i>Alcaligenes</i> sp.
FJ842653	<i>Alcaligenes</i> sp.
GQ246868	<i>Bacillus cereus</i> strain
GQ246869	<i>Bacillus</i> sp.
GQ246870	<i>Bacillus pumilus</i> strain
FJ842657	<i>Bacillus</i> sp.
FJ842658	<i>Bacillus</i> sp.
FJ842659	<i>Bacillus</i> sp.
FJ842660	<i>Bacillus</i> sp.
FJ660932	<i>Bacillus</i> sp. DBTD4
FJ660933	<i>Bacillus</i> sp. DBTA2
FJ660934	<i>Bacillus</i> sp. DBTN1
GQ214403	<i>Vibrio</i> sp. DBTG
FJ842656	<i>Vibrio</i> sp. DBTRY

Table 25. Sequences of functional gene submitted in the GenBank

GenBank Accession No.	Functional Gene
FJ609138 to FJ609150	Nitrifying bacteria clones- <i>nitrite oxidoreductase (norB)</i> genes (414bp)
FJ609151 to FJ609167	Nitrogen-fixing bacteria clones- <i>dinitrogenase reductase (nifH)</i> genes (407 bp).
FJ905001 to FJ905004	Uncultured denitrifying bacteria clones – <i>nitrate reductase (napA)</i> gene.
FJ904993 to FJ905000	Uncultured denitrifying bacteria clones – <i>nitrate reductase (napA)</i> gene.(414 bp)
FJ905006 to FJ905013	Uncultured denitrifying bacteria clones – <i>nitrate reductase (narG)</i> gene.
FJ620652 to FJ620659	Sulfur-oxidizing bacteria clones <i>sulfate thioesterase / sulfate thiohydrolase (soxB)</i> genes (753 bp).
FJ620646 to FJ620651	Sulfur-oxidizing bacteria clones <i>sulfate thioesterase / sulfate thiohydrolase (soxB)</i> genes (488 bp).
FJ620641 to FJ620645	Sulfur-oxidizing bacteria clones <i>sulfate thioesterase / sulfate thiohydrolase (soxB)</i> genes (282 bp).
FJ905005	Uncultured methanotrophic bacterium clone- <i>Methane monooxygenase (pmoA)</i> gene.
FJ976652	<i>Pseudomonas aeruginosa</i> DBT1BNH3 <i>nitrite reductase nirS</i> gene.
FJ976653	<i>Pseudomonas aeruginosa</i> DBT1BNH3, <i>nitrous oxide reductase (nosZ)</i> gene.
GQ214402	<i>Achromobacter</i> sp. N1DBT <i>Nitrous oxide reductase (nosZ)</i> gene.
GQ214400	<i>Achromobacter</i> sp. DBTN3 <i>Nitrous oxide reductase (nosZ)</i> gene.
GQ214398	<i>Achromobacter</i> sp. N1DBT <i>Nitrous oxide reductase (nosZ)</i> gene.

ICAR NETWORK

Title of the project : **Mega seed project on “Seed production in agricultural crops and fisheries”.**

Nodal Officer : Dr.S.M.Pillai

Location of the project : Chennai

Principal-Investigators

Shrimp : Dr.P. Ravichandran

Seabass : Dr.A.R.Thirunavukkarasu

The mega seed project started in the X Plan during 2005-06 has two components of quality seed production of shrimp and seabass. Realising the importance of this project in the agricultural production of the country, ICAR

has extended this project during the XI Plan with the revised seed production targets of shrimp and seabass for 2008-09 as 25 lakhs and 10 lakhs, respectively. During 2008-09, 13.4 lakh PL20 of shrimp seed (*P. monodon* – 11 lakh, *F. merguensis* – 0.4 lakh and *M. japonicus* – 2 lakhs) and 3.1 lakhs seabass *L. calcarifer* seed were produced and supplied to farmers and other agencies.

Title of the project : Impact assessment of fisheries research in India

Lead Centre	:	National Academy of Agricultural Research Management, Hyderabad
Co- Investigator	:	Dr.T.Ravisankar
Location of the project	:	Chennai
Colloborating Centres	:	CIBA, Bhubaneswar; CMFRI, Kochi; CIFT, Kochi, CIFRI, Barrackpore; NCAP, New Delhi; IASRI, New Delhi and College of Fisheries, Mangalore

The macro (secondary) data for the period 1987 to 2006 were collected and basic analysis for growth and stability were done and research investments were correlated to sectoral growth. Salient findings of macro data at the national level are the following: efforts put on popularizing the BMPs including seed testing with PCR kits by CIBA, MPEDA and other related institutions and widespread use of CIBA-PCR kit which has led to reduction in amplitude of variation in shrimp production. To be specific, inter year production change oscillations which were on the negative side came down from -30 to +10% to -3 to +25%. Sustainability of production was one of the impacts of research conducted by CIBA.

The results presented below relate to the work done by CIBA with regard to brackishwater aquaculture sector. Primary data were collected from 240 shrimp farms. The states identified for survey were Andhra Pradesh and Tamil Nadu for modern scientific shrimp farming and Kerala and West Bengal for traditional shrimp farming. From each state, two districts were identified according to a multi state random sampling procedure. In Andhra Pradesh, East Godavari and West Godavari districts were selected. In a similar way, Thanjavur and Nagapattinam districts in Tamil Nadu; Ernakulam and Allapuzha districts in Kerala and North 24 Parganas and South 24 Parganas districts in West Bengal were selected. The survey work was completed in November 2007. The data and summary results indicate the positive returns to research investments in brackishwater aquaculture. Yields are higher by three to six times in modern scientific farms of Tamil Nadu and Andhra Pradesh compared to traditional farms in Kerala, West Bengal. However, number of crop failures were also higher (three failures in six crops) in modern scientific farms indicating the need for research support to ensure availability of disease free seed of *Penaeus monodon* and a design enforce the implementation of Better Management Practices (BMPs) for health management. More than disease risks, loss of realization of profits was the major problem faced by the farmers. Slump in farm gate prices from Rs. 330 - 480 per kg to Rs. 240 - 320 per kg was the outcome of lowering global demand and fall in global prices from 11 USD to 6 USD per kg of shrimp during the period 2007-2008. Wild fluctuations in dollar-rupee exchange rates (between Rs. 38 to Rs. 50 per USD) during 2007-2008 was the other reason for fall in effective price realisation. Implications for future research are diversification of species cultured to mitigate the production and price risks due to mono cropping of *P.monodon*. Suitable policy support to mitigate the risk due to falling global prices and to develop a local market is a crucial requirement at this stage in order to revive the sector. The project was completed in September 2008.

Title of the project : Application of micro organisms in agriculture and allied sectors - microbial diversity and identification

Lead Centre : National Bureau of Agriculturally Important Microorganisms, Mau
Principal Investigator : Dr.T.C.Santiago
Location of the project : Chennai
Co-Investigators : Dr. N. Kalaimani and Dr. S.V.Alavandi

Brackishwater ecosystems such as mangroves, estuaries, salt pans and aquaculture environments are abundant in microbial diversity known to have diverse biological properties of their own. This project aims to identify microbes with novel properties and isolate novel genes such as salt tolerant genes and drought resistant genes which are of great significance to agriculture. A total of 805 isolates of microbes comprising of 657 bacteria, 65 actinomycetes, 55 fungi 21 yeast isolates and 7 *Archaeobacteria* were isolated from different types of brackish water eco-systems. Notable among the bacteria include a halophilic bacterium, *Bacillus sp* which has the ability to grow in 30% NaCl concentration. The gene responsible for the transport of glycine- betaine (osmolytes) has been identified in a *Bacillus sp*. (Fig. 44).



Fig. 44. Amplification of glycine betaine gene in *Bacillus sp*.



Fig. 45. PCR Amplification of fungal internal transcribed space region by using ITS primers

Phosphate solubilising bacteria are an ecologically important group of microbes that help in availability of phosphorus to the plants. The molecular identification of phosphate solubilising fungi using internal transcribed spacer (ITS) primers was standardised (Fig. 45) and the three fungal isolates so far identified were *Aspergillus sydowii*, *Aureobasidium pullulans* and *Phialemonium curvatum*.

A total of 48 bacterial isolates were identified and two archaeobacterial isolates were deposited to NBAIM.

Title of the project : Application of micro organisms in agriculture and allied sectors - agrowaste management, bioremediation and microbes in post harvest processing

Lead Centre : National Bureau of Agriculturally Important Microorganisms, Mau
Principal Investigator : Dr.S.V.Alavandi
Location of the project : Chennai
Co-Investigators : Dr.T.C.Santiago and Dr.N.Kalaimani

Microbes play an important role in biogeochemical cycling in the biosphere and are primary agents for the bioremediation of the contaminated environments. These can be used for bioremediation of shrimp farm discharge water, which includes metabolites and substances such as ammonia, nitrite and sulphides. Hence, environmentally

important groups of bacteria involved in nitrogen and sulfur cycles in the environment such as chemolithotrophic nitrifiers, aerobic denitrifiers, heterotrophic nitrifiers, chemolithotrophic and heterotrophic sulfur oxidizers were isolated using enrichment protocols (Table 26) from shrimp culture pond water and sediment samples, and evaluated for their efficiency to oxidize ammonia, nitrite and sulfide *in vitro*. Efficient heterotrophic nitrifying bacteria were identified as

Rhodococcus ruber, *Kytococcus sedentarius*, *Virgibacillus pantothenicus*, *Agromyces* sp., *Alcaligenes* sp., *Bacillus horikoshii*, *B. flexus*, *B. firmus*, *B. aquimaris*, *Micrococcus pseudomonas* spp., etc. Other important groups, isolated from shrimp culture ponds were incomplete aerobic denitrifying bacteria such as *Nitratireductor* sp., aerobic denitrifying bacteria such as *Marinobacter* sp. denitrifying and agarolytic bacteria such as *Marinimicrobium* sp., and heterotrophic sulfur oxidizers such as *Halomonas* sp., *Liella* sp., and *Arthrobacter* sp. Sediment samples from aquaculture ponds were also enriched and processed for sulfur bacteria such as *Beggiatoa* sp. using six different media. Young colonies show concentric circles and super coiled structures with accumulation of elemental sulfur inclusions when grown in agar containing sulfide (Fig. 46). Four isolates were successfully isolated and their efficiency in sulfide removal is being examined.

Table 26. Bacteria with potential for bioremediation of ammonia, nitrite and sulfide isolated from shrimp culture ponds

S.No	Bacterial Group	No. of isolates
1	Chemolithotrophic ammonia oxidizing bacteria	23
2	Aerobic denitrifying bacteria	8
3	Chemolithotrophic nitrite oxidizing bacteria	2
4	Heterotrophic nitrifiers	22
5	Chemolithotrophic sulfur oxidizers	60
6	Heterotrophic sulfur oxidizers	33



Fig. 46. Isolation of heterotrophic sulfur oxidizing *Beggiatoa* sp. (a) on extracted hay agar, (b) on extracted hay agar containing sulfide

Anaerobic batch bioreactor was designed for enrichment of anaerobic ammonia oxidizing (anammox) bacteria and five deep core sediment samples are being enriched for anammox bacteria and are periodically monitored using anammox specific PCR. However, growth of anammox bacteria is yet to be observed.

Efficient isolates of nitrifying and denitrifying bacteria were used for construction of biofilms on few biodegradable and non-biodegradable materials such as nylon mesh, aquamats etc., in order to use biofilms for the experimental evaluation of bioremediation of ammonia and they were examined using scanning electron microscopy (Fig. 47). Initial experiments indicated that biofilms on aquamats were efficient in the removal of ammonia.

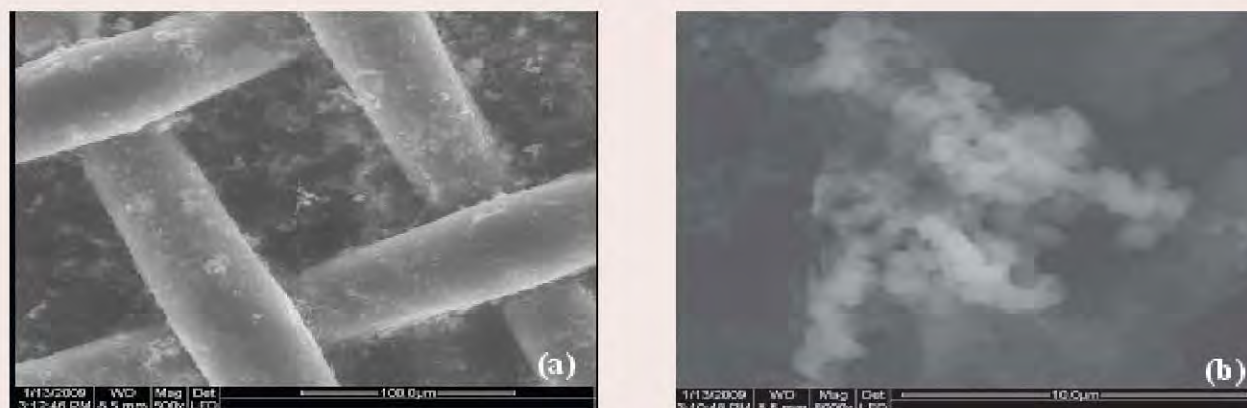


Fig. 47. Biofilm of nitrifying bacteria (a) attached to alginate coated nylon mesh (b) magnified view showing bacteria.

Title of the project : Outreach Activity on Fish Feeds

Principal Investigator : Dr.S.A.Ali
 Lead Centre : CIFA, Bhubaneswar
 Location of the project : Chennai
 Co-Investigators : Dr.J.Syama Dayal, Dr.K.Ambasankar, Dr.T.K.Ghoshal, Dr.A.R.Thirunavukkarasu, Dr.M.Kailasam, Dr.J.K.Sundaray and Dr.Debasis De

Determining optimal protein : fat ratio in the diet of seabass

Diets with three levels of protein (high, medium and low), and each diet having three levels of lipids were evaluated in a 3 x 3 factorial experiment using seabass fingerlings (9-10 g) in a 60 day feeding trial with the objective of finding the optimal protein : fat (energy) required for Asian seabass. The results (Fig. 48) indicate that seabass fingerlings require a high protein and high energy diet for better growth and FCR. The fish can also perform equally well with low FCR at medium protein with high lipid level.

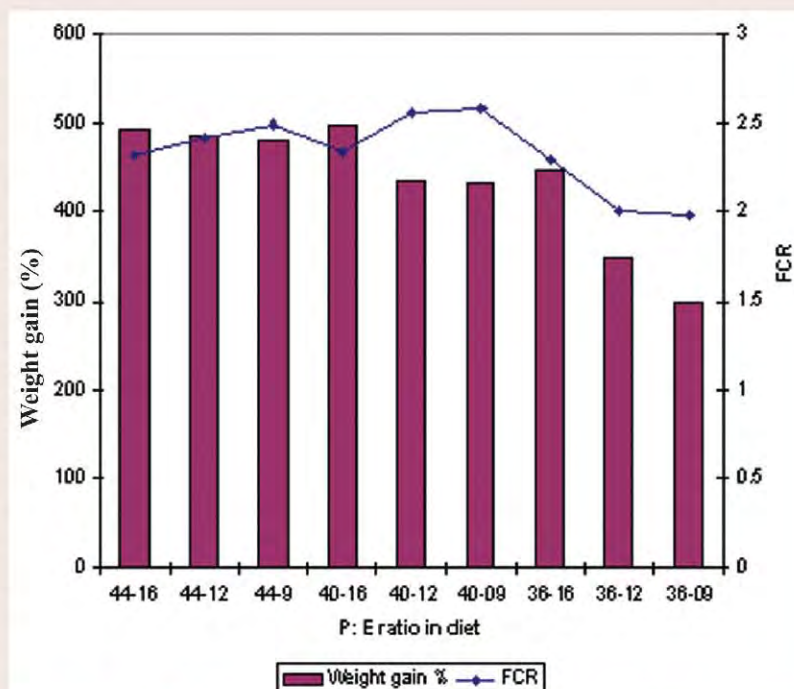


Fig. 48. Effect of protein: fat ratio on growth and FCR in seabass

Evaluation of potential animal and plant products as feed ingredients for seabass.

Attempts are being made to explore the potential of new ingredients for inclusion in fish feeds, especially for carnivorous fishes like the seabass. Two ingredients, meat/bone meal and chicken waste meal were identified and collected from Tamil Nadu. The proximate composition of both the ingredients was analyzed and given in Table 27. Both ingredients have high protein and lipid content, and are good potential ingredients for seabass feed formulations.

Plant feed ingredient samples like mustard oil cake, sunflower cake and sesame cake, from four regions of West Bengal (four samples of each ingredient from each region) have been collected and analysed for their proximate composition. The data are summarized in Table 28.

Table 27. Proximate composition of meat and bone meal and chicken waste meal

Nutrient composition/ ingredient	Chicken waste meal	Meat and bone meal
Moisture (%)	2.0	2.41
Crude protein (%)	55.30	47.42
Ether Extract (%)	25.0	8.24
Crude fibre (%)	5.76	6.85
Total Ash (%)	8.89	34.15
NFE (%)	3.05	0.93
Acid insoluble Ash (%)	2.13	4.32
Gross energy Cal/g	5838	4031



Chicken waste meal



Meat and bone meal

There was no significant difference in proximate composition of ingredients from different regions except for sunflower cake from the eastern region where the protein was low (25.77%) and ether extract was high (15%) in which extraction of oil is incomplete. The data on the ingredients from different regions indicate that these can be utilized in aqua feeds.

