वार्षिक प्रतिवेदन
ANNUAL REPORT
2007-08

भाकृअनुप
ICAR

Central Institute of Brackishwater Aquaculture
(Indian Council of Agricultural Research)
Chennai

Ciba

वार्षिक प्रतिवेदन

Annual Report

2007 - 2008

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ICAR

केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद्)
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CAPTION FOR COVER PHOTOGRAPH :

Haul of organic shrimps

Citation

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CONTENTS

1. PREFACE

Brackishwater aquaculture has been a dynamic sector in the past two decades with the emergence and expansion of commercial scale shrimp farming in the country. Presently aquafarmers are looking for alternative species, particularly an exotic species, the western white shrimp *Litopenaeus vannamei* which has replaced the tiger shrimp all over the world. At the same time the sector in India still carries on with the tiger shrimp farming with modifications in culture practices, such as growing the shrimps for slightly a longer period than the normal duration to attain bigger size that fetches premium price in the export market. Diversification in brackishwater aquaculture towards other species, such as mud crabs and Asian seabass, is also gradually taking off.

In this year 2007-08 significant achievements have been made in brackishwater aquaculture research leading to the contribution towards the development of technologies in the emerging fields and transfer of the technologies to the common man in the country. The important highlights of the research work carried out were: risk assessment for the introduction of *L. vannamei,* natural maturation and on-farm culture trials of the shrimps *Fenneropenaeus merguiensis* and *Marsupenaeus japonicus* , nursery rearing and grow-out culture of the mud crabs, genetic improvement of *Penaeus monodon,* development of methodology for the estimation of aquaculture farms in larger areas using remote sensing techniques, developments in captive broodstock management of Asian seabass *Lates calcarifer* and milk fish *Chanos chanos,* grow-out culture trials of seabass, captive maturation of the grey mullet *Mugil cephalus* achieved for the first time, studies on luminescent bacterial disease and loose shell syndrome , impact of diseases in brackishwater cultured shrimp production and the economic loss, development of molecular kit for the detection of chemoautotrophic ammonia oxidizing bacteria (AOB), shrimp pond soil and water management practices and products that mitigate environmental impact and increase productivity, use of vegetable oils (*in lieu* of fish oil) as a component in the shrimp feed, pellet feed development for mud crab culture, formulation of micro diets for the seabass larvae, assessment of suitability of plant protein sources as a component in organic shrimp feed and genetic studies on shrimps for WSSV resistance. Due emphasis was given to the socio-economic aspects of the brackishwater aquaculture including the transfer of technology through training programmes, farmers meets, stakeholders meets, exhibitions and through extension materials. Empowerment of coastal women in brackishwater aquaculture technologies as means of alternative livelihood options has also been achieved during the year.

The encouragement and constant support received from Dr.Mangala Rai, Secreary, DARE and Director General, ICAR and Dr.S.Ayyappan, Deputy Director General (Fy.), ICAR, Dr.A.D.Diwan, Assistant Director General (M.Fy.) and Dr.V.V.Sugunan, Assistant Director General (I.Fy.) are gratefully acknowledged. Thanks are also due to the Research Advisory Committee and Institute Management Committee for their valuable inputs in planning our research and allied activities.

A.G.Ponniah
Director

2. EXECUTIVE SUMMARY

Development of techno-economically viable and sustainable culture system for brackishwater finfishes and shellfishes and transfer of technologies to benefit different stakeholders are the major mandate of Central Institute of Brackishwater Aquaculture (CIBA). The Institute has been involved in preparing the risk assessment study on the introduction of the western white shrimp *Litopenaeus vannamei* and also for the development of SPF broodstock of the tiger shrimp *Penaeus monodon* for the Ministry of Agriculture, Government of India and the National Fisheries Development Board. The major research achievements accomplished by the Institute during 2007-08 are:

- Natural maturation of tiger shrimp *Penaeus monodon* and banana shrimp *Fenneropenaeus merguiensis* was achieved in ponds and viable spawnings were obtained. Natural maturation of kuruma shrimp *Marsupenaeus japonicus* and the banana shrimp were also achieved under controlled conditions in the hatchery.
- The production of kuruma shrimp in the institute pond and banana shrimp in farmer's pond was 987 kg/ha and 903 kg/ha, respectively.
- Culture of *F. merguiensis* was also carried out at Kakdwip in two ponds at a stocking density of 6 no./m^2. A total production of 381 kg/ha and 525 kg/ha was attained in 172 and 155 days of culture. The shrimp reached average final size of 22 g with the survival of 28% and 40% respectively.
- Grow-out culture of the mud crab *Scylla serrata* recorded a very high growth rate of 62.5g/month in 45 days rearing at 0.7 no./m^2 with clam meet as feed. The survival rate was 64.8%.
- Nursery rearing of larger species of the mud crab *Scylla tranquebarica* was taken up in an earthen pond and stocked with 4700 nos. of early juveniles. In 45 days, the crabs attained an average size of 48.1mm/ 21g with a survival rate of 38%.
- As part of the research programme in validation of the technology for nursery phase-II of mud crab *S. tranquebarica,* experimental studies indicated that there was no significant difference in the growth of the crabs under low (2-5 no./m^2) and high (13-19 no./m^2) stocking densities during 45 days rearing in ponds with trash fish and clam meat as feed. However, the average survival showed significant difference with higher survival at low densities (45%) and lower survival (34%) at high densities.
- Under Indo-Norwegian collaborative project on genetic improvement of *P. monodon,* the data collected on the different families in the challenge test and commercial rearing were analyzed. The results showed significant genetic variations in body weight at harvest and in general pond survival of the families. The estimated heritability for resistance to WSSV was low (~ 0.01) and the analysis did not reveal significant additive genetic variations for resistance to WSSV, but a cluster of three families appeared to have relatively higher resistance to WSSV. The results indicated that the selection program can be continued and will result in significant improvements in growth.
- Using IRS LISS III data, the existing and pre-aquaculture period land use pattern in and around Punnakayal mangroves of Tamil Nadu was mapped to assess the present status of mangroves and causes for degradation.
- Captive broodstock of 70 seabass in the size range of 2-10 kg was maintained with regular water exchange under controlled conditions. They were found to be in gravid condition in all the months and even in low

saline condition of 15 ppt. By gradually raising the salinity up to 28±2 ppt, spontaneous spawning was noticed in six cases during October – November. A total of 10 breeding trials were conducted and 3.94 lakhs fry were produced.

- Nursery rearing of seabass fry of 1.0 cm stocked in varying densities of 200 - 2000 no./m^3 and fed with formulated diet registered survival rate of 43 - 78% in nursery tanks, 81 - 90% in hapas and 23 - 74% in hatchery tanks.
- About 30 numbers of milkfish in the size range of 2-4 kg were maintained under controlled conditions fed with formulated feed @ 3% body weight to develop as broodstock for breeding trials.
- Grow-out culture of seabass was undertaken at Institute ponds at Muttukadu and Kakdwip and farmer's ponds at Thambikkottai in Tamil Nadu and Kakdwip under varying densities and encouraging results were observed. Milk fish culture was also initiated in Institute and farmer's ponds at Kakdwip.
- Captive maturation of *Mugil cephalus* was achieved for the first time and the spawning was induced through hormonal manipulation. Larval rearing was achieved beyond 30 days and further rearing is under progress.
- As a part of the programme on germplasm cataloguing and conservation of fish and shellfish resources of the country, the fish biodiversity assessment made at Pulicat Lake and Kakdwip revealed that the number of species were 56 for finfishes and 15 for crustaceans in Pulicat Lake and 74 for finfishes and 11 for crustaceans in Kakdwip.
- Luminescent bacterial (LB) disease is one of the major bacterial diseases and has been often responsible for shutting down of shrimp hatcheries, resulting in huge economic losses. Based on a detailed study of the source water, sand filtered water, nauplius, zoea, mysis and post larval rearing tanks, maturation and spawning tanks, *Artemia* hatching tanks and algal culture tanks in hatcheries, it is confirmed that the shrimp brooders and the maturation and spawning tanks are the main source of LB.
- The viral-like pathogenic agent has been found to be involved in loose shell syndrome (LSS), a disease causing economic havoc among shrimp farmers of India. The transmission electron microscopic examination and nucleic acid analysis have revealed viral-like nature of the purified agent. The possibility of involvement of this viral-like agent in LSS is inferred based on its isolation from LSS affected shrimp and induction of LSS symptoms in healthy tiger shrimp by experimental challenge with purified viral like agent.
- Around one hundred microbes from different extreme environments have been isolated and the collection has been deposited to National Bureau of Agriculturally Important Microorganisms, Mau.
- The impact of diseases in brackishwater cultured shrimp on economic loss in the states of Orissa and West Bengal along the East Coast and Goa and Karnataka along the West Coast were studied. The loss of production was estimated to be 14,600 tonnes per year and the economic loss as Rs. 486.62 crores.
- Laboratory experiments proved that WSSV could be transmitted to shrimp from infected crabs by cohabitation and oral feeding.
- A sensitive and accurate molecular kit has been developed and revalidated for the detection of chemoautotrophic ammonia oxidizing bacteria (AOB) associated with aquatic and agricultural environments and commercially available bioaugmentors. AmoA has been sequenced and released in the GenBank.
- Denitrifying bacteria have been characterized, for which functional gene-nitrous oxide reductase gene (nosZ) implicated in catalysis of reduction of nitrous oxide to nitrogen in the last step of denitrification has been

sequenced and released in the GenBank .

- The results of eight week feeding trial on *P.monodon* revealed that fish oil can be effectively replaced by other vegetable oils without compromising on growth and FCR.
- Nursery rearing of seabass larvae using high lipid micro diets showed significantly higher body weight (1.83g) than low lipid diet (1.51g). Another experiment using micro diets in fresh water showed significantly better growth up to 2% inclusion level of common salt.
- Studies conducted with oil cakes to assess the suitability of plant protein sources as a component in organic shrimp feed, revealed that soybean cake with 40-42% crude protein can be used to replace major portion of fish meal in organic shrimp diet.
- Feeding trials in yard experiments on tiger shrimp showed that maize gluten and wheat gluten can be incorporated at 10% and 15% level individually in place of fishmeal without compromising on the growth and FCR.
- The juveniles of *M. japonicus* from ten families are being reared in 500 l FRP tanks. About 532 shrimp from eight wild and two inbred families were tagged with visible implant elastomer tags. From these 365 shrimps were stocked in a 600m^2 pond that attained an average body weight of 23.20 g, with an increase of about 54% in their body weight.
- Around 120 tagged shrimps were challenge tested with WSSV. Analysis of survival data revealed that there were no significant differences between the families for WSSV resistance.
- Evaluation of change in quality of marketing services brought in by implementation of the aquachoupal model in West Godavari and East Godavari districts of Andhra Pradesh indicated that there has been significant improvement in prompt payment, reduction in transportation cost and accessibility of timely information which helped the shrimp farmers to get higher profit.
- The performance of Varanasi model of agri-clinics in three districts of Uttar Pradesh was studied for the establishment of aqua clinics in the country. Critical assessment of agri-clinics in the coastal states revealed that establishment of aqua clinics necessitates identification of reputed training organisation in each major aquaculture state, selection of fisheries graduates with minimum three years of marketing experience in private companies, screening of candidates during interview for two months training by the training institution, more focus on marketing extension skill in the training content and involving the rural bank managers from the areas for project preparation.
- Cluster farming and dynamics of its success in shrimp aquaculture studies based on farmers' societies and creek based farmers associations respectively in Andhra Pradesh and Tamil Nadu revealed that farmer groups enforced collective seed procurement, simultaneous stocking and non-use of banned antibiotics in their farm clusters. Tangible deliverables, collectiveness, committed leadership and strong social cohesiveness were the critical factors that determine the success of these associations.
- Aquafarmers meets, field days, exhibitions and workshops were conducted for transfer of brackishwater technologies. Under public-private partnership mode, crab culture was demonstrated in a farmer's pond at Chellangkuppam, Cuddalore, Tamil Nadu. The CIBA pellet feed for fattening water crabs was successfully tested with *S. tranquebarica* in cages by a SHG of Jamilabad Village in Pulicat lake, near Chennai which revealed that the crabs fed on pellet diet hardened in 24 days with 9.5% weight gain compared to that of 26 days and 9% obtained respectively with conventional trash fish feed.

3. INTRODUCTION

The brackishwater resources of the country comprise 3.9 million ha of estuaries, 3.5 million ha of coastal brackishwater area and 8 million ha inland salt affected areas. The 8129 km coast line of the country offers immense potentials for development of coastal aquaculture. Around 1.2 million ha brackishwater area suitable for aquaculture development is available in the coastal regions of the country and around 1,75,670 ha has been developed so far contributing a production of 2.2 million tonnes which is largely by a single species, the tiger shrimp *Penaeus monodon.*

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 25 Administrative and 56 Supporting staff as on 31.3.2008.

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. These activities were carried out under twelve in-house projects, and nineteen externally funded projects that comprise six Agricultural Produced Cess fund , seven Department of Biotechology four network, one Indo-Norwegian and one National Fisheries Development Board.

Research Advisory Committee

DIRECTOR

Institute Management Committee

HEAD QUARTERS, CHENNAI, TAMIL NADU

- Crustacean Culture Division
- Finfish Culture Division
- Nutrition, Genetics and Biotechnology Division
- Aquatic Animal Health and Environment Division
- Social Sciences Division
- Administration
- Accounts & Audit
- Stores
- Library & Documentation Section
- ARIS Cell
- Technical Cell
- Engineering Cell
- Hindi Cell
- Project Monitoring & Evaluation Cell
- Institute Technology Management Committee

RESEARCH CENTRE

Kakdwip, West Bengal

FIELD CENTRE

Muttukadu, Chennai

HEADQUARTERS

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MUTTUKADU EXPERIMENTAL STATION OF CIBA

Kovalam Post
Muttukadu 603 112
Tamil Nadu
Telephone : 044-27472344, 044-27472061

FINANCIAL STATEMENT

BUDGET 2007-08 (Rs. in lakh)		
	Allocation	**Expenditure**
Plan	548.00	547.95
Non-Plan	309.51	309.48

OFFICIAL LANGUAGE IMPLEMENTATION PROGRAMME

Official Language Implementation Committee Meetings were conducted on quarterly basis. Second Sub-Committee of the Parliamentary Committee on Official Language visited CIBA on 12 July 2007. The Hindi week was celebrated during the period 24-30 September 2007. Debate and Vadh-Vivadh competitions in Hindi were conducted on the occasion and cash awards were distributed to the winners. 12 staff members were nominated

for various Hindi courses of Hindi Teaching Scheme (HTS) and 3 staff members were nominated for Hindi typing courses during the year 2007-08. All the 12 staff members had qualified in Hindi course examinations/ Hindi typing examination of HTS and received the cash awards. Two officers were deputed for attending Hindi workshops at Goa and Manali during the year.

STAFF POSITION

The details of the number of positions sanctioned, filled and remaining vacant as on 31.3.2008 are as follows:

Position	Sanctioned	Filled	Vacant
Director (R.M.P.)	1	1	-
Head of Division	2	2	0
Principal Scientist	1	0	1
Senior Scientist	10	1	9
Scientist	52	40	12
Technical Assistant	30	29	1
Administrative Officer	1	1	-
Finance & Accounts Officer	1	1	-
Assistant Administrative Officer	1	1	-
Junior Accounts Officer	1	1	-
Personal Assistant	3	3	-
Stenographer Gr.III	2	2	-
Assistant	5	4	1
Senior Clerk	6	6	-
Junior Clerk	8	6	2
Supporting Staff	64	56	5
Total	188	157	31

4. RESEARCH ACHIEVEMENTS

IN-HOUSE PROJECTS

CRUSTACEAN CULTURE DIVISION

RESEARCH PROJECTS

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 (CCD/B & C/2)**

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.D. Vimala, Dr.K.Ponnusamy, Dr.M.Kumaran, Dr.M.Muralidhar, Dr.R.Saraswathy and Dr.J.Syama Dayal

Title of the project : **Development of packages for nursery rearing and grow-out culture of mud crabs (*Scylla spp*). (CCD/CF/2)**

Principal Investigator : Shri M.Kathirvel

Location of the project : Chennai

Co-Investigators : Dr.S.Kulasekarapandian, Dr.A.Panigrahi, Dr.C.P.Balasubramanian, Dr.J.Syama Dayal, Dr.M.Poornima, Dr.T.K.Ghoshal

Title of the project : **Aquaculture farm appraisal and impact assessment using remote sensing and GIS (CCD/RA/2)**

Principal Investigator : Dr.M.Jayanthi

Location of the project : Chennai

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

SUSTAINABLE SHRIMP PRODUCTION THROUGH DOMESTICATION OF *PENAEUS MONODON,* DEVELOPMENT OF CULTURE PRACTICE FOR *MARSUPENAEUS JAPONICUS* AND ADOPTION OF BEST MANAGEMENT PRACTICES IN FARMING (CCD/B&C/2)

Improvement of reproductive performance of *Penaeus monodon*

Three sets of experiments were carried out during the year *viz.,* evaluation of seasonality of reproductive performance, evaluation of maturation diet and development of biosecurity protocol to optimize the maturation and spawning performance.

Evaluation of seasonality of reproductive performance

The experimental trials were conducted in October-December/January and February. The results indicated (Fig. 1.) that spawner survival in February was extremely poor (8.1%). Animals that underwent vitellogenesis were higher in December-January (44%) followed by October-November (33%) and successful spawning was higher in December-January (35%). Due to the poor spawner survival in February, experiment could not be completed. There was no significant difference in hatch rate between October-December/January (70% and 69% respectively). Mean value of eggs per spawn was maximum in October-November (144.7 X 103). Mean salinity and temperature during October-December/January were sub optimum, whereas, water quality characteristics of Feb were within the optimum levels. The prevalence of WSSV infection varied between 36 and 41% and there was no significant variation in prevalence between experimental trials. Spawning performance during October-January (commercial off season) is comparable to the reported results even at the sub optimal levels of salinity and temperature.

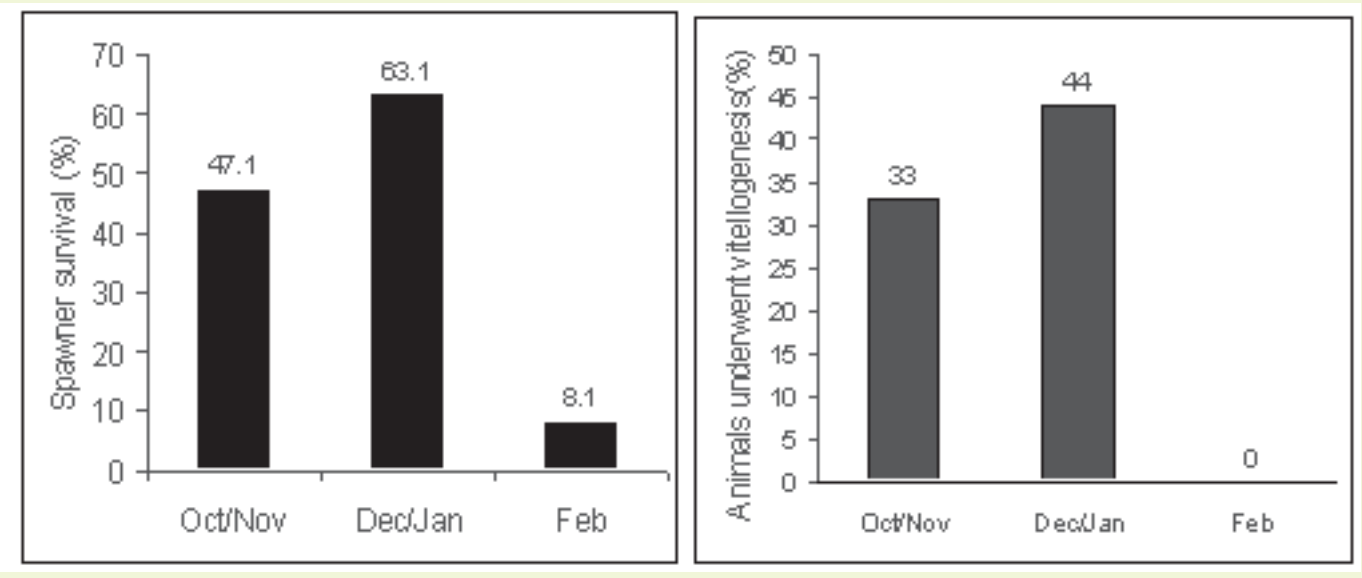


Fig. 1. Reproductive performance of *P. monodon* during October-February

Evaluation of maturation diet developed at the Institute

This programme is aimed to replace the fresh feed, at least partially, from the maturation feeding schedule of *P. monodon.* A total of 40 broodstocks (22 ♀ and 18 ♂) were divided into two groups and stocked in 6 m diameter tanks after eye-stalk ablation. Shrimps in one tank were fed with fresh feed consisting of polychaetes and the other with formulated feed and polychaetes. About 63% of shrimps in the control group survived through the 30 days experiment, whereas 50% of shrimps in the experiment group survived. Although none of the animals in the experiment group spawned, 40% of animals underwent vitellogenesis. This experiment indicates that partial replacement of fresh feed with dry diet is successful in inducing maturation. However, further studies are needed to confirm the preliminary results and to obtain viable spawning.

Biochemical composition of wild and pond reared *P.monodon* broodstock

Comparison of biochemical composition of muscle, hepatopancreas and ovary of wild and pond reared *P. monodon,* showed that there was no significant variation in the protein composition in both males and females of either group. However, significant variation was observed in the ovary of wild (5.31%) and pond reared (3.47%) in the lipid composition. The role of natural feed availability in the wild might be having significant effect in the lipid composition of the ovary.

Evaluation of the efficiency of water treatment system

The bacterial load (total colonies/ ml) at different water supply points *viz.,* source water, tank water, sand filtered water and UV filtered water and at different sections *viz.* maturation, larval rearing and algal culture of the shrimp hatchery was monitored for a period of 30 days. The bacterial load is less in sand filtered water and negligible in the UV treated water. The bacterial load in maturation tank water showed a decreasing trend while it was constant in larval rearing tanks. In the algal culture tanks the bacterial load showed an increasing trend.

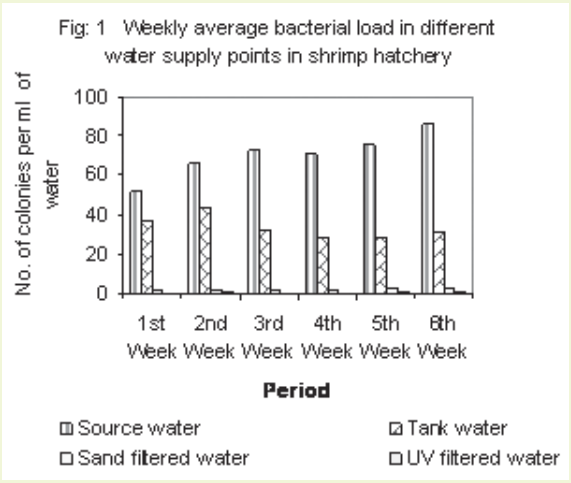


Fig. 2. Difference in weekly average bacterial load in different water supply points in shrimp hatchery

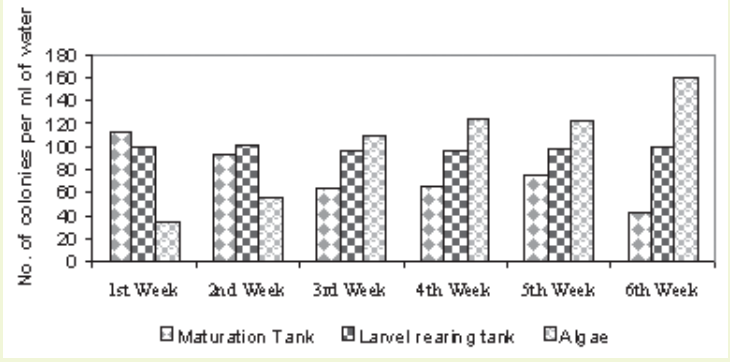


Fig. 3. Variation in weekly average bacterial load in different tanks in shrimp hatchery

Effectiveness of chlorination

The residual chlorine level and the bacterial load in water treated with five different levels of calcium hypochlorite

(10 to 50 ppm) were monitored every three hours. The time taken for residual chlorine to become nil at 10 ppm concentration was 6 h, at 20 and 30 ppm it was 18 h and for 40 ppm and 50 ppm it was 21 h. The bacterial load was nil in all the treatments *viz.* 10 to 50 ppm. The 10 ppm concentration with the retention time of 6 h is sufficient to ensure elimination of bacteria and residual chlorine in the water.

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

In order to understand the existing BMPs, farmers' traditional practices, their adoption rate and to develop location specific BMPs, studies were conducted during 2007 winter crop in cluster ponds of National Centre for Sustainable Aquaculture (NaCSA) at Kunduran Valley (S1-C) and Chinnathumbur (S2-C) in Tamil Nadu and Ullipalem (S3-C) and Matsyapuri (S4-C) in Andhra Pradesh and in the independent/cluster farmers' ponds using the same source water nearer to the above mentioned villages *viz.,* Mudaliappan Kandi (S1-I), Paravai (S2-I), Salimpalem, Pittalnka and Badevaripalem (S3-I) and Matsyapuri (S4-I).

Classification and categorization of existing farming systems in relation to practices and environmental conditions

The farming systems in the study area were categorised based on the crop season and cropping system, water source, soil type, stocking density, water exchange and use of chemicals / probiotics.

Implementation of BMPs: Adoption rate and the factors influencing the adoption

The adoption rate for BMPs were 100% in almost all the farms surveyed among the society and non-society farmers (n=40) excepting for the use of aerators and reservoir ponds. The major factors influencing the variation in the adoption of BMPs are financial capacity of individuals, lack of knowledge and motivation and non-unity among farmers.

Investigations on soil and water quality and shrimp health status - temporal and spatial sampling

Soil and water samples were collected every month from five ponds from each cluster and in five independent farmers' ponds from each site. High total ammonia nitrogen concentration was observed in zero water exchange ponds. All the ponds at Mudaliappankandi (S1-I), Ullipalem (S3-C) and few ponds at Kunduran Valley (S1-C) were affected with WSSV without any harvest produce (Table 1). This is mainly due to the release of water from the disease affected pond by the farmers without intimation and hence water and soil parameters in the ponds could not be correlated.

In spite of BMPs being followed in both the society and non-society ponds, the WSSV outbreaks could not be prevented. This observation stresses the need for inclusion of bio-security protocols in the list of BMPs, to prevent the horizontal transmission of viral pathogens.

Table1. Particulars of temporal and spatial sampling on soil and water quality and shrimp health status

Particulars	Tamil Nadu				Andhra Pradesh			
	S1-C	S1-I	S2-C	S2-I	S3-C	S3-I	S4-C	S4-I
Av. Pond area (ha)	0.5-0.8	0.45-0.7	0.5-0.6	0.5-1	0.45	0.4-0.6	0.45-0.9	0.68-0.9
Stocking density (PL/m^2)	5-5.5	4.4-6.6	5-8.5	3.1 – 10	0.66 -2.66	1.11 – 7.5	Scampi -1.1 Tiger – 1.18	Scampi – 0.73 -0.89 Tiger – 1.11
DOC at the time of first sampling	1-40	56-57	34-95	27-35	6-44	10-150	30-80	7-60
Remarks	All ponds except two affected with the disease.	All ponds affected with the disease.	Successful harvest	Two ponds with loose shell syndrome.	No inputs into pond other than seed.	All ponds harvested with disease.	Poor survival	One pond affected with white spot disease.
Average Production of harvested ponds (count) (kg/ha)	894 (28 to 56)	-	1647 (29-42)	1425 (30-40)	80 count	-	150	200

Specific experimental studies

i) Evaluation of use of zeolite products in aquaculture

Twelve different zeolite products were evaluated for their characteristics and efficiency. The colour of the samples varied from white to yellow to grey and brown. Bulk density of dry zeolite ranged from 0.44 to 0.94 g/cm^3. The pH and conductivity in 1:1 mixture of zeolite and distilled water ranged from 3.65 to 11.74 and 0.23 to 1.73 dS/m respectively. The cation exchange capacity (CEC) of the samples ranged between 8.5 and 168 me/100 g. Particle size of samples ranged from coarse (0.51 to 10.32%), medium (3.6 to 78.24 %) and fine (21 to 93.94 %). Under experimental conditions, application of zeolite @ 50 kg/ha decreased total ammonia - N concentration initially in both freshwater and brackishwater and afterwards there was very little removal. There was no significant difference among the rate of removal of ammonia - N in freshwater than brackishwater. Considering the efficiency and the cost, use of zeolite for the removal of total ammonia – N is not advisable in brackishwater conditions.

ii) Grow-out culture of *P. monodon* with biosecured zero water exchange farming technology (BZEST)

Grow-out culture of *P. monodon* with biosecured zero water exchange farming system technology (BZEST) with the adoption of BMPs was demonstrated successfully in KRC ponds and production upto 2660 kg/ha was achieved from a stocking density of 13 nos./m^2. Two ponds were managed with probiotic based zero water exchange system and another two ponds as control with water exchange and no biotherapeutic agents. The yeast (Saccharomyces cerevisiae) based preparations were applied twice in a week in BZEST ponds. A feed probiotics *Lactobacillus rhamnosus* JCM 1136 was cultured in laboratory and was applied with feed in six meals in a week. The performance of the shrimps in terms of growth and feed conversion ratio was better than that of the control ponds (Table 2). BZEST shrimps registered better average body weight of 33.29 g at harvest compared to control ponds (31.17 g) and there was 9.24 % gain in terms of production and 11.3 % gain in FCR in BZEST ponds.