Evaluation of formulated micro feeds for nursery rearing of Asian seabass

A micro diet with 45% protein and 12 % lipid was developed for nursery rearing of seabass (*Lates calcarifer*). The feed was tested in different farmer's ponds in Andhra Pradesh (Nellore and Bhimavaram) both in hapas (9) and in nursery ponds (2). The performance of the nursery feed was very good with survival rate of 50-72% in 30 days and the fishes attained an average body weight of 2-4 g in the hapas. Nursery diet was also tested in farmer's ponds in two locations at Bhimavaram and Nellore in Andhra Pradesh. The seabass larvae were successfully reared with diet for 60 days and the fry attained 60-80 g with 35-50% recovery. The CIBA nursery diet can be successfully used for large-scale nursery rearing of seabass fry for producing fingerlings. This feed technology is now ready for commercial scale production.

Table 28. Proximate composition (% dry matter basis) of three major oilseed cakes available in the four regions of West Bengal

Ingredients	Region of West Bengal	Dry matter (%)	Crude protein (%)	Ether extract (%)	Crude fibre (%)	Ash (%)	Acid insoluble ash (%)
Mustard cake	East	93.9± 2.12	36.9±0.16	5.5±0.08	5.9±0.11	8.5±0.20	4.2±0.11
	West	92.5±1.16	33.2±0.51	5.2±0.04	5.3±0.25	8.5±0.15	4.0±0.35
	North	91.9±1.21	34.3±0.29	5.0±0.03	5.9±0.06	7.9±0.12	3.6±0.41
	South	93.6±1.58	34.6±0.41	5.6±0.11	5.1±0.03	8.2±0.26	4.1±0.09
	Average	92.9±0.46	34.8± 0.77	5.3±0.13	5.5±0.20	8.3±0.15	3.9±0.14
Sunflower cake	East	94.3±1.52	25.8±0.31	15.1±0.32	11.3±0.12	7.0±0.11	0.9±0.05
	West	93.7±2.65	31.3±0.35	12.1±0.12	10.4±0.15	7.6±0.05	1.1±0.02
	North	92.2±1.32	30.9±0.46	11.9±1.01	12.4±0.19	7.1±0.05	1.7±0.12
	South	94.2±2.45	32.6±0.86	10.3±0.86	11.4±0.29	8.1±0.12	1.1±0.10
	Average	93.6±0.53	30.1±1.50	12.3±1.02	11.3±0.41	7.5±0.25	1.2±0.15
Sesame cake	East	95.5±1.58	31.8±0.52	8.9±0.35	9.5±0.05	7.5±0.32	1.1±0.02
	West	95.4±1.98	32.2±0.22	9.2±0.29	9.6±0.04	8.2±0.12	3.4±0.05
	North	90.5±2.21	29.4±0.10	9.4±0.42	8.9±0.11	8.5±0.11	2.9±0.01
	South	93.6±1.12	31.0±0.15	7.9±0.32	9.5±0.24	7.4±0.02	1.9±0.21
	Average	93.7±1.15	31.1±0.63	8.8±0.34	9.4±0.15	7.9±0.27	2.3±0.49

Evaluation of formulated pellet feeds for grow-out culture of Asian seabass

A formulated feed containing 38% protein and 8% fat was developed for grow-out culture of seabass. The feed was produced as sinking pellets and tested for grow-out culture in FRP tanks at Muttukadu and in farmer's ponds. The feed acceptability was very good and the fish attained 0.8-1.0 kg in 6-8 months with FCR of 1.8:1 in FRP tanks. The grow-out feed was also tested in farmer's ponds at Nellore and Bhimavaram. The stocked fish attained an average of 1.0 kg weight at Nellore and 840 kg fish were harvested from a one acre pond in 8 months. At Bhimavaram, the fish attained 900-1100 g and 2000 kg fish were harvested from a 2 acre pond in 8 months (including nursery rearing). The FCR was 2.1 at both the places. CIBA formulated feed can now be successfully used for grow-out culture of seabass and this feed technology is now ready for commercial production.

Development of Farm-made feeds for seabass

Farm made feed was developed using exclusively local ingredients for seabass. Four different feeds containing mustard cake and poultry waste as the main ingredients with protein levels in the range of 36-38% were formulated

and tested in yard experiments with wild seabass fry (4-5 g) at Kakdwip research station. The fry were quickly weaned to the formulated feeds and attained 8-10 g weight in 5 weeks (Table 29). The fish fed with feed IV attained the highest weight gain. These feeds can be easily made by farmers themselves at farm site and are less expensive than commercial feeds.

Table 29. Performance of Asian seabass fry fed with farm made feeds

Parameter	Feed I (mustard cake 5% + poultry waste 40%)	Feed II (mustard cake 5% + poultry waste 33%)	Feed III (mustard cake 7% + poultry waste 30%)	Feed IV (mustard cake 10% + poultry waste 24%)
Initial body wt. (g)	4.4 ± 0.02	4.4 ± 0.01	4.4 ± 0.02	4.6 ± 0.01
Final body wt. (g)	8.2 ± 0.11 ^a	8.3 ± 0.20 ^a	9.4 ± 0.07 ^b	9.9 ± 0.05 ^c
Total wt. gain (g)	3.8 ± 0.15 ^a	3.9 ± 0.19 ^a	4.9 ± 0.07 ^b	5.4 ± 0.05 ^c
ADG (mg/d)	108.6 ± 4.36 ^a	110.4 ± 5.45 ^a	142.5 ± 1.97 ^b	155.3 ± 1.42 ^c
Weight gain (%)	85.6 ± 3.62 ^a	87.1 ± 4.13 ^a	112.6 ± 1.72 ^b	122.2 ± 1.02 ^c
DM intake (g/d)	0.4 ± 0.01 ^a	0.4 ± 0.01 ^a	0.4 ± 0.00 ^b	0.4 ± 0.00 ^b
FCR	3.2 ± 0.02 ^c	3.2 ± 0.03 ^c	2.9 ± 0.05 ^b	2.6 ± 0.02 ^a
SGR (%)	1.8 ± 0.04 ^a	1.7 ± 0.08 ^a	2.2 ± 0.02 ^b	2.3 ± 0.01 ^b
Survival (%)	63.3 ± 1.67 ^a	68.3 ± 1.67 ^{ab}	71.7 ± 1.67 ^{bc}	76.7 ± 1.67 ^c

Means with different superscripts are significantly different in the same row

Title of the project : Nutrient profiling and evaluation of fish as a dietary component

Principal Investigator : Dr. J.Syama Dayal
Lead Centre : CIFRI, Barrackpore
Location of the project : Chennai
Co-Investigator : Dr.S.Kannappan

Nutrient profiling of brackishwater species

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, *Penaeus monodon*, Indian white shrimp, *Fenneropenaeus indicus*, seabass, *Lates calcarifer* and grey mullets, *Mugil cephalus*

were collected from Andhra Pradesh, Kerala, Tamil Nadu and West Bengal from August 2008 to January 2009. Different size groups of samples were analysed for their nutrient profiles of the edible portions (Table 30). The average crude protein values ranged between 19.3 - 23.5% and this can be taken as the baseline value for tiger shrimp. Wide variations of ether extract values were observed between different size groups and it ranged between 0.38 - 3.01%.

Table 30. Proximate composition (g/100 g edible portions) of two different shrimp and two finfish species collected from different geographical locations during August 2008 to March 2009

Species	Weight (g)	No of samples	Moisture (%)	Crude protein (%)	Ether extract (%)	Total ash (%)
<i>P. monodon</i>	36.7 ± 0.34	60	72.9 ± 0.34	21.5 ± 0.25	1.6 ± 0.13	1.7 ± 0.07
<i>F. indicus</i>	23.4 ± 3.36	24	73.2 ± 0.63	21.7 ± 0.41	1.0 ± 0.11	1.5 ± 0.11
<i>L. calcarifer</i>	393.3 ± 28.94	24	74.5 ± 0.67	18.1 ± 0.43	1.9 ± 0.22	3.4 ± 0.20
<i>M. cephalus</i>	314.5 ± 49.23	30	71.6 ± 0.74	18.4 ± 0.55	3.8 ± 0.49	3.5 ± 0.14

The average crude protein and ether extract values of *F. indicus*, were in the range of 20.4 - 23.41 % and 0.85-1.28 % respectively. The average crude protein and ether extract values of *L. calcarifer* were in the range of 17.86 - 18.62 and 1.14-2.51%, respectively. The average crude protein values of *M. cephalus* ranged between 17.15 - 18.80%. Variations in ether extract values were observed between different size groups and it ranged between 2.02-6.24%. Glutamic acid is the most predominant amino acid in all the four species analysed and it ranged between 12.73-17.19 g/100 g protein (Table 31). Among the essential amino acids, arginine, leucine and lysine are abundant in all the four species and values were in the range of, 6.14-8.32 g/100 g protein. The nutritional data base of these species will be compiled over the years and analysed. This database can be used by physicians for dietary advice.

Table 31. Amino acid composition of shrimp and finfish collected from different geographical locations

S.No	Amino Acid (g/100 g protein)	<i>P. monodon</i> ¹ (Wild)	<i>P. monodon</i> ¹ (Cultured)	<i>F. indicus</i> ² (Wild)	<i>L. calcarifer</i> ¹ (Wild)	<i>M. cephalus</i> ³ (Wild)
1	Aspartic acid	7.99	8.79	8.32	8.89	9.02
2	Threonine	4.33	4.01	3.45	4.21	4.32
3	Serine	3.16	2.98	2.94	3.95	4.14
4	Glutamic acid	17.19	16.52	15.77	12.73	14.15
5	Proline	3.87	4.02	3.85	3.25	3.18
6	Glycine	6.58	6.16	6.68	7.32	4.73
7	Alanine	5.04	4.86	6.12	5.87	5.86
8	Cystine	0.87	0.74	0.66	1.12	0.27
9	Valine	4.39	4.87	5.27	5.19	4.24
10	Methionine	3.15	2.88	2.19	3.16	3.27
11	Isoleucine	4.62	4.63	4.98	5.03	4.27
12	Leucine	7.92	7.88	7.16	8.15	7.53
13	Tyrosine	3.37	3.28	4.25	3.32	3.11
14	Phenyl alanine	2.87	3.10	3.86	3.96	4.94
15	Histidine	2.16	1.99	2.11	1.87	1.24
16	Lysine	7.91	7.82	7.34	8.32	6.85
17	Arginine	8.12	8.35	8.11	6.42	6.14
18	Tryptophan	1.23	1.16	1.07	0.98	1.31

¹West Bengal; ²Tamil Nadu; ³Andhra Pradesh

A survey has been conducted to assess the fish consumption rate and pattern correlating it to general health profile of population in Salem, Cuddalore and Nagapattinam Districts of Tamil Nadu. The results indicated that mainly fresh water species like Catla and Rohu are predominantly consumed in Salem District, whereas marine fish species are consumed in coastal districts of Cuddalore and Nagapattinam. This data base will be analysed after developing the software and this analysis will be carried out on all India basis with data from other collaborating institutions.

Title of the project : Fish genetic stocks

Principal Investigator : Dr.G.Gopikrishna
 Lead Centre : NBFGR, Lucknow
 Location of the project : Chennai
 Co-Investigators : Dr.K.Vinay Kumar

This inter-institutional project aims to characterize the morphological variations and intra-specific genetic variability in different stocks of tiger shrimp *Penaeus monodon* stocks from different geographic locations viz. Kakdwip, Paradip, Vishakapatnam, Chennai and Tuticorin in the East Coast, Kollam, Ratnagiri and Mangalore in the West Coast and Andaman Islands. During 2008, seventysix wild samples of tiger shrimp were collected from Kasimedu fish landing centre in Chennai. The digital images of these shrimps have been stored for conversion into truss morphometric data. The DNA from 20 shrimps has been isolated and stored for DNA marker studies. Instead of using a custom made commercial software, three free software available in the web viz., tpsUtil, tpsDig and PAST were downloaded and by utilizing them for specific steps, it was possible to obtain morphometric measurements from digitized images.

National Fisheries Development Board

Title of the project : Exploring market opportunities for fisheries sector in India

Lead Centre : National Centre for Agricultural Economics and Policy Research (NCAP)
 Principal Investigator : Dr. T.Ravisankar
 Location of the project : Chennai
 Co-Investigators : Dr.M.Krishnan and Dr.M.Kumaran

The objectives of the study were to assess the existing fish market infrastructure and to document the innovative fish marketing models as case studies. CIBA was assigned to cover major fish markets in Chennai and conduct case studies in Tamil Nadu and Andhra Pradesh covering all fishery sub sectors. The investigations done by CIBA revealed that intermediaries take 42 to 58 % of the consumer rupee as marketing margin and therefore focused effort to shorten the marketing channel from the present 6-8 steps would allow for more benefits to both the

producer and consumer. Domestic fish demand would further increase if the present consumer dissatisfaction on poor marketing infrastructure (72%) and unhygienic handling of fish (68%) in city markets is addressed. However, one of the impediments in modernizing conventional fish markets is 'private individual/organization' ownership of traditional fish markets. Since fish consumption drops to 15 to 25 % according to day of the week, moon phase, auspicious months, if aquaculture production is to be targeted for domestic market, the timing of the output reaching the market should be synchronised with the peak seasons of demand.

According to the Confederation of Indian Industries (CII) estimate, Chennai is to grow to a \$100-billion economy, 2.5 times its present size, by the year 2025, offering good scope for expanding domestic marketing of fish. Chennai wholesale fish markets source from across the country's major fish markets like Howrah and Calicut to fill the demand supply gap for particular fish varieties arising due to ban on fish capture from the seas of east coast. These markets also source their fish from fish farms of Andhra Pradesh, Tamil Nadu and fish from capture fisheries of Tamil Nadu, Andhra Pradesh and Kerala landing Centres. Chennai has presently five major wholesale cum retail fish markets and 150 medium and small sized neighbourhood fish markets. The Chindadripet, Saidapet, Kasimedu, Vanagaram, and Moolakothalam markets are traditional wholesale cum retail fish markets in Chennai. They transact between Rs. 100 and 150 lakhs worth of fish and dry fish in a day. On an average as reported by office bearers of the traders association, around 100 wholesalers, 500 retailers and 5000 unskilled labourers are directly employed in these markets along with a large number of people indirectly employed in backward and forward linkages. The mini consumer survey of 400 fish consumers in Chennai city indicated that the performance of these markets could be considerably improved if sanitation, parking facilities, proper weighing and icing facilities are introduced. Market share of these markets are slowly being taken away by Modern Retail Format (MRF) chain stores like Reliance Fresh, Spencer's Daily, Fish-O-Fish and Neithal stalls which are spread across the city. Modern Retail Format chain stores' performance suit the busy schedule of Chennai consumers' lifestyle and these business establishments are developing fast in the city.

A National symposium on 'Developing Domestic Fish Markets for Self Sustaining Aquaculture Sector in India - Prospects, Problems & Policy Interventions' was held under the project on 30th October 2008 in the CIBA Headquarters. Aqua farmers, hatchery owners, feed millers, traders and fish retail chains and a Women Self Help Group were invited to present their side of issues regarding domestic fish marketing. The major consensus arrived with regard to an immediate action plan were: increasing the visibility of fish at national level; determination of the market share – region wise of fresh / chilled / frozen / value added products species, size-wise local retail / supermarkets / restaurants, seasonal variation; developing a comprehensive and consistent reporting base for national aquaculture production and value and the creation of large fish markets, where aqua farmers can sell the produce. Learning and understanding existing innovative model marketing initiatives so that they could be reproduced in other places was also identified as an action point.

Title of the project : Demonstration of Asian seabass *Lates calcarifer* farming in the pond culture system

Principal Investigator : Dr.A.R. Thirunavukkarasu

Location of the project : Chennai, Sirkazhi, Nellore, Saphale

Co-Investigators : Dr. M. Kailasam, Dr.J.K.Sundaray, Dr.S.A.Ali and Dr.J.Syama Dayal

The objective of the project is to demonstrate the techno-economic viability of seabass farming in pond culture systems. The work has been initiated in three selected farmers' ponds in Saphale (Maharashtra), Sirkazhi (Tamil

Nadu) and Nellore (Andhra Pradesh) from March 2009. This frontline demonstration has been made possible since CIBA is able to produce required seabass seed in its hatchery based on the technology developed for round the year production of seabass fry. It incorporates the results of the package of practices developed for nursery and grow-out rearing of seabass. Instead of the costly imported feed, feed developed for seabass with indigenous ingredients is being used. Currently in the three locations one set of nursery rearing has been completed and grow-out culture is progressing.