Table 2. Performance of *P.Monodon* in BZEST ponds

Treatments	Production Variables						
	Stocking	Seeded Area (Sq. m.)	ABW (g)	Survival rate (%)	Produc-tion (Kg)	FCR	Produc-tion Rate (Kg/ha)
BZEST A	25480	1960	34.47	55.22	485	1.39	2327
BZEST B	48750	3750	32.10	63.64	996	1.45	2660
BZEST Av.			33.29			1.42	2494
Control A	35750	2750	29.46	64.37	678	1.59	2465
Control B	35750	2750	32.87	52.25	614	1.57	2233
Control Av.			31.17			1.58	2349

Development and standardization of culture practices for *Marsupenaeus japonicus*

Wild and captive breeding and production of seed

The experiments on induction of maturity showed that 91% wild females and 35% of domesticated (F_5) females yielded viable spawning. The poor hatching rate could be due to lower size of males (22-32g) grown along with the females.

M. japonicus culture in different salinities

A study was conducted to evaluate the growth and survival of the shrimp in different salinities. The experimental trials were carried out in 100 l FRP tanks at a stocking density of 20 nos./l. The result indicated that salinity around 30 ppt was the optimum, as the growth was highest in both the experiments. Even though the highest survival was recorded at 30 ppt (79.66%) and 40 ppt (79.6%) in trial I and II respectively, the salinity between 25 and 35 ppt was found to be suitable for kuruma shrimp culture.

M. japonicus culture with different soil substratum

A yard experiment was conducted to evaluate the growth and survival of kuruma shrimp *M. japonicus* with or without substratum over 30 days rearing. The substratum constituted loamy, clayey, and sandy soils. The results indicated that loamy soils are best suited for kuruma shrimp since the highest survival (93.3%) and growth (0.626 g) were recorded, followed by sandy soils (89.9%, 0.506 g). Comparatively, very poor growth and survival were recorded with clayey soil.

Field evaluation of immunostimulant through on-farm trial in farmers' ponds

CIBASTIM – an immunostimulant developed at the Institute, was field tested in 13 farmers' ponds. A total of 13

control ponds and 22 treatment ponds were monitored. Since the field testing was done in farmers' ponds, there was no control on the variables. The ponds ranged between 0.5 and 1.2 ha with stocking density of 0.6 – 2.0 lakhs and days of culture from 70 to 165 days. Out of the 22 treatment ponds, nine showed either lower or equal production in comparison to their respective control ponds (Fig. 4). Only six ponds registered more than 20% higher production levels than their control ponds. Since the results are highly variable and because of the wide variations in the culture parameters, no valid conclusion could be drawn.

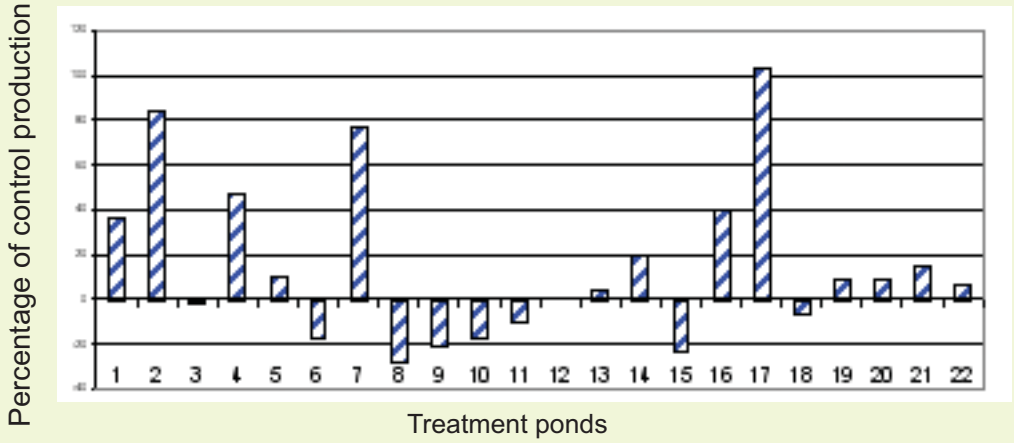


Fig. 4. Percentage change in shrimps production levels in CIBASTIM appiled ponds

Use of chemicals, probiotics and immunostimulant in shrimp culture

A survey conducted to evaluate the commercial use of chemicals, probiotics and immunostimulants in shrimp culture (n =103) showed that 51 and 27 products were used in Tiruvallur and Kancheepuram districts of Tamil Nadu respectively. The level of use depended on the stocking density followed. However, no antibiotics were used by shrimp farmers in these two districts. The farmers who appiled these products were encouraged by technicians of the companies as well as their own consultants. Commonly used products are categorised as soil and water treatment products, feed probiotics, disinfectants, immunostimulants and feed additives. The expenditure incurred by the farmers on these chemicals in the two districts ranged from Rs. 12,000 to Rs. 70,000 /ha, which was roughly 7-10 % of the total cost of production.

DEVELOPMENT OF PACKAGES FOR NURSERY REARING AND GROW-OUT CULTURE OF MUD CRABS *(SCYLLA SPP)*. (CCD/CF/2)

Experimental trials were conducted to study the growth pattern and survival of hatchery raised megalopa larvae of larger species of mud crab *Scylla tranquebarica,* in two nursery phases. The objective of first phase of nursery was to rear the megalopa larvae (average size: 4 mm CW (carapace width); 0.003 g TW (total weight)) at different stocking densities either in hapas placed in experimental tanks or in hapas kept inside the nursery ponds or in earthen ponds for 30 days, while that of second nursery phase was to culture the crabs from early juvenile (2-3 g) to juvenile stage (20-25 g) in earthen ponds for 45 days. To enhance the survival rate as well as to prevent cannibalism among the reared megalopa larvae/early juvenile crabs, bunches of sea weed *(Gracilaria verrucosa)* were provided as hide-outs in hapas and earthen ponds. The details of growth and survivial at different stocking densities are illustrated in Fig. 5.

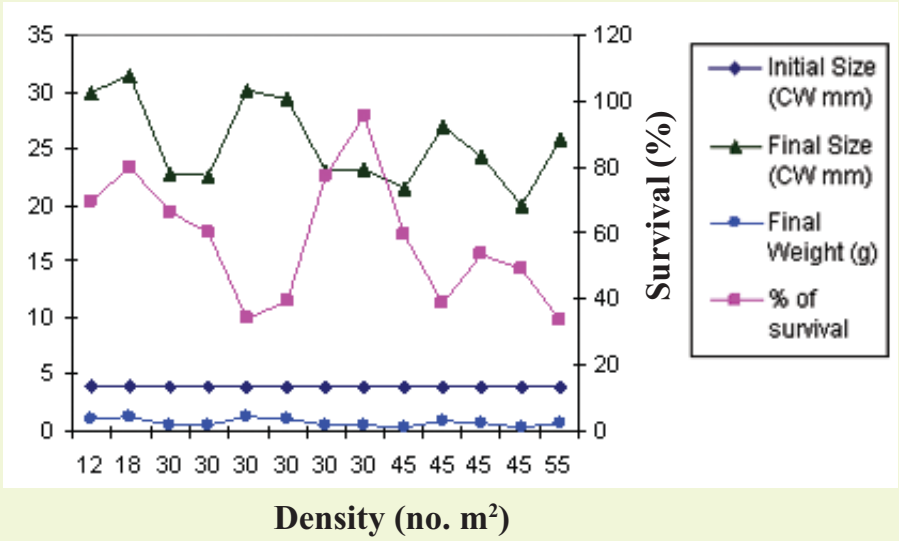


Fig. 5. Growth and survival of megalopa larvae of S.tranqubarica at different stocking densities.

Feeding

The reared megalopae/early juveniles were fed with boiled clam meat twice a day @ 100 % of stocked biomass for a week and then gradually reduced 25 % in the last week of rearing. A final count was made on 31st day of rearing.

Growth and survival

The average size of a single megalopa was 4 mm in CW and 0.003 g in TW. After 30 days rearing, the average size attained in hapas stationed in ponds was 24.9 mm/2.6 g at 58.3 % survival, while the crabs raised from the direct stocking of megalopae in ponds attained the size of 22.9 mm/2.0 g at 41.4 % survival, which may be due to higher stocking densities. Thus, there was low growth in those reared under direct stocking than that of hapa reared. However, a higher growth rate of 30.7 mm/4.2 g was recorded in the crabs reared in the hapas stationed in experimental tanks which registered 75 % survival.

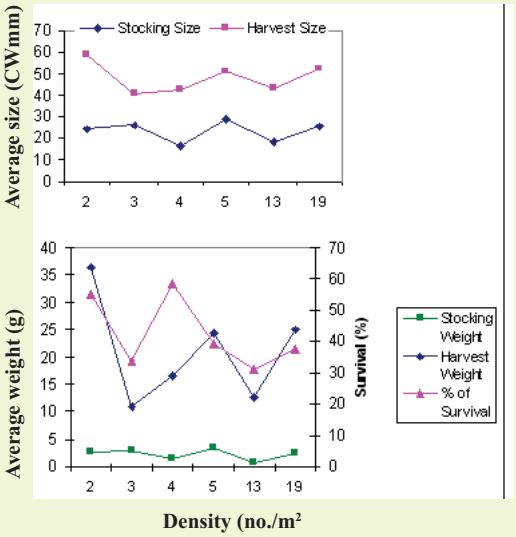


Fig.6. Growth and survival of *S. tranquebarica* in nursery Phase II

Nursery rearing – Phase-II

The early juveniles of *S. tranquebarica* obtained from nursery phase-I were stocked in six nursery ponds at different stocking densities (2 to 19 no./m^2.) and reared for 45 days. Crabs reared in the control pond were fed with trash fish, while the crabs reared in other ponds were provided with clam meat as feed. The rate of feeding was 10 % of stocked biomass. The growth and survival after 45 days of rearing are given in Fig. 6.

Growth and survival

The average size at stocking ranged from 18.3 mm/0.8 g to 28.9 mm/3.3 g, while it varied from 40.9 mm/10.9 g to 58.6 mm/36.4g after 45 days of rearing The survival rate also varied from 31.1 % to 58.6 %. In the lower stocking densities (2 to 5 nos/m^2), the survival rate varied from 33.6 to 58.6 % (av. 46.6 %), while in the higher stocking densities (13 to 19 nos/m^2) the survival was less (31.1 to 37.7 %; av. 34.4 %).

Hatchery raised megalopa larvae of *S. tranquebarica*

Grow-out trial

Transport of live crab seeds

Live juveniles of *S. tranquebarica* (625 nos.) obtained from 4 nursery ponds were tied and packed in nine perforated plastic containers (size: 60 cm x 40 cm x 30 cm; bottom spread area: 0.24 m^2). The stocking density was 50 nos/0.24 m^2 in two containers and 75 nos/0.24 m^2 in seven containers. The live crabs were packed by 22.00 h in the night, transported to Cuddalore by road and unpacked next day in the early morning by 03.00 h (transport duration: 5 hours). The number of crabs recovered was 612.

Stocking and monitoring

A total of 612 crabs were stocked in 0.4 ha pond @ 0.15 nos./m^2 The size of the stocked crabs ranged from 35 mm/7.1 g to 112 mm/225 g with an average of 68.6 mm/79.3 g. The reared crabs were fed with trash fish @ 10 % of stocked biomass for 75 days. Out of 612 crabs stocked, 268 (52 kg) live and 105 (48 kg) dead crabs were recovered. Among the harvested crabs, the male: female ratio was 4:3 The overall growth recorded was 43 mm/168 g in 75 days (Fig.7), while the monthly growth was 17 mm/67 g. The survival rate was 61 %.

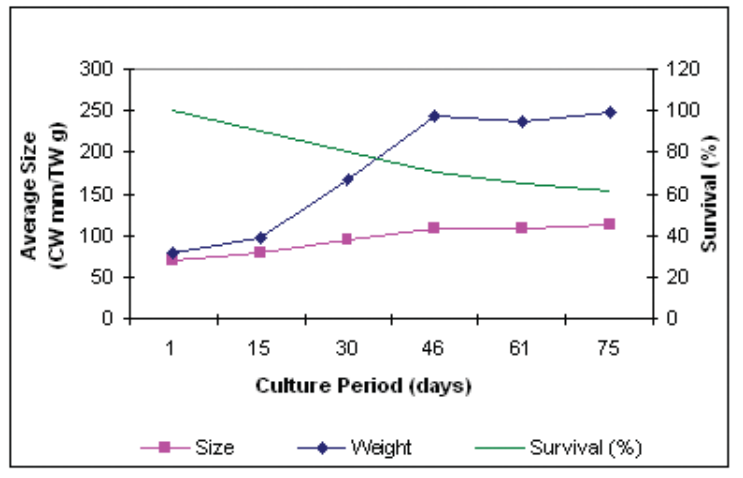


Fig. 7. Growth and survival of stocked mud crabs under grow - out culture

Evaluation of mud crab farming systems

Field visits to mud crab fattening/grow-out culture system in Sivanarpuram near Cuddalore (Tamil Nadu), Chollangi near Kakinada and Kammawarpalem near Nagayalanka (Andhra Pradesh) indicated the utilization of "water crabs" as well as juveniles of larger species *S. tranquebarica.* At Sivarnarpuram, the low cost plastic drums were used instead of costly fibreglass

Hide-outs for crabs in pond grow-out system

cages to make the fattening process more economical. At Chollangi, the fattening was carried out throughout the year except during summer (April-May). At Kammawarpalem, polyculture of mud crab *(S. tranquebarica)* and tiger shrimp *(P. monodon)* has been practiced successfully for the last three years.

At Kakdwip

Grow-out culture

The mixed sex and monosex mud crab culture trials were carried out in two ponds at KRC and the details are given in Table-3.

Table 3. Production parameters of mixed sex and all female culture trials of *S. serrata*

Mixed sex / All Female	Initial carapace width (mm)	Initial body weight (g)	Final carapace width (mm)	Final body weight (g)	Survival (%)	Yield (kg/ha)	Total biomass produced (kg/ha)
M:F= 1:1	57.6 (37.8)	49.89	98.97 (71.10)	205.17	40.01	820 98.4kg	978
All Female	63.50 (43.2)	48.36	102.57 (70.60)	174.80	35.25	616 49.3 kg	790

Cage culture

Bamboo-split cages used for rearing *S. serrata* at Kakdwip

A cage culture experiment was carried out with variable compartment space and feed (formulated feed and trash fish as feed) and gender as different treatments. Initial observations have shown higher growth pattern in all-female population irrespective of the treatments. Besides the feed type, the compartment space was also found to influence the growth.In most cases, females showed better growth performance than males.

Health monitoring of reared crabs

Periodical health monitoring of the crabs in the grow-out culture experiments revealed that the stock remained healthy till 140 days of culture and later in few crabs (3 %) the shell fouling with filamentous algae and protozoans was observed and it was successfully mitigated. No serious disease outbreaks like WSSV were encountered during the culture. In cage culture experiments, a few crabs with incomplete moulting and loss of limbs were observed.

AQUACULTURE FARM APPRAISAL AND IMPACT ASSESSMENT USING REMOTE SENSING AND GIS (CCD/RA/2)

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

Delineation of aquaculture farms by supervised classification is difficult and not accurate as the digital number values of shallow water bodies and aquaculture farms are not different. There was a need for the methodology to delineate aquaculture farms automatically, hence, it can be applied for larger areas with less time, avoiding manual digitization. The high resolution (3.5m) IKONOS satellite data were used in the study. The image was georeferenced and subsetted. The selected image had water class, aquaculture farms, agriculture, mudflats and river (Fig. 8). The vector layer was created for water bodies by digitizing water class features in the digital image

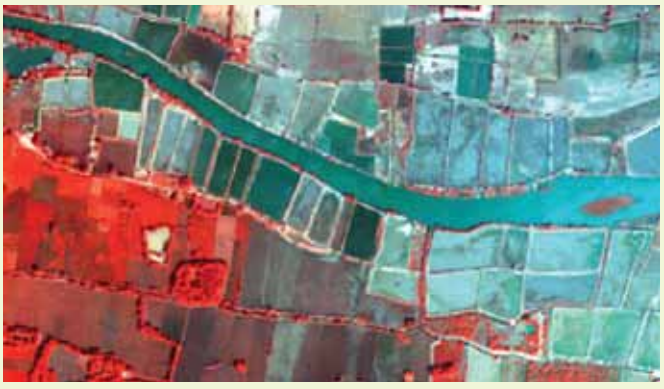


Fig. 8. High resolution digital image from IKONOS sattellite data

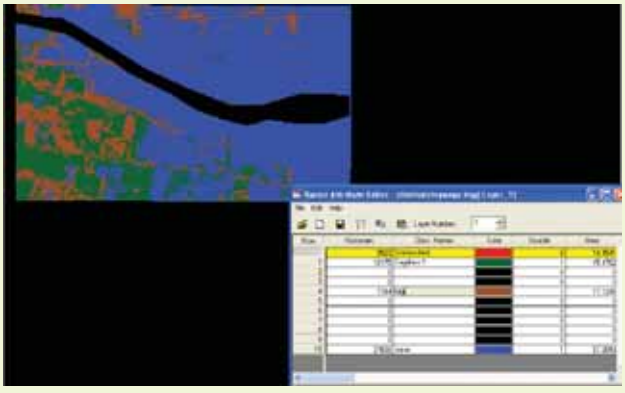


Fig. 9. High resolution image without water classes and supervised classification

The masking of water layer was carried out in the digital image by applying different functions through ERDAS Imagine 9.1. The digital image without water class was obtained for further processing (Fig.9). The supervised classification was applied to delineate different classes. The supervised classified output with different classes was derived with spatial and areal extent.

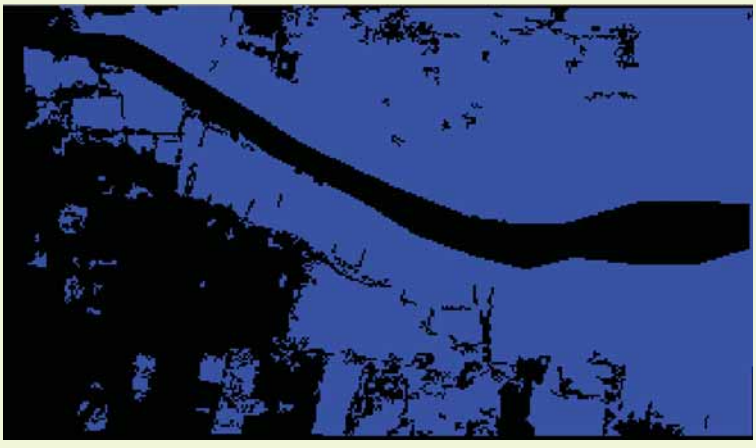


Fig 10. Aquaculture farms (blue colour) delineated from high resolution sattellite data

Methodology has been developed by masking out the water bodies from the digital images using models and applying supervised classification to delineate aquaculture farms. (Fig. 10). Further validation will be carried out to assess its accuracy with other methods in terms of shapes, resolution and area.

Assessment of impact of aquaculture on mangroves and agricultural lands

Impact of aquaculture on Punnakayal mangroves was assessed using LISS III data of 2005 and TM data of 1987 and updated with the ground truth verified data in 2007. The images were georeferenced using Survey of India topographic maps. The land use pattern was derived using ERDAS Imagine and ArcGIS (Fig.11). From the landuse maps, it was found that there are no aquaculture farms located around mangrove areas. The present mangrove area was 244 ha, that was 37 ha less than mangroves in 1987 (281 ha).

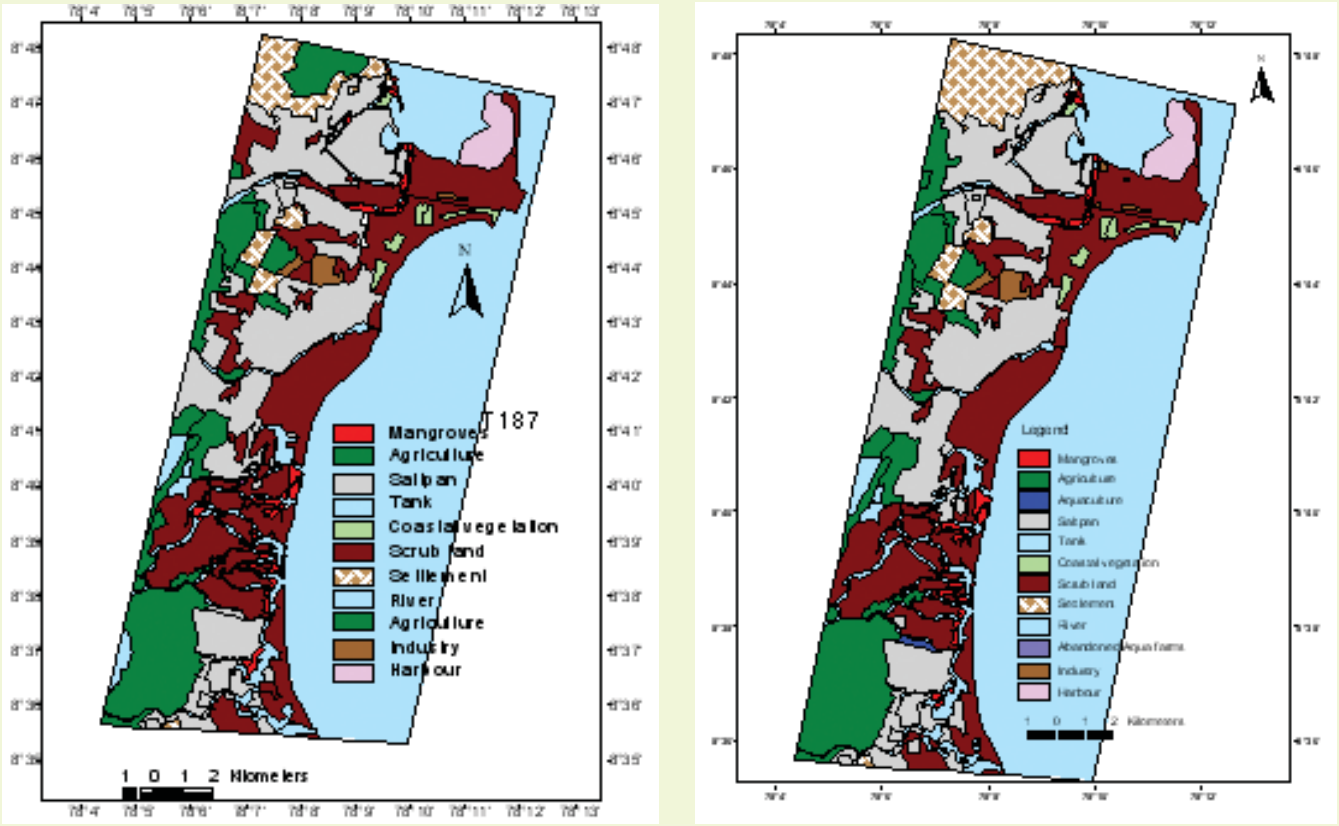


Fig. 11. Land use pattern in and around Punnakayal mangroves in 1987 and 2007

The present salt pan extent in the study area was 4097 ha. There were no aquaculture farms present in and around mangroves. During ground truth verification with Global Positioning System (GPS), it was found that aquaculture was not permitted for a distance of 15 km from the Gulf of Mannar reserve, that includes Punnakayal mangroves area.

The change detection analysis (Fig.12) revealed that salt pan nearer to mangrove areas were the main reason for the degradation. The mangroves were converted to scrub land (29.4 ha) and salt pan (7.9 ha). The high salinity

that prevailed in that area was the main reason for reduction in mangrove. The soil and water analyses nearer to mangrove areas revealed that the electrical conductivity values (measure for salinity) have gone more than 59 dS/m and 110 dS/m in soil and water respectively. The study indicated that aquaculture is not responsible for the degradation of Punnakayal mangroves.

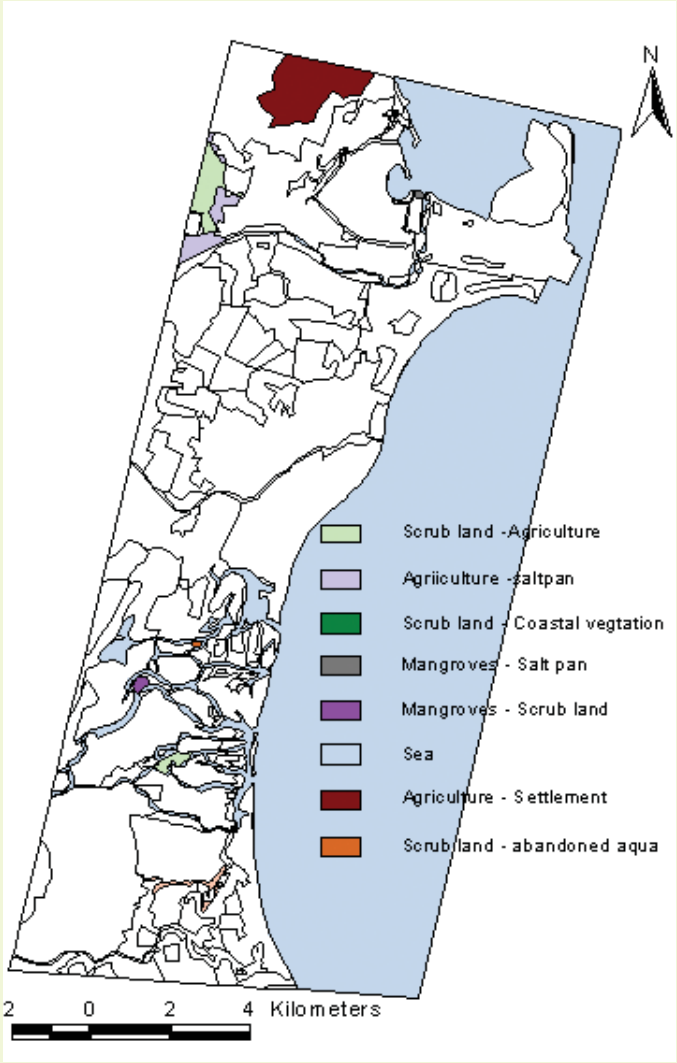


Fig. 12. Change detection map in mangrove areas between 1987 and 2005

Potential impact of shrimp farming on coastal aquifer

To assess the impact of shrimp farming on the coastal aquifer, watershed approach has been used. Two adjacent coastal watershed areas, *viz.,* Lower Vellar and Coleroon in Cuddalore district, Tamil Nadu have been identified and delineated. The Survey of India toposheets in the scale 1: 50,000 were used to get the elevation contours. The secondary data pertaining to the coastal watershed, *viz.,* drainage pattern , geology, geomorphology lithology, soil sub-group and soil texture of the watershed have been collected and accordingly the different thematic maps in the scale 1: 50,000 were prepared. The shrimp farming areas in these two watershed covered nine micro watershed. The total extent of the study area is 244 Sq. km. The coastal watershed, where shrimp farming was prominent was traversed and the groundwater samples were taken adjacent to the shrimp farming area.