National Agricultural Innovation Project

Title of the project : Agro-web digital dissemination system for Indian agricultural research

Consortium Lead Centre : NBPGR, New Delhi

Co-Principal Investigator : Dr.T.Ravisankar

Location of the project : Chennai

The major objective of this subproject is to identify standards, develop uniform guidelines, content management strategies and a model template for websites of ICAR institutes. The role of CIBA is to develop a model website for fisheries institutes. CIBA's website was completely revised and a module of intranet enriched with staff utilities was included. Apart from a web based email service, the circulars, official forms, staff telephone directory and other information are posted in intranet. Users access intranet with their email id and password were provided. Five databases viz., aquaculture production and export database, GPF status, earned leave details, personal computer inventory and non consumable stock entries were made operational.

As part of approved technical programme, a stakeholder meeting for analyzing website development and maintenance issues faced at ICAR Fisheries Institutes was organized on 17th November 2008. Webmasters of all ICAR Fisheries research institutes and two associate partner institutes participated in the deliberations. Experts from TANUVAS, NIC and industry also participated in the discussions. The output of the meeting was summarized and published as 'Heuristic evaluation of ICAR Fisheries Research Institutes'. A consortium project review meeting was hosted by CIBA on 10th February 2009.

Title of the project : An export oriented marine value chain for farmed-seafood production using Cobia (*Rachycentron candum*) through rural entrepreneurship

Consortium Lead Centre : TANUVAS, Chennai

Co-Principal Investigator of the Consortium Partner : Dr. A.R. Thirunavukkarasu

Location of the project : Chennai

The objectives of the project is the domestication of the breeders of cobia *Rachycentron candum*, and standardisation /validation of breeding protocol to produce quality seed for coastal farming in Indian conditions. The project was initiated in December 2008. Collection of cobia breeders from wild sources has been initiated. Transportation and acclimatization of the fishes to hatchery conditions are being standardized.

5. 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	NFDB sponsored fish farmers' training programme on coastal aquaculture	20 April 2008	80
2	On-farm training to the 4 th year B.F.Sc students of West Bengal University of Animal & Fishery Sciences, Kolkata	9-24 June 2008	15
3	Seabass <i>Lates calcarifer</i> fish seed production and culture	20-29 August 2008	15
4	Shrimp breeding and hatchery technology	16-30 September 2008	5
5	Brackishwater aqua farming	5 December 2008	19
6	SPSS orientation training	17 December 2008	50
7	NFDB sponsored fish farmers' training programme on fishery livelihood	18 December 2008	30
8	Soil and water quality management in brackishwater aquaculture	29 December 2008 - 7 January 2009	4
9	ICAR sponsored Winter School on seed production and culture of brackishwater finfishes with special reference to Asian seabass <i>Lates calcarifer</i>	20 January – 9 February 2009	25
10	Statistics, SPSS and software skills	16-21 March 2009	40



Inauguration of Winter School on seed production and culture of brackishwater finfishes with special reference to Asian seabass *Lates calcarifer*



SPSS Training

6. TRAINING AND EDUCATION

HUMAN RESOURCE DEVELOPMENT

INTERNATIONAL

Sl. No.	Name & Designation	Training Programme	Organisation	Duration
1	Dr. S. Kulasekarapandian Principal Scientist	Study visit in mariculture discipline	Central Laboratory for Aquaculture Research, Agricultural Research Centre, Egypt	16-29 July 2008
2	Dr.(Mrs.) P. Nila Rekha Senior Scientist	Training programme under "Norman E.Borlaug Fellowship Programme 2008 under Indo-US Agricultural Knowledge Initiative"	Iowa State University, USA	10 October - 23 November 2008
3	Dr.P. Ravichandran Head, CCD	Shrimp dialogue organised by WWF and NACA on Identifying challenges and opportunities for scaling up BMP adoption in the Asia-Pacific region	NACA, Thailand	17-21 November 2008

NATIONAL

I) SCIENTISTS

Sl. No.	Name and Designation	Training programme	Duration	Organisation
1	Dr.K.Vinaya Kumar Scientist	Molecular biology techniques for personnel involved in aquaculture / marine biology	20 February - 18 April 2008	Centre for Cellular and Molecular Biology (CCMB), Hyderabad
2	Dr.R.Ananda Raja Scientist			
3	Dr.S.A.Ali Principal Scientist	Graduate course in IPR and technology transfer	13-16 April 2008	Society for Technology Management, Hyderabad
4	Dr.K.P.Jithendran Principal Scientist	Negotiating strategies in work environment	5-16 May 2008	Administrative Staff College of India, Hyderabad

5	Dr.M.Kumaram Senior Scientist	HACCP for hatchery and culture operation	14-17 May 2008	SAP and Central Institute of Brackishwater Aquaculture (CIBA), Chennai
6	Dr.K.Ponnusamy Senior Scientist			
7	Dr.(Mrs)M.Poornima Scientist (SS)			
8	Dr.Sujeet Kumar Scientist	Refresher course to aquaculture sector and hatchery management	18-22 June 2008	Mandapam Research Centre, Central Marine Fisheries Research Institute (CMFRI), Mandapam
9	Dr.Sujeet Kumar Scientist	Molecular biology for personnel involved in works pertaining to aquaculture / marine biology	4 August - 29 September 2008	CCMB, Hyderabad
10	Dr.K.K.Krishnani Senior Scientist	DNA sequencing and microbial identification	1-7 September 2008	National Bureau of Agriculturally Important Microorganisms, Mau, U.P.
11	Dr.J.Syama Dayal Senior Scientist	Training on “Methodology workshop for standard analytical methods”	16-21 September 2008	Central Institute of Fisheries Technology, Kochi
12	Dr.S.Kannappan Senior Scientist			
13	Dr.T.Ravisankar Senior Scientist	Management development programme on “Public-private partnerships for innovation in agriculture”	15-21 October 2008	National Academy for Agricultural Research Management (NAARM), Hyderabad
14	Dr.A.Panigrahi Senior Scientist	Winter school on “Recent advances in fish and shellfish immunology and its applications”	21 October - 10 November 2008	Central Institute of Freshwater Aquaculture, Bhubaneswar
15	Dr.(Mrs.)M.Poornima Scientist (SS)	Intellectual Property Rights and related issues	3-7 November 2008	Consumer Unity & Trust Society, Jaipur
16	Dr.Debasis De Scientist (SS)	Winter school on “Harnessing microbial diversity for use in animal nutrition”	4-24 November 2008	National Institute of Animal Nutrition and Physiology, Bangalore
17	Dr.A.R.Thirunavukkarasu Head, FCD	Management development programme on “Leadership development”	22-26 December 2008	Indian Institute of Management, Lucknow

18	Dr.K.K.Krishnani Senior Scientist	DST programme on “Dimensions of nanotechnology”	9-13 February 2009	National Institute of Advanced Studies, Bangalore
19	Dr.K.Vinaya Kumar Scientist	Advances in DNA marker techniques	17-28 February 2009	Cochin Unit of National Bureau of Fish Genetic Resources, Kochi
20	Mrs.P.Mahalakshmi, Scientist (SS)	Bioinformatics and its applications with special reference to genomics, proteomics and drug discovery	9-13 March 2009	Madras Veterinary College, Chennai
21	Dr.(Mrs.)M.Poornima Scientist (SS)			

II) TECHNICAL STAFF

Sl. No.	Name and Designation	Training programme	Duration	Organisation
1	Shri S.Nagarajan Technical Officer (T-5)	Web standards, technologies and standardisation	3-12 December 2008	NAARM, Hyderabad

III) ADMINISTRATIVE STAFF

Sl. No.	Name and Designation	Training programme	Duration	Organisation
1	Mrs.K.Nandhini Junior Accounts Officer	Financial management system under NAIP	11-12 November 2008	CMFRI, Kochi
2	Shri R.Kandamani Assistant			

Students project work

Final year M.Sc./B.Tech/B.E. students (26) 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

- M.Sc. Biotechnology students (15) and one executive of M/s.Biosys Biotech Laboratory & Research Centre, Chennai on 30 May 2008.
- B.F.Sc. students (37) from the College of Fisheries, Mangalore on 4 June 2008.
- Fish farmers (25) and two faculty of KVK, Kattupakkam on 4 July 2008.
- B.F.Sc.students (14) and two Professors from College of Fisheries, Mangalore on 7 May 2008.
- M.Sc. (Marine Studies) and (Coastal Management) students (24) from Madras Christian College, Chennai on 18 July 2008.

- B.F.Sc students (24) from the College of Fisheries, Muthukuru on 3 August 2008.
- B.Tech. (Biotechnology) students (74) from the Department of Biotechnology, Adhiyamaan College of Engineering, Hosur on 19 August 2008.
- Scientists (4) from the Centre for Ocean Research, Sathyabhama University, Chennai on 21 August 2008.
- M.Sc. (Marine Biotechnology) students (14) from the National Facility for Marine Cynobacteria, Bharathidasan University, Tiruchirapalli on 13 September 2008.
- M.Sc. (Biotechnology) students (10) from the Malankara Catholic College, Nagercoil on 15 September 2008.
- B.Sc. (Nautical Science) students (14) from the Central Institute of Fisheries Nautical & Engineering Training, Kochi on 24 September 2008.
- M.Sc. (Zoology) students (12) from the Kongunadu Arts and Science College, Coimbatore on 30 September 2008.
- B.Tech (Agricultural Information Technology) (22) and B.Sc. (Agribusiness Management) students (28) from the Tamil Nadu Agricultural University, Coimbatore on 16 October 2008.
- M.Sc. (Marine Biotechnology) students (12) from CAS in Marine Biology, Annamalai University on 16 October 2008.
- M.Tech (Coastal Management) students (9) from the Institute of Ocean Management, Anna University, Chennai on 20 October 2008.
- M.Sc (Zoology) students (9) from the Barathidasan University, Tiruchirapalli on 31 October 2008.
- M.F.Sc. students (12) from the College of Fisheries, Rajendra Agricultural University, Dhauli, Muzzafarpur, Bihar on 14 January 2009.
- M.Sc. (Zoology) students (19) from the Udai Pratap Autonomous College, Varanasi on 2 January 2009.

7. AWARDS AND RECOGNITIONS

- Dr.V.S.Chandrasekaran, Principal Scientist, Dr. B.Shanthi, Dr. K.Ponnusamy and Dr. M.Kumaran, Senior Scientists were awarded the Shri. K.Chidambaram Annual Memorial Award of 2008 for extension work by Fisheries Technocrats Forum, Chennai on 14 June 2008.
- Dr.J.K.Sundaray, Senior Scientist was awarded the Best Young Scientist Award for the year 2007 - 08 by the Hiralal Chaudhary Fisheries Foundation, Central Institute of Fisheries Education, Mumbai on 10 July 2008.



Dr.J.K.Sundaray, Senior Scientist receiving Best Young Scientist Award from Dr. V.S. Somvanshi, Director General, Fisheries Survey of India

- Shri T.D. Babu, Senior Research Fellow was awarded the Best Poster Presentation for the paper entitled “Loose Shell Syndrome – A silent killer of farmed black tiger shrimp, *Penaeus monodon* in India” in the International Conference on “Emerging infectious diseases of animals and biotechnological applications organized by Virginia University of Animal Medicine, USA and Tamil Nadu Veterinary and Animal Sciences University at Chennai during 28- 29 July 2008.
- Dr.M.Shashi Shekhar, Senior Scientist received the Best Paper Award for his paper entitled “Application of dot blot for detection of white spot syndrome virus” at the National Hindi Workshop conducted at Central Institute of Brackishwater Aquaculture, Chennai during 23-24 September 2008.
- Dr.M.Shashi Shekhar, Senior Scientist was presented with the Best Paper Award for his paper entitled “Expression of phagocytosis activating protein (PAP) in shrimps immunised with recombinant WSSV protein.” at the 8th Indian Fisheries Forum held at Kolkata during 22-26 November 2008.

- Dr.K.Ponnusamy, Senior Scientist along with Dr. T.K.Walli, Principal Scientist (Retd.), NDRI, Karnal received the Best Article Award - 2007 for the research article entitled, “Contract dairy farming versus dairy cooperatives - relative strengths and weaknesses” published in Indian Dairyman by Indian Dairy Association, New Delhi on 9 February 2009 at Goa.

DBT Overseas Associateship Award

Name of the Scientist	Research area	Organisation	Duration
Dr. M.Shashi Shekhar Senior Scientist	Antiviral silencing by RNAi (interference) and identification of antiviral factors for pathogenic virus in shrimps	University of Hawaii at Nabia, Hawaii, USA	15 January to 13 April 2008
Dr. M. Kailasam Senior Scientist	Aquaculture biotechnology related to rotifer genetics	Graduate School of Agricultural and Life Sciences, University of Tokyo, Japan	24 February to 23 August 2009
Dr. S.V.Alavandi Senior Scientist	Viral metagenomics	College of Marine Science, University of South Florida, USA	23 February to 22 August 2009

Ph.D. Programme

Name	Guide	Thesis title	Date of award of degree
Shri V.Mohan Raj, SRF	Dr.A.R.Thirunavukkarasu Head, FCD	Effect of heavy metals, cadmium and mercury on the eco physiology of Asian seabass <i>Lates calcarifer</i> (Bloch)	01.09.2008
Shri S.Jagan Mohan, SRF	Dr.P.Ravichandran Head, CCD	Studies on the growth, biochemical constituents and reproductive performance of the domesticated kuruma shrimp, <i>Marsupenaeus japonicus</i> (BATE)	10.10.2008

8. 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

Other Institutes / SAUs

- 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
- Tamil Nadu Agricultural University, Coimbatore
- University of Madras, Chennai

Govt. of India

- Ministry of Agriculture
- National Fisheries Development Board
- Department of Animal Husbandry, Dairying and Fisheries
- Coastal Aquaculture Authority, Chennai
- Ministry of Science and Technology
- Ministry of Commerce
- Marine Products Export Development Authority
- Department of Biotechnology
- Department of Science and Technology
- National Institute of Ocean technology

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.

9. LIST OF PUBLICATIONS

Institute publications

- CIBA Annual Report (2007-2008)
- Training programme calendar 2009-10
- Special Publications
 - ▲ Pulicat Lake – The Matsya Granary of Coromandal Coast (CD-ROM)
 - ▲ Quality shrimp seed production for sustainable aquaculture
 - ▲ Recent advances in soil and water management for brackishwater aquaculture
 - ▲ Crab fattening techniques through pens and cages – A livelihood option among the coastal WSHGs (in Tamil)
 - ▲ Crab feed development – A livelihood option among the coastal WSHGs (in Tamil)
 - ▲ Value added fish food product development - A livelihood option among the coastal WSHGs (in Tamil)
- Technology Series
 - ▲ Indigenous shrimp feed technology by CIBA
 - ▲ Decision support software on carrying capacity: Estimation of maximum area under shrimp farming for a selected water body
- Technical Advisory Series
 - ▲ Luminescent bacteria in shrimp hatchery and their control through better management practices

PAMPHLETS IN BENGALI LANGUAGE

- ▲ Shrimp culture-pond preparation
- ▲ Shrimp culture-feeds and feed management
- ▲ Shrimp nutrition and feed technology
- ▲ Lime and its application in brackishwater aquaculture
- ▲ Mud crab culture
- ▲ Seabass - seed production and culture

GENBANK SEQUENCES SUBMITTED

Sl. No.	GenBank accession no.	No. of gene sequences	Year of submission	Gene	Authors
1.	FJ002572-74	3	2008	16s rRNA mitochondrial genes of <i>F. merguensis</i> , <i>F.indicus</i> , <i>F.penicillatus</i>	Shekhar,M.S., Gopikrishna,G., Vinaya Kumar,K., Gopal,C.,Pillai,S.M. and Ravichandran,P.
2.	FJ002575-77	3	2008	Control region mitochondrial genes of <i>F. merguensis</i> , <i>F.indicus</i> , <i>F.penicillatus</i>	Shekhar,M.S., Gopikrishna,G., Vinaya Kumar,K., Gopal,C.,Pillai,S.M. and Ravichandran,P.
3.	FJ013355-57	3	2008	Cytochrome oxidase I mitochondrial genes of <i>F. merguensis</i> , <i>F.indicus</i> , <i>F.penicillatus</i>	Shekhar,M.S., Gopikrishna,G., Vinaya Kumar,K., Gopal,C.,Pillai,S.M. and Ravichandran,P.