FINFISH CULTURE DIVISION

RESEARCH PROJECTS

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.V.S.Chandrasekaran, Dr.K.P.Jithendran, Dr.K.Ambasankar and Shri G.Biswas

Title of the project : **Culture of commercially important brackishwater fishes**

Principal Investigator : Dr.C.P.Rangaswamy

Location of the project : Chennai

Co-Investigators : Dr.A.R.Thirunavukkarasu,Dr.M.Natarajan,Dr.J.K.Sundaray, Dr.M.Kailasam, Shri G.Biswas and Dr.S.A.Ali

SEED PRODUCTION TECHNOLOGY FOR COMMERCIALLY IMPORTANT BRACKISHWATER FISHES (FCD/B&C/4)

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

Broodstock development and maintenance

Captive land based broodstock of Asian seabass *Lates calcarifer* was maintained in RCC and FRP tanks. A total of 40 nos. domesticated stock of F_3 and F_4 generations in the size range of 2.5 - 12 kg were maintained in 12 x 6 x 2 m RCC tank. During this year 30 nos of new stock, which were bred in 2004 at Pancham Aqua, Safela, Mumbai, Maharashtra and stocked as fingerlings in the culture ponds of M/s The Water Base P Ltd at Nellore, Andhra Pradesh were also introduced to the existing stock and maintained. The fishes were in the size range of 1.5 - 6.0 kg. The broodstock fishes were fed with low cost fishes like tilapia *(Oreochromis mossambicus)* and sardines *(Sardinella sp)* @ 5% of the body weight, once a day. The water was changed with saline water drawn from intertidal borewell to the extend of 80%.

Captive maturation

Gonadal maturation of the captive stock was monitored regularly. When the adult females and males were maintained in the recirculation facility by providing uniform water conditions, fully riped fishes could be obtained during althrough the year. Gravid fishes could be obtained in 19±1 ppt salinity without resorption. This is the lowest salinity, in which, the gravid females and oozing males could be maintained, indicating the possibility of successful maturation and spawning of domesticated stock even in low salinity.

Spawning

The spawning of seabass was noticed throughout the year from May 2007 - March 2008. Under natural conditions, seabass spawns upto the onset of north east monsoon till the seawater salinity is normal. In the domesticated stock, successful spawning was obtained even during low saline months of October-December. Though the salinity was around 19 ppt during December, successful spawning was observed indicating progressive adaptation of the domesticated stock for maturation and spawning in low saline conditions. During the year there were 39 spawnings, of which 24 was natural and 15 was induction through administration of single dose of exogenous hormone LHRH-a @ 60µg/kg body weight for females and half the dose for males. Spawning occurred after 30-32 hours of hormone administration. Natural spawning occurred in the recirculation tanks without any exogenous hormonal administration.

A total of 45 spawning trials were conducted. Successful spawning was observed in 30 cases. In 14 cases second spawning of the same fish and in seven cases third spawning during subsequent days were observed. The number of eggs obtained per spawning varied from 5000 to 1.20 million. The fertilization rate was between 20 and 95% in the first spawning, 50 and 99% in the second spawning and between 80 and 95% in the third spawning. The hatching rate was between 10 and 95% in the first spawning 50 and 95% in the second spawning and 60 and 95% in the third spawning (Table. 4). A total of 5.2 million hatchlings were obtained during the year.

Table 4: Average fertilization and hatching rate of repeat spawning details of seabass

	1st spawning	2nd spawning	3rd Spawning
No of spawning	24	14	7
No of eggs	6420000	2041000	1860000
Average fertilization rate (%) eggs)	78.45	78.07	83.57
Average hatching rate (%)	63.13	58.84	67.02

Larval rearing

The floating fertilized eggs were kept in 40 to 200 nos./l with flow through arrangements for hatching. The hatched out larvae were transferred @ 12 to 40 nos/l to *viz.,* FRP and RCC tanks. The rearing duration was for a period of 21-25 days in the tanks. The larvae were feed from 3 dph with rotifer *Brachionus plicatilis* @ 15 nos./ml initially and then gradually increasing to 30 nos./ml on the 9th day. The green water system of rearing was followed.

dominated with *Nanochloropsis sp* during September to March and with *Chlorella sp* during May to August. In the rearing tanks, depending upon the condition, 30-60% water exchange was done and the cell concentration varied from 10 to 12 thousand cells/ml. From 10th day onwards, the larvae were fed with *Artemia* nauplii @ 5-20 nos/ml also along with rotifer. The larval survival rate ranged from 0 to 48% with an average of 24.4%. A total of 12.71 lakhs of 25 days old fry were obtained. The larvae have to be adequately fed with required nutritional larval diet to produce healthy seeds. Though, live feed like rotifer and *Artemia* are apt for seabass fish larval rearing, some of the required nutrients have to be added through enrichment for providing nutritionally balanced diet.

An experiment was conducted to understand the efficacy of enriching *Artemia* with natural algae *Chlorella sp* and commercial media SELCO a product of INVE. The *Artemia* nauplii were maintained in the algal medium with @ 50,000 cells/ml, for enrichment in the SELCO medium of 0.3g DHA selco/l. After enrichment, the nauplii were collected, washed and fed to the larvae. The *Artemia* were maintained at a density of 15nos./ml. The details of the experiment are given in Table 5 and the results indicated that the larval growth and survival were slightly better when they were fed with enriched *Artemia* nauplii.

Table 5: Evaluation Artemia of enriched feed on the survival and growth of seabass larvae.

	Initial size of the larvae (mm/g)	Final size of the larvae (mm/g)	Survival (%)
Control: Normal Artemia nauplii	5.1 / 0.014	22.6 / 0.172	89
Artemia nauplii enriched with SELCO	5.1 / 0.014	24.5 / 0.216	91.5

Weaning of larvae to formulated diet

During the year, the weaning protocols for the seabass larvae from live zooplankton like *Artemia* nauplii to formulated diet were developed. The formulated feed (INVE feed) of NRD ½ particle size 100-200 µ was introduced from 17th day of rearing initially as co-feeding with *Artemia* nauplii for 8-10 days and from 25th - 27th day the larvae could feed exclusively on formulated diet.

Comparative evaluation of larval rearing in indoor and outdoor tanks

In order to simplify the larval rearing protocols, an experiment was conducted to rear the larvae in indoor tanks, following standard protocols of feeding, water exchange, etc. The larvae were stocked @ 20nos./l. After 20 days of rearing, the larvae attained an average size of 14.2 mm/36mg in the outdoor tanks and11.6 mm/30.2 mg in the indoor tanks. However, the survival rate was 13% in out door tanks and 22.45% in the indoor tanks.

Culture of live feed organism

Stock culture of different species of green algae such as *Nannochloropsis oculata, Isochrysis galbina, Tetraselmis costata* and *Chlorella salina* were maintained. Maximum algal density of 10 million cells/ml was achieved under controlled conditions (temperature 23^{o}C). Out-door culture of *N.oculata* using modified Yashima Culture medium resulted in the maximum density of 6 million cells / ml. This green algae were used as feed for developing mass culture of rotifer *Brachionus plicatilis* to feed seabass larvae.

Nursery Rearing

The main focus during this year was to simplify the protocol so that farmers can rear the fry to stockable size (fingerlings) for further stocking in the grow out system. Emphasis was made to standardize nursery rearing protocols in hapa net, which was more cost effective and practicable. Nursery rearing trails were done in the on-farm facilities of CIBA, as well as the culture sites of farmers.

On-station trials at Muttukadu

Nursery rearing trials were conducted in 2 x 2 x 1 m hapa nets fixed in a pond. The fry of average initial size of 35.97 mm/ 0.68 g were stocked @ 250 nos./m^3, 500 nos./m3 and 750 nos./m^3 and the rearing was continued for 30 days, with cleaning of hapas on alternate days. The fry were fed with formulated diet @10% of the biomass thrice a day and grading was done once in seven days. The fry attained average size of 0.185 g, 0.171 g and 0.097g and 65.8%, 32.5% and 22.2% survival in the order of the stocking densities followed.

On-farm trials at Kakdwip Research Centre

Nursery rearing of thirty days old seabass fry (35.97 mm/0.68 g) was conducted in nine double-layered mosquito-net hapas (1.5x1x1m) with three three stocking densities of 120, 180 and 240 nos./m^3 in triplicate. Fry were fed with imported larval feed @ 5-3% body weight thrice daily. Sampling and shooter segregations were performed at weekly intervals. After 30 days of rearing, the fry attained an average size of 1.53±0.22 g (46.96±2.55 mm), 1.19±0.19 g (44.9±2.82 mm) and 1.27±0.19 g (45.56±2.96 mm) with a survival rate of 85.53%, 81.38% and 81.87% in the stocking densities of 120, 180 and 240 nos./ m3 respectively. The shooter emergence in the three treatments was 9.17%, 11.39% and 11.04%, whereas the FCR was 1.21, 2.41, and 1.83 respectively. Better survival was obtained in higher (240 nos/ m^3) density and growth rate was relatively better in less density (120 nos/ m^3).

Battery of seabass hapa nurseries

Hapa nursery reared seabass

On-farm trial of seabass nursery rearing in farmers ponds at Myppa and Nellore in Andhra Pradesh

- In a farmer's pond at Myppa, Andhra Pradesh, 1.2 cm fry reared on artificial feed attained the size of 3-7cm in 60 days with 95% survival.
- In the cement cistern rearing system at Nellore, Andhra Pradesh, after 60 days rearing, the seabass fry stocked @ 250/m^3, attained mean length of 10 cm with 94.5% survival rate.

Hapa nursery at Myppa Village, Andhra Pardesh

Cement cistern nursery at Nellore, Andhra Pradesh

Seabass seed production and supply

A total of 4.55 lakhs seabass seed were supplied to 43 farmers in seven states, namely Andhra Pradesh, Tamil Nadu, Kerala, Goa, Maharashtra, West Bengal and Pondicherry and of Rs.3.06 lakhs was realized.

Development of captive broodstock of milkfish *Chanos chanos*

The broodstock of milk fish, *Chanos chanos*

A total of 36 adult and sub adult milkfish *Chanos chanos* in the size range of 1.5 to 3.5kg were maintained under captive conditions. The fishes were fed with formulated diet @ 2 - 3 % body weight. Oozing males were observed in March 2008, but females have not shown maturity under captivity.

Broodstock development of ornamental fishes

Around 150 spotted scat *Scatophagus argus* (50-150g) were maintained in FRP tank and earthern pond at Muttukadu by feeding with pellet feed @5% of body weight. No gonadal maturity was observed in the captive stock. A wild spotted scat of 210 g was found to contain eggs with mean oocyte diameter of 344 µm. Breeding trails will be attempted when the breeder attains maturity.

→ Spotted scat, *Scatophagus argus*

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

Captive broodstock development of *Mugil cephalus*

M. cephalus of 2 to >4 years old (128 nos.) were successfully maintained in two 100 t RCC tanks with daily seawater flow-through for 12 h. The water temperature ranged from 27 to 31º C and the salinity fluctuated between 27 and 28 ppt upto September 07 and dropped to 21–22 ppt in late October 2007 which was maintained above 30 ppt by mixing high saline water (42 - 45 ppt) drawn from deep bore-well. The fishes were examined at monthly intervals for their health status and prophylactic formalin bath (100 ppm for one hour) was done at regular intervals to ward off external parasites.

The fishes were fed on specially formulated broodstock pellet feed (crude protein 33% and lipid 8%) @ 2-3% body weight in two daily installments. To enhance maturation Alfalfa, fish oil, phopholipids, Spirulina, protected Vitamin C, α-tocopherol and squid meat were incorporated at appropriate levels in the feed.

Maturation and breeding

The female and male *M. cephalus* were examined since September 2007 for gonadal maturation. The ovarian biopsies (obtained using 1.2 mm polyethylene canula) were examined for development of ova. Ova growth was sustained with intramuscular injections of carp pituitary extracts or Human Chorionic Gonadotrophin. The captive stock of *M. cephalus* was successfully induced bred for the first time in the country and successful fertilization and hatching were achieved. The details of the induced breeding experiments are tabulated in Table 6. Out of three females, two responded positively to hormone treatment and ovulated. One female released eggs spontaneously but the eggs were not fertilized since the males did not respond. Therefore the second female was subjected to stripping and the eggs were fertilized with milt obtained from three males.

Table 6. Details of induced breeding experiments of *M. cephalus*

	Fish # 1	Fish # 2	Fish # 3
Female size (g/cm)	1650 / 55	1600 / 55	1500 / 52
Male size (g/cm)	500 / 40; 500 / 38 & 580 / 40		
Initial oocyte diameter (mean) (µm)	517	517	481
Priming dose	Carp pituitary extract @ 20 mg / kg		
Resolving dose	LHRHa 200 µg / kg in two split doses on consecutive days (24 h apart) for females. For males single dose of 50 µg / kg.		
Salinity & Temperature.	33 ‰ and 31 ° C		
Latency period (h)	22	23	-
Response	Spontaneous egg release	Dry stripping & fertilisation	No response
Egg diameter (µm)	681-701 (685)	701 – 741 (715)	-
Fecundity (x 10^3) / kg	1091 (1.8 million)	1250 (2.0 million)	-
Rate of fertilisation	Un-fertilised	2.5 % (50000 nos.)	-
Hatching (%)		2.7 % (1350 nos.)	

Egg incubation and hatching

The fertilized eggs were washed three times with fresh filtered sea water and incubated in two 500 l FRP tanks. Good floating eggs were separated and transferred to hatching tanks of 1.2 t and 6.8 t capacity. The embryonic developments were recorded at regular intervals till hatching. The eggs hatched after about 29 h at water temperature of 25 – 29 ºC.

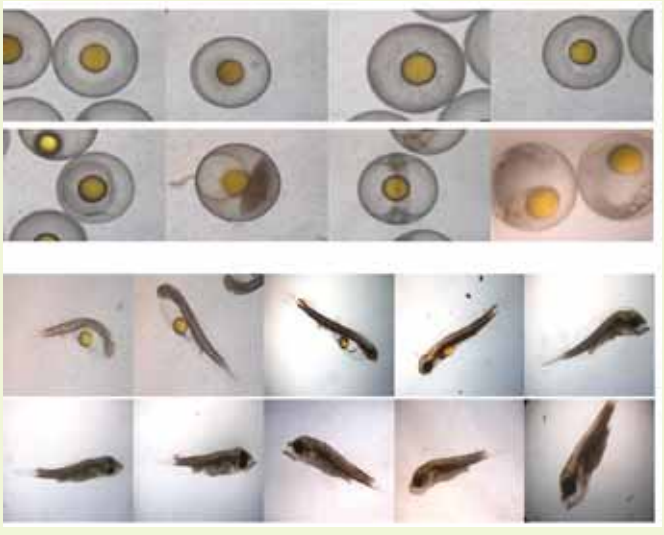


Fig 26. Embryonic and larval developmental stages of hatchery bred *Mugil cephalus*.

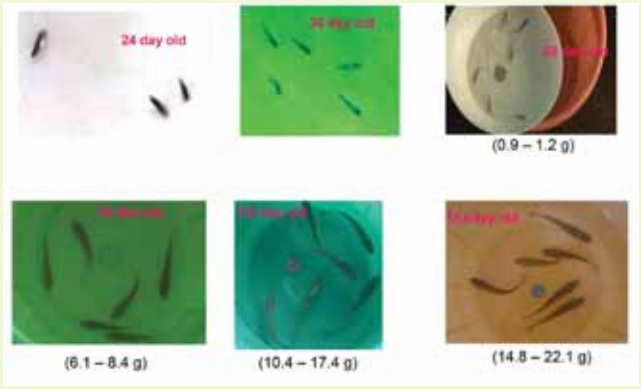
Larval rearing

The newly hatched larvae measured 1.96 mm. Mouth opening was observed after 48 h post hatch. Small sized rotifer *(Brachionus plicatilis)* and *Nannochloropsis sp* were introduced in the hatching tank before the mouth

opening stage and continued every day. The mullet larvae were slowly weaned to *Artemia* nauplii from 12th day and micro particulate feed (100 – 300 µ) from 18th day. The feeding protocol adopted is summarized in Fig.27. The larval rearing phase extends up to 35th day post hatch (dph), and the larvae measured 1.0 – 1.5 cm in length at 35 dph. After 30th day, the fry were fed only dry commercial feed particles (500 – 800 µ). Water temperature during larval rearing was found to be between 25 – 26 ºC and the salinity 24-30 ppt.

Use of surface skimmer (Fig 28) was very essential to remove surface film which can prevent gulping of air and swim bladder inflation in the developing larvae. This also removes oil, dissolved proteins and dust from water. Using skimmer improved survival of hatchling by 50% compared to that in tanks without skimmer (from 5 dph to 10 dph).

Surface skimmer.

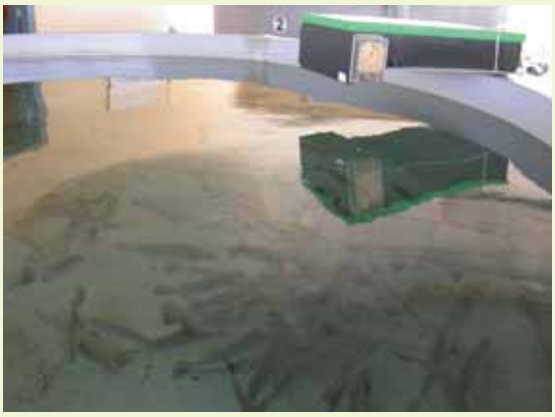


Artificially induced bred M. cephalus fingerlings at CIBA upto 153 days

CULTURE OF COMMERCIALLY IMPORTANT BRACKISHWATER FISHES (FCD/B&C/5)

Intensive culture of seabass *Lates calcarifer* at Muttukadu fish hatchery

Intensive rearing of seabass *Lates clacarifer* was carried out in four10 t FRP tanks with flow- through facilities. Four size groups of juvenile seabass with initial size of 28.34 cm/ 290.5 g, 24.17 cm/ 192.22g, 20.3 cm/ 104.2g and 15.88cm/44.7g were stocked in varying densities of 8, 18, 25 and 30 no. /m^2, respectively. The initial total biomass under each density was 13, 18, 27 and 19.9 kg respectively. Daily the fishes were fed with CIBA pellet feed @ 3% body weight. Every day water exchange @ 200% and bottom cleaning of the rearing tanks were done. After 180 days of rearing the respective total biomass obtained was 90.1, 40.2, 72.6 and 99.1 kg at densities of 8, 18, 25 and 30 no./m^2. The results indicated that it is possible to achieve substantial production of seabass under intensive rearing system with flow through facilities.



Intensive seabass rearing tank

Seabass in the intensive rearing tank

Cage culture of seabass at Muttukadu

At Muttukadu lagoon culture of seabass was taken up in nylon thread cages (5x3x2 m) with mesh size of 2.5 cm. The cages were fixed by casuarinas poles. Seabass juveniles with mean size of 90g were stocked @ 5 nos./m^2 and after 30 days of rearing the fishes attained mean body weight of 150g. The trail got vitiated due to pollution in the Muttkkadu lagoon

Cage installation

Stocking of seabass fingerlings

Pond culture of seabass at Kakdwip

Monoculture of seabass was carried out in four tide-fed ponds at KRC to assess their production potential under sustainable farming system. In one system the fishes/shrimps drifted along with the tidal water were allowed through the sluice as feed for the stocked seabass. The quality of the fish/shrimp that entered through the tidal water was estimated by random quantification In another system seabass stock was fed with low cost feed and natural forage fishes/shrimps were not allowed..

The ponds were stocked @10,000 nos./ ha with seabass fry of 19.3 mm /0.08 g .After a culture period of 355 days, fishes fed with live tilapia as forage attained size range of 50-650 g (avg. 211.46 g). The total production obtained was 754.21±8.39 kg/ ha. With frozen low cost fish feeding, seabass grew to the size of 110-840 g (avg. 351.18 g) and yielded production of 1661.42±170.53 kg/ ha. The survival rate was 21% in fishes fed with forage fish and 45% in the group fed with frozen trash fish with FCR of 8.57. The low survival rate in live forage fed fishes might

be due to the lack of adequate size food at initial stages.

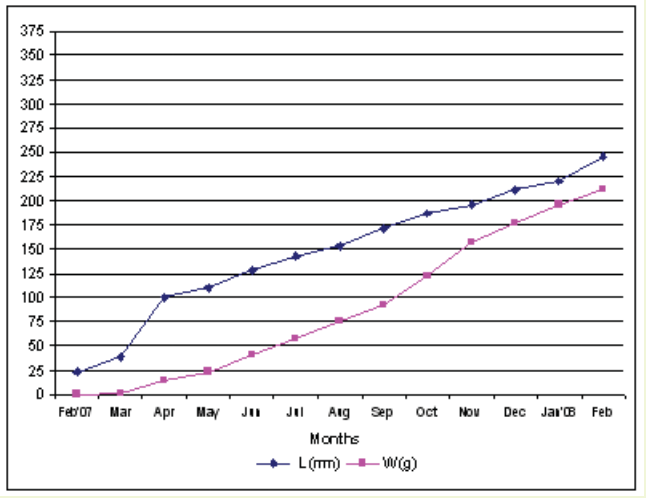


Fig.13. Growth of seabass in predatory-prey culture system

Harvested sea bass and tilapia from prey predator culture

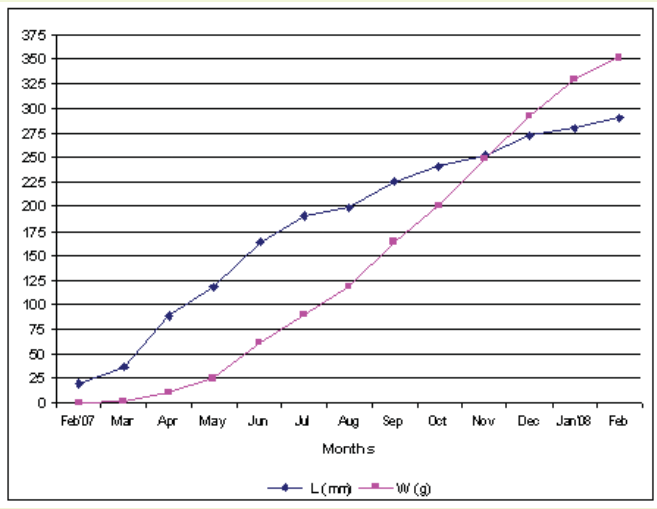


Fig.14. Growth of seabass in trash fish feeding system

Seabass grown with frozen rash fish as feed

Demonstration of polyculture in farmer's pond at Kakdwip

Polyculture of seabass and minor carp *Puntius japonicus* along with tilapia as forage for seabass was demonstrated in a farmer's pond at Akshaynagar, Kakdwip. The pond was dewatered, tilled and then lime was applied @300kg/ ha. The pond was filled with water and fertilized with organic and inorganic fertilizers @ 1000 kg/ ha and 2 ppm/ harespectively. The seabass fry of 20 mm /0.1 g were stocked @10,000 nos./ha in the 0.135 ha pond. The minor carp *Puntius japonicus* was also stocked @ 2000nos. /ha. The fishes were fed with tilapia spawns and fry and larvae of fish and shrimps collected from nearby river. In 260 days of culture, seabass attained the size of 0.18-1.19 kg (av.. 590 g) with production of 107.3 kg and survival rate of 36%. The total production including the minor carp and prey fish from this culture was 208.3 kg. The total productivity from this trail was 1542.96 kg/ ha, and that of seabass was 794.81 kg/ ha. The harvested fishes were marketed locally, and seabass with different size grades fetched Rs.130-180/ kg, while other fishes were sold at Rs.50-100/ kg depending upon the size. The farmer received net income of Rs.1.18 lakhs/ ha.

Pond culture seabass at Ganapvaram, Andhra Pradesh

Evaluation of the growth performance of hatchery produced seabass seed supplied to farmers was carrried out at Ganapavaram (A.P. Seabass was farmed @ 1000nos. /ha under polyculture along with tilapia as forage. In 120 days of culture, the fishes attained 400-850 g from an initial size of 50-70 g. The culture is on progress. In Repally (A.P), direct stocking of 1.5cm sized seabass fry @ 1250/ha with tilapia as forage, attained size of 100 to 400g in 60 days of culture. The culture is on progress

Seabass grow out pond at Ganapvaram

Farmer with harvested seabass at Repally

Culture of grey mullet *Mugil cephalus* in ponds

Polyculture of grey mullet *M. cephalus*

Polyculture of *Mugil cephalus* is continued at two farmer's pond at Kakdwip region of West Bengal under two different species composition. *M.cephalus* fry of 94 mm /10.17 g size were cultured @3000/ha with Liza parsia in one pond and Indian major carps in the other pond @ 2250/ha. *M.cephalus* has attained average size of 135.5 mm/ 32.26 g in the pond with *Liza parsia* where as in the pond with IMC the fishes have attained average size of 127.24 mm /29.12 g respectively. The culture is on progress.

Culture of *Etroplus suratensis* at Kakdwip

Grow out culture of *Etrolpus suratensis* is being carried out in three farmers pond (0.03 to 0.13 ha) in Kakdwip region at stocking density of 2500, 3000 and 3500nos./ha. The fishes have reached 11 g during the partial harvest and the culture isbeing continued

Monoculture of milkfish *Chanos chanos* in pens and ponds at Kakdwip

Pond culture of milkfish, *Chanos chanos* in farmer's pond

Mikfish seed in the size range of 12-20 mm were collected using seine net from the tidal pools of Kovalam beach in Tamil Nadu and transported to Muttukadu hatchery under oxygen packing. After 15 days of rearing with *ad libitum* feeding of a formulated feed, 250 fry (50-60nos/liter) were transported in polythene bag containing 5-6 l water under oxygen packing to Kakdwip. The transport duration was 9 h and the survival rate of the fry was 95%. The fry were acclimatized for 10days and fed with a pellet feed and stocked in farmer's pond.

Monoculture of milkfish, *C.chanos* @ 25,000 nos./ ha was demonstrated in a farmer's pond at Bhuvan Nagar. From the initial size of 0.09 g /24 mm, the fishes attained the final average size of 220.24mm/69.67g in 262 days. The total production obtained was 661.76 kg/ ha and the survival rate was 42%. The poor growth and survival may be due to the smaller size of the fishes at stocking, higher stocking density and more water depth resulting in poor growth of benthic algae which serves as the most preferred natural food to milkfish and inadequate supplementary feeding.

Monoculture of milkfish is however being continued in a pond stocked @ 35000/ha. Feeding is done with mustard oil cake, broken rice and rice bran @5% of the body weight on every alternative day. Partial harvest of 50 kg biomass (average body weight of 70 g) was done at the end of 170 days of culture. The culture is in progress.

Milk fish in nursery phase

Milk fish harvested by cast netting

Germplasm exploration, cataloguing and conservation of fish and shellfish resources of india

Fish biodiversity of Pulicat lake

Field tours to two main landing centres namely, Pulicat and Arambakkam villages in Pulicat lake were undertaken for exploration of germplasm resources. Fishing boats and fish markets were surveyed for collection of samples. Examination of the samples revealed the occurrence of 71 species – 56 fish species belonging to 37 familes and 15 crustacean species belonging to 3 families. Identification of the other samples collected is in progress.

Fish biodiversity of Kakdwip

Exploration on fish and shellfish resources is being carried out from Kakdwip, Namkhana, Bakhali and Sagar fish landing places in Kakdwip area and other parts of Sunderban Biosphere. A total of 85 species, consisting of 74 fish species belonging to 42 families and 11 crustacean species belonging to 3 families have been recorded.

Gene banking

A live gene bank on brackishwater species commonly available in the Kakdwip area is being maintained in a pond of 875 m2 at Kakwip Research Centre. Monitoring of water quality of the pond, health, growth and maturity of the fishes were regularly carried out.