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10. LIST OF ON-GOING RESEARCH PROJECTS

IN-HOUSE PROJECTS

Sl. No.	Title of the Project	Principal Investigator
CRUSTACEAN CULTURE DIVISION		
1	Sustainable shrimp production through domestication of <i>Penaeus monodon</i> , development of culture practices for <i>Marsupenaeus japonicus</i> and adoption of best management practices in farming	Dr.P.Ravichandran Head, CCD
2	Development of packages for nursery and grow-out culture of mud crabs (<i>Scylla</i> spp.)	Dr.S.Kulasekarapandian Principal Scientist
3	Aquaculture farm appraisal and impact assessment using remote sensing and GIS	Dr.M.Jayanthi Senior Scientist
FINFISH CULTURE DIVISION		
4	Seed production technology for commercially important brackishwater fishes	Dr.A.R.Thirunavukkarasu Head, FCD
5	Culture of commercially important brackishwater fishes	Dr.P.Natarajan Principal Scientist
AQUATIC ANIMAL HEALTH AND ENVIRONMENT DIVISION		
6	Investigations on epidemiology of infectious diseases of fish and shellfish and development of diagnostics and prophylactics.	Dr.T.C.Santiago Principal Scientist
7	Shrimp soil and water management practices and products that mitigate environmental impact and increase productivity	Dr.B.P.Gupta Principal Scientist
NUTRITION, GENETICS AND BIOTECHNOLOGY DIVISION		
8	Development and demonstration of balanced feeds for Asian seabass, crabs and improvement of shrimp feeds	Dr.S.A.Ali Principal Scientist
9	Genetic studies and application of molecular techniques in brackishwater shellfish breeding programmes	Dr.G.Gopikrishna Senior Scientist
SOCIAL SCIENCES DIVISION		
10	Studies in resource use efficiencies and development strategies in coastal aquaculture	Dr.M.Krishnan Principal Scientist
KAKDWIP RESEARCH CENTRE		
11	Refinement of traditional brackishwater aquaculture systems for sustainable production of shrimp and fishes	Dr.A.Panigrahi Senior Scientist & OIC, KRC

EXTERNALLY FUNDED PROJECTS

Indo-Norwegian Projects		
1	Genetic improvement of <i>Penaeus monodon</i> (tiger shrimp) through selective breeding for growth and white spot disease resistance	Dr.P.Ravichandran Head, CCD
2	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	Dr.G.Gopikrishna Senior Scientist
ICAR AP Cess Fund Projects		
3	Investigation on loose shell syndrome among farmed tiger shrimp <i>Penaeus monodon</i>	Dr.S.V.Alavandi Senior Scientist
4	The assessment of losses in shrimps in brackishwater aquaculture due to diseases	Dr.N.Kalaimani Principal Scientist
5	Molecular characterisation and analysis of virulence factors in pathogenic <i>Vibrio harveyi</i> isolates from shrimp larviculture systems	Dr.S.V.Alavandi Senior Scientist
Department of Biotechnology (DBT) Projects		
6	Gene expression in <i>Penaeus monodon</i> and <i>Penaeus indicus</i> in relation to microbial infection and environmental stress	Dr.T.C.Santiago Principal Scientist
7	Characterization and development of diagnostics for viral nervous necrosis in seabass (<i>Lates calcarifer</i>) and mullet (<i>Mugil cephalus</i>)	Dr.K.P.Jithendran Principal Scientist
8	Development of substrate specific fibrolytic enzymes for enhancing nutrient utilization in shrimp	Dr.K.Ambasankar Senior Scientist
9	Development and application of CMG family recombinant hormones, their antagonists and RNAi technique for induced maturation and spawning of <i>Penaeus monodon</i>	Dr.C.P.Balasubramanian Senior Scientist (Co-PI)
10	Enrichment of aquafeed with cellulolytic and amylolytic microbes isolated from digestive tract of brackishwater fishes	Dr.Debasis De Senior Scientist
11	Development of antiviral therapy using double stranded RNA (dsRNA) against shrimp viruses, WSSV, MBV and HPV	Dr.T.C.Santiago Principal Scientist
12	Diversification of livelihoods among women SHGs through coastal aquaculture technologies	Dr.B.Shanthi Senior Scientist
13	Immunomodulation studies in freshwater prawn <i>Macrobrachium rosenbergii</i> using recombinant proteins of <i>Macrobrachium rosenbergii</i> nodavirus	Dr.M.Shashi Shekhar Senior Scientist
14	Development and evaluation of green water technology for aquatic bioremediation in coastal aquaculture	Dr.K.K.Krishnani Senior Scientist

ICAR Network Projects		
15	Mega seed project on “Seed production in agricultural crops and fisheries”	Dr.S.M.Pillai Principal Scientist (Nodal Officer)
16	Impact assessment of fisheries research in India	Dr.T.Ravisankar Senior Scientist
17	Application of micro organisms in agriculture and allied sectors - microbial diversity and identification	Dr.T.C.Santiago Principal Scientist
18	Application of micro organisms in agriculture and allied sectors - agrowaste management, bioremediation and microbes in post harvest processing	Dr.S.V.Alavandi Senior Scientist
19	Outreach activity on fish feeds	Dr.S.A.Ali Principal Scientist
20	Nutrient profiling and evaluation of fish as a dietary component	Dr.J.Syama Dayal Senior Scientist
21	Outreach activity on fish genetic stocks	Dr.G.Gopikrishna Senior Scientist
National Fisheries Development Board		
22	Demonstration of Asian seabass <i>Lates calcarifer</i> farming in the pond culture system	Dr.A.R.Thirunavukkarasu Head, FCD
23	Exploring market opportunities for fisheries sector in India	Dr.T.Ravisankar Senior Scientist
National Agricultural Innovation Project (NAIP)		
24	Agro-web digital dissemination system for Indian agricultural research	Dr.T.Ravisankar Senior Scientist

11. CONSULTANCY / 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. (Rs.75,000 and royalty @Rs.50/- per tonne of feed).
- Matrix for probiotic bacteria (*Lactobacillus* and *Bifido*) to M/s Shrimpex Biotech Services, Chennai (Rs.50,000).



Shri Jayaraman, District Collector, Nagapattinam releasing Bismi Shrimp Feed in the presence of Dr.S.Ayyappan, DDG (Fy.) and Director, CIBA on 11th October, 2008

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 3 years from 25 July 2007 with the following.

Dr.P.Natarajan Professor, Rajiv Gandhi Chair, School of Environmental Studies Cochin University of Science & Technology Thrikkakara Campus, Kochi 682 022, Kerala	Chairman
Dr.Apurba Ghosh Ex-Principal Scientist & Project Coordinator, All India Coordinated Project 23, Gora Chand Road, Kolkata 700 014	Member
Dr.H.C.Joshi Professor, Department of Environmental Science Indian Agricultural Research Institute, Pusa, New Delhi 110 012	Member
Dr.(Ms.)M.S.Shaila Professor, Microbiology & Cell Biology Laboratory Indian Institute of Science, Bangalore 560 012	Member
Shri M.Sudarsan Swamy President, All India Shrimp Hatcheries Association 7-1-44, Kirlampudi, Visakhapatnam 530 017, Andhra Pradesh	Member
Dr.A.G.Ponniah Director, CIBA, Chennai	Member
Dr.S.M.Pillai Principal Scientist & OIC, Technical Cell, CIBA, Chennai	Member Secretary

The 14th Meeting of the Research Advisory Committee was held on 21 February 2009 and the major recommendations are:

Overall development of brackishwater aquaculture

- To study the individual production potential of each candidate species based on culture systems. Based on this analysis, identify the research efforts required for production enhancement and technological perfection, for developing packages for each species.
- The requirements for development of domestic market to be investigated and to compile scientific information on health benefits of seafood, to increase the public awareness.

Diversification

- Diversification with more number of species to provide wide choice to consumers with quality food.
- To evaluate ornamental fish species which have export potential and explore possibility of developing packages.
- The potential for introduction of Andamans tilapia for aquaculture along with risks to be evaluated.
- The reasons for slow growth of seabass in the East Kolkata wetland to be evaluated, and the role of wintering to be addressed.
- The potential for reviving *Fenneropenaeus indicus* culture to be evaluated.
- Feed based technology for growing seabass should be given top priority.
- In addition to polychaetes, work on maturation diets for shrimp to be undertaken.



Research Advisory Committee Meeting

Environment and Health

- For understanding the impact of climate change on fisheries and aquaculture and to draw conclusions about the role of each factor, analysis of the secondary data on environmental parameters for the last few years to be done.
- To provide scientific advice with regard to environmental / health problems due to shrimp farm intake and discharge water, the role and potential of reservoirs and ETP to be evaluated.
- Environmental data of shrimp pond intake water, discharge water and the receiving environment to be collated to support the claim that aquaculture is not contributing towards environmental pollution.
- Include the effect of temperature when carrying out challenge tests and to use only one isolate.
- The role of the identified viral agent in loose shell disease in shrimps.
- Intensify work on identifying causative agent for slow-growth disease.
- In support of the disease work, cell culture work to be taken up and scientists sent for training to other institutions

Technology transfer

- The mechanism and channels of transfer of technology for gender improvement of women through women SHGs to be evaluated to make it more effective.
- More trainings / stakeholder meetings are to be conducted with focus in regional languages in other regions of the country.

STAFF RESEARCH COUNCIL

The Staff Research Council (SRC) of CIBA has the following composition. The 21st and 22nd SRC meetings were held during 1-2 May 2008 and 24-25 March 2009 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
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:

- Selection of farmers for trials and demonstrations has to be done carefully since the outcome will largely depend on their cooperation.
- Biosecurity of reservoir ponds in farms is to be taken up under BMPs to have an in-depth understanding of at least one component in the farming system and its contribution to raise healthy crop.
- Species identification of the Indian mud crabs needs immediate attention to establish the identity of the two



Staff Research Council Meeting

native species *vis-a-vis* international classification.

- The impact of aquaculture on mangroves in Krishna district and that of Gujarat need to be included for the current year study.
- Under seabass breeding emphasis has to be given to develop protocols for the synchronized maturation of males and females.
- Finfish breeding trials with hormones other than LHRHa should be with the sole objective of simplifying induced maturation.
- Polyculture production level should be targeted at one ton level for attracting farmers to this production system.
- Microbes producing cellulolytic enzymes have to be screened from environment rather than from the digestive tract of fishes.
- Since Monodon Slow Growth Syndrome (MSGs) is another emerging disease to be tackled, priority has to be given to develop a diagnostic kit immediately.
- Studies on LSNV infectivity are to be planned to understand the nature of contamination and virulence.
- The mortality caused by iridovirus in seabass has to be contained by improving the biosecurity in both hatchery and farm.
- It is important to identify the factors influencing WSSV infection and approach by cloning dsRNA may facilitate better understanding of the sequence.
- Identification of microbes with commercial application in different projects should be referred to the Institute Technology Management Unit.
- Literature survey for nanoparticles for delivery system has to be completed.
- Characterization of viral like particle of Loose Shell Syndrome disease has to be done by SEM to prove conclusively its viral nature.
- The role of environmental factors in shrimp loss due to diseases needs to be considered.
- The cell culture facility has to be established with all facilities and cell lines have to be obtained from other institutions/agencies.
- More studies are needed to substantiate that bagasse reduces the ammonia load at the end of culture in zero water exchange system.
- Domestication of tiger shrimp is to be continued as an activity under CCD project.
- More farmers' meets are to be organised in farmer's areas on specific themes.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

The Institute Management Committee has the 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, TANUVAS, 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 32nd and 33rd meetings of the Institute Management Committee were held on 2nd June and 1st December 2008 respectively. The major decisions taken during the meetings are:



Institute Management Committee Meeting

- Approval for new major works amounting Rs.146 lakhs during 2008-09.
- Clearance for procurement of equipments worth Rs.124.30 lakhs.
- Recommended the proposal for getting approval by Council for the additional posts of technical and administrative personnel.
- EFC approved items for the year 2009-2010 for major works worth Rs.284 lakhs were cleared.
- Approval for the procurement of equipments worth Rs.200 lakhs for 2009-2010.

INSTITUTE JOINT STAFF COUNCIL (IJSC)

The composition of the Institute Joint Staff Council (reconstituted by CIBA for a period of 3 years with effect from 24.11.2006, vide Office Order F.No.13-1/2006-Admn. Dated 5th December 2006) was as follows. During the year, one meeting was held on 5th November 2008.

OFFICIAL SIDE

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

STAFF SIDE

Shri R.Subburaj, Technical Assistant (T-4)	Member
Shri R.Balakumaran, Technical Assistant (T-2)	Member
Shri A.Sekar, UDC	Member
Shri V.Jeevanandham, 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.



Institute Joint Staff Council Meeting

13. PARTICIPATION IN CONFERENCES / MEETINGS / WORKSHOPS / SYMPOSIA

Particulars	Organisation	Duration
(1)	(2)	(3)
Dr.A.G.Ponniah, Director		
Meeting of the study tour team to Vietnam and Thailand for the field level arrangements to study <i>L.vannamei</i> culture	DAHD&Fy., Ministry of Agriculture New Delhi	8 April 2008
Consultative workshop on restructuring masters and doctoral programs in fisheries	Central Institute of Fisheries Education, Mumbai	16 April 2008
National conference on aquatic genetic resources	National Bureau of Fish Genetic Resources, Lucknow	26 April 2008
Sub-committee meeting for studying the potential and viability of culturing endemic & exotic species	CIBA, Chennai	7 May 2008
Fourteenth meeting of the national committee on introduction of exotic species into Indian waters	DAHD & Fy., Ministry of Agriculture, New Delhi	9 May 2008
Stakeholders meeting on crisis in shrimp industry and the way forward	Society of Aquaculture Professionals, Chennai	19 May 2008
Fifteenth meeting of the Coastal Aquaculture Authority	CAA, Chennai	29 May 2008
First meeting of the Sub-committee on aquaculture under NPOP	APEDA, New Delhi	12 June 2008
Meeting of the secretaries of fisheries of all the governments in the coastal states to seek their views on the 'Guidelines for the farming of <i>L.vannamei</i> and norms for setting up the multiplication centre	Coastal Aquaculture Authority and CIBA, Chennai	23 June 2008
One hundred seventy fourth board meeting of Tamil Nadu Fisheries Development Corporation Limited	TNFDC, Chennai	25 June 2008
Seminar on WTO and its impact on Indian Seafood Trade	Society of Fishery Technologists (India) Cochin	28 June 2008
Farmers – scientists interaction meet at Tiruvarur District in Tamil Nadu	CIBA at Tiruvarur	8 July 2008

ICAR Foundation Day	ICAR, New Delhi	16 July 2008
Sixteenth meeting of the Coastal Aquaculture Authority	Coastal Aquaculture Authority, Chennai	23 July 2008
National seminar on emerging issues in quality and safety of fish & shellfish (EIQASFISH'08)	Fisheries College & Research Institute, Thoothukudi	7 August 2008
Sixth meeting of the DBT task force on aquaculture & marine biotechnology	Department of Biotechnology, New Delhi	19 - 20 August 2008
National expert consultation conference on fisheries lease policy,	Fisheries Department, Govt. of Tamil Nadu, Dept. of Fisheries Resources & Economics, Fisheries College & Research Institute, Tuticorin, MPEDA and TNFDC	4 September 2008
Sensitisation workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA, Chennai	10 September 2008
Zoology Association 'Fauna-08'	Ethiraj College, Chennai	18 September 2008
Seventeenth meeting of the CAA	Coastal Aquaculture Authority, Chennai	19 September 2008
Workshop on strategies for conservation and resource enhancement of sea cucumbers in Indian seas	CMFRI at CIBA, Chennai	25 September 2008
Launch of Bismi prawn feed manufactured with CIBA technology	Perunthottam, Nagapattinam district, Tamil Nadu	11 October 2008
Workshop on ecologically sensitive coastal areas	CED and CIBA at Chennai	14 October 2008
DBT sponsored brainstorming meet on identifying research needs for controlling WSSV disease in shrimp aquaculture	Department of Biotechnology, New Delhi & CIBA, Chennai	17 October 2008
Meeting with DDG (Fy.), ICAR and Mr. John Benzie, Moana Technologies, on the genomic research on shrimp	ICAR, New Delhi	29 October 2008

ASRB Foundation Day	ICAR, New Delhi	4 November 2008
First meeting of the Fisheries Institute of Technology and Training (FITT)	Fisheries Institute of Technology and Training, Chennai	12 November 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Meeting of the Directors of fisheries research institutes	SMD (Fy.), ICAR, New Delhi at CMFRI, Kochi	29-30 November 2008
International workshop on DNA barcoding	NBFGR, Lucknow	3-5 December 2008
CAA meeting along with the scientists of Genomics and Integrative Biology (CSIR)	CAA, Chennai	12 December 2008
Inauguration of the training programme on marine ornamental fish culture for coastal self-help group of Tamil Nadu	CAS in Marine Biology, Annamalai University, Parangipettai	15 December 2008
DBT task force	Department of Biotechnology, New Delhi	18-19 December 2008
Ninety sixth session of Indian Science Congress	ISCA, Kolkata at NEHU, Shillong	5-7 January 2009
Directors' Conference	ICAR, New Delhi	15-16 January 2009
National consultation meet on development of fisheries information system network (FISHNET)	DAHD & Fy., Ministry of Agriculture, New Delhi.	21 January 2009
National level symposium on current trends in marine science & technology (CUTMAST'09)	Madras Christian College, Tambaram, Chennai	24 January 2009
International symposium on marine ecosystems – challenges and opportunities,	MBAI and CMFRI, Cochin	10 February 2009
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
CAA meeting for shortlisting of suppliers of SPF broodstock of <i>L.vannamei</i>	Coastal Aquaculture Authority, Chennai	18 February 2009