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

Co-Investigators : Dr. N. Kalaimani, Dr.K.P.Jithendran, Dr. S.V.Alavandi, Dr. M. Poornima, Dr. R. Ananda Raja & Dr. M. Sashi Shekhar

Title of the project : **Shrimp pond soil and water management practices and products that mitigate environmental impact and increase productivity (AAHED/ SWM/1)**

Principal Investigator : Dr.B.P.Gupta

Location of the project : Chennai

Co-Investigators : Dr.K.K.Krishnani, Dr.M.Muralidhar, Dr.R.Saraswathy, Dr.M.Jayanthi, Dr.M.Kailasam, Dr.M.Shashi Shekhar and Dr.K.Ponnusamy

INVESTIGATIONS ON EPIDEMIOLOGY OF INFECTIOUS DISEASES OF FISH AND SHELLFISH AND DEVELOPMENT OF DIAGNOSTICS AND PROPHYLACTICS

Assessing the risk to shrimp farming due to increased crab culture

Samples collected from *Scylla tranquebarica, S.serrata, Neoepisesarma tetragonum Uca spp, Macrophthalmus spp., Metaplax distincta, Cardisoma carnifex, Thalamita crenata ,Charybdus feriata,Metapograspa, P.monodon,*

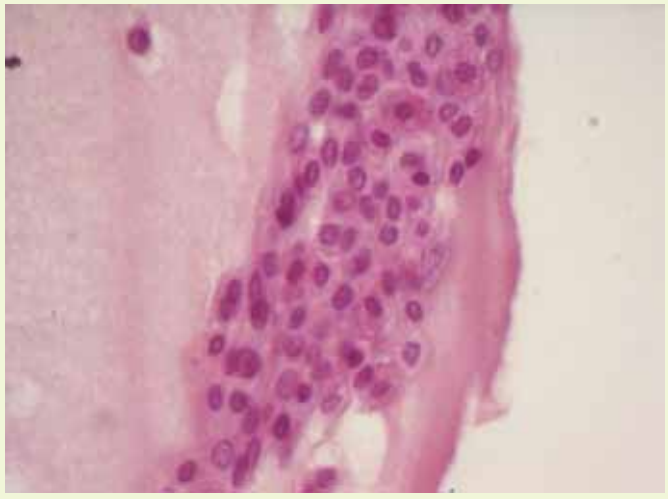
Fenneropenaeus indicus, Metapenaeus monoceros, Metapenaeus dobsoni, copepods, amphipods and plankton from Andhra Pradesh Tamil Nadu Maharashtra and West Bengal were screened for white spot syndrome virus (WSSV) infection by nested PCR. The prevalence of WSSV in crab was 4.71% and the over all WSSV prevalence was 7.85%. The study indicated that low incidence of WSSV in wild crabs under natural habitat.

Analysis of samples collected from *S. tranquebarica* crab culture farms (both poly and mono culture, extensive and intensive) in Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal for assessing bacterial and WSSV infection by nested PCR revealed that WSSV out breaks in four crab farms. The virus load was tested by Real time PCR. The study showed WSSV occurrence in crabs under intensive culture conditions.

Experimental testing of the transmission of WSSV from crab to shrimps by co inhabitation and oral feeding

P. monodon (6.5 ± 0.2 g) were infected by per os using WSSV infected shrimp and this infected shrimps were used for developing WSSV infection in *S. tranquebarica* (5.5 ± 0.5 cm; 60.53 ± 2.77 g). Control and infected (by oral feeding of infected tissue) crabs were co-habitated with healthy shrimp (average wt 6.44±0.31g) @ 1 : 5 ratio. Studies were also carried out by oral feeding of shrimp with WSSV infected crab tissue. WSSV was transmitted to shrimp from WSSV infected crabs by co habitation through water and oral feeding resulting in gradual mortalities. The infection caused 100 % mortalities in shrimp by 35 (oral feeding) and 50 days of cohabitation. The virus remained active for eight months in crabs under experimental conditions. However the actual risk of transmission of WSSV from crabs to shrimp or *vice-versa* under farm conditions, may vary depending on the prevalence, virus load in the carrier, environment triggers and threshold density of shrimp to reach magnitude of out breaks.

Black discoloration of WSSV infected *S. tranquebarica*



Gills of WSSV infected *S. tranquebarica* showing hypertrophied nuclei with basophilic inclusions near basal membrane (100 X).

Detection of WSSV load by real time PCR

Epidemiology of nodavirus in fish

The methodology for collection and preservation of RNA in the target tissues using commercial kits (RNA later

tissue protect tubes, Quiagen) were optimized in the laboratory using confirmed nodavirus positive fish samples. This procedure allows the storage of fish samples for later analysis. Testing of fish samples for the presence of nodavirus was performed using three nodavirus specific primer sets. Electron microscopy of nodavirus infected fish brain showed crystalline arrays of viral particles (Fig. 15).

Fig. 15. Scanning electron microscopy of nodavirus infected fish brain

Screening for emerging diseases and application of proven technologies in aquatic animal health management

In the preceding year, partial sequences of four WSSV genes viz., vp28, vp281, rr1 and dnapol were amplified and cloned in Litmus28i vector. Corresponding dsRNAs were synthesized by in vitro transcription. These dsRNAs were injected in *P. monodon* experimentally infected with WSSV. There was marked increase in the survival of shrimp injected with dsRNA. The efficacy of dsRNA as antiviral therapeutic against WSSV was established.

Practical application of dsRNA therapeutics would entail injection in brooders to produce WSSV-free seeds. To produce enough dsRNA to inject in brooders, *in vitro* transcription reactions would not suffice. To scale-up dsRNA production, it was decided to produce the dsRNA in a suitable bacterial strain which does not encode RNase III. The Litmus28i plasmids containing the WSSV genes were transformed in HT115 (DE3) (Fig. 16) bacterial strain. RNA was extracted from the transformed cultures and treated to remove the contaminating host DNA and ssRNA. The protocol was optimized to maximize the yield of dsRNA (Fig. 17 and 18)

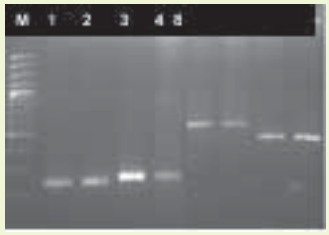


Fig. 16 Transformation of Litmus28i-WSSV gene clones in HT115 (DE3) (Lanes1-2: vp28, Lanes 3-4: vp281, Lanes 5-6: rrl, Lanes 7-8: dnapol)

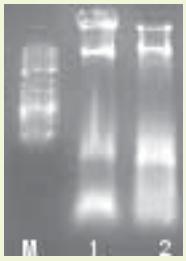


Fig.17. Extraction of dsRNA from HT115. (Lanes 1-2 show dsRNA of vp28. No DNaseI and RNaseA treatment)

Fig.18.Standardization of dsRNA extraction. (Lane 1 shows vp28 dsRNA without DNAseI and RNAse A treatment. Lane 2 shows vp28 dsRNA treated with DNase I and RNase A for 15 min, Lane 3 shows vp28 dsRNA treated with DNase I and RNase A for 30 minutes).

To permanently introduce RNAi mediated antiviral resistance in animals, one of the methods adopted is to clone shRNAs targeting the viral gene of interest in suitable vectors and introduce them in the zygote/cell line.

A total of 260 farms were surveyed for disease prevalence in three districts of West Bengal and Orissa . Among the farms surveyed, 186 farms showed disease outbreak contributing to 71.54 %. The major diseases encountered from shrimp farms were white spot syndrome virus disease (54.23%), bacterial disease (1.9%), loose shell syndrome (1.9%), black gill (1.9%) and black spot (1.9%), while from finfish ponds fin rot (4.2%), gill rot (0.77%) and diseases associated with nutrition, environmental problems like low pH and low salinity were noticed. None of the samples collected from coastal districts of West Bengal were found positive for infectious hypodermal and hematopoietic necrosis (IHHN) virus.

Evaluation of antioxidants for WSSV and LSS mitigation

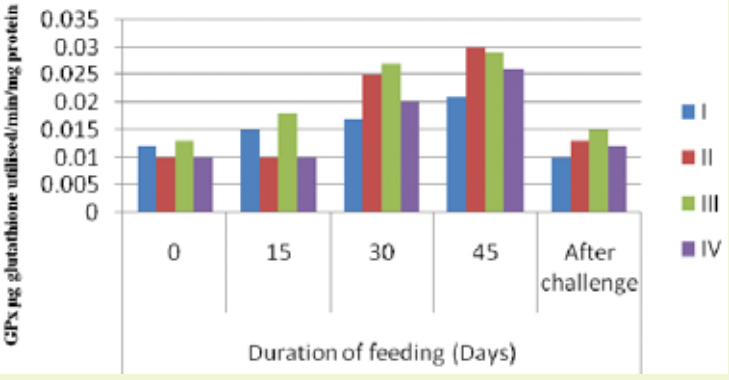


Fig. 19. Antioxidant status in *F. indicus* fed with four feeds (I Control, II Spriluna, III β glucan, IV Spriluna+ β glucan

Four types of feeds namely (i) control, (ii) Spirulina , (iii) β glucan and (iv) Sprilulina alongwith β glucan were used respectively to feed four groups of *F.indicus* for 45 days with monitoring of antioxidant enzymes, LPO and antioxidants at intervals of every 15 days.(Table.7.) After 45 days, the animals were challenged with WSSV and the antioxidants status was evaluated. All the animals except with β glucan treatment died after 3 days, whereas the β glucan treated animals survived upto 7days. β glucan is more effective than Spirulina in enhancing the antioxidant status, thereby reducing the oxidative stress due to disease (Fig. 19).

Table. 7. Antioxidant status in normal and loose-shell infected *P.monodon*.

Nature of sample	Tissue	SOD	CAT	GPx	LPO	Glutathione reduced	Vitamin C	Vitamin E
Healthy	Hepatopan-creas	0.014 ±0.004	1.256 ±0.915	0.469 ±0.338	0.008 ±0.004	0.013 ±0.005	0.003 ±0.001	0.075 ±0.046
	Muscle	0.012 ±0.004	0.868 ±0.448	0.314 ±0.166	0.002 ±0.001	0.015 ±0.012	0.600 ±0.560	0.005 ±0.004
LSS affected	Hepatopan-creas	0.023 ±0.007	0.422 ±0.127	0.151 ±0.068	0.028 ±0.006	0.009 ±0.010	0.098 ±0.022	0.027 ±0.021
	Muscle	0.008 ±0.003	0.012 ±0.008	0.304 ±0.149	0.003 ±0.004	0.005 ±0.002	0.148 ±0.056	0.003 ±0.002

Investigations on use of antimicrobials in shrimp aquaculture and withdrawal period of selected antibiotics

Data collected from six hatcheries located in Kancheepuram and Villupuram districts, Tamil Nadu indicated that the chemicals such as treflon, bleaching powder, hydrochloric acid, formalin and iodine were used Most of the selected hatcheries have shut down the seed production due to poor seed procurement and it was planned to evaluate the withdrawal period of selected antibiotics through wet lab experiments.

On the request of the Coastal Aquaculture Authority (CAA), data provided on antibiotics prevalence in shrimp and shrimp feeds were analysed and the following were the conclusions

- The use of chemicals was higher in Andhra Pradesh followed by West Bengal since the quantities of residues of these drugs detected were also higher
- It could not be concluded that the antibiotics nitrofuran and chloramphenicol detected in farms have their sole origin from hatcheries.
- The detection of SEM, oxytetracycline and tetracycline in feed samples indicated that feed could be a source of these chemicals. However since the brands of feed were not given, the use of chemicals could be in the unorganized feed sector. A similar conclusion could be drawn with regard to the detection of heavy metals.
- The steroids have been detected in shrimp and prawn samples from farms. The mode of feeding these steroids was not clearly understood as the feeds analysed did not show the presence of any of these steroids. An analysis of all inputs is required to find out the real causative agent for the presence of steroids in shrimp and prawn samples.

Development of immunodiagnostic test for detection of WSSV

A 615 bp of VP28 gene of WSSV was PCR amplified and cloned in expression vector pET32a using NcoI and HindIII restriction enzymes (Fig.20.). The competent cells of *E. coli* (DH5α) were transformed with ligated vector containing the VP28 gene as insert. The transformed colonies were screened by PCR. The positive clones were confirmed for the presence of inserts by restriction enzyme digestion with NcoI and HindIII and by PCR (Fig 37). The recombinant protein was expressed as fusion protein in *Escherichia coli,* BL21 (DE3). The expression of the recombinant protein was analyzed on SDS-PAGE with estimated molecular size of 44.55 kDa (Fig 38). Purification of the expressed recombinant protein was achieved by electroelution. The production of polyclonal antibodies using purified recombinant protein of WSSV VP28 is under progress by rabbit immunization.

Immunomodulatory effect of expressed recombinant protein was studied in shrimps *P. monodon* and *F. indicus.* The healthy shrimps weighing. 20 g were immunostimulated by intramuscular injection with 20 µg and 40 µg of purified recombinant WSSV VP28 protein (Fig.21.). Muscle tissues from immunized shrimps were collected at 24, 40 and 64 h post inoculation and total RNA was isolated. First strand cDNA synthesis was carried out on the total RNA extracted from tissues of immunostimulated shrimps. RT-PCR using the primers for amplification of phagocytosis activating protein (PAP) resulted in 360 bp of PCR product. The use of purified WSSV VP28 recombinant protein was successful in eliciting the immune response in shrimps. This indicates the use of recombinant protein for eliciting immune response and its possibility to use as immunostimulant to facilitate protective defense against WSSV infection in shrimps.

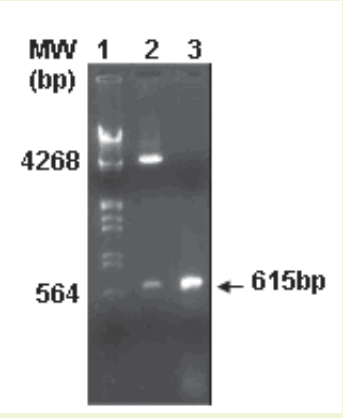
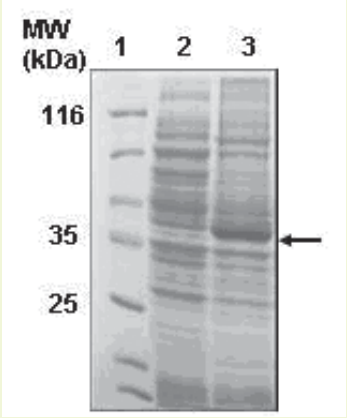


Fig.20. Cloning of VP28 gene of WSSV. (Lane 1. Lambda DNA/EcoR I/Hind III double digest marker. Lane 2. Restriction enzyme digestion of expression vector pET32a with Nco I and Hind III. Lane 3. PCR amplified 615 bp VP28 gene of WSSV).

Fig. 21. Expression of the VP28 WSSV recombinant protein. (Lane 1. Protein molecular weight marker. Lane 2. Uninduced bacterial cell lysate. Lane 3. IPTG induced bacterial cell lysate showing expression of the VP28 WSSV recombinant protein as indicated by arrow).



SHRIMP POND SOIL AND WATER MANAGEMENT PRACTICES AND PRODUCTS THAT MITIGATE ENVIRONMENTAL IMPACT AND INCREASE PRODUCTIVITY (AAHED/SWM/1)

Bioremediation in shrimp farming

Ammonia and nitrite levels in shrimp ponds

The nitrogenous metabolites levels of a shrimp farm in Kancheepuram District was monitored from 15 DOC onwards and found that the increase in ammonia and nitrite levels from 0.038 to 0.78 mg/l and BDL to 0.071 mg/l respectively. Natural attenuation was not sufficient due to lack of oxygen as electron acceptor, essential for chemolithoautotrophic ammonia and nitrite oxidizing bacteria, present in the system as confirmed by the molecular techniques.

Evaluation of *Gracilaria verrucosa* as bioremedial agent

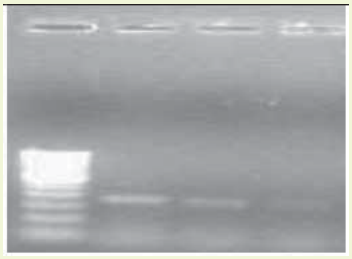
Yard experiment was conducted for the removal of ammonia from shrimp pond water by the seaweed *Gracilaria verrucosa* obtained from Muttukadu backwater. *G. verrucosa* @ 1g/l was found to be effective to remove ammonia nitrogen level at the 60th h of the experiment.

Yard experiments with bagasse as bioremediator

Yard experiments conducted with bagasse in one tonne tanks having *P. monodon* with regular aeration and feeding in treatment and control tanks, revealed sufficient periphyton growth on bagasse which in turn conditioned the water quality by removing ammonia and nitrite. The material is biodegradable, which started degrading after 26 to 28 days. This suggests that bagasse has to be replaced after every month. In addition, the field trials were conducted in the of 0.3 ha pond stocked with *P. monodon* @ 6 nos / m^2. Fifteen numbers of bagasse units were kept in the centre of the pond (without aeration) using Kadapa stones, one week before the harvest. The removal of ammonia and nitrite was not significant due to the lack of aeration in the pond.

Molecular biological characterization of indigenous nitrifying, denitrifying and sulfur oxidizing bacteria

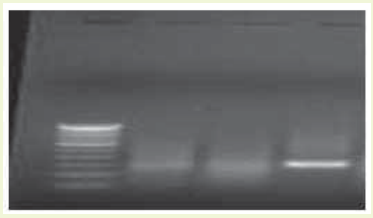
Indigenous nitrifying, denitrifying and sulfur oxidizing bacteria from coastal aquaculture have been characterized using molecular techniques, for which functional genes such as *ammonia monooxygenase gene (amoA), nitrous oxide reductase gene (nosZ), and sulfate thioesterase/thiohydrolase gene(soxB)* (Fig.22. a, b, c, d, e, f) have been sequenced respectively through creation of meta-genomic clone libraries. Novel sequences obtained were released in the GenBank (amoA: EU104363 to EU104367 and EU156172 to EU156174; nosZ: EU284710 to EU284712, soxB: EU855122, FJ403220 to FJ403222). Sequence alignment of *amoA* revealed close affiliation with *Nitrosomonas nitrosa* and other uncultured beta-proteobacteria. The nosZ sequence alignment revealed maximum homology with *Marinobacter sp* and other uncultured denitrifying gamma-proteobacteria. This study has the potential for making combined nitrification and denitrification and also biostimulation strategies. Phylogenetic tree constructed from aligned amino acid sequences of *soxB* amplified using Petri Ralf protocol (2001) revealed different clusters associated to the branches of α- and β- proteobacteria.



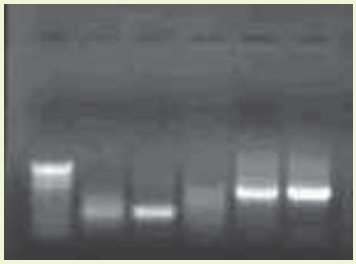
(a). Gradient PCR amplification of 349 bp amoA

(b) Gradient PCR amplification of 669 bp amoA

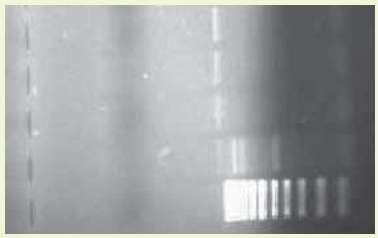
(c). 753, 483 and 710 bp soxB



(d). 282 bp soxB



(e). 239 bp and 503 bp soxB



(f). Gradient PCR amplification of 1092 bp nosZ

Fig.22 a,b,c,d,e and f. PCR amplification of specific fragments of the amoA, nosZ and soxB genes.

DNA probe and molecular tool for the detection of ammonia oxidizing bacteria

Ammonia oxidizing bacteria can not be detected by cultivation-dependent analysis, which has qualitative and quantitative biases and underestimate by several order of magnitude due to the slow growth rates, long incubation period and co-contamination with fast growing heterotrophic bacteria. Hence, PCR based molecular tool and SYBR-Green chemistry of real time PCR have been standardized for qualitative and quantitative detection of AOB, for which different set of primers have been developed.

Evaluation of matrix developed for the immobilization of non-indigenous bacteria

Matrix developed from bagasse for immobilization of bacterial biomass has application in the development of bioremediation products, probiotics and other bacterial products for aquaculture use. A matrix technology (CIBAX-1) as a filler material has been commercialized to a private entrepreneur for feed probiotic bacteria. The matrix, developed by CIBA, is cost- effective and environmentally viable, which is an ideal alternative to the expensive solid matrices.

Commercialization of environmental technologies

Environmental technologies such as “Matrix for immobilizing and imaging bacteria, “Biosorbent for heavy metals removal from contaminated water”, and “Molecular kits” are being offered to private entrepreneurs and research incubators at the Institute’s website. Micro-brackishwater analysis kit has been commercialized to a private entrepreneur for analysis of ammonia, nitrite and phosphate in brackishwater aquaculture and hatchery systems. It is cost effective, sensitive and useful for entrepreneurs, aqua-farmers and hatchery operators to maintain water quality.

Nutrient dynamics in shrimp ponds under varying culture practices

The exchange properties between soil and water influence water quality, nutrients status and productivity of the pond system. To understand productivity and nutrient dynamics under different stocking density of postlarvae of *P. monodon* (8 m^2 and 16 m^2), soil, water and plankton samples were collected at regular intervals from two shrimp farms near Mahabalipuram, Kancheepuram District, Tamil Nadu during winter crop (July – December, 2007). Salinity and pH values during culture period ranged between 11.7 to 24 ppt and 7.05 and 8.25 respectively. Nitrate, phosphate and metabolites of nitrogen increased with the culture period irrespective of stocking density. There was no significant difference between stocking densities and the values were within the permissible limit. Farms following high stocking density registered maximum values of 0.93, 0.06, 0.37 and 0.25 ppm, respectively for total ammonia, nitrite, nitrate and phosphate. The average production in the farms was 2 and 3.6 t/ha for low and high stocking density respectively. The average shrimp body weight was less under high stocking density when compared to low stocking density.

Diurnal studies were conducted for five consecutive days to understand the relationship between nutrient concentrations and plankton. pH, dissolved oxygen and nutrient content increased during the course of day. Maximum average value of 0.31 and 0.172 ppm was recorded at 2 p.m. for nitrate and phosphate respectively. Average phytoplankton density at 6 a.m. and 2 p.m. ranged between 87200 – 105600 nos./100 ml and 55200 – 72800 nos./100 ml respectively. Zooplankton density was high at 6 a.m. (319 – 437 nos. / 100 ml) when compared to 2 p.m. (214 – 239 nos. / 100 ml) at surface level which may be due to vertical movement of zooplankter from surface to bottom. Crustacean larval forms, copepods, amphipods, *Acetes* and mysis were the most dominant groups of zooplankton.

Yard experiments were conducted to study the nutrients release from soil to water phase under different environmental conditions *viz.,* temperature (18^0c, 24^0c and 32^0c simulated using thermostat) and salinity (15, 25 and 30 ppt). pH, salinity and nitrate increased with temperature. Among the salinities, nutrient content in water was high at 25 ppt when compared to 15 and 30 ppt.

Assessment of carrying capacity of creek for sustainable brackishwater aquaculture

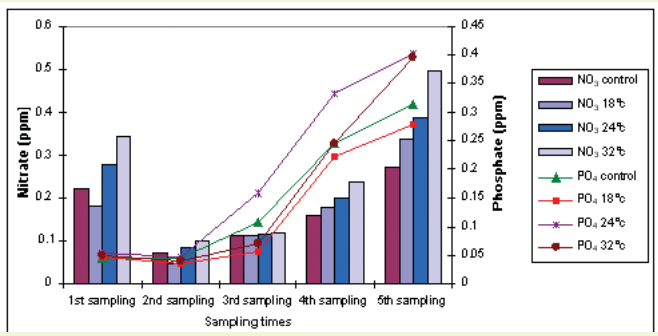


Fig.23 Nutrient loading (average values) in the discharge water from the shrimp farms located on Vellar and Uppanar Rivers

The study was carried out on Vellar and Uppanar Rivers, the source and sink for discharge water from shrimp farms located adjacent to Pichavaram mangroves to validate the carrying capacity based area recommendation software. Pichavaram Mangrove is interconnected with the Vellar Estuary in the north the Coleroon estuary in the south and the Uppanar in the west and receives freshwater during north east monsoon from October to November. The tidal amplitude of rivers is very low ranging from 0.03 – 0.67 m. The water samples were collected on monthly basis from September 2007 onwards from fixed sampling stations in the water bodies and discharge points of shrimp farms along with GPS markings and will be continued for one year for the estimation of maximum allowable shrimp farming area based on the carrying capacity of the rivers. The analysis of samples indicated that all water quality parameters are in optimum range prescribed for shrimp farming (Fig. 23).

Identification and digitisation of different land use categories in the study area using IRS ID LISS III digital data of 2005 and further updating based on IKONOS data of 2006 revealed that 275 and 87 ha area was developed for aquaculture on Vellar and Uppanar Rivers, respectively (Fig.24).

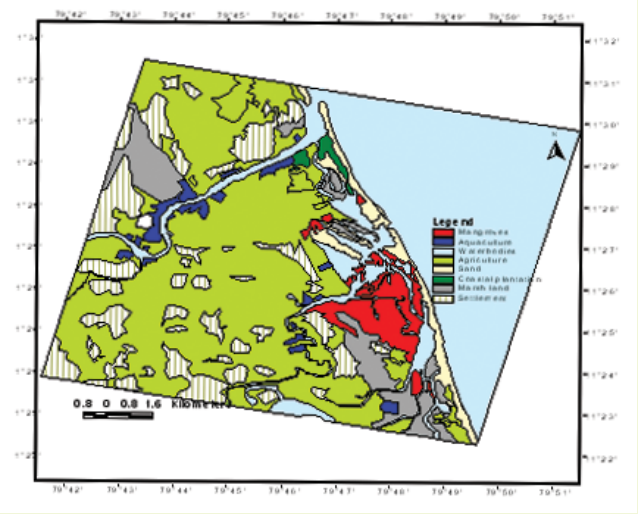


Fig. 24 Different land use categories in the study area from LISS III data

The extent of different land use categories in the study area is given in (Table.7.) The other end of rivers receiving freshwater was utilised for agriculture to an extent of 8276 ha.

Table. 7 Extent of coverage under different land use categories in the study area

Land use	Area (ha)
Agriculture	8276
Aquaculture	362
Mangroves	837
Marsh land	1245
Sand	622
Settlement	2484

Assessment of impact of shrimp farm discharge water on the receiving water body

Study was conducted on Paminiyar River, one of the six distributaries of Cauvery near Muthupet mangroves. shrimp farms at Pudukottagam, Thambikottai Varakadu and Thambikottai Maravakadu with water spread area of 273 ha, discharge water into this river. Water and soil samples were collected once in a quarter coinciding with the harvest from the fixed sampling stations on the water body and discharge water (DW) samples from the shrimp ponds along with GPS markings from August 2007 onwards. Water samples were analysed for pH, total suspended solids (TSS), total N and total P. All the parameters were in optimum range as per the standards prescribed for the discharge of wastewater (Table 8).

Table.8 Average values of water parameters along with standard deviation in the shrimp farm discharge water (DW) and receiving water body

Sampling period					Prescribed standards suggested by CAA at final discharge point
Parameter	Sampling site	August-07	November-07	February-08	
pH	Shrimp farms DW	7.25 ± 0.29	7.47 ± 0.22	-	6.0-8.5
	Receiving water body	7.05 ± 0.19	6.97 ± 0.17	7.14 ± 0.23	
TSS (ppm)	Shrimp farms DW	38.5 ± 2.25	64.6 ± 6.25	-	100 (max)
	Receiving water body	34.6 ± 3.17	42.4 ± 5.5	37.9 ± 6.72	
Total N (ppm)	Shrimp farms DW	1.42 ± 0.32	1.74 ± 0.28	-	2 (as N max)
	Receiving water body	0.92 ± 0.12	1.04 ± 0.11	1.12 ± 0.09	
Total P (ppm)	Shrimp farms DW	0.25 ± 0.08	0.34 ± 0.10	-	0.2 (dissolved phosphate as P max)
	Receiving water body	0.21 ± 0.09	0.24± 0.10	0.26± 0.08	

Environmental impact information and services

Weather watch information and advisory services related to brackishwater shrimp culture with respect of Tamil Nadu and Andhra Pradesh was communicated weekly for updating ICAR web site under 'Latest Weather Situation and Advisory'. The information related to brackishwater aquaculture under the 'Fishery Management' was also updated.

NUTRITION, GENETICS AND BIOTECHNOLOGY DIVISION

RESEARCH PROJECTS

Title of the project : **Development and demonstration of balanced feeds for Asian seabass, crabs and improvement of shrimp feeds (NGBD/NT/2)**

Principal Investigator : Dr. S.A. Ali

Location of the project : Chennai and Kakdwip

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

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. Vinaya Kumar Katneni (from 18.10.2007)

DEVELOPMENT AND DEMONSTRATION OF BALANCED FEEDS FOR ASIAN SEABASS, CRABS AND IMPROVEMENT OF SHRIMP FEEDS (NGBD/NT/2)

Development of feeds for Asian seabass

A. Seabass larval feed

A micro diet with 50% protein and 12 % lipid was developed and tested for the 10-15 day post hatch (DPH) larvae of Asian seabass *(Lates calcarifer)* in the earlier experiments. The micro diet was prepared with four different combinations of fish oil and lecithin ratios to further improve this micro diet (Table.9.) Each of these test diets was fed to 250 seabass larvae of 16 DPH (6.385 ± 1.45mg wet weight and 7.15±0.88mm length) randomly stocked in 50 l FRP tank with sea water flow through system, having three replicates for each treatment. The results of the 20-day feeding trial Fig. 25.

Table 9. Proximate composition of experimental larval micro diets

Parameter	Fish oil : Lecithin ratio in diet			
	(0:15)	(5:10)	(10: 5)	(15:0)
Moisture	10.92	10.17	9.79	9.76
Crude protein	48.62	48.89	49.13	49.24
Crude fat	19.63	19.89	20.01	19.58
Crude fibre	0.34	0.31	0.28	0.44
Total Ash	17.26	17.54	17.93	17.21
NFE	3.23	3.2	2.86	3.77

In the second intervention, stable vitamin C (L-ascorbyl poly phosphate) was incorporated in the micro diet at three different levels of 250, 500 and 1000 mg/kg. A control diet without vitamin C was also prepared for comparison. These diets were tested in 20- day feeding trial on 200 seabass larvae (6.385 ± 1.45mg wet weight and 7.15±0.88mm length) of 16 DPH stocked in 50 FRP tanks with facilities for sea water flow through system. There were three replicates for each treatment. The results (Fig. 26.) showed that weight gain and survival of seabass larvae was significantly (P≤ 0.05) higher at 500 (78.90mg ±4.02) and 1000 mg/kg (81.30mg ±2.56) of vitamin C supplementation. The survival of the fish larvae fed with these Vitamin C supplemented diets was also significantly (P≤ 0.05) higher (50.90% ±1.33, 51.10% ±3.97 respectively) against those fed control diet (weight increase 63.00mg ±1.96; survival (40.10% ±2.11). Air exposure stress survival of post fed larvae was significantly (P≤ 0.05) higher in 500 and 1000 mg/kg (59.1c±6.5, 62.4c±8.4, respectively) vitamin C supplemented diets indicating that incorporation of vitamin C in diet has beneficial effect to counteract the stress. The air exposure survival of post fed larvae of control diet was significantly lower (9.8% ±2.3).

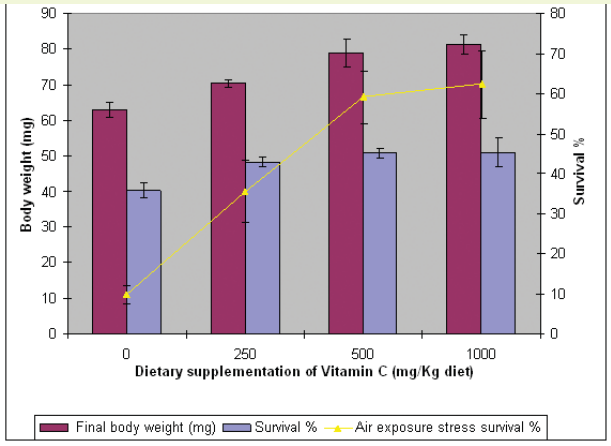


Fig. 26. Growth performance of seabass larvae fed with different levels of Vitamin C supplementation

The results revealed that a fish oil: lecithin ratio of 5:10 showed significantly (P≤ 0.05) better weight gain (78.90mg) and survival (48.80) of fish larvae than the other treatments indicating the significance of phospholipids (lecithin) in the diet in improving the growth and survival of seabass larvae.

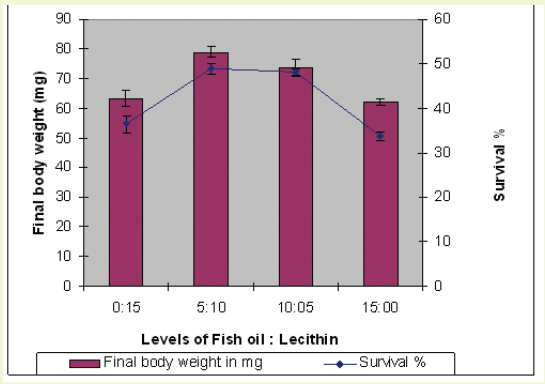


Fig. 25. Growth and survival of 16 DPH seabass larvae fed with different levels of fish oil: lecithin micro diets.

B. Feeds for nursery rearing of seabass

The effect of lipid level in the diet for nursery rearing of seabass larvae was studied. A diet with 45% protein was taken and three test diets were prepared with 5, 10 and 15% lipid by

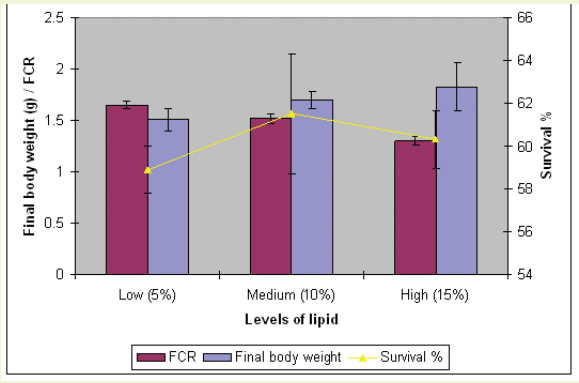


Fig. 27.Effect of different levels of lipid on growth and survival of seabass fry

adding a mixture of fish oil and lecithin in the ratio 5:10. These test diets were fed to 100 seabass larvae of 34 DPH (initial mean weight of 64.97 ±12.26 mg) stocked in 50 l FRP tanks with sea water in triplicate. The feeding trial was carried out for 60 days and the resultsn showed (Fig.27.) that weight gain significantly (P≤ 0.05) increased (1.51g ±0.11 to 1.83g ±0.23) and feed conversion ratio (FCR) significantly (P≤ 0.05) improved with increase in lipid level in diet. There was no significant difference in survival among different treatments (58.90% ±1.10 to 61.50 %±2.80).

C. Feed for nursery rearing of seabass in freshwater

Feeds containing different levels of common salt were tested for nursery rearing of seabass larvae in freshwater. Five different test feeds (having 48% protein and 14% fat) were prepared by adding 0, 1, 2, 3 and 4% common salt to the standard CIBA nursery feed for seabass. These test diets were fed to 100 seabass larva (initial mean weight 94.57 ±14.46 mg) of 40 DPH stocked in 50 FRP tanks with freshwater in triplicate. The experiment was carried out for 45 days. The results (Table.10.)indicate that addition of common salt in feed upto 2% significantly (P≤ 0.05) improved growth. There was no significant difference in survival among larvae fed with feeds having different salt levels.

Table. 10. Effect of common salt on growth and survival of seabass fry

Salt level in diet (%)	Final body weight (g ± SD)	Survival (% ±SD)
0	1.100a±0.105	62.66±1.91
1	1.197a±0.081	62.43±3.40
2	1.420b± 0.050	63.03±2.19
3	1.440b±0.079	61.46±1.67
4	1.390b±0.153	63.10±1.18

D. Testing of seabass nursery feeds in farmer's ponds

About 3000 hatchery reared seabass larvae of 30 DPH were stocked in a nursery pond of a farmer at Ganapavaram village near Bhimavaram in Andhra Pradesh and fed with CIBA nursery feed. (Table. 11). The fry attained 2.0g average body weight with 78% survival.

Table.11. Feeding trial in nursery on seabass fry at Ganapavaram village

Days of rearing	ABW (g)	Body Weight (g) range	Survival %
30 days	6	2-10	78.0
45 days	12	5-18	62.0
60 days	70	30-150	40.0

At Nellore, in Andhra Pradesh 1500 hatchery reared seabass fry of 30 DPH were reared in three hapas (1 x 1 x 1 m) @ 500 nos./ hapa and fed with seabass nursery feed. In 30 days, the fry attained average body weight of 2.0g with 70% survival.

E. Testing of grow-out feed for seabass

Formulated feed containing 38% protein and 8% fat was developed as sinking pellet for grow-out culture of seabass. Seabass fingerlings of 40-250g were stocked in 8 t FRP tanks provided with seawater flow through system at different stocking densities (60-280 nos) and fed with pellet feed @ 8-10% of body weight. The feed acceptability was very good and the fishes attained 0.8 to 1kg in 6-8 months with an FCR of 1.8:1.

The seabass fingerlings (2 g size) stocked @ 1500/ 0.4 ha was fed with CIBA pellet feed. About 149 kg of the fish was harvested with an average weight of 1.0 kg at the end of 10 months. The FCR was 2.34:1

About 1000 fingerlings with an average body weight of 1.5g were stocked in a 0.25 acre fresh water pond of Krishi Vigyan Kendra, Pondicherry and fed with pellet feed supplied by CIBA. Production of 110 kg, was obtained with size range of 0.5-1.0 kg at the end of eight months. The FCR was 2.5:1 with survival rate of 44%.

Performance of seabass fry fed different level of mustard cake

The effect of inclusion of mustard oil cake (MOC) in the diet of seabass fingerlings was carried at 5, 10 and 15% levels in the fishmeal based diet. The feed was fed to seabass fry in a 30-day feeding trial and the results have shown that mustard oil can be used up to 5% in the feed without compromising growth and FCR and higher levels of MOC in feed decreased growth and increased FCR (Table .12).

Table. 12. Results of feeding seabass fry with feeds having different levels of mustard oil cake.

Parameter	Group I Control (MOC-0%)	Group II (MOC-5%)	Group III (MOC-10%)	Group IV (MOC-15%)
Initial body wt. (g)	1.56 ± 0.02	1.52 ± 0.02	1.54 ± 0.05	1.53 ± 0.01
Final body wt.** (g)	5.54 ± 0.20b	5.32 ± 0.19b	4.44 ± 0.06a	4.03 ± 0.05a
Total wt. gain (g)**	3.98 ± 0.18b	3.80 ± 0.18b	2.90 ± 0.03a	2.50 ± 0.06a
Weight gain percent **	255.07 ± 10.42b	249.92 ± 10.73b	188.74 ± 6.80a	163.51 ± 5.62a
Total Feed intake (g) *	12.42 ± 0.49b	12.16 ± 0.16b	11.36 ± 0.33ab	10.63 ± 0.33a
FCR **	3.14 ± 0.25a	3.21 ± 0.16a	3.92 ± 0.16b	4.25 ± 0.06b

* Significant ** Highly significant

Weaning of wild seabass with formulated diet

A practical feed (36.79 % CP and 8.20 % lipid) with 5 % mustard cake was prepared and tested for weaning wild seabass fingerlings (4.5-5.0g). The fish could be successfully weaned to the formulated diet and reared for 100 days. The fingerlings attained an average body weight of 75.58g with 55.4% survival.

Development of broodstock feed for milk fish

A specially formulated feed for broodstock of milk fish was prepared as dry pellet by enriching them with critical nutrients required for maturation. The fishes were daily fed @ 5-8% body weight in cement out door tanks.

Determination of lipid requirement for grey mullet

The lipid requirement in the diet of grey mullet *Mugil cephalus* was determined by formulating feeds containing 0, 3, 6 and 9 % lipid and 30% protein. Feeding trial with test feeds on *M. cephalus* fry was conducted in FRP tanks for a period of 30 days. The results (Table 13) indicated that growth of the fry increased with lipid level upto 6% and improved FCR. Further increase in lipid level decreased the growth and increased FCR. The suggested dietary lipid requirement of *M. cephalus* is 6%.

Table. 13. Results of feeding trails on grey mullet fry fed with feeds with different lipid levels.

Parameter	Group I 0%	Group II 3%	Group III 6%	Group IV 9%
Initial body wt. (g)	0.81 ± 0.06	0.84 ± 0.06	0.82 ± 0.04	0.76 ± 0.04
Final body wt. (g)	2.10 ± 0.06	2.20 ± 0.11	2.35 ± 0.08	2.39 ± 0.04
Total wt. gain (g)	1.29 ± 0.09	1.36 ± 0.18	1.64 ± 0.06	1.53 ± 0.05
Weight gain(%)	162.90 ± 21.77	168.21 ± 36.79	217.93 ± 17.29	186.96 ± 5.21
FCR**	4.23 ± 0.15b	3.97 ± 0.04bc	3.39 ± 0.19a	3.74 ± 0.10ab
PER**	0.79 ± 0.03a	0.85 ± 0.07a	0.99 ± 0.05b	0.90 ± 0.02ab
SGR(%)	2.28 ± 0.21	2.31 ± 0.31	2.75 ± 0.13	2.51 ± 0.04

2. Low fish meal feed for shrimp tested in grow-out ponds

A low fish meal shrimp feed was formulated by replacing 40% fish meal and 28% other marine protein sources with plant protein sources in a standard shrimp feed formulation. The ratio of protein sources contributed from different sources (fish meal: other marine protein sources: plant protein sources) is 23: 24: 53 in low fish meal feed. The control feed had these ingredients in the ratio 38: 35: 27. Both the feeds were produced at MES pilot-scale feed mill and tested on *P. monodon* in grow-out ponds at KRC. The ponds were stocked at the rate of 6.5 nos./m^2 and harvested in 120 days. The production of 1308 kg/ha was obtained with FCR 1.31:1 in low fish meal feed and 1116 kg/ha with of FCR 1.37:1 in control feed.

Protein requirement of banana shrimp

The dietary protein requirement of banana shrimp, *Fenneropenaeus merguiensis,* was determined by formulating six practical diets having different protein levels ranging from 41.69 to 24.7 %. The test feeds were fed to juveniles of banana shrimp with initial weight of 0.4-0.6 g. The growth of shrimp increased with increase in protein level (Table.14). The increase in growth rate beyond 35.2 % protein level is not significantly different with that of 41.69 % level. The *in vitro* digestibility of dietary protein in banana shrimp (Fig. 28.) indicate that feed with 35.2% CP has the maximum protein digestibility (66.22%).Based on the growth, FCR and dietary protein digestibility, the desirable protein level in feed appears to be 35% for banana shrimp.

Table.14. Effect of different protein level feeds on banana shrimp

Test diets	Crude protein (%)	Weight gain (%)	FCR	Survival (%)
1	41.69	142.17	2.18	86.66
2	38.22	140.43	2.19	88.89
3	35.2	137.50	2.35	88.89
4	32.75	129.00	2.54	86.67
5	29.5	107.54	2.79	86.66
6	24.7	91.63	2.84	84.44

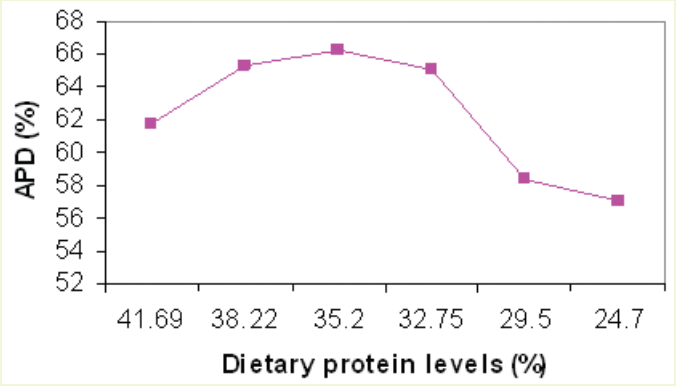


Fig. 28. Effect of dietary protein on its digestibility (in vitro) in banana shrimp

Protein requirement of kuruma shrimp

Six practical diets having different protein levels (50 to 30%) were formulated and prepared to determine the protein requirement of the kuruma shrimp, *Marsupenaeus japonicus.* These feeds were tested in juvenile shrimps having initial weight of 0.4 g in a 45-day feeding trial. The results (Table. 15) indicated that kuruma shrimp requires 45% protein in its diet.

Table. 15. Effect of different protein level feeds on kuruma shrimp

Test diets	Crude protein (%)	Weight gain (%)	FCR	Survival (%)
1	49.4	135.33	2.34	80.00
2	45.4	132.3	2.33	82.22
3	39.8	124.3	2.59	88.89
4	36.8	112.33	2.75	82.22
5	32.9	104.21	2.76	91.11
6	29.5	91.63	2.87	82.22

4. Formulated feed for tiger shrimp broodstock

A formulated feed with 48% crude protein and 10% ether extract was prepared and fed to tiger shrimp (22g weight) stocked in a pond for raising broodstock. The shrimp attained 50g (male) to 73g (female), and were used for maturation and breeding in captivity. The biochemical composition of different tissues of the wild and pond reared broodstocks of tiger shrimp was analyzed. The results indicated comparable (17.14% & 16.84%) protein levels (Table. 16.) in the ovary of wild and pond cultured broodstocks. The lipid levels were low in the pond reared shrimp (3.47%) than the wild shrimp (5.31%). The nutrient levels in the whole body and hepatopancrease were almost similar in both wild and cultured shrimps. .

Table.16 Biochemical composition of wild and cultured *P. monodon* broodstock

	Female						Male			
	Whole body		Hepatopancreas		Ovary		Whole body		Hepatopancreas	
	Wild	Cultured	Wild	Cultured	Wild	Cultured	Wild	Cultured	Wild	Cultured
Protein (% wet tissue)	15.34	15.06	8.45	9.08	17.14	16.84	16.47	16.68	8.54	8.62
Lipid (% wet tissue)	3.71	4.07	7.30	7.33	5.31	3.47	2.45	3.77	7.11	6.94

Use of exogenous enzymes to improve digestibility of shrimp feeds

Bacteria isolated from gut microflora of shrimp was cultured on Luria bertani (LB) agar plate. Pure culture of the proteolytic marine bacteria was obtained and the bacteria were identified by biochemical tests for catalase, hydrolysis of starch, methyl red, indole production, nitrate reduction, Voges proskauer and citrate utilization. In addition, the identification of bacteria is also being carried out by molecular characterization.

CIBA Shrimp feed technology

The indigenous shrimp feed technology developed by CIBA has been successfully commercialised for production to the following two clients :

1. M/s Bismi Feeds (P) Ltd., Perunthottam village, Sirkazhi taluk, Nagapattinam district., Tamil Nadu.
2. M/s Pisciculture Care Unit, Madhubati, P.O.-Kamarpukur, Hooghly district, PIN- 712612, West Bengal.

The feed produced by the entrepreneur, M/s Bismi Feeds Ltd., was tested in 24 ponds of his own farm and compared with three commercial feeds (CF). The feeds were also distributed to six other farmers. The farm is located in high salinity zone and the crop was continued for longer duration to get marketable size shrimps. The pond wise data provided by the entrepreneur was analyzed and summarized below in Table. 17. and that the six farmers in Table. 18.

Table. 17 Performance of Bismi feeds (CIBA formutation) in P. monodon ponds.

Feed tested	Area (ha) & Nos. of ponds	Stocking dentity (nos./m^2)	Production (kg/ha)	FCR	Cost of feed (Rs./kg)	Feed cost for per kg shrimp
Bismi	22.92 (24)	15/m	2223 (25-26g)	2.3	40	92.0
*CF1	4.33 (6)	18/m	2946 (26-27g)	2.1	50	105
*CF2	5.66 (6)	13/m	1331 (10-12g)	Soft shell	--	
*CF3	4.76 (6)	13/m	1510 (10-12g)	Soft shell	--	

The impressive performance of CIBA shrimp feed in terms of growth, FCR and production of shrimp are highly comparable to that of the commercial feeds. But CIBA shrimp feed produced by M/s Bismi (P) Ltd has the advantage of less cost of shrimp production over the commercial feeds. Further reduction of feed cost by 8-10% has been undertaken by optimization of feed formulations.

The second entrepreneur from West Bengal produced about 140 t of shrimp feed and marketed to farmers targeting low-density shrimp culture in bheri regions. Simultaneously the entrepreneur produced freshwater fish feed for Indian major carps from the same facilitity and captured a sizable market. The feed mill needs to be strengthened with appropriate capacity grinder and mixer for producing good quality shrimp feed.

Table. 18 Performance of commercial feed

Area	6.0 ha
Stocking	15-20/m
Duration of culture	120-140 days
Production	3200-4200 kg/ha
FCR	1.4-1.5
Weight at Harvest	36-40g
Cost of feed for shrimp Prod	Rs 56-60 /kg
Cost of feed paid by farmers	Rs 41- 44/kg

Shrimp feed usage patterns

A study was conducted in Krishna and Guntur districts of Andhra Pradesh (AP) and Tiruvallur district of Tamil Nadu (TN) in October-December 2007 with randomly identified farmers using semi-structured interview schedule with the objective of finding out shrimp feed usage patterns by farmers. The study revealed that

- one-third of farmers in AP used indigenous feed where as no one used it in TN.
- The major constraints in usage of indigenous feed were poor water stability, non-availability on credit basis, no technical guidance, poor growth rate and longer culture duration.
- Two-third of farmers were willing to adopt indigenous feeds, provided, they are demonstrated for their effectiveness and are supplied on credit basis with technical advice.

Shrimp feed marketing patterns

A study was carried out in Nellore (AP), Nagapattinam and Tiruvallur districts (TN) with feed dealers, technicians and farmers about different shrimp feed marketing strategies. The study revealed that

- feed companies that have strong market presence employ network of technicians and free diagnostic services to serve the clientele farmers.
- seventy percent of dealers sell feed on credit basis followed by 20% on ready cash and 10 % on buy back mode.
- few dealers also mentioned that 3% discount offered by companies on sales is also passed on to farmers to maintain the competitive advantage in the highly volatile aquaculture market.

Field testing of mud crab feeds

Pellet feed for crab fattening

Pellet feed with 38% protein and 6% ether extract was developed for fattening mud crabs *Scylla tranquebarica* and *S. serrata*. The feed was tested for fattening crabs in cages during the 2006-07. More cage fattening trials were conducted in four different locations during 2007-08 by crab farmers. The pellet feed was compared with conventional trash feed. The cages contained units of nine crab holding compartments each and feeding trials were conducted taking equal number of water crabs both for pellet feed and control. The results of the trials are summarized in Table. 19 and showed that CIBA pellet feed was readily acceptable to crabs and results in fast fattening without any mortality. The weight gain during fattening with pellet feed is consistently above 9% while it is around 9% in the case of control feed. Regular collection of trash fish in fresh condition by the farmers and difficulty to store them without refrigeration facility and their undependable availability are the pratical problems faced by farmers. On the other hand pellet feed can be conveniently used off the shelf and has advantage in performance and cost effectiveness.

Table.19 Details of crab fattening in cages using CIBA pellet feed and trash fish

Details	Locations						
	Pulicat	Jamilabad		Alambarai Kuppam		Kattur	
	CIBA pellet feed	CIBA pellet feed	Trash fish	CIBA pellet feed	Trash fish	CIBA pellet feed	Trash fish
Total weight before fattening (kg)	22.5	5.84	5.33	46.30	38.00	38.80	34.00
Total weight after fattening (kg)	24.5	6.395	5.804	50.75	41.45	42.55	37.05
Weight increase (%)	8.9	9.5	8.99	9.6	9.1	9.7	9.0
No. of days taken for fattening	-	24	26	22	22	23	23
Survival (%)	100	100	100	100	100	100	100

Pellet feed for crab culture

For mud crab culture a pellet feed with 36% protein and 6% ether extract was developed and evaluated earlier in earthen ponds. Two more feeding trials were conducted during this year in two locations. At Nagayalanka in Andhra Pradesh a farmer stocked 600 juvenile *S. tranquebarica* collected from wild (60 – 170 g) in three ponds each 0.4 ha area. In two ponds CIBA crab pellet feed was tried and in the third pond trash fish was used as control. After six months of culture the farmer harvested 112 kg and 97 kg (380- 485 g) from two test ponds and 110 kg from the control pond. The size distribution of crabs harvested from test ponds and the control pond is given in Fig. 29. The expenditure incurred on pellet feed (400 kg) was Rs 6400 in each pond and Rs 7200 in control pond (720 kg). The results indicated that pellet feed could be successfully used for culturing mud crabs in place of trash fish, which is conventionally used by the farmers.

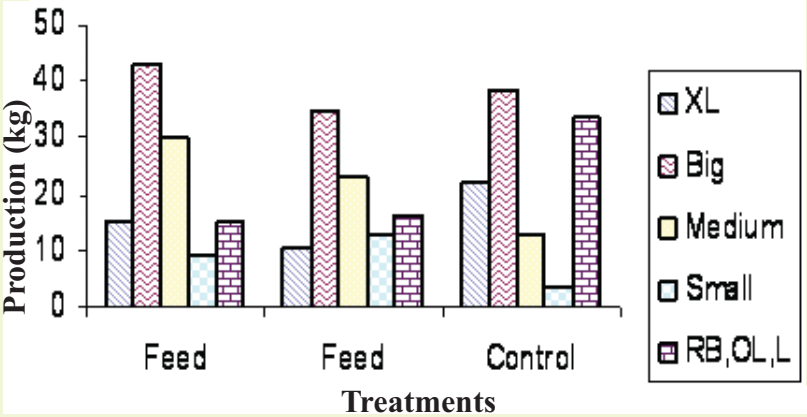


Fig. 29. Size distribution of harvested crabs

Two ponds each of 1200 m^2 were stocked with 1200 juvenile *S. serrata* collected from wild at Kakdwip. In one pond male and female crabs were stocked in 1:1 ratio and in the second pond only female crabs were stocked. The crabs were fed with pellet feed in earthen trays. After 210 days of culture the male crabs attained an average body weight of 205 g and female crabs 176 g. The survival was 35%.

Replacement of marine protein source in mud crab feeds

Table. 20 Performance of mud crabs with test feeds

Test diets (replacement of marine protein sources %)	Weight gain (%)	Survival (%)	FCR
1 (0)	81.35	80	2.94
2 (33.0)	80.1	80	3.17
3 (50.0)	68.7	75	3.44

Three crab test diets were prepared by replacing marine protein sources at 0, 33 and 50% levels with corn gluten, soybean meal, groundnut cake and sesame cake. The test feeds were fed to juvenile *S.tranquebarica* (average initial size 80 g) in a 30-day feeding trial. The results (Table. 20.) indicated that marine protein sources could be replaced @ 33% without compromising growth and FCR.

GENETIC STUDIES AND APPLICATION OF MOLECULAR TECHNIQUES IN BRACKISHWATER SHELLFISH BREEDING PROGRAMMES (NGBD/MG/2)

As part of the programme to evaluate the potential for undertaking genetic selection in the Kuruma shrimp *Marsupenaeus japonicus,* families were obtained from wild (8 nos) and inbred families (2). These were reared upto taggable size and tagged with visible implant elastomer tags for family identification in indoor FRP tanks . After 200 days of rearing, family 5 exhibited the highest body weight compared to the rest of the families. The coefficient of variation in body weight of different families ranged from 27.07 to 54.72%. The tagged shrimps from each family were subjected to a challenge-test with White Spot Syndrome Virus (WSSV). The survival curves are depicted in Fig. 30. The median survival values were 63 hours in family 3 and 85.5 hours in family 8. The rest of the families including the inbred, exhibited a survival value of 61.5 hours. When PCR was carried out for WSSV presence in these two shrimps, they tested negative.

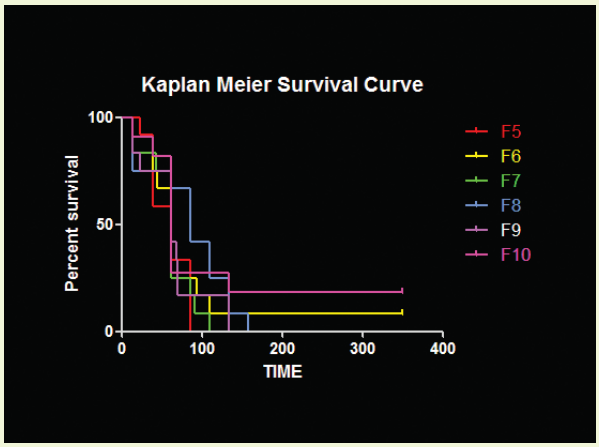


Fig. 30 Comparison of the survival curve of four wild (F_6,F_7, & F_8) and two inbred families (F_9&F_{10}) challenged with WSSV.