Meeting of the expert committee to prepare rules for management and conservation of biodiversity heritage sites	National Biodiversity Authority, Chennai	19 February 2009
International workshop on natural hazards and coastal zone management	Dept. of Applied Geology & Centre for Ocean and Coastal Studies, University of Madras, Chennai	20-21 February 2009
Expert advisory committee meeting for the selection of awardee in biological sciences	Tamil Nadu State Council for Science and Technology, Chennai	6 March 2009
Final Meeting of the NORAD Workshop	CIBA, Chennai	12 March 2009
Twentieth meeting of Coastal Aquaculture Authority	Coastal Aquaculture Authority, Chennai	20 March 2009
Meeting on aquatic quarantine facility	National Fisheries Development Board, Hyderabad	26 March 2009
Launching of ICAR-NAIP (Component II) programme on export oriented marine value chain for farmed seafood production using cobia (<i>Rachycentron canadum</i>) through rural entrepreneurship.	ICAR-NAIP at Chennai	30 March 2009
One hundred seventy seventh board meeting of Tamil Nadu Fisheries Development Corporation	TNFDC, Chennai	30 March 2009
Dr.A.R.Thirunavukkarasu, Head, FCD		
Brainstorming session on Development of island fisheries	CARI, Port Blair	22 June 2008
“Aquatica – 2008” Seminar on Ornamental fishes	Indian Aquarium Hobbyists Association, Chennai	29 June 2008
National seminar on recent trends in aquaculture biotechnology	Jamal Mohamed College, Tiruchirapalli	19-20 August 2008
National expert consultation conference on fisheries lease policy	Department of Fisheries, Govt. of Tamil Nadu, Chennai	4-5 September 2008
Norwegian project meet	Mangalore Fisheries College	25-26 September 2008

Second meeting of peer review committee	ICMAM, Chennai	29 September 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Workshop on launching of NAIP Project	NAIP-ICAR at TANUVAS, Chennai	31 March 2009
Dr.P.Ravichandran, Head, CCD		
Brainstorming meet on Aquaculture 2025: Challenges and opportunities	CIFA, Bhubaneswar	7-8 June 2008
ILDEX India 2008	Pixie Consulting Solutions Limited, Karnal at New Delhi	23 August 2008.
Workshop on ecologically sensitive coastal areas	CES Trivandrum and CIBA, Chennai	14 October 2008
Shrimp aquaculture dialogue	WWF, Thailand	17-18 November 2008
NACA project meeting	NACA, Thailand	19-21 November 2008
NFDB Meeting with ICAR Fisheries Directors	NFDB, Hyderabad	23 December 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
International workshop on natural hazards and coastal zone management	Dept. of Applied Geology & Centre for Ocean and Coastal Studies, University of Madras, Chennai	20-21 February 2009
FAO/NaCSA meeting on implementation of HACCP principles in shrimp farming for disease prevention and food-safety.	NaCSA, Kakinada	23-26 February 2009
Meeting of committee constituted for approving SPF broodstock suppliers by CAA	CAA, Chennai	13 March 2009
Dr.S.Kulasekarapandian, Principal Scientist		
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009

Dr.S.M.Pillai, Principal Scientist		
Meeting for preparation of draft standards for fish/prawn/shrimp feed for BIS certification	CIFA, Bhubaneswar	21 April 2008
Thirteenth all India competitive examination for master's degree programmes in agriculture and allies sciences	ICAR at Chennai	17 May 2008
ARS/NET Examination – 2007	ICAR at Tirupati	25 May 2008
ILDEX India 2008	Pixie Consulting Solutions Limited, Karnal at New Delhi	23 August 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22-26 November 2008
Conference of the Directors of fisheries institutes	SMD (Fy.), ICAR at Cochin	29-30 November 2008
Review meeting of the national mega seed project, seed production in agricultural crops and fisheries	SMD (Fy.), ICAR at New Delhi	2 December 2008
Annual review meeting of the ICAR seed project, seed production in agricultural crops and fisheries	Directorate of Seed Research, Mau at New Delhi	5-6 January 2009
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr.S.A.Ali, Principal Scientist		
Graduate course in IPR and technology transfer sponsored by ICAR	Society for Technology Management, Hyderabad at Ooty	13-16 April 2008
BIS Meeting of fish nutrition scientists	CIFA, Bhubaneswar	21 April 2008
Workshop on outreach activities	ICAR, New Delhi	29-30 April 2008
Launch workshop under ICAR outreach activities on fish feed and nutrient profiling	ICAR at CIFA, Bhubaneswar	30 July - 1 August 2008
Launch of Bismi prawn feed manufactured with CIBA technology	Bismi and CIBA at Perunthottam	11 October 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
ICAR outreach activities	CIFRI, Barrackpore	26-27 February 2009

Dr.N.Kalaimani, Principal Scientist		
SAP meeting on “ACC Certification – The process and benefits”	SAP, Chennai.	29 May 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr. M. Natarajan, Principal Scientist		
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr.M.Krishnan, Principal Scientist		
Golden jubilee celebrations of the faculty of agriculture of the Annamalai University	Annamalai University, Annamalai Nagar	12-15 April 2008
SAP meeting on “ACC Certification – The process and benefits”	SAP, Chennai.	29 May 2008
“Aquatica – 2008” Seminar on ornamental fishes	Indian Aquarium Hobbyists Association, Chennai	29 June 2008
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Use of e-FORUM in promoting networking, dissemination of information, communication and knowledge among Telecentre Managers/Grameen Gyan Abhiyan	MSSRF, Chennai	27-28 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
UGC sponsored interactive workshop on emerging trends in food processing industry	Department of Agricultural Economics, Annamalai University, Chidambaram	23-24 February 2009
Dr. K. P. Jithendran, Principal Scientist		
International conference on emerging infectious diseases of animals and biotechnological applications	Tamil Nadu Veterinary and Animal Sciences University, Chennai	28-29 July 2008

Meeting of DBT task force to review the progress of the ongoing DBT funded project	DBT at Kochi	20 August 2008
National seminar on recent trends in parasitology	UGC and Srinarayanan College, Kannur, Kerala	11- 12 December 2008
Dr.C.Gopal, Principal Scientist		
National Seminar on recent trends in aquaculture biotechnology (AQUABIOTECH)	Jamal Mohamed College, Tiruchirapalli	19-20 August 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Data Analysis workshop of the NORAD project	CIFE, Mumbai	28 February - 3 March 2009
Dr.V.S.Chandrasekaran, Principal Scientist		
SAP meeting on “ACC Certification – The process and benefits”	SAP, Chennai.	29 May 2008
Workshop on consultancy needs and services in disaster management	Indian Bank Management Academy, Chennai	18-19 August 2008
National expert consultation conference on fisheries lease policy	Department of Fisheries, Govt. of Tamil Nadu	4-5 September 2008
Sensitisation workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA, Chennai	10 September 2008
Workshop on community participation and facilitation skills	MSSRF, Chennai	18–20 December 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr.G.Gopikrishna, Senior Scientist		
Workshop on outreach activities	ICAR, New Delhi	29-30 April 2008
Review meeting of the foreign-aided projects (NORAD)	Fisheries Division of ICAR, New Delhi	9 July 2008
Meeting relating to outreach activity on fish genetic stocks	NBFGR, Lucknow	26-27 July 2008
National seminar on recent trends in aquaculture biotechnology (AQUABIOTECH)	Jamal Mohamed College, Tiruchirapalli	20 August 2008
Workshop on identifying research needs for controlling White Spot Syndrome Disease in shrimp aquaculture	DBT and CIBA at Chennai	17 October 2008

Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Review meeting of the foreign-aided projects (NORAD)	Fisheries Division of ICAR, New Delhi	22 January 2009
Data analysis workshop of the NORAD project	CIFE, Mumbai	28 February - 3 March 2009
Outreach activity on fish genetic stocks	CIFA, Bhubaneswar	28 March 2009
Dr. T. Ravisankar, Senior Scientist		
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Use of e-FORUM in promoting networking, dissemination of information, communication and knowledge among Telecentre Managers/ Grameen Gyan Abhiyan	MSSRF, Taramani, Chennai	27-28 November 2008
Exploring market opportunities for fisheries sector in India	NCAP, New Delhi	11 February 2009
Dr.K.K.Krishnani, Senior Scientist		
National seminar on emerging issues in quality and safety of fish & shellfish (EIQASFISH'08)	Fisheries College & Research Institute, Tamil Nadu Veterinary and Animal Sciences University at Thoothukudi	7 August 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Water expo	Water Today, Chennai	27-28 February 2009
Dr.M.Muralidhar, Senior Scientist		
Stake Holders meeting regarding shrimp aquaculture in Andaman & Nicobar Islands	Dept. of Fisheries, Port Blair	27 June 2008
National seminar on emerging issues in quality and safety of fish & shellfish (EIQASFISH'08)	Fisheries College & Research Institute, Tamil Nadu Veterinary and Animal Sciences University at Thoothukudi	7 August 2008
Technology gaps in shrimp farming – An Andhra Pradesh perspective	SAP at Ongole, Andhra Pradesh	25 August 2008

Fifth governing council and second annual general body meeting of National centre for sustainable aquaculture	NaCSA at Kakinada	26 August 2008
Sensitization workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA at Chennai	10 September 2008
Workshop on ecologically sensitive coastal areas	CES Trivandrum and CIBA, Chennai	14 October 2008
Meeting of scientists working on climate change and fisheries	Fisheries Division, ICAR, New Delhi	15 December 2008
Sixth governing council meeting of National Centre for Sustainable Aquaculture	NaCSA at Hyderabad	30 December 2008
International symposium on marine ecosystems challenges and opportunities	Marine Biological Association of India, Cochin	9-12 February 2009
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
International workshop on natural hazards and coastal zone management	Dept. of Applied Geology & Centre for Ocean and Coastal Studies, University of Madras, Chennai	20-21 February 2009
Project inception workshop: 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	Network of Aquaculture Centres in Asia-Pacific, Bangkok	19-29 March 2009
Dr. (Mrs.) M. Jayanthi, Senior Scientist		
National training on application of remote sensing and GIS on coastal and ocean resource mapping, monitoring and management	CAS in Marine biology, Annamalai University, Parangipettai	22 September 2008
Workshop on ecologically sensitive coastal areas	CES Trivandrum and CIBA, Chennai	14 October 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009

Dr.(Mrs.)B.Shanthi, Senior Scientist		
Workshop on violence among the women and disabled in the coastal areas	AHSU, Coimbatore, MFCDS, Chennai and Special Olympics Asia Pacific at Chennai	27 March 2008
Workshop on community participation and facilitation skills	MSSRF, Chennai	18 – 20 December 2008
Dr. C. P. Balasubramanian, Senior Scientist		
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr.M.Kailasam, Senior Scientist		
“Aquatica – 2008” Seminar on ornamental fishes	Indian Aquarium Hobbyists Association, Chennai	29 June 2008
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr.(Mrs.) D.D. Vimala, Senior Scientist		
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Sensitization workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA at Chennai	10 September 2008
Use of e-FORUM in promoting networking, dissemination of information, communication and knowledge among Telecentre Managers/Grameen Gyan Abhiyan	MSSRF, Taramani, Chennai	27-28 November 2008
Workshop in e-learning education	National Institute of Technical Teacher’s Training & Research, Taramani, Chennai	19 December 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
UGC sponsored interactive workshop on emerging trends in food processing Industry	Department of Agricultural Economics, Annamalai University, Chidambaram	23-24 February 2009

Dr.M.Shashi Shekhar, Senior Scientist		
Genetic characterization of fish and disease diagnosis of fish/shrimp for a refresher course in life sciences	Pondicherry University, Pondicherry	2 September 2008
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
NAIP meeting	NAIP, New Delhi	23 February 2009
NAIP project formulation workshop	NAIP, New Delhi	28 February - 2 March 2009
Data analysis workshop of the NORAD Project	CIFE, Mumbai	28 February - 3 March 2009
Dr. S. Kannappan, Senior Scientist		
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Data analysis workshop of the NORAD Project	CIFE, Mumbai	28 February - 3 March 2009
Dr. K. Ponnusamy, Senior Scientist		
Bangalore Bio 2008	Vision group on Bio-Technology, Bangalore at International Exhibition Centre, Bangalore	24-26 April 2008
“Aquatica – 2008” Seminar on ornamental fishes	Indian Aquarium Hobbyists Association, Chennai	29 June 2008
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Sensitization workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA at Chennai	10 September 2008

Launch of Bismi prawn feed manufactured with CIBA technology	Bismi and CIBA at Perunthottam in Nagapattinam district, Tamil Nadu	11 October 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Chennai Science Festival 2009 - Science in everyday life	Tamil Nadu State Council for Science and Technology, Anna University, Chennai	19-22 February 2009
UGC sponsored interactive workshop on emerging trends in food processing industry	Department of Agricultural Economics, Annamalai University, Chidambaram	23-24 February 2009
Dr.J.K.Sundaray, Senior Scientist		
“Aquatica – 2008” Seminar on ornamental fishes	Indian Aquarium Hobbyists Association, Chennai	29 June 2008
National Seminar on recent trends in aquaculture biotechnology	Jamal Mohamed College, Tiruchirapalli	19- 20 August 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr. Nila Rekha, Senior Scientist		
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Chennai Science Festival-2009: Science in Everyday Life	Tamil Nadu State Council for Science and Technology, Anna University, Chennai	19-22 February 2009
Dr. K. Ambasankar, Senior Scientist		
BIS meeting of fish nutrition scientists	CIFA, Bhubaneswar	21 April 2008
Launch workshop under ICAR outreach activities on fish feed and nutrient profiling	ICAR at CIFA, Bhubaneswar	30 July - 1 August 2008
Launch of Bismi prawn feed manufactured with CIBA technology	Bismi and CIBA at Perunthottam in Nagapattinam district, Tamil Nadu	11 October 2008

Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Dr. T.K. Ghoshal, Senior Scientist		
Brainstorming meet on aquaculture 2025: Challenges and opportunities	CIFA, Bhubaneswar	7-8 June 2008
Launch workshop under ICAR outreach activities on fish Feed and nutrient profiling	CIFA, Bhubaneswar	30 July -1 August 2008
First workshop on outreach activity on fish feed	CIFA, Bhubaneswar	8-9 August 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
ICAR outreach activities	CIFRI, Barrackpore	26-27 February 2009
Meeting on fisheries development in the Sunderban region	CIFRI, Barrackpore	27 February 2009
Dr.J.Syama Dayal, Senior Scientist		
Workshop on outreach activities	ICAR, New Delhi	29-30 April 2008
Launch workshop under ICAR outreach activities on fish feed and nutrient profiling	ICAR at CIFA, Bhubaneswar	30 July - 1 August 2008
Methodology workshop under ICAR outreach activity on nutrient profiling and evaluation of fish as dietary component	CIFT, Kochi	16-22 September 2008
Launch of Bismi prawn feed manufactured with CIBA technology	Bismi and CIBA at Perunthottam in Nagapattinam district, Tamil Nadu	11 October 2008
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
ICAR outreach activities	CIFRI, Barrackpore	26-27 February 2009
Dr. A. Panigrahi, Senior Scientist		
ICAR Regional Committee No. II review meeting	Orissa University of Agriculture and Technology (OUAT), Bhubaneswar	26- 27 September 2008

Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
International Society of Biotechnology Conference	Sikkim	28-30 December 2008
Dr.M.Kumaran, Senior Scientist		
SAP meeting on “ACC Certification – The process and benefits”	SAP, Chennai.	29 May 2008
Technology gaps in shrimp farming – An Andhra Pradesh Perspective	SAP at Ongole, Andhra Pradesh	25 August 2008
Sensitization workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA at Chennai	10 September 2008
Exploring market opportunities for fisheries sector in India	NCAP, New Delhi	11 February 2009
Chennai Science Festival 2009 - Science in everyday life	Tamil Nadu State Council for Science and Technology, Anna University, Chennai	19-22 February 2009
International workshop on natural hazards and coastal zone management	Dept. of Applied Geology & Centre for Ocean and Coastal Studies, University of Madras, Chennai	20-21 February 2009
Dr. Debasis De, Scientist (SS)		
Brainstorming meet on aquaculture 2025: Challenges and opportunities	CIFA, Bhubaneswar	7-8 June 2008
First workshop on outreach activity on fish feed	CIFA, Bhubaneswar	8-9 August 2008
DBT task force meeting	CUSAT, Kochi	20 August 2008
Mrs. P. Mahalakshmi, Scientist (SS)		
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Workshop on web design methodologies, protocols and content management strategies	NAARM, Hyderabad	9-10 September 2008
Use of e-FORUM in promoting networking, dissemination of information, communication and knowledge among Telecentre Managers/Grameen Gyan Abhiyan	MSSRF, Taramani, Chennai	27-28 November 2008

National symposium on e-learning in education	National Institute of Technical Teachers Training & Research, Taramani, Chennai	19 December 2009
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Chennai Science Festival-2009: Science in Everyday Life	Tamil Nadu State Council for Science and Technology, Anna University, Chennai	19-22 February 2009
Dr. (Mrs.) M. Poornima, Scientist (SS)		
International conference on emerging infectious diseases of animals and biotechnological applications	TANUVAS, Chennai	28-29 July 2008
National seminar on emerging issues in quality and safety of fish & shellfish (EIQASFISH'08)	Fisheries College & Research Institute, Tamil Nadu Veterinary and Animal Sciences University at Thoothukudi	7 August 2008
Workshop on Consortium of e-Resources in Agriculture (CeRA)	IARI, New Delhi at TANUVAS, Chennai	5 September 2008
Brainstorming workshop on identifying research needs for controlling White Spot Syndrome Disease in shrimp aquaculture	DBT and CIBA at Chennai	17 October 2008
Dr. (Mrs.) R.Saraswathy, Scientist (SS)		
Sensitization workshop for the representatives of the district level committees of the CAA from the States of Tamil Nadu, Andhra Pradesh, Kerala and Pondicherry	CAA and CIBA at Chennai	10 September 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Chennai Science Festival-2009: Science in Everyday Life	Tamil Nadu State Council for Science and Technology, Anna University, Chennai,	19-22 February 2009