After 200 days of rearing in indoor tanks, the tagged shrimp of all the families (n = 408) were stocked in an experimental pond (600 m^2) for monitoring growth. A commercial feed was provided to the shrimp four times in a

day. The water quality parameters were also recorded. The growth of shrimps during the culture period is depicted in Fig. 31.

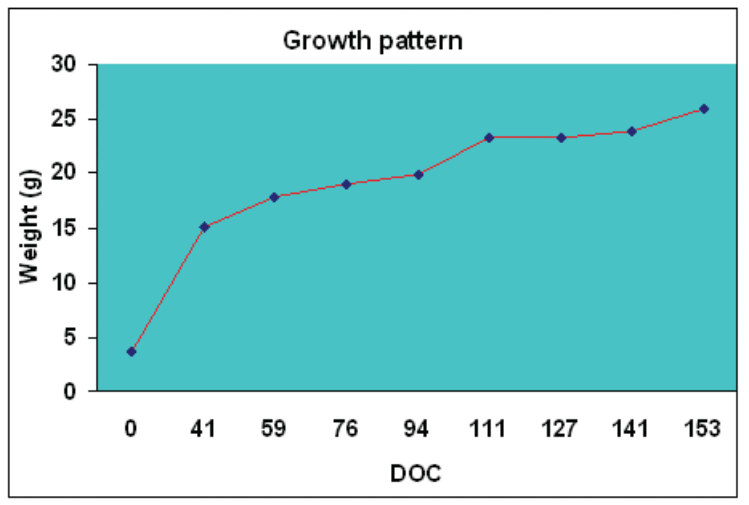


Fig. 31 Growth of tagged kuruma shrimp in a pond

After 153 days of stocking the tagged shrimps were harvested and the average weight are depicted in Table 21. The average wet weight ranged from 22.93 (Family 3) to 29.57 g (Family 6), whereas the inbred families exhibited average weight of 29.93 and 24.54 g. The coefficient of variation ranged from 16.22 to 21.46% indicating that this trait would respond well to selection. The survival ranged from 18 to 52%. A t-test was carried out on the means of both the sexes and it was observed that female shrimps were heavier (29.40 g) compared to their male counterparts (21.73 g), the differences being highly significant ($P<0.01$).

Table. 21 Average harvest weight (g) of families of kuruma shrimp

Family	Average weight	No. sampled	CV (%)	Survival (%)
1	$28.57^{ac} \pm 2.21$	6	18.92	43
2	$27.53^{ad} \pm 2.26$	6	20.11	24
3	$22.93^{be} \pm 1.86$	6	19.87	33
4	$24.57^{cde} \pm 0.45$	3	03.16	18
5	$26.09^{cdf} \pm 1.46$	11	18.61	52
6	$29.57^{a} \pm 1.58$	12	18.49	35
7	$24.76^{bef} \pm 0.70$	33	16.22	45
8	$24.71^{bef} \pm 0.98$	29	21.46	66
9*	$29.93^{a} \pm 2.00$	7	17.70	18
10*	$24.54^{de} \pm 2.07$	5	18.90	28

* Inbred families

Means followed by the same superscript do not differ significantly ($P<0.05$) from each other.

SOCIAL SCIENCES DIVISION

RESEARCH PROJECTS

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. T. Ravisankar, Dr. V.S. Chandrasekaran, Dr. (Mrs.) B. Shanthi, Dr. (Mrs.) D.D. Vimala, Dr. K. Ponnusamy, Dr. M. Kumaran, Mrs. P. Mahalakshmi

STUDIES IN RESOURCE USE EFFICIENCY AND DEVELOPMENT STRATEGIES FOR COASTAL AQUACULTURE (SSD/EEI/3)

Contract farming in brackishwater aquaculture

Contract shrimp farming was approached from two angles such as the production system angle, concentrating on selected villages in 44 mandals of Prakasam district of Andhra Pradesh, where shrimp farmers have the potential and also cultured large sized shrimp and the marketing angle, studying the market channels for farmed shrimp from culture to sale. The following costs were identified as drivers for contract farming

- Search costs: costs associated with identifying potential buyers and sellers
- Screening costs: costs associated with gathering information about the reliability of a buyer/seller and the quality of goods being transacted
- Bargaining costs: costs of gathering information on prices in other transactions, on factors influencing the willingness to transact by the contracting party, on implications of contract terms.
- Monitoring costs: costs associated with monitoring contract performance
- Enforcement costs: incurred in ensuring contract provisions are met, including the costs of default provisions
- Transfer costs: transport, storage, processing, retailing, wholesaling and losses

Economics of organic farming

Organic shrimp farms in Kerala and West Bengal were assessed to understand their productivity. It also addressed the usage of wild caught seed in some traditional farms of West Bengal and supplemental feeding with pelleted feeds in Kerala which were the major deviations identified and are to be attended to for declaring them organic

farms. The reduced income from low average yield of shrimp of 300 - 400 kg/ha is partly compensated by increased price (15% to 25% higher) realized for lower count from organic farms than scientific farms.

Status of traditional seabass farming in Andhra Pradesh

The study was carried out to understand the traditional seabass farming practices, in West Godavari and Krishna districts. About 30 farmers were engaged in seabass farming in about 100 ha of farm area in and around Bhimavaram, West Godavari and eastern parts of Krishna districts. Most of them were farming seabass exclusively and others were farming seabass along with freshwater fishes like grass carp and catfish *Pangasius* sp. The stocking was done using wild seed (100-150 g sized seed fish procured at the rate of Rs.5/- each from the seed collectors) and stocked @ about 600 nos./ha. Live tilapia was the feed invariably used and it was co-stocked with seabass in the ponds. The live tilapia costs about Rs.4-6 / kg. The culture ponds have an average area of 0.5 ha . Seabass culture was done in two phases, the first one for a period of 9 -12 months, by that time the fishes attain size of about 1.0 kg (varying growth). In the second phase the bigger ones were sorted out, shifted to another pond and stocked @ 200 nos./0.4 ha, fed at higher rate and grown to 3-5 kg. Demand for seabass was high in Calcutta market and large sized fishes fetch Rs. 190/kg during March-May. The farm gate price of seabass was Rs.110 – 130/kg.

An assessment of gender participation and women entrepreneurs in aquaculture

Twelve case studies were made from women entrepreneurs engaged in shrimp farming, crab culture, crab fattening in cages, pens and concrete tanks, shrimp hatchery management, crab hatchery management, fish meal formulation and feed development. Seven Irular tribal community engaged in crab fattening at Kulathumedu, Pulicat, were identified and the data on farming practices were collected from them.

Information gaps in shrimp health management

Purposive sampling method was employed to study the information gap in Tallarevu mandal in East Godavari district, Andhra Pradesh and 68 respondents were selected and grouped into different levels of adopter category by using the Adoption index method. Analysis of data indicated that none of the technology advocated were utilized fully. The majority of the farmers sometimes use the technology in half measure and at times fully. Since the awareness was not converted into action, it is the responsibility of extension specialists to drive home the importance of adoption of specific technologies in totality among the stakeholders.

Manpower planning for coastal aquaculture development and evaluating success of agri-clinics

A set of criteria for manpower planning was arrived, *viz.,* available resources, growth and expansion of aquaculture, export of commodities, level of unemployment in the aquaculture and fisheries sector and job work load analysis, based on the literature survey and expert consultation. Criteria ranking was also done by circulating the identified criteria among the fisheries experts to rank the criteria in the order of importance. The expert opinion clearly indicated the need to plan the manpower based on the growth and expansion of aquaculture and also resources availability in the coastal districts

To emulate the success of agri-clinics for the operation of aquaclinics, critical factors which influenced the success of agri-clinics were studied. The analysis revealed that most of the entrepreneurs belonged to the age group of 31-

40 years, 60 % of them are undergraduates and possessing more than five years of marketing experience in private firms. Majority of the respondents cited poor job satisfaction with earlier jobs as the major reason for starting their own venture followed by an internal urge to take up own enterprise. Based on some of the constraints expressed by the agripreneurs, the success of aqua-clinics would depend on easy access and timely availability of institutional credit, improved inter-personal relationships between concerned government departments and farmers and adequate post harvest facilities located at vantage points.

Cluster farming and dynamics of its success in shrimp aquaculture

To make an assessment of significant institutional and social factors responsible for success of cluster farming, for evolving a strategy for inclusion of cluster farm approach in technology development, validation, diffusion and adoption process, this study was taken up with shrimp farmer groups operating in Tamil Nadu (TN) and Andhra Pradesh (AP). About 23 farmer groups (11 in AP and 12 in TN) were contacted to assess their collective cluster management, group functioning and significant institutional and social factors responsible for their success or otherwise.

An Aqua Farmers Group Effectiveness index (AFGEI) was developed to assess the effectiveness of shrimp farmers' association/group. Two types of farmer groups *viz.,* (i) creek-wise and (ii) the area based were observed. Creek based groups were of two kinds, namely (a) the one initiated and facilitated by the public extension agency (MPEDA / NACSA) and (b) that initiated by the farmers themselves. Farmers initiated clusters have performed better then the facilitated groups. (Table. 22.) This might be due to the later's nascent origin and voluntary membership option. The creek based self-initiated farmer groups were found functioning effectively. They enforce complete membership in the cluster and certain bio-security measures. Group action was absent in area centric associations prevalent along the sea coast, where, every farm was independent of the other and directly lifted the required saline water from the sea. Economic (tangible) deliverables, social cohesiveness (community), size of the cluster and committed leadership were observed to be critical factors contributing to the success or otherwise of the farmers groups

Table. 22. Factors affecting success or failure of farmers groups

Sl.No	Factors	Self – initiated FOs (N – 12)	Facilitated FOs (N – 11)
1	Deliverability of the association in terms of successful culture and assured income	100.00	100.00
2	Social cohesiveness due to same community group / same village/nearby	67.00	81.00
3	Conviction of the that through group action their goal could be more easily attained	50.00	54.50
4	Efficient Leadership to carry forward the functions	67.00	54.50
5	Prevalence of commitment and mutual trust among members	50.00	54.50
6	Support from government agencies	16.70	90.00
7	Failure : Large size clusters and more number of farms, hence management become very difficult.	75.00	81.00
8	All time low market price	83.00	72.00
9	Presence of non-member in the cluster	0.0	72.00
10	Complacency/over confidence	67.00	54.00

Strengthening information infrastructure for aquaculture development through ICT

Analytical Hierarchy Process (AHP) technique was used for assessing the change in service quality in aquaculture marketing as a result of e-marketing system implementation in West Godavari and East Godavari districts, Andhra Pradesh. Evaluating e-marketing service in aquaculture induced service quality changes, the two candidate alternatives are service quality under the aquachoupal model and the traditional marketing system in aquaculture. The opinions of 88 shrimp farmers on service quality dimensions were investigated. The aquachoupal model scores over the traditional system of marketing because of its transparency in operations and functions. Moreover it ensures timely delivery of inputs and also payment scheduling which enables the stakeholders to make a proper assessment of their monetary and resources availability and delivery management systems. The weighted average indicated that the aquachoupal model received 64% and traditional marketing system received 36% in respect of the priorities in the marketing system.

Marketing of shrimp through e-hub

A study on marketing of shrimp through e-hub in West and East Godavari districts, Andhra Pradesh was undertaken to identify the mandate and scope of aqua-choupal models, use patterns, farmers perceptions, constraints, marketing channels and analyse the suggestions for improvement. Majority of the respondents (64%) made use of the pricing facility frequently. About half of the respondents (51%) frequently adopted the customized quality solution facility. (Fig. 32). Awareness creation, provision of brackishwater aquaculture farming system oriented information, interfaced information sharing among aquachoupals, and gender empowerment in aquachoupal use needs to be improved.

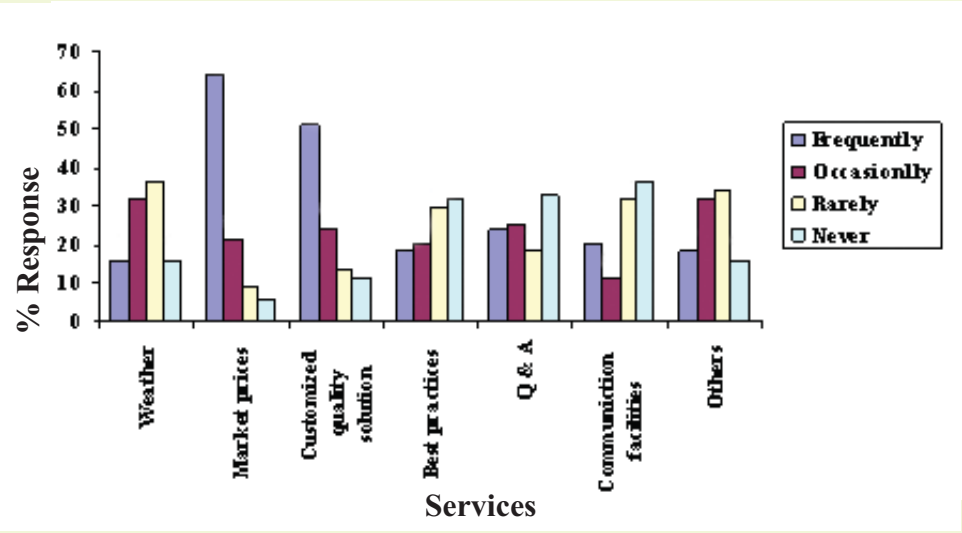


Fig.32. Response of users of aqua choupal

KAKDWIP RESEARCH CENTRE

RESEARCH PROJECT

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

Principal Investigator : Dr.M.Natarajan (till October 2007) and Dr. A.Panigrahi (from November 2007)

Location of the project : Kakdwip

Co-Investigators : Dr. T.K. Ghoshal, Dr. Debasis De, Dr. J.K. Sundaray (till July 2007), Mr.G. Biswas, Dr. R. Ananda Raja, Dr. V.S. Chandrasekaran, Dr. M. Jayanthi and Dr. R. Saraswati.

REFINEMENT OF THE TRADITIONAL SHRIMP CULTURE PRACTICES AND DEVELOPMENT OF ORGANIC FARMING TECHNOLOGY

Organic shrimp culture pond integrated with mangrove saplings and other plants

A successful demonstration of shrimp farming with organic principles was performed with tiger shrimp stocked @ 6500 nos./ha were stocked. A low fish meal feed was used in organic ponds along with other organic inputs to make it close to the concept of organic farming. The ponds were prepared following scraping top layer of soil from the feeding zone after drying, followed by liming with lime stone powder. The organic inputs like RCD, organic juice, vermicompost etc., were applied in organic culture ponds till good plankton bloom developed and stabilized before stocking. The yeast *(Sachharomyces cerevisiae)* based organic preparations were applied and found to induce higher growth in tiger shrimp significantly.

A higher production level of 1308 kg/ha with an average body weight of 33.28g was achieved in organically grown shrimps compared to that of conventionally grown shrimps with production level of 1078 kg/ha and an average body weight of 28.64g (Table 27). There was 21% gain in production level in organic ponds and 16% improvement in size at harvest with better FCR (lowered by 4.2 %). The average body weight (ABW) of shrimp was higher in organic

Table 23. Advantage of organic farming system *vis-à-vis* conventional system

Parameters	Conventional pond	Organic pond	Improvement (% change)
Survival (%)	59	61	3.4 %
ABW at harvest (g)	28.64	33.28	16.2 %
Productivity (kg/ha/crop)	1078	1308	21.3 %
FCR (biomass/dry wt feed)	1.36	1.31	4.2 %

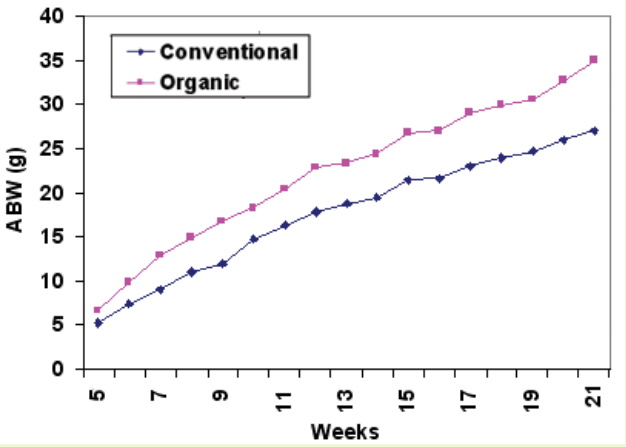


Fig.33. Growth performance of *P. monodon* in the conventional and organic ponds

ponds throughout the culture period than in the conventional ponds (Fig. 33). Better productivity was obtained with low fish meal feed by following the organic principles.

Improvement of productivity in traditional brackishwater aquaculture systems

The organic ponds maintained higher gross primary production throughout the culture compared to that of the control ponds.The conventional ponds showed higher levels of ammonia and nitrite which are critical to the growth and production of the shrimp. The other physico-chemical parameters that influenced the productivity, like, alkalinity, pH, dissolved oxygen, turbidity did not vary much with regard to the different systems. It was also observed that higher phosphate and nitrate levels in the culture system yielded better shrimp crop.

Analysis of representative soil samples indicated that the gross primary productivity was higher in pond system compared to the Bhery system. The pH and alkalinity were higher in the pond and dissolved oxygen level ranged from 5 to 11 ppm in pond, whereas it was in the range of 4 to 8 mg/l in the Bhery system.

Organic feeds for shrimp culture

Total protein, true protein and non-protein nitrogen in potential organic shrimp feed ingredients were analyzed to assess their suitability as a component in organic shrimp feed. True protein content was highest (42.45%) in soyabean meal and lowest in mangrove leaf meal (4.02 to 7.16%).The true protein content of mustard cake, sesame cake, duckweed, *Azolla sp* and *Moringa oleifera* leaves varied from 14.27 to 25.02%. The soyabean meal, mustard cake, sesame cake, duckweed, *Azolla sp* and *Moringa oleifera* leavs may be used for organic shrimp feed formulation along with reduced percentage of fish meal. The amino acid analyses of the six ingredients have also been completed.

Polyculture of brackishwater finfishes

Polyculture of fin fishes *Mugil cepahlus,* Liza tade, *Etroplus suratensis* and shrimp *P. monodon* was conducted in duplicate with lower (T-I) and its double stocking densities (T-II). Stocking densities followed in T-I were *M. cephalus* - 1250, *L. tade* - 2500, *E. suratensis*- 1500 and *P. monodon* - 16,000 nos./ha, whereas, T-II had double the number of the same species. Fishes were fed with low-cost pellet

Table. 24. Performance of fishes and shrimps in polyculture trials

Treatment	T- I	T- II	SEM
Initial biomass (kg)	21.69 ± 1.97	41.46 ± 5.87	4.38
Production of cultured species (kg)	69.87 ± 12.45	103.00 ± 15.76	14.20
Production of cultured species (kg/ha)*	630.08 ± 55.88a	979.46 ± 10.13b	40.15
Production of misc. fish (kg)	59.24 ± 2.72	60.67 ± 8.70	6.45
Production of misc. fish (kg/ha)	540.74 ± 24.41	577.77 ± 0.36	17.26
Total biomass production (kg)	129.10 ± 15.17	163.17 ± 24.46	20.35
Total biomass production (kg/ha)**	1170.78 ± 31.48a	1557.27 ± 10.49b	23.46
Total Feed Intake (kg)	203.98 ± 50.62	301.70 ± 42.30	46.64
FCR (on total biomass)	1.87 ± 0.24	2.47 ± 0.03	0.17

* $p<0.05$,** $p<0.01$ a,b values bearing different superscript in a row differ significantly

feed prepared from locally available ingredients @ 2-5% body weight daily. After 7 months, total production of 1170.78±31.48 kg/ha (Table.24.) along with some miscellaneous species with an FCR of 1.87±0.24, was obtained in T-I and in T-II total production of 1557.27±10.49 kg/ha with an FCR of 2.47±0.03 was achieved.

Evaluation of local feed ingredients

Thirty four locally available (11 conventional and 23 non-conventional) ingredients were identified and analyzed (Table. 25) for proximate principles. Among the non-conventional feed resources, sesame cake (CP-31.80 %), karanja cake (CP-23.06%) and green gram (CP-20.34%) were found to be good protein sources and mango seed kernel (total carbohydrate- 82.16%) and tamarind seed (total carbohydrate - 76.34%) the energy sources that may be considered as potential ingredients in aqua feed formulation due to their low costs. Inclusion level of moong husk was determined for *P. monodon* and *M. cephalus* in yard experiments to formulate low cost feed for polyculture. It was found that moong husk can be incorporated in the diet at 5 % level without affecting the growth and digestibility in both the species. Table.26 and Fig.34.

Table. 25. Proximate composition of potential locally available feed ingredients

Name of ingredients	DM %	CP %	EE %	ASH	OM	AIA	CF	NFE	Ca	P
Mustard cake	93.88 ± 0.005	36.88 ± 0.004	5.48 ± 0.002	8.64 ± 0.005	91.36 ± 0.005	4.21 ± 0.006	9.50 ± 0.005	39.50 ± 0.006	0.46 ± 0.001	1.14 ± 0.003
Sunflower cake	94.29 ± 0.006	25.77 ± 0.005	15.09 ± 0.006	7.02 ± 0.005	92.98 ± 0.004	0.99 ± 0.004	5.31 ± 0.007	52.13 ± 0.004	0.25 ± 0.007	1.30 ± 0.004
Sesame cake	95.45 ± 0.007	31.80 ± 0.007	8.91 ± 0.006	7.52 ± 0.005	92.48 ± 0.005	1.14 ± 0.035	26.88 ± 0.006	24.89 ± 0.005	0.51 ± 0.006	1.14 ± 0.005
Karanja cake	93.26 ± 0.007	23.06 ± 0.005	6.55 ± 0.007	6.26 ± 0.005	93.70 ± 0.005	3.81 ± 0.007	9.71 ± 0.006	54.42 ± 0.005	0.37 ± 0.006	0.31 ± 0.007
Mango seed kernel	38.60 ± 0.009	5.23 ± 0.005	8.94 ± 0.004	2.02 ± 0.003	97.98 ± 0.002	0.01 ± 0.011	1.65 ± 0.004	82.16 ± 0.006	0.0 ± 0.006	0.70 ± 0.002
Greengram husk	84.91 ± 0.006	20.34 ± 0.009	0.80 ± 0.028	4.56 ± 0.016	95.44 ± 0.007	0.37 ± 0.008	17.30 ± 0.03	57.00 ± 0.527	0.14 ± 0.007	0.37 ± 0.002
Tamarind seed powder	92.12 ± 0.002	14.15 ± 0.003	0.60 ± 0.006	3.43 ± 0.003	96.57 ± 0.003	0.41 ± 0.007	5.48 ± 0.002	76.34 ± 0.001	0.29 ± 0.002	0.33 ± 0.006

Table. 26. Performance of *Mugil cephalus* fry fed with different level of moong husk (MH)

Parameters	Group I (MH-0%)	Group II (MH-5%)	Group III (MH-10%)	Group IV (MH-15%)
Initial body weight. (g)	4.54 ± 0.15	4.60 ± 0.15	4.47 ± 0.02	4.51 ± 0.22
Final body weight. (g)	5.86 ± 0.14	6.00 ± 0.10	5.50 ± 0.12	5.76 ± 0.41
Total weight. gain (g)	1.32 ± 0.04	1.40 ± 0.22	1.03 ± 0.14	1.26 ± 0.28
FCR**	3.05 ± 0.11a	3.09 ± 0.02a	4.53 ± 0.06b	5.29 ± 0.08c
PER (%)	54.00 ± 1.76	57.00 ± 9.07	42.00 ± 5.78	51.00 ± 11.13
SGR(%)	1.23 ± 0.06	1.27 ± 0.21	0.99 ± 0.13	1.15 ± 0.23

** P<0.01

a,b,c bearing different superscripts in a row differ significantly

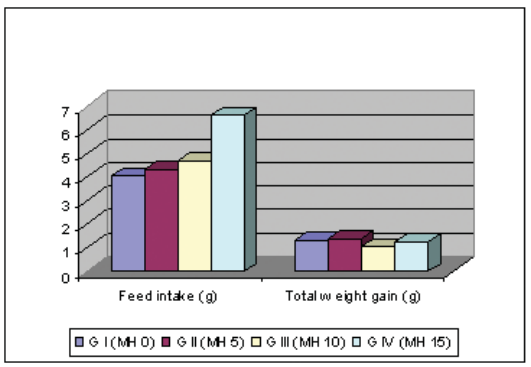


Fig.34. Feed intake and weight gain in *M. cephalus* with difference levels of moong husk

Socio-economic status of traditional brackishwater farming communities

Survey of 210 farms was completed in three coastal districts of West Bengal. MS Access database file is created defining each attribute with a code number and the collected data were entered in this database. Identification of parameters and characterization of tables and fields for development of a user friendly database has been initiated.

Documentation and evaluation of the Indigenous Technology Know-hows (ITKs) in brackishwater farming systems

A total number of 35 ITKs were collected across different culture systems. The criteria used for classification of ITKs were based on the time-line and their related use with culture, health and feed management. In field validation, the farmers are asked to score the ITK compared to the alternatives following a matrix scoring, besides weighing their experience and observation in support of the ITK is noted. The experimental validation is in progress by laboratory, yard and/or on-station trials.

Mapping of traditional farms in North 24 Paragnas district

To map the traditional farms in North 24 Paraganas district, West Bengal satellite data were rectified. Ground truth verification was carried out in doubtful areas using Global Positioning System (GPS). The major land classes were found to be water bodies, mangroves, Bheries, settlements, agriculture fields, mud flats and waste lands. The traditional farms were identified and digitalized.

Disease prevalence in traditional aquaculture systems and health management

An aquatic health laboratory was established at the KRC of CIBA. The disease prevalence in 24 Parganas South and East Midnapur districts has been documented. The PCR test and histological examinations of *P. monodon* samples showed the prevalence of WSSV disease across different farming systems. Further, this investigation revealed the presence of WSSV in different stocks, even though they appear to be healthy with no symptoms. A few samples showed Ist step positive for WSSV and others showed positive in the second step in the nested PCR. However, all the samples tested negative for IHHN (Fig. 35).

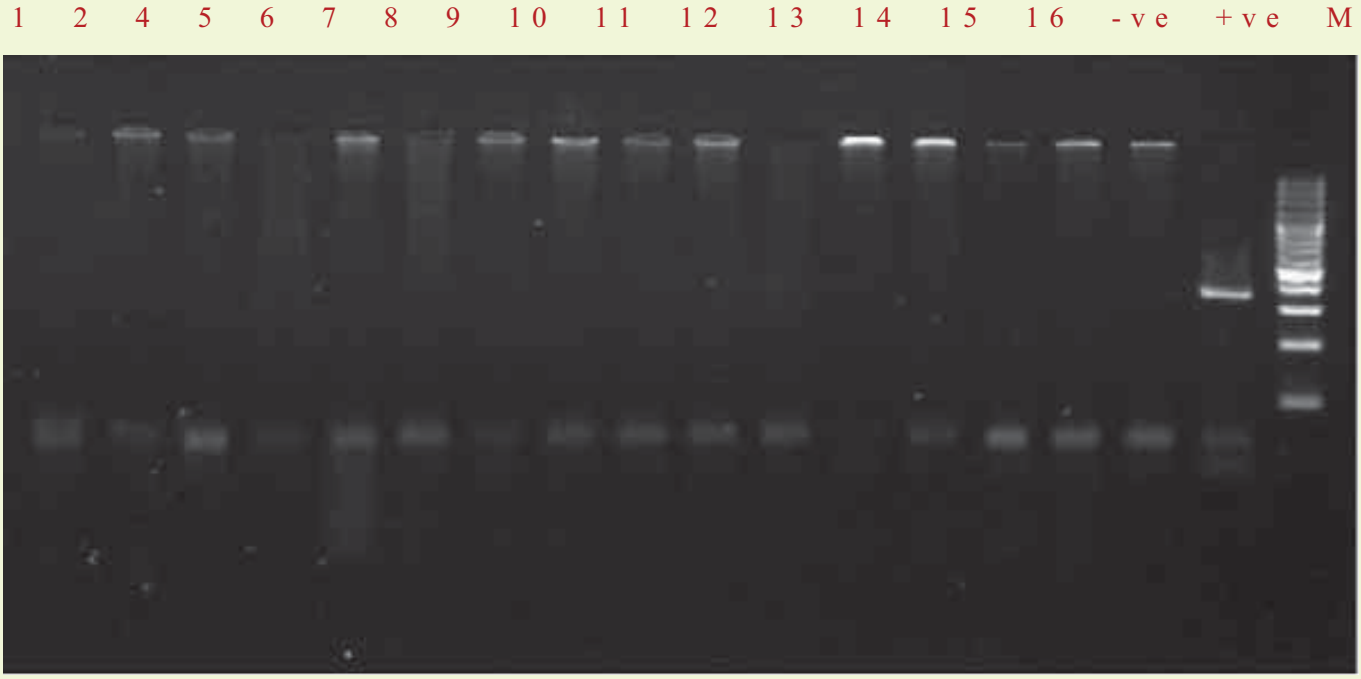


Fig. 35. Samples showing negative for the Infectious Hypodermal & Haematopoietic Necrosis (IHHN) Virus diseases

About 32 % of the farms were affected by diseases like WSSV, soft shell, emerging diseases like white gut disease, slow growth syndrome disease and loose shell syndrome Fig. 36).