Dr. K. Vinaya Kumar, Scientist		
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Aqua India 2008 on new technologies and initiatives	Society of Aquaculture Professionals, Chennai	16 February 2009
Training program on advances in DNA marker techniques	Cochin unit of NBFGR	17-21 February 2009
Data Analysis workshop of the NORAD project	CIFE, Mumbai	28 February - 3 March 2009
Outreach activity on fish genetic stocks	CIFA, Bhubaneswar	28 March 2009
Dr. R. Ananda Raja, Scientist		
Meeting on fisheries development in the Sunderban region	CIFRI, Barrackpore	27 February 2009
Mr. G. Biswas, Scientist		
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008
Mrs. Shyne Anand, Scientist		
Eighth Indian Fisheries Forum	AFS (Indian Branch) and CIFRI, Barrackpore	22 - 26 November 2008

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, Ministry of Agriculture, Govt. of India.
- Member, Coastal Aquaculture Authority (CAA), Ministry of Agriculture, Govt. of India.
- Member, ICAR Regional Committee No.VIII.
- Member, General Body of Orissa Shrimp Seed Production Supply and Research Centre (OSSPARC), Orissa.
- Member, Scientific Advisory Committee of Dr.Perumal Krishi Vigyan Kendra, Krishnagiri Dist., Tamil Nadu.
- Member, Task Force Committee on Fisheries Development Mission – Tamil Nadu State Fisheries Department.
- 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, Govt. of India.
- Member, Working Group on Fisheries for the Eleventh Five Year Plan (2007-2012).
- Member, National Centre for Sustainable Aquaculture (NaCSA), Kakinada.
- Member, Expert Committee to prepare rules for management and conservation of biodiversity heritage sites, constituted by National Biodiversity Authority, Chennai.
- Chairman, Study group to carry out the risk analysis study for the introduction of *L.vannamei* into India, CAA, Chennai.
- Committee for protection of fish germplasm through registration and documentation, constituted by ICAR, New Delhi.
- Sub-Committee for studying the potential and viability of culturing endemic and exotic species, constituted by Department of Animal Husbandry, Dairying & Fisheries (DAHDF), Ministry of Agriculture, Govt.of India, New Delhi.
- Member, Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur, Tamil Nadu.
- Member, Broad Subject Matter Area Committee for assisting National Core Group for restructuring of Masters' and Doctorate Course Curricula & Syllabi, CIFE, Mumbai.
- Member, Committee to study various aquaculture standards for inclusion in National Programme for Organic

Production (NPOP), constituted by National Steering Committee for Organic Products, APEDA, New Delhi.

- Member - National Organising Committee of 8th Indian Fisheries Forum held during 22-26 November 2008 at Kolkata.
- Member, Sub-Committee to formulate guidelines for farming of *L.vannamei* and norms for setting up Multiplication centres for production and supply of *L.Vannamei*, CAA, Chennai.
- Chairman, Sub-committee to frame guidelines for registration of PCR laboratories, feed manufactures/suppliers and dealers, constituted by CAA, Chennai.
- Member, Fisheries Institute of Technology and Training (FIFT), Govt. of Tamil Nadu, Chennai.
- 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, Organizing Committee of INDAQUA 2009 held during 21-23 January 2009 at Bhubaneswar.

Dr. A.R.Thirunavukkarasu, Head, FCD

- Member, Board of Studies of Botany and Zoology (PG), University of Madras, Chennai.
- Member, External Technical Committee for Marine Finfish hatchery, Government of Tamil Nadu.
- Non-academia Member in the Board of Studies in Zoology (G&P), University of Madras.
- Member, Selection Committee of Coastal Aquaculture Authority, Chennai
- Member, Selection Committee of Central Marine Fisheries Research Institute for the recruitment of SRF.
- Member, Peer Review Committee, ICMAM, NIOT, Chennai.
- Member, Board of Directors, Centre for Aquaculture Research & Development, Government 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. P. Ravichandran, Head, CCD

- Member Secretary, Coastal Aquaculture Authority, DAHDF, Ministry of Agriculture, Govt. of India during 26.11.2007 to 30.04.2008.
- Member, Committee constituted for risk analysis study for the introduction and culture of *Litopenaeus vannamei* in India. CAA, Chennai.
- Member, Committee constituted for drafting specific guidelines for the introduction and culture of *L. vannamei* in India. CAA, Chennai
- Member, Committee constituted for inspecting the jump-start facility of Moana India at Srikakulam and to offer suggestions on the biosecurity protocols to be followed in such a facility. CAA, Chennai.

Dr.S.M.Pillai, Principal Scientist

- Member, Sub-committee to review the guidelines for regulating Coastal aquaculture annexed to Coastal Aquaculture Authority Rules 2005. CAA, Chennai.

Dr. T. C. Santiago, Principal Scientist & SIC, AAHED

- Member, Committee to draft SOPs for quarantine facilities for import of SPF *L. vannamei*. CAA, Chennai.
- Member, Inspection team of the CAA, Chennai for the quarantine work related to import of SPF *Penaeus monodon* and PLs by M/s. Santir Aquatic Pvt. Ltd.,(Moana India) at Kirlampudi, Vishakapatnam.

Dr. S. A. Ali, Principal Scientist

- Member, Institute Management Committee, Directorate of Coldwater Fisheries Research, Bhimtal.
- Member, Fish and Fisheries Products Sectional Committee, Food and Agriculture Department, FAD 12 of the Bureau of Indian Standards, New Delhi.

Dr. N. Kalaimani, Principal Scientist

- Member, Expert group for review of standard condition for sanitary import of fish and fishery products at CIFT, Kochi, Ministry of Agriculture, Govt. of India, New Delhi.
- Member, Zonal Technology Management Unit of South Zone (ZTMU), ICAR, CIFT, Kochi.
- Member, Inspection team of the CAA, Chennai for the quarantine work related to import of SPF *Penaeus monodon* and PLs by M/s.Santir Aquatic Pvt. td.,(Moana India) at Kirlampudi, Vishakapatnam.

Dr.M.Natarajan, Principal Scientist

- Chairman, Best Thesis Award Committee of Professional Fisheries Graduates Forum (PFGF), Mumbai. Evaluated theses for awards under the following categories –
 - Dr. N. R. Menon Best Post-Graduate thesis (M.F.Sc Category) – 2008.
 - Dr. I.Karunasagar Best Post-Graduate thesis (Ph.D. - Indian Category) – 2008
 - Dr. V. G. Jhingran Best Post-Graduate thesis (Ph.D. – Overseas Category) – 2008

Dr. M.Krishnan, Principal Scientist & SIC, SSD

- Member, Assessment Committee for Group V staff, Central Institute of Fisheries Technology (CIFT), Kochi.
- Member, Institute Management Committee, Central Marine Fisheries Research Institute, Kochi.

Dr.K.P.Jithendran, Principal Scientist

- Supervisor for ARS/NET Examination 2007 conducted by Agricultural Scientists Recruitment Board, New Delhi at Chennai on 25 May 2008.

- Panel member for evaluation of research project proposal under the young investigators programme in Biotechnology, Kerala State Council for Science, Technology and Environment, Trivandrum.

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 to ICAR.

Dr. K.Ponnusamy, Senior Scientist

- Member, Selection committee for the KVKs, Tamil Nadu Board for Rural Development.

Dr. T.K.Ghoshal, Senior Scientist

- Member, Assessment committee for category I & II of technical personnel of CIFRI, Barrackpore.

Mr. G.Biswas, Scientist

- Member, Selection Committee, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Kolkata.

15. WORKSHOPS, SEMINARS, MEETINGS, ETC., ORGANISED BY THE INSTITUTE

WORKSHOPS

Sl. No	Programme	Venue	Date
1	Workshop on “Women in aquaculture development”	CIBA, Chennai	29-30 July 2008
2	National level brainstorming workshop on “Prospects of Asian seabass farming in India” sponsored by National Fisheries Development Board, Hyderabad	CIBA, Chennai	29 August 2008
3	A sensitization workshop for the representatives of the district level committees of the Coastal Aquaculture Authority (CAA)	CIBA, Chennai	10 September 2008
4	A National workshop on “Recent advances in aquaculture” (in Hindi)	CIBA, Chennai	23-24 September 2008
5	Brainstorming workshop on “Identifying research needs for controlling white spot syndrome disease in shrimp aquaculture”	CIBA, Chennai	17 October 2008

Workshop on women in aquaculture development

A two day workshop on ‘Women in aquaculture development’ was held at CIBA, Chennai during 29-30 July 2008. Around 75 participants from different stakeholder groups, NGOs and women Self Help Groups from Tamil Nadu participated. This workshop threw light on the efforts and contributions made by women in brackish and coastal aquaculture, the institutional support, linkages, factors that facilitate and motivate women, the problems encountered and the encouragement that has helped them to take up aquaculture for their livelihood.



Participants of the workshop on women in aquaculture development

Sensitization workshop for the representatives of the district level committees of Coastal Aquaculture Authority

A sensitization workshop for 26 representatives of the District Level Committees (DLCs) of the Coastal Aquaculture Authority (CAA) from the States of Tamil Nadu, Andhra Pradesh, Kerala and Puducherry, was jointly organised by CAA and CIBA on 10th September 2008 at CIBA, Chennai. The issues on land ownership, land use pattern, distance of shrimp farm location from the HTL/ buffer zone, CAA's geographical limitations, clarifications regarding ETS/EMP/EIA, powers and limitations of DLCs, registration and licensing procedures were discussed in the meeting.



CAA-CIBA sensitization workshop for DLCs

National Hindi workshop

National Hindi Workshop on “Recent advances in aquaculture” was organised during 23-24 September 2008. Delegates from all over India participated and presented research papers in the workshop. Fifteen invited resource lectures and twenty research papers were presented. Dr. A.G. Ponniah, Convener and Dr. Indrani Karunasagar, Chief Guest of the workshop emphasized the need of using Hindi in promoting recent advances in aquaculture.

FARMERS' MEETS

BRACKISHWATER AQUAFARMERS' MEET AT KRC

Kakdwip Research Centre organized a Brackishwater aquafarmers' meet on 3rd July 2008. The meet highlighted the popularisation of CIBA technologies to the local fish farmers and also understanding the current trends with regard to brackishwater aquaculture development in West Bengal. Around 120 farmers from different parts of South 24 Parganas District viz. Sagar, Namkhana, Pathar Pratima and Kakdwip blocks took part in this meet.



Farmers - Scientist interaction

Farmers' Interaction Meet

A Farmers' interaction meet was organised by CIBA at Muthupettai, Thiruvavur District of Tamil Nadu on 8th July 2008, to create awareness among the farmers on BMPs and biosecurity principles to be adopted in shrimp farming to prevent the vertical and horizontal entry and spread of pathogens causing shrimp diseases in the ponds. Around 130 participants including officials from Fisheries Department, Govt. of Tamil Nadu participated.

EXHIBITIONS

The institute participated in the exhibitions organized during the following events:

- Bangalore Bio-2008 organised by Vision Group on Bio-Technology at International Exhibition Centre, Bangalore during 24-26 April 2008.
- Brainstorming meet on Aquaculture 2025, CIFA, Bhubaneswar during 7-8 June 2008.
- Chennai Science Festival 2009 exhibition organised by Tamil Nadu State Council for Science and Technology, Anna University, Chennai during 19-22 February 2009.
- 8th Indian Fisheries Forum exhibition at Kolkata from 22-25 November 2008



Vice Chancellor, University of Madras presenting memento to CIBA



Visitors in CIBA stall during Bangalore Bio-2008.



Dr.A.G.Ponniah, Director,CIBA explaining the exhibits in CIBA stall to Shri Kiranmoy Nanda, Hon'ble Minister for Fisheries, Govt. of West Bengal during 8th Indian Fisheries Forum at Kolkata

MEETINGS

The institute organised the following meetings:

i) Special meeting of Coastal Aquaculture Authority at CIBA on 23rd June 2008.

ii) Bureau of Indian Standards (BIS) aquafeed standards meeting

A meeting for preparing draft standards for fish and shrimp feeds to be brought out by the Bureau of Indian Standards, Govt. of India, New Delhi was held on 27th June 2008 at CIBA, Chennai. A total of 18 delegates consisting nine delegates representing the core feed industry and nine scientists of nutrition and feed research from CIBA and CIFA attended the meeting. The meeting brought a draft proposal of feed standards for marine shrimp, freshwater fish and scampi and forwarded to Bureau of Indian Standards for further necessary action.



a



b

BIS aquafeed standards meeting (a) Participants, (b) Interactive session

RESEARCH INFORMATION SYSTEM

Research Information System (RIS), intranet-based application software was developed to store and retrieve the information on all research papers, project proposals and reports and special publications of CIBA. This system was inaugurated by Dr. P.S.B.R James, former Director, CMFRI, Kochi on 25th August 2008 in the presence of Dr. S. Ayyappan, Deputy Director General (Fisheries), Dr. A.G. Ponniah, Director, CIBA, Dr. G. Syda Rao, Director, CMFRI, Kochi and officers and staff of CIBA.



Inauguration of the Research Information System

WORLD ENVIRONMENT DAY

World Environment Day was organised on 5th June 2008 at CIBA, Chennai with the theme “Climate change- moving carbon economy towards low”. Dr. A.G. Ponniah, Director, CIBA in his presidential address, outlined the purpose of celebration and also elaborated various steps like effective usage of electronic devices in offices use of fluorescent tubes, vehicle pool sharing, avoiding plastics and number of other useful tips to create more awareness and promote attitudinal change among the people towards low carbon economy and lifestyle.

The thematic talks were delivered by Dr. P.G. Lavanya, Head, Agricultural Policy and Planning, Tamil Nadu State Planning Commission, Chennai in her thematic talk reviewed the fishery development programmes focused in XI Plan in Tamil Nadu with emphasis on environmental conservation including the schemes planned for eco-restoration, well being of coastal communities and coastal area development to reduce climate and market risks. Dr.K.Ponnusamy, Senior Scientist, CIBA delivered a talk on the impact of climate change on farming systems and livelihoods and highlighted the causative factors of climate change, its likely impact on human settlement, farming systems including agriculture, livestock as well as the mitigation and adaptation strategies to get along with the ramifications of climate change.



Dr.P.G.Lavanya delivering thematic talk during world environment day

ICAR FOUNDATION DAY

ICAR Foundation day was celebrated on 16th July 2008 at CIBA, Chennai. All scientists, staff and research scholars participated in the event. Dr.A.G.Ponniah, Director, CIBA delivered the presidential address highlighting the role played by ICAR in the food and nutritional security of the country.

Dr.U.A.Balasubramanian, Assistant General Manager, Indian Bank, Chennai delivered special address on “Emerging Agri-Business Opportunities,” covering the importance of agriculture as business, agro-climatic and agri-export zones, contract farming, food processing, value chain, domestic market, food parks and potentials of allied farm enterprises. The master-piece documentary film “An Inconvenient Truth”, on the global environment, produced by Mr. Al Gore, former Vice-President, USA and Chairman, Intergovernmental Panel on Climate Change (IPCC) was screened.

NATIONAL SCIENCE DAY

National Science day was celebrated at CIBA, Chennai on 28th February 2009. Shri A Joseb Raj, the Chairman & Managing Director and founder of M/s Oceana Group of Companies, delivered the key note address, explaining how the private sector could contribute effectively towards achieving sustainable aquaculture through innovative approaches. The live interaction between the key note speaker and scientists brought out more clarity on public private partnership by offering a variety of integrated services at the doorstep of farmers.