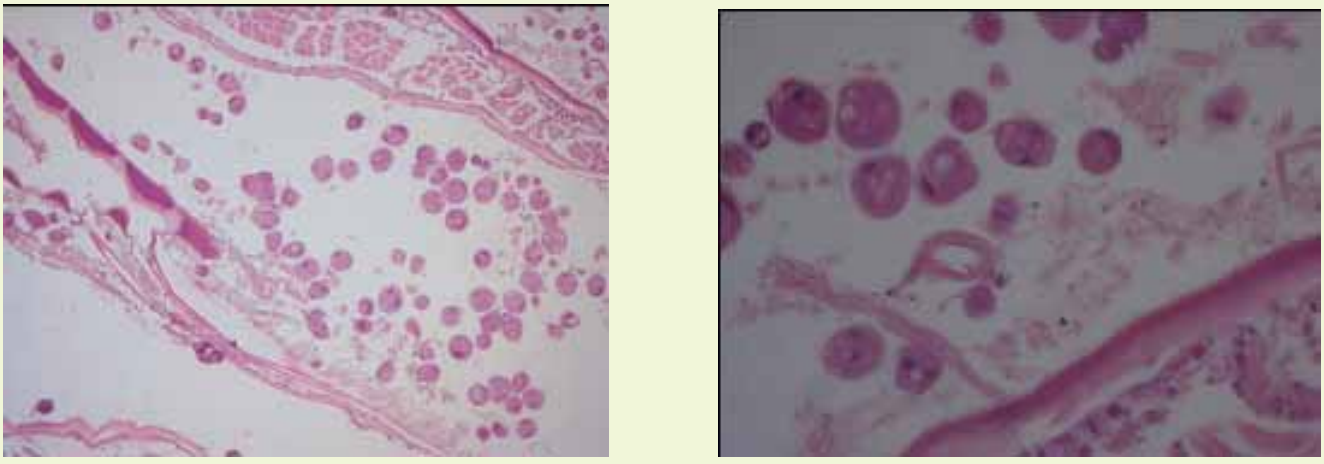


Fig. 36. Photomicrograph of infected pleopod *P. monodon* showing prominent intranuclear inclusion bodies (10x & 40x).

EXTERNALLY FUNDED PROJECT

INDO-NORWEGIAN (NORAD) COLLABORATIVE PROJECT

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

Tagged *P. monodon* stocked in a pond along with untagged shrimps for the purpose of monitoring growth were harvested in the first fortnight of May 2007. In the commercial study, a total of 375 tagged shrimp (out of 2360) were harvested, body weight recorded, eye-ring tagged and re-introduced into another pond. The survival in this case was 16%. They were kept as a buffer stock. Out of 3347 untagged shrimp stocked along with the tagged shrimp, 1740 shrimp were harvested (survival 52%). In the broodstock category, 439 tagged shrimp were harvested out of 4305 shrimp stocked (survival 11%). The body weight of these shrimps were also recorded, eye-ring tagged and re-introduced into another pond for broodstock development.

The body weight data were subjected to detailed analyses. It was observed that the harvest weight was significantly affected by factors, *viz.,* rearing pond and sex. This trait was not affected either by rearing location (Chennai and Kakinada) or origin (Chennai, Andhra and Andamans).There was substantial additive genetic variance for harvest weight. As regards pond survival, there was no effect of origin of stock and there was considerable additive genetic variance for this trait. The genetic correlations between the two ponds for these two traits were high. Regarding the analysis of data on challenge-test, different statistical models were used, *viz.,* Linear Binary Model, Linear Time Model and Weibull Proportional Hazards model. However, none of these models could estimate additive genetic variance for WSSV resistance.

In November 2007, a fresh set of dam families from Tamil Nadu (11 nos) and mixed families from Andamans (12 nos) were collected and reared in 500 l FRP tanks till taggable size. These shrimps are ready to be tagged for stocking in a pond. Representatives from each family would be subjected to a challenge-test with WSSV.

In February 2008, after 15 months' of pond culture, 58 tagged shrimps were retrieved from the ponds and shifted to the maturation unit. Efforts are on to obtain progeny from single pair-matings.

ICAR AP Cess Fund Projects

Title of the project : **Evaluation of nutritive value of different strains of rotifers *(Brachionus spp.)* and their suitability for larviculture of Asian seabass Lates calcarifer (Bloch)**

Principal Investigator : Dr.M.Kailasam

Location of the project : Chennai

Co-Investigators : Dr.A.R.Thiruvanukkarasu and Dr..J.Syama Dayal

Five rotifer species *Brachionus plicatilis, B.rubens, B.calyciflorus, B,angularis* and *B.caudatus* were collected from different locations and evaluated to find out the optimum rotifer with reference to size and nutritive value suitable for larviculture of Asian seabass *Lates calcarifer.*

Morphometric and biochemical constituents of different rotifer species

Morphometric characteristics were measured for all the five species. The maximum lorica length of 200.93±72.2 µm was in *B. rubens* followed by *B. calyciflorus, B. caudatus, B.plicatilis* and *B. angularis* with 194.13±22.5 µm, 150.03±2.74 µm, 145.15±20.7 µm and 96.13±7.7 µm, respectively.

Biochemical constituents of different rotifer species were determined (Table.27). Maximum lipid level of 17.2 % was observed in *B. plicatilis,* and since lipid is very essential for the fish larvae, this species would serve as good larval diet.

Table.27. Biochemical constituents of different rotifer species

Constituents	*B. plicatilis*	*B.calyciflorus*	*B.rubens*
Protein (%)	47.2±2.66.	51..2±3.67	56.0±3.98
Carbohydrate(%)	5.6±0.42	7.9±0.54	8.7±0.68
Lipid (%)	17.2±1.25.	11.3±0.97	12.4±1.08
Moisture (%)	87.7±6.57	91.1±8.62	90.8±8.18

Effect of different salinities on the production of rotifers

B. rubens attained the maximum density in 15 ppt salinity with 345 nos./ml followed by 297 nos./ml in 10 ppt, 206 nos/ml in 5 ppt, 160nos./ml in 20 ppt and 94 nos./ml in 25 ppt . In 0 ppt, *B. rubens* did not show increased production. In the case of *B.calyciflorus* higher density was recorded in lower salinities such as 0, 5 and 10 ppt. Maximum density of 363 nos./ml was observed when *B.calyciflorus* was maintained in fresh water condition (0 ppt) followed by 130 nos./ml in 5 ppt and 79 nos./ml in 10 ppt. In other salinities (15, 20 and 25 ppt), *B. calyciflorous* did not show any increase in density. The above study clearly stated that *B. rubens* and *B. calyciflorus* can grow in lower salinity ranges of 5 - 15 and 0-10 ppt respectively and they can be used as fish larval feed.

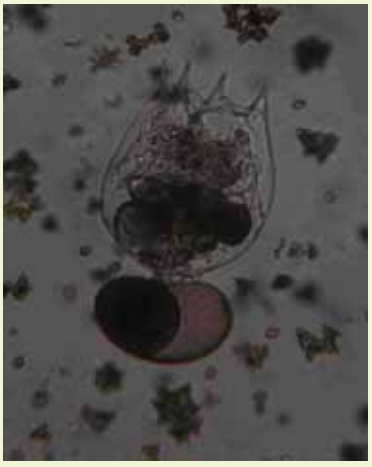
Performance of seabass larvae fed with *rotifers* under different salinity conditions

Taking advantage of the lower salinities required by *B. rubens* and *B. calyciflorus* an experiment was conducted to check if seabass larvae can be grown under low salinities. This could be of use in hatcheries during the monsoon period. The experiments indicated that seabass larvae can be also reared in low salinities by feeding with rotifer *B.rubens*. However, large volume of low saline water or fresh water is required in order to maintain *B.rubens* and larval rearing.

The seabass larvae can be also reared under low salinity ranging from 10 to 20 ppt. Very poor survival of 3.1% was recorded at 5 ppt indicating that eventhough the rotifer *B. calyciflorus* can survive in this salinity, the seabass larvae could not withstand low saline water. However, while seabass larvae were reared with *B.plicatilis* in different salinities of 15. 20, 25 and 30 ppt, the maximum mean total length of 5.12±0.8 mm and the mean survival rate of 41.6±2.36% could be observed at 25 ppt. The minimum mean total length of the larvae measured was 4.16±0.52 mm and the mean survival rate recorded was 18.6±1.26% at 15 ppt.

Production of rotifer cysts/resting eggs

Mass culture of green algae was carried out in 1.0 t capacity FRP tank and when the algal density reached the maximum (3-4 million cells/ml), rotifer species to be culture were inoculated separately @ 25 nos./ml. The rotifer attained density range of 400 - 450 nos./ml within seven days of culture. Sediments along with the resting eggs from the tanks were collected separately using 50 µm bolting net. Then, the sediment was treated with 150-200 ppt brine solution, screened through 50 µm bolting net and centrifuged @ 3000 rpm for 10 minutes. All the cysts floating on the surface in the centrifugal tubes were stored in dark condition at 4.0°C.



Rotifer with the resting egg

A batch of resting eggs

The maximum cyst size was found in *B rubens* with average egg diameter of 124.02 µm and yolk diameter of 75.92±2.37 µm. The egg size of *B. calyciflorus was* 114.64 µm with yolk diameter of 80.8±1.04 µm. Since the rotifer eggs have sufficient yolk content, they have adequate endogenous food resources during storage period.

Title of the project : **Development and demonstration of hatchery and culture technology for the banana shrimp, *Fenneropenaeus merguiensis* as an alternate species for shrimp aquaculture.**

Principal Investigator : Dr.S.M.Pillai

Location of the project : Chennai

Co-Investigators : Dr. P. Ravichandran, Dr. C. Gopal, Dr. C. P. Balasubramanian

A total of 120 pond reared (78 females and 42 males) and 27 wild (11 females and 16 males) banana shrimps *Fenneropenaeus merguiensis* were collected from Bilimora (Gujarat) and Puri (Orrisa) in May and October 2007, respectively. The pond reared shrimps from Gujarat were raised from the PL supplied by CIBA to the farmer, earlier under this project. In addition, the broodstock were also raised in indoor FRP tanks and outdoor RCC tanks.

Induced maturation, spawning and larval rearing

The broodstock shrimps were acclimatized to hatchery conditions before eyestalk ablation and held under photoperiods of 12 h light and 12 h darkness in the maturation room. The shrimps were fed @ 20% of shrimp biomass per day with fresh polychaete worms and clam meat in four installments daily (06.00, 12.00, 18.00, and 24.00 h) in 40%:60% day and night proportion. The gonadal development was assessed daily by observing the size and colour of the ovaries. The fully matured females with stage IV ovaries were selected and individually spawned in 200/500 l spawning tanks. The eggs were collected by siphoning, cleaned with filtered seawater, disinfected and then transferred in to hatching tanks. The details of maturation and seed production are presented in Table.28. The results indicated that wild broodstock performed better in terms of maturation and fertilization compared to the pond and tank reared shrimps. However, in the case of seed production, the tank reared shrimps fared better than the pond raised and wild broostock.

Table.28. Maturation and seed production of *F.merguiensis*

Source	Wild	Pond	Tank
Spawner size (g)	18	28	24
Maturity stage	IV	III / IV	III
Maturation (%)	98	80	95
Latency period (days)	3-5	10-21	5-8
Fertilization (%)	95-100	40-60	60-85
PL 20 (in lakhs)	1.5	4.0	5.0
Period	November-December	June-August	May-August

Domestication of *F. merguiensis*

Postlarvae produced from the hatchery reared F_0 broodstock were stocked in 5 t FRP tank for domestication. The shrimps were fed with clam meat, squid meat, polychaete worms and pellet feed. In 10 months of rearing, the shrimps have attained average weight of 16.4 g (Fig.37). Further rearing of the shrimps is in progress to raise them to 25 g for taking up breeding trails.

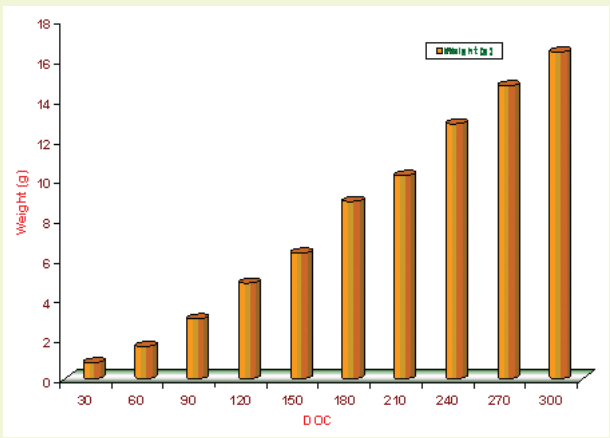


Fig.37. Growth of F. merguiensis (F_0)

Broodstock development

A 0.07 ha pond at Muttukadu was stocked with 8000 PL 26 of *F. merguiensis* to raise captive broodstock. The shrimps were fed with a commercial pellet feed. They attained average weight of 11 g in 90 days of culture.

Table.29. Growth of *F.merguiensis*

Tank	PL stage	Survival (%)	Initial weight (g)	Final weight (g)
1	52	42	0.57	3.20
2	40	74	0.41	2.12
3	37	71	0.32	1.59
4	63	76	0.61	2.61

In the second trial, 3000 PL 20 each were stocked in four 15 t RCC tanks to develop captive broodstock. In tanks 1,2,3, and 4, PL 52, PL 40, PL 37 and PL 63 were stocked and fed with clam meat and pellet feed. The growth and survival of *F. merguiensis* is shown in Table.29. While the survival was highest (76 %) in tank 4, the growth was better in tank 1.

Production of healthy seed using CIBASTIM

An experiment was conducted to produce healthy *F. merguiensis* seed using the shrimp immunostimulant CIBASTIM at concentrations of 0.05, 0.1, 0.5, and 1 ml/l. PL 20 were stocked @ 30 nos. each in 8.0 1 plastic containers in triplicate for each concentration and reared for 30 days. Although there was marginal difference in terms of growth and survival of shrimps treated with CIBASTIM @ 1ml/l compared to the control, the shrimps under the other three concentrations showed lesser growth and survival (Table.30.). Further trails are needed to understand the real potential of CIBASTIM to improve the health status of postlarvae.

Table.30. Performance of CIBASTIM treated postlarvae of *F.merguiensis*

Concentration (ml)	Initial weight (g)	Final weight (g)	Survival (%)
Control	0.12	1.30	64
0.05	0.20	0.72	62
0.10	0.27	0.83	59
0.50	0.13	0.91	63
1.00	0.11	1.26	72

Culture of *F. merguiensis* at different agro-climatic zones

Pond culture of *F. merguiensis* was done in Gujarat and West Bengal during monsoon season. In Gujarat, with higher density (17nos./m^2) the culture was continued for 189 days and the production achieved was only 413 kg. The final weight attained was 22.09g and the survival was also low (41.8%). In Kakdwip, the culture trials were done in two farmers' ponds @ 9 nos./m2. In 85 days of culture, the shrimps reached an average size of 16.8 g and 18.1 g with production of 756 kg/ha and 636 kg/ha, respectively (Table.31). The culture was terminated on the 85th day due to poisoning. The growth of the shrimps in this trial was very good indicating the potential of this species for culture during low saline period.

Table.31. Growth and production of *F.merguiensis* in different regions

Location	Pond size (ha)	Density (no./m^2)	DOC (days)	Final weight (g)	FCR	Production (kg/ha)
Gujarat	0.25	17	189	22.09	1:3.18	413
Kakdwip I	0.075	9	85	16.8	1:1.45	756
Kakdwip II	0.075	9	85	18.1	1:1.48	636

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 project was aimed to understand the causative factors involved in the 'loose shell syndrome'. Bioassay experiments and histopathological investigations carried out during the first two years indicated involvement of a filterable infectious agent. These indications were confirmed by further intensive bioassay, histopathological and electron microscopic studies. Histological sections of LSS affected shrimp showed increased space between the muscle and the exoskeletal layer compared to the healthy shrimp (Fig. 38), and in some sections, coagulated protein could also be observed. General musculature of LSS affected shrimp was dystrophied and haemocytic infiltration was also noticed between the muscle fibres (1c). Infectious nature of LSS was further confirmed by bioassay experiments with LSS infected tissues and purified agent. The lymphoid organ of LSS affected shrimps revealed constriction of lumen, diffused necrosis of the stroma with hypertrophied nuclei in the stromal matrix cells and separation of tubules.

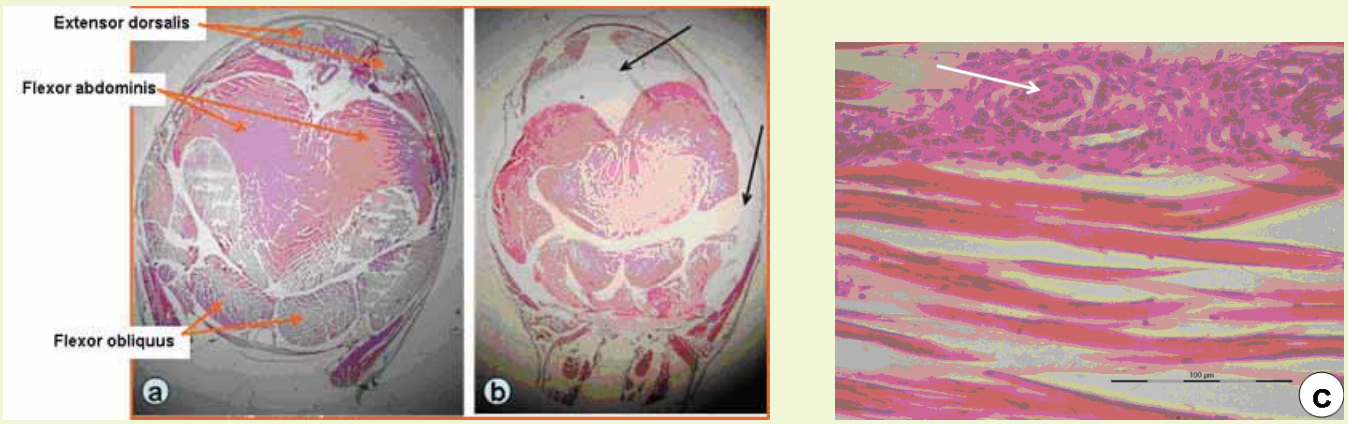


Fig. 38. Histological sections of (a) normal and (b) LSS affected shrimp showing space between the muscle and the exoskeletal layer, and (c) haemocytic infiltration within the musculature.

Title of the project : Development of low fish meal feeds for shrimp aquaculture

Principal Investigator : Dr.J.Syama Dayal

Location of the project : Chennai

Co-Investigators : Dr.S.A.Ali, Dr.P.Ravichandran, Dr.Ambasankar

Utilization of gluten meals in shrimp feed

Incorporation of plant protein in formulated shrimp feeds would reduce considerably the dependance on fish meal and thereby the feed cost. Feeding trials in yard experiments on tiger shrimp showed that maize gluten can be incorporated at 10% level and wheat gluten at 15% level individually in place of fishmeal without compromising the growth and FCR.

Nutrient utilization of promising oil cakes in combination

Testing of plant protein sources at various combinations would help in balancing amino acid profiles by complementing each other. The following three combinations of oil cakes tested in separate feeding trials for 45 days indicated that all three combinations can be included up to 7.5% in shrimp diets by replacing the fish meal. with i). Groundnut cake : Soya: Sunflower flower cake in 1: 2: 1 ratio, ii). Groundnut cake: Soya: Cotton Seed cake in 1: 2: 1 ratio and, iii). Gingelly: Soya: Copra in 1: 2: 1 ratio.

Crystalline amino acid supplementation

The steep increase in fish meal prices necessitate replacement of fish meal with plant protein sources and balancing essential amino acids for better utilization of feed by shrimp. The most limiting essential amino acids, lysine and methionine were incorporated in low fish meal shrimp feed individually and in combination and were tested in juveniles tiger shrimp, *Penaeus monodon*. Weight gain was significantly ($P< 0.05$) highest (218.14 ± 1.804%) in control feed compared to low fish meal feeds irrespective of amino acid supplementation. Significantly ($P< 0.05$) higher weight gain (194.27 ± 5.62%) was observed in shrimp fed with low fish meal feeds along with combination of lysine and methionine compared to low fish meal feed without any amino acid supplementation (178.69 ± 3.38%) (Table. 32). However, no significant differences were observed in shrimp fed with amino acids individually or in combination and as well as FCR and survival in all the treatments

Table.32. Growth of *P. monodon* fed with amino acid supplemented diets

Treatments	Weight gain %	FCR	Survival %
Control	218.14a ± 1.804	1.98 ± 0.026	82.22 ± 2.22
Low fish meal	178.69b ± 3.38	2.25 ± 0.026	75.55 ± 11.11
Low fish meal + Lysine	184.71bd ± 5.07	2.21 ± 0.051	93.33 ± 3.85
Low fish meal + Methionine	187.33bd ± 4.739	2.22 ± 0.95	93.33 ± 3.85
Low fish meal + Lysine + Methionine	194.27cd ± 5.62	2.23 ± 0.127	97.78 ± 2.22

Nutrient value of ingredients

Knowledge of the digestibility of the ingredients of a diet, as well as of the whole diet will help to understand the acceptance of the same by shrimp. A digestibility study as suggested by Cho *et al.,* (1982) and modified by Bautista-Teruel *et al.,* (2003) was conducted in juveniles *P. monodon* weighing 2.3 g. The better apparent dry matter digestibility (ADMD) was observed in soy bean cake followed by coconut cake, mustard cake, Groundnut cake, cotton seed cake and sunflower cake. The least digestible are palm kernal cake (PKC) and silk cotton cake (Fig.39). The apparent protein digestibility (APD) has also followed the same trend.

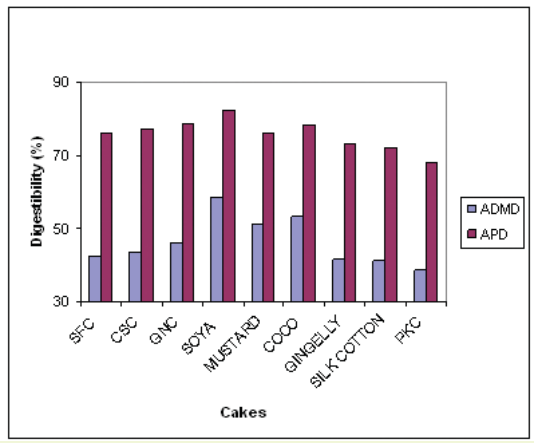


Fig.39. Digestibility of different oil cakes in *P.monodon*

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

Primary data were collected by using modified questionnaire covering additional 806 farms all over the coastal states of India. Diseased shrimp samples were collected for screening and identification of associated human pathogen (bacteria), if any, from harvested shrimps in Tamil Nadu and Andhra Pradesh. Single colonies were obtained through passage technique and DNA was extracted for 16s r RNA amplification using FD1 and RP2 primers from this single colony of bacterial isolates (Table. 33). The shrimps infected with Loose Shell (LSS) and WSSV as well as the uninfected shrimps collected from various shrimp farms were stored at -20°C to evaluate their keeping quality and the study is in progress.

A case study was conducted with the collected data from 336 farms in Andhra Pradesh (AP) and Tamil Nadu (TN), to determine the predictors of LSS in shrimp aquaculture. Data on farm characteristics and culture management practices were taken into consideration for analysis. To identify best independent predictors, initially all variables were subjected to univariate logistic regression analysis. All variables with chi-squared p-value <0.25 were included in the multivariate regression analysis. Step-wise backward logistic regression with model removal set at $p = 0.15$ and model entry set at $p = 0.05$ was carried out with final model refinement. Significant predictors were state, experience, type of farming, water spread area, stocking rate, chlorinated reservoir , amount of chlorine, pollution and days of culture. Among these most significant predictors were stocking rate >12/m^2 followed by absence of chlorinated reservoir and presence of organic pollution.

Table. 33. Bacteria Identified by 16s r RNA typing

S.No	Submitted Bacterial Name	NCBI Accession Number	% of simil-arity	Similar bacterial names in Gene Bank
1	*Klebsiella sp*	EU518399	92	*Klebsiella pneumoniae* 16S rRNA gene, strain ATCC13883T
2	*Acinetobacter johnsonii*	EU518400	97	*Acinetobacter johnsonii* (strain ATCC 17909T)
3	*Vibrio mimicus*	EU518401	97	*V. mimicus* (ATCC 33653T)
4	*Pseudomonas sp*	EU518402	95	*Pseudomonas sp*
5	*Exiguobacterium sp*	EU518403	73	*Exiguobacterium sp*
6	*Klebsiella sp*	EU518404	91	*Klebsiella pneumoniae sub sp. pneumoniae* MGH 78578
7	*Planococcus sp*	EU518405	90	*Planococcus rifietoensis*
8	*Staplylococcus sp*	EU518406	88	*Staphylococcus nepalensis*
9	*Bacillus sp*	EU518407	87	*Bacillus fusiformis*
10	*Shewanella sp*	EU518408	95	*Shewanella amazonensis*
11	*Salinococcus roseus*	EU518409	98	*Salinicoccus roseus* 16S ribosomal RNA gene
12	*Bacillus sp*	EU531803	91	*Bacillus sp*
13	*Vibrio sp*	EU531804	96	*Vibrio alginolyticus* strain YJ06167B 16S ribosomal
14	*Pseudomonas pseudoalcaligenes*	EU531805	97	*Pseudomonas pseudoalcaligenes*
15	*Pseudomonas stutzeri*	EU531806	97	*Uncultured Pseudomonas sp.*
16	*Microbacterium oxydans*	EU531807	96	*Microbacterium oxydans* strain 448
17	*Klebsiella sp*	EU531808	96	*Klebsiella pneumoniae* 16S ribosomal RNA gene
18	*Bacillus boroniphilus*	EU531809	96	*Bacillus boroniphilus* gene for 16S rRNA
19	*Bacillus sp.*	EU531810	95	*Bacillus sp.* R-25542 partial 16S rRNA gene,
20	*Bacillus sp.*	EU531811	98	*Bacillus sp.* FE-1 16S ribosomal RNA gene,

The national (excluding Kerala) economic loss due to diseases in 2006 (provisional estimates from production sector only) is given below:

Loss in production =14,600 t of shrimp per year approx 10 % in total ~1.43 lakh t
Loss in income = Rs. 486.62 crores per year (US $ 122 million)
Loss of employment = 3.2 million man days per year

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 aimed to build a stock of luminescent bacteria (LB), characterize them and develop methods to differentiate pathogenic and non-pathogenic strains. Three commercial shrimp hatcheries were closely monitored for the occurrence of luminescent bacterial disease (LBD) and LB were routinely isolated from various sources within the hatchery. A total of 395 cultures of *Vibrio harveyi* have been characterized during the year using

morphological, physiological and biochemical traits. 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 differentiation. Phylogenetic analysis carried out based on degenerate primed PCR revealed occurrence of 13 major clusters at 30% hierarchical level. 395 isolates of *V. harveyi* were subjected to phage typing using 76 bacteriophages. Data of phage typing of 247 isolates were analysed using Phylip phylogeny inference package. The analysis revealed 39 clusters at 80% hierarchical level. 395 isolates of *V. harveyi* were serotyped using 10 polyclonal antisera raised in rabbits. Serotyping had indicated occurrence of cross-reacting antibodies on the luminescent bacteria and these difficulties are to be sorted out. Thirteen isolates of *V. harveyi* were screened for the presence of bacteriophage *V. harveyi* myovirus like bacteriophage (VHML), which has been reported to be responsible for the virulence. However, VHML could not be detected in any isolates, including those recovered from Luminescent bacterial disease episodes.