Dr.A.G.Ponniah, Director, CIBA greeting Shri. A, Joseb Raj, CMD, Oceana Group, Chennai

16. VISITORS

The following dignitaries visited CIBA:

Name of the Visitor	Date of Visit
Dr.M.Sakthivel, President, Aquaculture Foundation of India, Chennai and a team of Norwegian Experts	26 April 2008
Mr.Arun S.Sutaria, IAS, Secretary, Dept.of Animal Husbandry, Cow Breeding, Dairying & Fisheries, Govt. of Gujarat	3 May 2008
Dr.S.Vasudevappa, Sr. Executive, NFDB, Hyderabad	17 May 2008
Dr.T.Balasudha Hari, Deputy Director, National Horticulture Board, Chennai	5 June 2008
Dr.P.Natarajan, Chairman, RAC of CIBA	20 June 2008
Dr.E.G.Silas, Former Vice-Chancellor, Kerala Agricultural University, Trichur	26 June 2008
Mr.Dilip Barman, Manager, ERNET & Dr.P.C.Sarkar, Senior Scientist, ARIS Unit, ICAR, New Delhi	27-28 June 2008
Dr.U.A.Balasubramanian, AGM (Training), Indian Bank, Chennai	16 July 2008
Mr.Roland Herrmann, German Consul General, German Consulate, Chennai	1 August 2008
Dr.Syda Rao, Director, CMFRI, Kochi	1 August 2008
Dr. S. Ayyappan, DDG (Fy), ICAR, New Delhi (visited KRC)	25-26 November 2008
Dr.Mangala Rai, Secretary, DARE & DG, ICAR, Dr.S.Ayyappan, DDG(Fy.), ICAR & Dr.Mohan Joseph Modayil, Member, ASRB, New Delhi	8 January 2009
Dr.A.E.Eknath, Director, CIFA, Bhubaneswar and Dr.I.A.Siddique, DAHD&Fy., New Delhi	9 January 2009
Ms.Anitha Ramanna (Indo-Norwegian Project), Pune	30 January 2009

17. PERSONNEL

Dr. A.G.Ponniah

DIRECTOR

HEADQUARTERS

Scientific Personnel

HEAD OF DIVISION

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

PRINCIPAL SCIENTIST

Shri M.Kathirvel (superannuation on 30.9.2008)
Dr. S.Kulasekarapandian
Dr. S.M.Pillai
Dr. T.C.Santiago
Dr. Syed Ahmed Ali
Dr. C.P.Rangaswamy (superannuation on 31.8.2008)
Dr. B.P.Gupta
Dr. N.Kalaimani
Dr. M.Natarajan
Dr. M.Krishnan
Dr. K.P.Jithendran
Dr. C.Gopal (w.e.f. 27.7.2006)
Dr. V.S.Chandrasekaran (w.e.f. 27.7.2006)

SENIOR SCIENTIST

Dr. G.Gopikrishna
Dr. T.Ravisankar
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.D.Vimala
Dr.(Mrs.) Shiranee Periera
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

SCIENTIST (SENIOR SCALE)

Mrs. P.Mahalakshmi
Dr.(Mrs.) M.Poornima
Dr.(Mrs.) R.Saraswathy

SCIENTIST

Dr. K.Vinaya Kumar
Dr.(Mrs.) Krishna Sukumaran (joined on 14.5.2008)
Dr.(Mrs.) Ezhil Praveena (joined on 16.5.2008)
Dr. Sujeet Kumar (joined on 16.05.2008 and transferred to KRC on 25.7.2008)
Mrs. Shyne Anand (joined on 16.05.2008 and transferred to KRC on 10.7.2008)

Technical Personnel

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

T-5

Shri M.G.Subramani (Driver)
Shri M.Gopinathan Nair (Driver)

Shri S.Rajamanickam
Shri S.Rajukumar
Shri Joseph Sahayarajan

TECHNICAL ASSISTANT

T-4

Shri S.Nagarajan
Shri S.Stanline
Dr. A.Nagavel
Shri R.Subburaj
Shri R.Rajashekarani

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
Shri K.Karaian

T-2

Shri C.Anandanarayanan
Shri K.Paranthaman (Driver)

T-1

Shri K.V.Delli Rao

Administration and Finance

ADMINISTRATIVE OFFICER

Shri M.S.N.Murty (superannuation on 31.5.2008)
Shri A.Muthuraman (joined on 21.7.2008 from CTCRI,
Rajamundry)

FINANCE & ACCOUNTS OFFICER

Shri S.Krishnaswamy

ASSISTANT ADMINISTRATIVE OFFICER

Shri R.G.Ramesh

JUNIOR ACCOUNTS OFFICER

Mrs. K.Nandhini

ASSISTANT

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 CLERK

Shri S.Pari
Mrs. E.Amudhavalli
Shri A.Manoharan
Shri A.Sekar
Mrs. E.Mary Desouza

LOWER DIVISION CLERK

Shri P.Srikanth
Mrs. R.Vetrichelvi
Shri B.Palanivelmurugan
Mrs. M.Mathuramuthu Bala
Mrs. B.Prasanna Devi
Shri R.Kumarasen
Shri A.Paul Peter (promoted from Skilled Support
Staff on 10.12.2008)

SKILLED SUPPORT STAFF

Shri P.Arumugam
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

S.S.Gr.I

Shri E.Manoharan

Kakdwip Research Centre

Scientific Personnel

SENIOR SCIENTIST

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

SCIENTIST (SENIOR SCALE)

Dr. Debasis De

SCIENTIST

Dr. R.Ananda Raja
Shri Gouranga Biswas
Dr. Sujeet Kumar (from 25.7.2008)
Mrs. Shyne Anand (from 10.7.2008)

Technical Personnel

(T - 2)

Shri P S.Samanta
Mrs. Chanda Mazumder

Administrative Staff

PERSONAL ASSISTANT

Shri S.K.Halder

ASSISTANT

Shri S.K.Bindu
Shri P.K.Roy

UPPER DIVISION CLERK

Mrs. Arati Rani Panigrahi

SKILLED SUPPORT STAFF

Shri A.K.Biswas (superannuation on 31.3.2009)
Shri N.N.Mondal
Shri N.C.Samanta
Shri Rash Behari Das
Shri Gour Hari Jana
Shri Sasadhar Betal
Shri Kalipada Mondal
Shri Pranesh Chandra Saha
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
Mrs. Lakshmi Rani Bhuiya
Shri Uttam Kumar Santra
Shri Bholalal Dhanuk
Shri Purna Chandra Das

REDEPLOYED TO CIFA, BHUBANESHWAR

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.

- Earth filling - Phase - II
- Augmentation of generator capacity from 165 KVA to 320 KVA
- Campus lighting and gate lights

Muttukadu Experimental Station of CIBA, Muttukadu

- Extension for crab hatchery with A.C. sheet roof
- Effluent treatment pond with pump house and re-modeling of drainage canals in main building and in shrimp hatchery.

Kakdwip Research Centre of CIBA, Kakdwip

- Construction of hatchery shed and water distribution system

19. LIBRARY, INFORMATION AND DOCUMENTATION

Library holdings

The CIBA Library acquired 52 new books. To meet the reference needs and for up-dating the current knowledge of the scientists, subscriptions to 25 foreign journals for headquarters and 31 Indian Journals each for headquarters and Kakdwip Research Centre libraries were also made. The total library holdings in March 2009 were 2225 books, 1545 bound journal back volumes, 675 reprints and photocopies, 1910 reports / bulletins and 4180 miscellaneous publications.

For better dissemination of scientific information, the following facilities have also 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 also in the local site of CIBA.
- Membership in the libraries of Indian Institute of Technology, Anna University, University of Madras and Central Leather Research Institute in Chennai.

Exchange services

The library maintained exchange relationship with national and international organizations on mutual interest. Complimentary copies of CIBA publications are regularly being sent 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, members from NGOs and other agencies / individuals through reference of books and journals.

20. कार्यकारी निष्कर्ष

पहले की सालों की तरह, “केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान” के अनुसंधान एवं विकास के प्रयास जारी हैं ताकि खारापानी जलजीव पालन के क्षेत्र में दीर्घकालिक विकास किया जा सके। वर्ष 2008-2009 के दौरान सीबा का झींगा खाद्य पदार्थ प्रौद्योगिकी का विमोचन ही सबसे महत्वपूर्ण उपलब्धि थी और एक उद्यमी ने इसे वाणिज्यीकृत किया है। प्रौद्योगिकियों के प्रभावशाली हस्तांतरणों के लिए विशेष महिला स्वयं सेवक दलों की आजीविका के लिए पद्धति निरूपण कार्यक्रमों के साथ वैज्ञानिक एवं विभिन्न पणधारियों के बीच में बैठके आयोजित की गई। वर्ष 2008-2009 की अवधि के दौरान संस्थान के अनुसंधान की उपलब्धियों के विवरण निम्नानुसार हैं।

छोटे स्तर के किसानों के लिए तकनीकों को उचित बनाने पर ध्यान देने के साथ साथ पर्यावरणानुकूल एवं लागत प्रभावी खारापानी जलजीव पालन तकनीकों का विकास।

सीबा का झींगा खाद्य पदार्थ प्रौद्योगिकी (शुरु करनेवाला, पैदाइशी बढ़ानेवाला और पूरा करनेवाला) को मेसर्स बिस्मी फीड्स लिमिटेड, पेरुणोटोटम, तमिलनाडु को वाणिज्यीकृत किया जा चुका है। सीबा के झींगा खाद्य पदार्थ की रचना ऐसे बनाई गई है कि यह *पेनेयिस मॉनोडॉन* और *फेन्नरोनेनियस इंडिकस* के पोषण युक्त आवश्यकताओं को पूरा करता है।

कम लागत तथा अधिक लाभ की झींगा की खेती सीबा के काव्दीप अनुसंधान केन्द्र में चलाई जा रही है। जिसमें कार्बनिक इनपुटों का उपयोग अधिक किया जा रहा है। टाइगर झींगा, पी.मॉनोडॉन का औसत उत्पादन 1289 kg/ha प्रति फसल प्राप्त हुआ तथा 1121 kg/ha प्रति फसल के तथा परंपरागत खेती के अंतर्गत 1.36 FCR की तुलना में 1.28 FCR प्राप्त किया गया। यह उत्पादन में काफी महत्वपूर्ण लाभ है, जिसमें बेहतर FCR और उत्पादन की लागत में कमी जैसे पहलू दिखाई देते हैं।

12 no./m² की स्टॉक सघनता के साथ शून्य पानी विनिमय की झींगा खेती प्रौद्योगिकी में खेतों में परीक्षण किए गए। प्रायोगिक तालाबों में इसमें 80 % की जीवंतता के साथ 3109 kg/ha प्रति फसल का औसत उत्पादन प्राप्त हुआ जिसमें उत्पादन के संदर्भ में 7.95 % लाभ की वृद्धि पाई जाती है, जीवंतता दर में 6.96 % की वृद्धि तथा कंट्रोल तालाबों की तुलना में FCR में 10.24% की वृद्धि पाई जाती है। इस प्रौद्योगिकी का विकास संस्थान के काव्दीप तालाबों में किया गया और यह खेतों में निरूपण और किसानों को हस्तांतरित करने के लिए तैयार है।

कम एवं उच्च लवणता की स्थितियों के अंतर्गत पालन के लिए विशेष खाद्य पदार्थों का विकास करने के प्रयासों के एक भाग के रूप में बहुत ही तरुण टाइगर झींगा पी.मॉनोडॉन में वृद्धि एवं पोषण उपभोग पर लवणता के प्रभाव का अध्ययन किया गया। विभिन्न शारीरिक प्राचलों से यह संकेत मिलता है कि पी. मॉनोडॉन उच्च लवणता (50‰) की परिस्थितियों की तुलना में कम लवणता को सहन कर लेता है।

झींगा खाद्य पदार्थों में पौधे प्रोटीनों के प्रभावशाली उपयोग लाने के लिए आठ संभाव्य सामग्रियों को रेशेदार एवं गैर स्टार्च पॉलीसेकक्वराइड (NSP) अंश के लिए विश्लेषित किया गया। चावल और गेहूँ के भूसे में विलेयशील NSP अधिकतम पाया गया, जबकि सोयाबीन मील, सफेद सरसों के मील, सूरजमुखी मील तथा

कपास बीज के मील में इतनी अधिक भिन्नता नहीं थी। NSP प्रकार के अंश पर प्राप्त इस डेटा से पचन प्रक्रिया में सुधार करने के लिए उचित एन्जाइम मिश्र प्राप्त करने में सहायता मिल जाती है।

कम लागत के खाद्य पदार्थ तैयार करने के लिए सूरजमुखी केक, तेल निकाले गए करंजा केक, आम के बीज का गूदा और इमली के बीजों के चूर्ण को शामिल करने के लिए उचित स्तरों को निर्धारित किया गया, जिसका पी. मॉनोडॉन एवं मुगिल सिफेलस के बहुपालन में प्रयोग किया जा सकता है।

पी. मॉनोडॉन के विटिल्लोजेनेसिस के स्टेरॉयडोजेनिक हॉर्मोन के प्रभावों पर इन-विट्रो एवं इन-वाइवो अनुप्रयोग किए गए जिसमें यह पाया गया कि 17α हाईड्रॉक्साइल प्रोगेस्टेरोन ने विटिल्लोजेनेसिस (वीजी जीन की अभिव्यक्ति) की गति में वृद्धि लाता है। उक्त परिणामों से यह पता चलता है कि गोनाड को कम करनेवाली हॉर्मोन को न्यूट्रिलाइज करके किसी भी तरह की परिपक्वता लाने के हस्तक्षेप उनकी ओवेरियन प्रजनन स्तर में काफी प्रभावशाली होता है।

पी. मॉनोडॉन में नर गैमिट की गुणवत्ता पर किए गए प्रायोगिक कार्यों से यह संकेत मिलता है कि स्पर्मटोस्फीयर्स के आवधिक मैन्युअल अभिव्यक्ति द्वारा प्राप्त स्पर्म की गुणवत्ता को बनाए रख सकते हैं।

उष्णदेशीय पॉलीचेइयट प्रजाति, पेरेनैरीज नुन्टिया के पालन हेतु एक सरल प्रोटोटाइप पालन व्यवस्था का विकास किया गया है जो झींगा ब्रूडस्टॉक के लिए परिपक्व खाद्य पदार्थ के लिए बहुत ही उत्कृष्ट हैं। 5-6 महीनों में 300g/200l के टैंक के परिमाण के जैव उत्पादन के साथ स्त्री एवं पुरुषों का आकार 5-8 cm/0.4-0.9g तथा 6-14 cm/0.6-1.3 क्रमशः पाया गया।

नवीन गुणधर्म युक्त सूक्ष्म जीवियों की पहचान करने तथा लवण सहनशील जीनों जैसे नवीन जीनों को आइसोलेट करने के लिए विभिन्न प्रकार के खारापानी पारिस्थितिकी से सूक्ष्म जीवियों (सूक्ष्मजीवाणु, अक्टिनोमिसाइट्स, कवक, खमीर आइसोलेट एवं आर्किबैक्टीरिया) का कुल 805 आइसोलेट किए गए। महत्वपूर्ण सूक्ष्मजीवाणुओं में हैलोफिलिक, बैसिलस एसपी जैसे सूक्ष्म जीवी भी शामिल थे जिनमें 30% NaCl की सान्द्रता में बढ़ने की क्षमता पाई जाती है। बैसिलस एसपीपी में जीन के परिवहन के लिए जिम्मेदार ग्लाइसीन-बीटेयन (ऑस्मोलइट्स) की पहचान भी की गई।

झींगा पालन में अमोनिया एवं नाइट्रेट को निकालने के लिए झींगा तालाबों में जैव उत्प्रेरक के रूप में बेगासे के प्रयोग को भी सफलतापूर्वक निरूपित किया गया है। नाइट्रिफाइंग सूक्ष्म जीवियों की अधिकाधिक वृद्धि देखी गई और इसे रियल-टाइम PCR के साथ परमाण्विक तकनीकों द्वारा निश्चित किया गया है।

तटवर्ती पर्यावरण में कीमोलिथोऑटोट्रॉफिक नाइट्रिफाइंग, डीनाइट्रिफाइंग, नाइट्रोजन फिक्स करनेवाली तथा आक्सीकरण सूक्ष्म जीवियों के परमाण्विक जैविक लक्षण वर्णन के लिए फंक्शनल जीनों को लक्ष्य बनाया गया। *amoA*(531bp), *norB*(412 bp), *nirS*(873bp), *nosZ*(710bp), *soxB*(753bp, 483bp, 503bp, 239bp), *nifH*(407bp) जीनों के अनुक्रम जीनबैंक में प्रस्तुत किए गए।

प्रश्न पत्र (n=112) सर्वेक्षण से यह स्पष्ट हुआ कि कीटाणुनाशक एवं पंछी नेट जैसे जैव-सुरक्षा उपायों के अभाव में गैर-परीक्षित बीज के उपयोग तथा फसल के कैलेण्डर में असमानता ही झींगा में रोगों के फैलने का कारण बना।

समाज से संबद्ध एवं गैर संबद्ध किसानों में आमतौर पर अपनाए जानेवाले BMP तथा जैव-सुरक्षा BMP के कुछ हद तक का कार्यान्वयन पाया गया। गैर-समाज किसानों में इनका अपनाया जाना काफी अधिक देखा जाता है और यह वास्तव में समाज में छोटे एवं गरीब किसानों की तुलना में स्वतंत्र किसानों के उच्च-वित्तीय स्तर के कारण था। तालाबों के दोनों वर्गों में संपूर्ण पानी एवं मिट्टी की गुणवत्ता के संदर्भ में इतनी कोई बड़ी भिन्नता नहीं देखी जाती है और उक्त सभी प्राचल उचित श्रेणी में ही पाए गए।

किसानों से प्राप्त सूचना से उत्पादन में बढ़ोतरी लाने की क्षमता का विश्लेषण किया गया। मिट्टी, पानी एवं खाद्य पदार्थ के लिए उत्पादन एवं प्रोबयॉटिक्स के प्रयोग के बीच सहसंबद्धता विश्लेषण किए गए और इसके परिणामों से उत्पादन को बढ़ाने में उनकी भूमिका की पहचान करने में मदद मिलती है। खाद्य प्रोबयॉटिक्स के लिए 0.91 के r मूल्य की तुलना में पानी की लागत एवं मिट्टी प्रोबयॉटिक्स तथा उत्पादकता के बीच सहसंबद्धता गुणांक (r) क्रमशः 0.68 और 0.52 पाया गया।

पश्चिम बंगाल में 60 स्वदेशी प्रौद्योगिकी जानकारी प्रयोग (ITK) करनेवाले खारापानी खेतों का मूल्यांकन किया गया और इनके दस्तावेज़ बनाने के कार्य पूर्ण हैं और इसमें कुछ आशाजनक ITKS के प्रायोगिक कार्यों का वैधीकरण भी शामिल है।

पश्चिम बंगाल में अपनाई जानेवाली परंपरागत खारा जलजीव पालन पद्धतियों का विश्लेषण करने तथा उनका दस्तावेज़ बनाने के लिए एक रिलेशनल डेटाबेस मैनेजमेंट सिस्टम (RDMS) का विकास किया गया है। यह जलजीव पालन डेटाबेस व्यवस्था – खारा पानी, एक अप्लिकेशन सॉफ्टवेयर है जिसमें से तैयार की गई डेटाबेस से सूचना रिट्रीव की जा सकती है। इस अप्लिकेशन सॉफ्टवेयर को अन्य पालन व्यवस्थाओं के लिए भी इस्तेमाल किया जा सकता है।

झींगा एवं मछली उत्पादन व्यवस्थाओं में वर्तमान एवं उभरनेवाले रोगों से निपटने के लिए एक बृहत् स्वास्थ्य प्रबंधन व्यवस्था

आन्ध्र प्रदेश, तमिलनाडु एवं महाराष्ट्र के राज्यों में पी. मोनोडॉन में कम वृद्धि के असर से प्रभावित खेतों से इकट्ठित 110 नमूनों के आधार पर मोनोडॉन की वृद्धि में कमी के कारण के स्थिति की पहचान की गई है तथा 76 प्रतिशत के नमूने लेइम-सिंह वायरस के पॉज़ीटिव पाए गए।

केरल, तमिलनाडु, आन्ध्र प्रदेश एवं पुदुच्चेरी से प्राप्त खारापानी एवं समुद्री मछलियों में असिम्टोमैटिक इण्डोवायरस दूषण (85 नमूनों में 42%) की पहचान की गई है। इन्हें हिस्टोपैथोलोजी, इलेक्ट्रॉन माइक्रोस्कोपी एवं परमाण्विक पद्धतियों से निश्चित किया गया है।

नरवस नेर्कासिस वायरस के स्क्रीनिंग के लिए RT-PCR (नेस्ट किए गए) ऐस्से किए गए प्रयोगशाला में समुचित बनाए गए। चार तटवर्ती प्रदेशों से समुद्री एवं खारापानी मछलियों ($n=168$) में 16% की उप-क्लिनिकल दूषण स्तर पाए गए। मस्तिष्क के ऊतकों के इलेक्ट्रॉन माइक्रोस्कोपी से यह पता चला कि 35nm के आयामों वाले माप के कण जैसे नोडावायरस के कई ऐर्रे पाए गए।

विभिन्न भौगोलिक स्थानों में की गई साथ साथ की पुनरावृत्ति (VNTRs) के संबंध में सफेद दाग सिन्ड्रोम वायरस के जीनोटाइपों के होने में भिन्नता तथा जंगली एवं पाले गए कैकड़े एवं झींगा प्रजातियों के

जीनोटाइपों के बीच में भिन्नताओं के विवरणों का दस्तावेज़ बनाया गया है।

विब्रिड्यो हार्वेड्यी का नियंत्रण करने के लिए फेज थेरपी का विकास करने के लिए फेज टाइपिंग एवं क्लस्टर विश्लेषण के आधार पर प्रकाशप्रभावी वी.हार्वेड्यी के 42 आइसोलेटों को चुना गया। इन 42 आइसोलेटों के विरुलेण्ट तत्त्व, परमाण्विक पैथोजेनेसिटी, फेज टाइपिंग तथा इन-वीवो पैथोजेनेसिटी से यह संकेत मिलता है कि वी. हार्वेड्यी के स्ट्रेनों का फेज टाइपिंग पैथोजेनिक एवं नॉन पैथोजेनिक में भिन्नता बताई जा सकती है।

आनुवंशिकी एवं जैवप्रौद्योगिकी दूलों के प्रयोग के माध्यम से उच्च स्वास्थ्य एवं उच्च-वृद्धि झींगा

आनुवंशिकी कार्य के अध्ययन से पी.मॉनोडॉन की वृद्धि, रोग प्रतिरोधी क्षमता तथा जीवतता एवं रोग की अधिक जानकारी मिली एवं एक ही परिवार की वृद्धि का अध्ययन विभिन्न भौगोलिक स्थानों में करने का कोई खास अंतर नहीं पाया गया, जिससे पता चलता है कि आनुवंशिकता तथा वातावरण का पारस्परिक प्रभाव में कमी है।

प्रायोगिक रूप से दूषित एफ. इंडिकस तथा पी. मॉनोडॉन में चार प्रकार के dsRNA इंजेक्ट करते हुए सफेद दाग सिन्ड्रोम वायरस के विरुद्ध सुरक्षा प्रदान करने के लिए डबल स्ट्रैंडेड RNA (dsRNA) की क्षमता का अध्ययन किया गया। जीवतता के संदर्भ में मापित सुरक्षा 80 से 98 % तक पाई गई तथा राइबोन्यूक्लियोटाइड रिडक्टेज़ जीन (rr1) में अत्यधिक जीवतता पाई गई।

स्वच्छ पानी झींगा में सफेद मांस रोग के संदर्भ में कंप्यूटेशनल पद्धति की सहायता से MrNV वायरस के RdRp जीन पर आधारित पाँच siRNAs की डिज़ाइन बनाई गई। *E.coli* DH5 आल्फा सक्षम कोशिकाओं में MrNV वायरस के RdRp जीन को क्लोन किया गया। प्रयोगशाला परिस्थितियों में स्वच्छ पानी झींगा में रोग को नियंत्रित करने में उनकी प्रभावात्मकता के आधार पर इनका मूल्यांकन किया जाएगा।

पेड़नियस मॉनोडॉन के फंक्शनल आनुवंशिकी पर कार्य के अंतर्गत इम्यून डिफेन्स पर संभवतः प्रभाव करने वाले टॉल रिसेप्टर जीन तथा झींगा मांस प्रोटीनों में अलर्जी के लिए जिम्मेदार ट्रॉपोउडसिन जीन को क्लोन किया गया और उन्हें अभिव्यक्त किया गया।

दीर्घकालिक खारापानी जलजीव पालन के विकास हेतु प्रजाति एवं व्यवस्थाओं का विविधीकरण

14 ppt (नवंबर-दिसंबर के दौरान) पर F₄ वंश सीबॉस पर सफल स्पॉनिंग किया गया और इससे यह पता चलता है कि पालतू बनाने तथा ब्रूडस्टॉक प्रबंधन में प्रोटोकॉलों में किए गए सुधार से कम लवण परिस्थितियों में भी पालतू स्टॉक का परिपक्वण पाया गया है। कुल 4.87 लाख फ्रई पैदा हुए जिनमें से 2.0 लाख, दिसंबर 2008 एवं जनवरी 2009 के महीनों में पैदा हुए तथा पहले इन्हें सीबॉस ब्रीडिंग के लिए अयोग्य पाए गए।

सुधार किए गए हैचरी प्रबंधन तकनीकों के साथ सीबॉस हैचलिंगों की जीवतता 25 दिन की फ्रई में 32% की वृद्धि देखी जाती है।

सीबॉस हैचलिंगों को पालने की प्रौद्योगिकी सीबा द्वारा मानकीकृत किया गया तथा मेसर्स पेरियार हैचरी मरक्काणम नामक उद्यमी की सुविधा में इसका वैधीकरण किया गया और 58% दर की जीवंतता दर प्राप्त की गई। इस सफलता का अर्थ है कि आवश्यक रूपांतरणों के साथ झींगा/स्कैम्पी तथा मिट्टी के कैंकड़ों के लिए नियत हैचरी को सीबॉस हैचरियों में बदला जा सकता है।

सीबा में मानकीकृत किए गए सीबॉस नर्सरी पालन तकनीक को किसानों को सफलतापूर्वक हस्तांतरित किया गया।

उचित प्रोटीन का मूल्यांकन : बेहतरीन वृत्ति और FCR सीबॉस फिंगरलिंग्स के लिए आवश्यक वसा (ऊर्जा) से यह संकेत मिलता है कि उन्हें उच्च प्रोटीन और उच्च ऊर्जा से युक्त खाद्य पदार्थ की जरूरत है। मध्यम स्तर की प्रोटीन स्थिति में कम FCR के साथ मछली भी अच्छी रह सकती है, लेकिन उसमें उच्च वसा स्तर होना चाहिए।

सीबॉस के नर्सरी पालन के लिए 45% प्रोटीन तथा 12 % वसा युक्त माइक्रो खाद्य पदार्थ का विकास किया गया। आन्ध्र प्रदेश में स्थित विभिन्न किसानों के हपस एवं नर्सरी के तालाब, दोनों में इस खाद्य पदार्थ का वैधीकरण किया गया। फिंगरलिंगों का उत्पादन करने के लिए सीबा के नर्सरी खाद्य पदार्थ को सीबाफस के बृहत् स्तर के नर्सरी पालनों के लिए इस्तेमाल किया जा सकता है तथा यह प्राण्योगिकी अभी वाणिज्यिक स्तर के उत्पादन के लिए तैयार है।

छिपने की कृत्रिम जगहों से स्कैल्ला ट्रेक्वीबेरिका के नर्सरी पालन में जीवंतता के दर में काफी वृद्धि देखी जाती है। छिपने के प्राकृतिक स्थान (0.12-0.17g/प्रतिदिन) युक्त तालाबों की तुलना में जिन तालाबों में छिपने की कृत्रिम जगह बनाए गए उनमें वृद्धि की दर में (0.27-0.35g/ प्रतिदिन) काफी बढ़ोतरी देखी जाती है।

नर्सरी में पाले गए एस. ट्रेक्वीबेरिका (60 g) के कैंकड़े की इल्लियों को चेन्नई से काकदीप में भेजा गया और उन्हें 0.75 no./m² की दर में स्टॉक किया गया। वे 44 से 51% की जीवंतता की दर के साथ 302 से 343g का आकार प्राप्त कर पाए थे। पश्चिम बंगाल में एस. ट्रेक्वीबेरिका का पहला ट्रायल है जिसमें उन्होंने पालन की संभावनाओं का संकेत दिया है।

सूखी सामग्री (DM), क्रूड प्रोटीन (CP) और समुद्री मील की ऊर्जा, असिटेट्स मील, सोयाआटा, गेहूँ और युवा मिट्टी के कैंकड़ा एस. ट्रेक्वीबेरिका के पचन गुणांक को निर्धारित किया गया है। इसके परिणामों से यह पाया गया कि पशु एवं पौधे प्रोटीन दोनों के स्रोत मिट्टी के कैंकड़े द्वारा प्रभावशाली ढंग से इस्तेमाल किया गया।

दीर्घकालिक खारापानी जलजीव पालन विकास हेतु सामाजिक-आर्थिकी विश्लेषण एवं नीतिगत समर्थन

भारत में मात्स्यिकी अनुसंधान पर प्रभाव का मूल्यांकन से यह पता चला कि केरल एवं पश्चिमी बंगाल में परंपरागत खेतों की तुलना में तमिलनाडु तथा आन्ध्र प्रदेश के राज्यों में प्रचलित वैज्ञानिक खेतों में उत्पादन 300 से 600 % की वृद्धि देखी जाती है। फिर भी, फसल में असफलता की बढ़ती हुई संख्या से यह संकेत मिलता है कि रोग मुक्त पी. मोनोडॉन बीज एवं बेहतरीन प्रबंधन पद्धतियों (BMPs) के

कार्यान्वयन की उपलब्धता सुनिश्चित किया जाना चाहिए।

122 परंपरागत झींगा खेतों (केरल में 60 तथा पश्चिमी बंगाल में 62) के एक सर्वेक्षण के आधार पर यह पाया गया कि पश्चिमी बंगाल में कुछ जंगली प्रकार के बीजों के उपयोग से तथा केरल में पेलेट खाद्य पदार्थ के पूरकों से यह पता चला कि कार्बनिक प्रामाणीकरण मानकों से केरल में काफी विसमान्यता पाई गई।

भारत में मात्स्यिकी क्षेत्र में मार्केट मौकों पर अध्ययन से यह पता चला कि बीच के उद्यमी मार्केट में अपने लाभ के रूप में ग्राहक रूप का 42 से लेकर 58% का भाग ले लेते हैं। अतः उत्पादक और ग्राहक के बीच में लाभ को बढ़ावा देने के लिए मार्केट चैनल को कम से कम करने का प्रयास किया जाना चाहिए। यदि मार्केटिंग संरचना (72%) में ग्राहक के असंतोष तथा शहरों में मछली के अस्वस्थपूर्ण संभालना (68%) से निपटा जाए तो पालतू मछली की माँग में बढ़ोतरी होगी।

रासायनिक संकेतक, सूक्ष्म जीवाण्विक संख्या एवं संवेदी मूल्यांकन अध्ययन के आधार पर ठंडे भण्डारण (-20°C) में सामान्य एवं रोग से ग्रस्त झींगा पी. मॉनोडॉन के शेल्फ लाइफ पर अध्ययन किए गए। इन अध्ययनों से यह पाया गया कि ठीला शैल सिन्ड्रोम (LSS) के कारण नमूनों पर प्रभाव पड़ा है तथा WSSV प्रभावित एवं झींगा नमूनों की तुलना में उसका शेल्फ लाइफ बहुत ही कम था।

वर्ष 2005- से लेकर 2008 की अवधि के दौरान खारापानी जलजीव पालन में रोग की उपस्थिति के कारण वार्षिक स्तर पर राष्ट्रीय हानि का आकलन 48,717 t बताया जाता है जिससे देश को रु. 1022.13 करोड़ रुपयों की हानि हुई है। झींगा में रोग लग जाने के कारण जलकृषि में रोजगार के संदर्भ में वार्षिक स्तर पर 21.56 लाख कार्मिक शक्ति दिवसों की हानि देखी जाती है।

आन्ध्र प्रदेश, केरल, तमिलनाडु तथा पश्चिमी बंगाल के पी. मॉनोडॉन, भारतीय सफेद झींगा, एफ.इंडिकस, एल. कैल्कैरिफेर तथा एम.सिफेलस, के पोषण के प्रोफाइलों में भौगोलिक एवं मौसमीय भिन्नताओं का दस्तावेज़ तैयार किया गया है।

मॉडल में एक और इनपुट प्राचलों के रूप में कुल निलंबित कणों के शामिल होने के साथ पहले विकसित वहन क्षमता (CC) निर्धारण योजना टूल को और परिष्कृत किया गया। आगे, टूल को वायुशिफों के पास स्थित नए स्रोत पानी निकासों के नए प्रकार के साथ वैधीकृत किया गया। इससे यह पाया गया कि वेल्लार तथा उपनार नदियों में CC पर 275 एवं 96 ha पाया गया जो विकसित वास्तविक क्षेत्र के अंदर ही था।

रिमोट सेंसिंग से प्राप्त चित्रों के आधार पर 1987 तथा 2006 के भूमि प्रयोग वर्ग की तुलना करते समय यह स्पष्ट होता है कि आरक्षित वन वायुशिफ के क्षेत्र को जलजीव पालन विकास के लिए इस्तेमाल नहीं किया गया था। आरक्षित वन क्षेत्र के बाहर निजी क्षेत्रों में ही अधिक से अधिक जलजीव पालन का विकास देखा जाता है।

इस सूचना के आधार पर ही तंगाटिचमडम, रामनाथपुरम जिले के ग्राम जानकारी केन्द्रों के प्रयोगकर्ताओं के निर्धारण की जरूरत है, अतः खारापानी झींगा जलजीव पालन में मिट्टी एवं पानी प्रबंधन पर एक ई-लर्निंग मॉड्यूल का डिज़ाइन तैयार करके उसका विकास किया गया है।

केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान (सीबा) के सभी अनुसंधान पत्र, परियोजना प्रस्ताव एवं रिपोर्ट, विशेष प्रकाशन आदि पर सूचना स्टोर करने तथा रिट्रीव करने के लिए एक इंटरनेट आधारित अप्लिकेशन सॉफ्टवेयर, अनुसंधान सूचना व्यवस्था (RIS) का विकास किया गया है।

तमिलनाडु के छः जिलों में स्थित पाँच सौ सात महिला किसानों पर इकत्रित डेटा के विश्लेषणों से यह पता चला कि महिलाएँ जलजीव व्यवसाय, छोटे स्तर के झींगा प्रक्रिया यूनिट, कैंकड़ा निर्यात, पिजरो और पेन में कैंकड़े को मोटे करने के व्यवसाय, कैंकड़ा हैचरी, बड़ी सीपी इकत्रीकरण, झींगा हैचरी, मछली मील प्रक्रिया, मूल्यवान उत्पादों को तैयार करने तथा सीबॉस खेती जैसे जलजीव पालन क्रियाकलापों के एक विस्तृत श्रेणी में लगे हुए थे।

महिला स्वयं सेवी दलों में रोजगार का अच्छा विस्तार करने के लिए खारापानी जलजीव पालन प्रौद्योगिकियों को अपनाने के लिए प्रेरणा के तत्वों की पहचान की गई।