DEPARTMENT OF BIOTECHNOLOGY (DBT) PROJECTS

Title of the project : **Functional genomics of *P. monodon* and *P. indicus* in relation to microbial infection and environmental stress**

Principal Investigator : Dr.T.C.Santiago

Location of the project : Chennai

CDNA Library construction to generatae ESTs for shrimp genomic studies

Invitrogen cDNA cloning kit was used to construct cDNA library from *P. monodon* and *F. indicus*. A total of 5 µg mRNA was taken as a starting material in both species for the construction of cDNA library. Positive white colonies were identified from a single transformation reaction into electrocompetent DH10B *E. coli* cells while doing the blue- white screening.

Screening for cDNA clones

Colonies were screened using colony PCR with T7 Reverse primer and SP6 Forward primer (Figs.40 & 41). Clones were confirmed to contain cDNA inserts of size ranging from 400 bp- 4 kb.

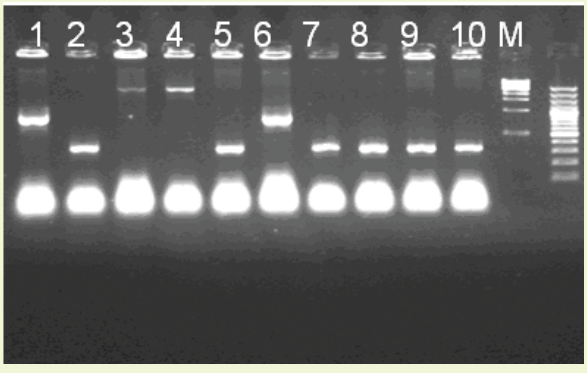


Fig. 40. Lane1-10: clones amplified by sp6 and T7 promoter primers, Lane11-12: Marker

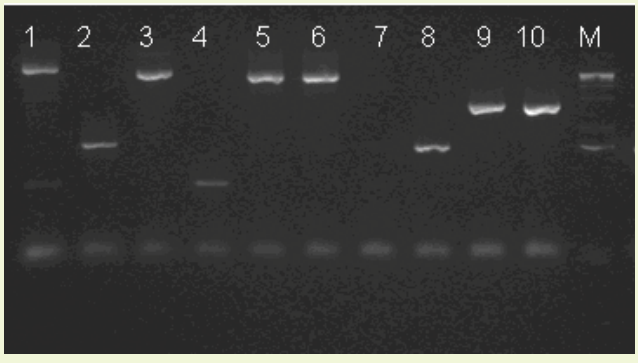


Fig. 41. Lane1-10: clones amplified with T7 and sp6 primers, Lane11: Marker

Submission of ESTs in NCBI data base

Clones were sequenced at M/s Banglore Genei and the obtained sequences were deposited in NCBI as EST data base. Total of 120 ESTs were submitted till date in dbEST out of which some ESTs accession numbers are given below:

Accession No: FE002722 -E002724,FE002725 -E002733, FE274831 -E274838

FG342006- FG342067

Blast Analysis

Blast analysis of some of the submitted sequences showed the homology with some of the enzymes which play key role in shrimp metabolism such as : Oxy glutarate dehydrogenase, GAP Associated protein, DNA Transposition protein, Aryl phosphatase and Protein kinase.

Cloning and expression of PmAv from *P.monodon* and *F.indicus*

Pm Av, the gene responsible for antiviral property in *P.monodon* was cloned in both the species and expressed in T7 promoter expression system. A total of 5 µg of total RNA was taken as a starting material for the amplification of PmAv gene with PmAv specific primers.

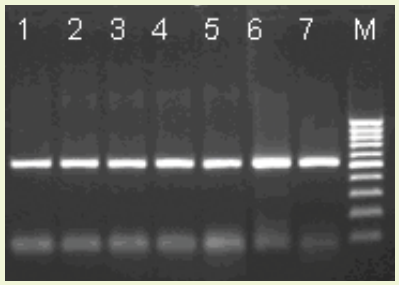


Fig.42. PmAV amplification
(Lane 1-4 *P.monodon;*
Lane5-7 *F.indicus;*
Lane 8 Marker)

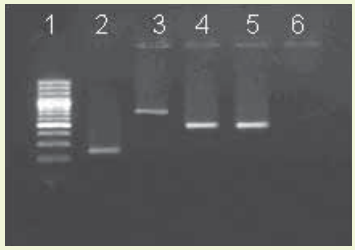


Fig.43. Clone confirmation
(Lane1: Marker
Lane2:pRSETA with vector specific primers
Lane3:clone amplified with vector specific primers
Lane4:Pmonodon amplified with gene specific primers
Lane5:F.indicus amplified with gene specific primers
Lane6:Negative Control)

Amplified product was ligated with EcoR1/BamH1 digested prset A and transformed into Ecoli DH5α competent cells (Fig 42). Colonies obtained were screened for the presence of PmAv gene and confirmed by gene specific PmAv primers, vector specific T7 forward and T7 reverse primers (Fig. 43).PmAv gene was then transformed into BL21DE3 for expression. Recombinant PmAv was induced with IPTG for the expression which is in progress.

Amplification of antimicrobial peptides

Penaedin gene was amplified from *P.monodon* (Fig. 44) cloning and expression studies are yet to be done.

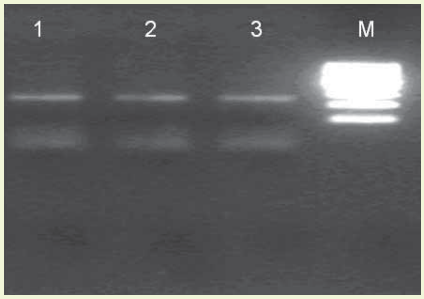


Fig. 44. Lane1-3: Penaedin gene amplification
Lane4:Marker

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

Location of the project : Chennai

Co-Investigators : Dr. M.S.Shekhar, Dr.M.Poornima (CIBA, Chennai)

The project was initiated in October 2007 with an objective to isolate, characterize and develop diagnostic kit (s) for viral nervous necrosis (VNN) which has been reported in fin fishes from almost all the aquaculture countries in Southeast Asia causing high mortalities in hatcheries and/or farms. It aims at providing a tool to control the spread of the pathogen by selecting viral free broodstock for hatcheries and disease free larvae / juveniles for farming. An RT-PCR based VNN detection system targeting the T4 region of the viral coat protein gene is standardized using published primers producing 426 bp amplicons and nested PCRs producing 294 and 280 bp amplicons separately for screening the fish (Fig. 45). The optimization of primers, reaction protocols, annealing temperature etc., were carried out using touchdown thermocycler. Using this optimized protocol, 53 samples (35 samples from wild and 18 samples from hatchery) from 10 different species were screened to find 12 positive samples (4 samples of *Lates calcarifer* from hatchery, 5 samples of *Mugil cephalus,* 1 sample, each of *Thrissocles dussumieri, Leiognathus splendens* and *Upeneus sulphureus* from wild). The RT-PCR confirmed positive samples were further inoculated into SIGE cell lines but it could not develop any CPE even after a prolonged maintenance for over 20 days.

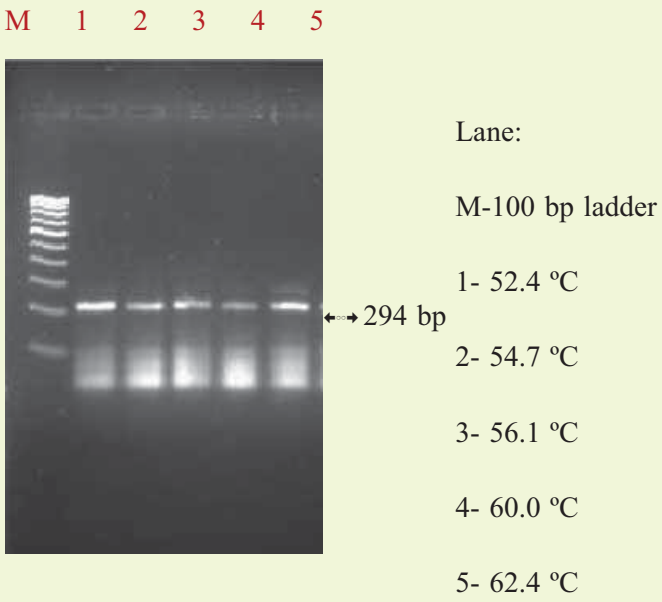


Fig.45. Optimization of annealing temperature in PCR protocol

Screening of *L. calcarifer* and *M. cephalus* (n = 41) for VNN infection revealed 14.6% cases positive by RT-PCR, hypothetically a source for culture site. This is the first report of natural occurrence of VNN in marine/brackishwater fishes in wild populations in India.

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. Syama Dayal

The main objective of the project is to test the presence of fibrolytic enzyme activity, its ontogeny and diurnal variations in the gut of the shrimp *P.monodon* and to determine optimal inclusion level of various fibrolytic/NSP degrading enzymes for improving the nutritive value of fibre/NSP rich feed ingredient and to assess the cost benefit ratio of enzyme supplementation. The substrate specific enzyme mixtures developed from this project will result in improving the digestibility, feed conversion efficiency, reducing feed related waste generation and thereby make shrimp feeds eco-friendly. Three different life stages of the shrimp, *viz.,* PL10, PL20 and juveniles (10g) were used for estimating the fibrolytic enzyme activity. The whole body homogenate was used for estimation of enzyme activity in PL10 and PL20 and in the juvenile shrimp enzyme activity was studied in hepatopancreas. Enzyme activity was assessed by dinitro salicylic acid reducing sugar method. The results of the enzyme activity studies are presented in (Table. 34).

Table .34 Fibrolytic enzyme activity postlarvae and juveniles of *P.monodon*

S.No	Fibrolytic enzyme	Maximum activity (IU/g) (Mean ± SD)		
		PL 10	PL 20	Juvenile (10g)
1	Cellulase	55.83± 2.16 at 30 minutes	27.51 ± 1.40 at 120 minutes	76.42±3.46 at 30 minutes
2	Xylanase	24.48± 1.27 at 30 minutes	14.73± 0.96 at 120 minutes	55.44±2.47 at 30 minutes
3	Pectinase	27.9± 1.21 at 30 minutes	4.19± 0.51 at 120 minutes	20.72±1.02 at 30 minutes
4	Chitinase	0.36± 0.04 at 90 minutes	1.62± 0.18 at 90 minutes	3.96±0.23 at 30 minutes

* Mean of three observations

The maximum activity of cellulase, xylanase, pectinase and chitinase was observed at 30 minutes of incubation in the juvenile shrimp and after that the activity showed a declining trend. Maximum activity for cellulase, xylanase and pectinase for PL10 was observed at 30 minutes and for PL 20 at 120 minutes while chitinase activity showed the same for both PL10 and PL20 at 90 minutes.

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*.

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

Location of the project : Chennai

Characterization of vitellogenesis using molecular and immunological tools

Basic knowledge on vitellogenic cycle of shrimp is critical to develop an effective management intervention for commercial penaeid hatchery operation. In order to understand the molecular and physiological mechanism that control reproduction, an in depth knowledge on various reproductive hormones and other reproductive proteins and their interaction is imperative. Developing oocytes of oviparous animals accumulate large amount of extra ovarian protein, vitellogenin (vg), during female gametogenenetic cycle. Because of their higher abundance in the oocytes and relative ease of purification, these proteins are considered to be excellent molecules to understand the physiology of shrimp reproduction. This study, therefore, focuses to characterize the vitellogenin/vitellin of *P. monodon* particularly at molecular and protein level

Partial amplification and sequencing of vitellogenin

To obtain Vg cDNA fragment of *P. monodon* containing coding region of Vg, polymerase chain reaction (PCR) was applied using primers designed based on the published sequences of Vg *P. monodon* (DQ 288843) (F:5' CAGAGCAACATTTGGCAAGA. R: TTCTTGATGGCAGCAGTCAC). The primers are designed to 905 bp regions of published Vg of *P. monodon*. The expected fragment was purified and sequenced a 495 bp sequence corresponding to 118 amino acid sequence was obtained. In the comparison of resulting *P. monodon* Vg sequence with those of reported *P.monodon* (Q 21691) the amino acid sequence exhibited 117/118 (99%) sequence identity. Whereas with *P. semisulcatus* (Q8WQT2), *Fenneropenaeus chinensis* (A1XFT3) and *F. merguiensis* (Q6RGO2) 94% identity has been observed (Fig. 46).

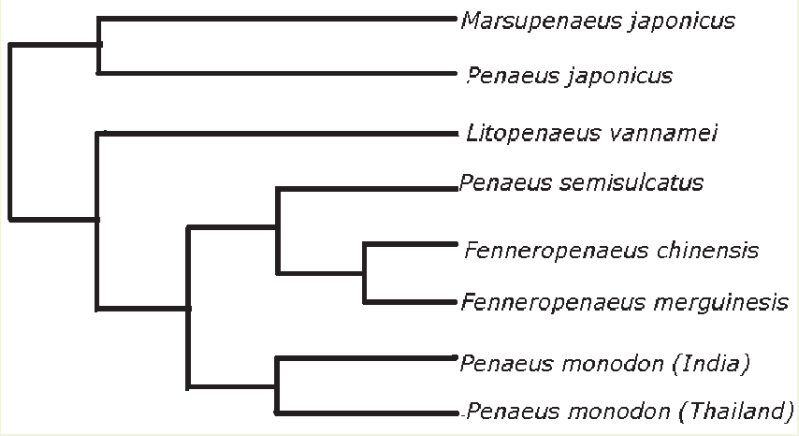
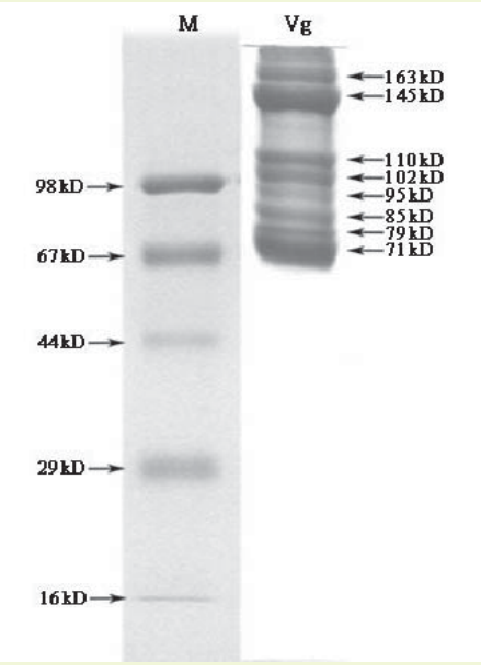


Fig. 46. Phylogenetic tree obtained by aminoacid sequence comparison of Vg of different penaeid shrimps with neighborhood-joining method

Vitellin purification and characterization



Vitellin was isolated from the excised ovarian tissue through differential centrifugation and purified from other protein by precipitation with increasing concentration of saturated ammonium sulfate (SAS). Purified Vn preparation was collected and analyzed by SDS PAGE and found that the ovarian protein was composed of 8 major polypeptides (Fig. 47.)

In this study, a partial cDNA of Vg gene and yolk protein, vitellin, were characterized. These works are the first step to understand the dynamics of expression of vitellogenin/ vitellin at molecular and protein levels during the vitellogenic cycle of *P. monodon.*

Fig. 47. SDS-PAGE analysis of *Penaeus monodon*: Under denaturing conditions (7.5% polyacrylamide) vitellin resolved as 8 subunits.

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 of gut microbial flora of brackishwater fishes

Four brackishwater fish species *Lates calcarifer, Mugil cephalus, Chanos chanos* and *Etroplus suratensis* were collected from wild and kept under starved condition for 48 h. The digestive tract from each species was homogenized and the supernatant was serially diluted with normal saline solution. The TSA, CMC and SA plates were inoculated with 100 µl of all the serial dilutions separately in triplicate and incubated for 48 h at 34 ºC.

The colony number and characteristics were observed in all the petri-dishes individually and total viable plate count were 60.19 X 105 , 4.22 X 105, 7.72 X 105, and 0.64 X 105 , CFUg-1 of digestive tract in *L. calcarifer, M. cephalus, C. chanos* and *E. suratensis,* respectively.

The cellulolytic bacterial counts were 0.22 X 103 , 14.45 X 103, 15.47 X 103 and 25.33 X 103 CFUg-1 and the amylolytic bacterial counts were 2.68 X 103, 7.40 X 103, 51.66 X 103, 22.09 X 103 CFUg-1 of digestive tracts of *L. calcarifer, M. cephalus, C. chanos* and *E. suratensis* respectively.

Amylolytic flora indicated maximum plate counts from the gut of *C. chanos* followed by *E. suratensis, M. cephalus* and *L. calcarifer.* Maximum density of cellulolytic bacterial flora was observed in *E. suratensis* followed by C. chanos, *M. cephalus* and *L. calcarifer.*

The single colonies were selected on the basis of their morphological characteristics from each petri dishes and again each type of colonies were inoculated on the separate specific media plates and incubated for 48 h at 34 ºC. After 48 h incubation, pure single colony from each plate were inoculated in specific media slant to obtain the pure culture of each type of bacterium. The tubes were then incubated for 24 h at 34 ºC. The bacterial smears from each of the slant were subjected to Gram staining for knowing their staining characteristics.

Eight types of gram positive colonies were found in gut of *L. calcarifer,* four types in *M. cephalus,* five types in *C. chanos* and only one type in *E. suratensis.* 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).

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.Balasubramanium, Dr.S.Kannappan and Dr.K.Ambasankar

Awareness creation

About 200 target groups have been identified, containing coastal women SHGs from Thonirevu, Light House Kuppam, Kattur villages in Thiruvallur District and Edaikalanadu, Kadapakkam villages in Kancheepuram District for the technology dissemination *viz.,* crab fattening, crab feed development and value added fish food products development. Two awareness meetings were held on 18. 8. 2007 and 30.8.2007 at Thonirevu and Alambaraikuppam villages, respectively and about 100 women beneficiaries participated in the meeting.

Survey and data collection

A baseline survey and Socio Economic and Gender Analysis (SEAGA) exercise were conducted at Thonireu village, Pulicat in Tiruvallur District to elucidate data from the beneficiaries of the project. 100 women beneficiaries from the selected Women Self Help Groups of Thonireu, Light House Kuppam, Pulicat, and Kattur villages of Tiruvallur District, participated in this exercise. The collected data were depicted under village and resource maps, seasonal calendar, fish availability and livelihood analysis, motivating and facilitating factors, time management, decision making practices among the respondents, stakeholders priorities and problems, ranking institution according to their perceived importance, attitude about women Self Help Groups, opinion on extension methods and materials and problems encountered.

SEAGA Exercise

Eco-tour

To motivate the beneficiaries of the project by showing success stories, an 'Eco-tour' was arranged for the coastal women Self Help Groups of Thiruvallur district, on 'crab fattening in pens' at Kancheepuram district, Tamil Nadu on 19.3.08.

Training and demonstration

A training and demonstration programme on selected brackishwater aquaculture technologies for 200 women Self Help Group beneficiaries was organized, during 10–17 December 2007 covering the technologies of crab fattening, crab feed development and value added fish food products development at Muttukadu, Kadapakkam and Kattur.

Demonstration of crab fattening among women SHG$_s$

Two demonstration programmes on 'Crab fattening and Crab feed technology' were organized between 15–19 March 2008 at Thonireu, Kattur villages in Thiruvallur district and Kadapakkam village in Kancheepuram district.

NETWORK Projects

Title of the project : ICAR 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 lakh and 10 lakh, respectively. The infrastructure for both shrimp and seabass seed production including procurement of equipments and machineries were completed.

As against the 2007-08 target of 20 lakh PL 20 of shrimps, 15.33 lakh seed were produced, comprising 3.17 lakh *P. monodon* and 12.16 lakh *F. merguiensis*. Out of the target of 5 lakh seabass fry, 12.7 lakh fry were produced.

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

Coordinating Centre : NAARM, Hyderabad
Principal Investigator : Dr. T.Ravisankar

Location of the project : Chennai

This network project was started in August 2005 with the major objective to assess the impact of research investments made in fisheries research in India. CIBA was involved in primary data collection from shrimp farmers, who were selected as per commonly agreed sampling frame. Accordingly, 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. Thanjavur and Nagapattinam districts of Tamil Nadu and East Godavari and West Godavari districts of Andhra Pradesh, Ernakulam and Alapuzha districts of Kerala and North 24 Parganas and South 24 Parganas districts of West Bengal were selected. The survey work was completed in November 2007. Salient findings of the work done were the following.

- Average yield obtained in traditional shrimp farms was only about 25 - 35 % under scientific farming systems in Kerala, West Bengal, Tamil Nadu and Andhra Pradesh.

- Though yields were higher in modern scientific farms, the number of crop failures were also high.
- The farms observed a holiday of 10 to 120 days between two crops. While the time gap was less in Kerala due to paddy-cum fish rotation as determined by characteristics of monsoon season. In Tamil Nadu, brake between crops extended from 60 to 120 days, depending upon the disease problems faced during the preceding crop.
- More than disease risks, loss of realization of profits was the major problem faced by the farmers. Slump in farm gate prices resulted due to low demand and wild fluctuations in dollar-rupee exchange rates.

In conclusion, the scientific shrimp farming system developed and demonstrated by research system has made the sector's competence higher by three to six times for increased yields, but at the same time vulnerability to disease incidences have almost doubled. Hence the research system should focus on disease surveillance and monitoring, forewarning and control systems to make the farm output more stable. Policy initiatives are needed to safeguard farmers from monetary losses due to market risks. Research priorities should be set in consonance with market dynamics of species preference and willingness to pay by domestic and international consumers.

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

Principal Investigator : Dr.T.C.Santiago

Location of the project : Chennai

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

Microbial diversity analysis from different brackishwater system of east coast of India

Sample collection

Samples were collected from various brackishwater ecosystems along the east coast and processed for microbiological analysis. The details of sampling are given in the Table 35. A total of 102 bacteria, 35 Actinomyctes and 31 fungi and yeast have been isolated and purified. The isolates are stored for further characterization and to study genes of economic importance like salt tolerance, antibiotic genes, enzymes production *viz.,* protease, amylase, lipase, cellulase, chitinase, agarase, xylanase and ligninase.

Geographical location	Type of ecosystem	Type of sample	Bacteria	Actinomyctes	Fungi and Yeast
Mullampadi	Creek	Water and soil	25	8	6
Diamond harbour	Backwater		30	9	7
Kakdwip	Mangrove		28	6	8
Nellore	Chinna Kateapalli Creek		19	12	10

Table. 35. Microbial diversity analysis from different sources

Isolation and characterisation of agarase producing organisms

All the samples collected were spread and pour plated on Zobell marine agar for screening of agarase producing microorganisms. The agarase enzyme production was initially screened by colonies showing depression in 48 h of

incubation at 37°C. Bacterial DNA was PCR amplified with 16S rRNA gene primers and the amplified products were sequenced (Fig.48). The 16S rRNA gene sequences were deposited in Genebank. Sequences were blast analysed using the NCBI blast site and the maximum identical species are given in the (Table. 36).

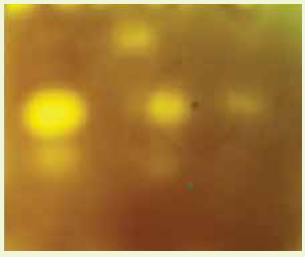
Table 36. Isolation and characterisation of agarase producing organisms

Isolates	Agarolytic species	Acession number	Isolates	Agarolytic species	Acession number
AG1	Vibrio hepatarius	EU529831	AG7	Marinimicrobium koreense	EU529835
AG2	Alteromonas macleodii	EU529839	AG8	Vibrio fortis	EU529836
AG3	Vibrio fortis	EU529832	AG9	Vibrio hepatarius	EU529837
AG4	Vibrio hepatarius	EU529833	AG10	Photobacterium rosenbergii	EU529838
AG5	Vibrio hepatarius	EU529834	AG11	Alteromonas hispanica	EU529840

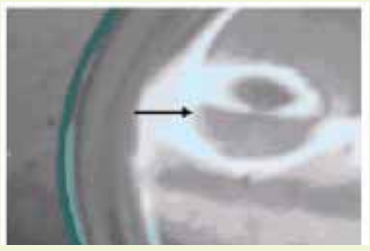
Isolation of enzyme and Zymogram analysis have been carried out using standard protocols. The results revealed high prevalence and diversity of agarolytic bacteria from the aquaculture settings, estuarine and coastal regions of south east coast of India. This study focused the presence of *Vibrio* species such as *V. hepatarius, V. fortis* and other bacterial species like *Photobacterium rosenbergii, Alteromonas macleodii* and *A.hispanica* which have not been associated with the agarolytic properties so far (Fig.49a,b,&c). This is the first report on the presence of these bacterial species in the south east coastal regions of India.

Fig. 48. Idenfication of agarase producing microbes using 16SrRNA

49.a



49.b



49.c

Fig. 49. a,b&c Agarase producing bacteria

Molecular identification and genotype diversity of *Vibrio harveyi* isolates

A total of 21 isolates of *Vibrio harveyi* have been isolated from different brackishwater system of east coast of India. All the isolates were identified using *V. harveyi* specific 16S rRNA gene primer and biochemical methods. ERIC and Box PCR was performed for all the 21 isolate. Antimicrobial susceptibility was performed by disk diffusion test according to the standard method. The results of the present study revealed high prevalence and diversity of *V. harveyi* from the aquaculture systems, estuary and coastal regions of south east coast of India (Fig.50). This is the first report to use ERIC and BOX primers for studying the diversity of these bacterial species in the coastal regions of India. The report shows high degree of variation among *V. harveyi* isolates.

Fig . 50. Identification of *Vibrio* Isolates using *Vibrio* specific 16SrRNA

16S rRNA based molecular identification of bacterial isolates

Amplification of 16S rRNA gene of marine bacterial isolates using universal primer has been carried out. A total of 36 isolates of bacteria have been sequenced and have been submitted in the GenBank. 16 sequences have been published and accession numbers have been received (Table. 37).

Table 37. recA gene as an alternative phylogenetic marker for identification of Vibrionaceae

1	*Vibrio hepatarius*	2	*Vibrio hepatarius*	3	*Halomonas salina*
4	*Alteromonas macleodii*	5	*Photobacterium rosenbergii*	6	*Halomonas salina*
7	*Vibrio fortis*	8	*Alteromonas hispanica*	9	*Vibrio hepatarius*
10	*Vibrio hepatarius*	11	*Enterobacter cloacae*	12	*Enterobacter cloacae*
13	*Vibrio hepatarius*	14	*Enterobacter cloacae*	15	*Bacillus sp*
16	*Marinimicrobium koreense*	17	*Bacillus spp*	18	*Bacillus sp*
19	*Vibrio fortis*	20	*Bacillus jeotgali*	21	*Vibrio campbellii*
22	*Sphingomonas sp*	23	*Halomonas salina*	24	*Vibrio campbellii*
25	*Halorubrum saccharovoru*	26	*Shewanella algae*	27	*Bacillus sp*
28	*Haloferax sp*	29	*Pseudomonas beteli*	30	*Bacillus sp*
31	*Halomonas salina*	32	*Staphylococcus aureus*	33	*Salmonella paratyphi*
34	*Shigella flexeneri*	35	*Salmonella typhi*	36	*Virgibacillus dokdone*

Amplification of recA gene of marine vibrio isolates using primers targeting recA gene has been carried out. A large fragment of the recA was amplified using specific primers. The product can be sequenced and used for identification of vibrio isolates

Isolation and molecular identification of *Salmonella* isolates

Amplification of invA gene has been carried out for the identification of *Salmonella* isolates from backwater water. A total of 20 *Salmonella sp* have been isolated and stored for further studies.

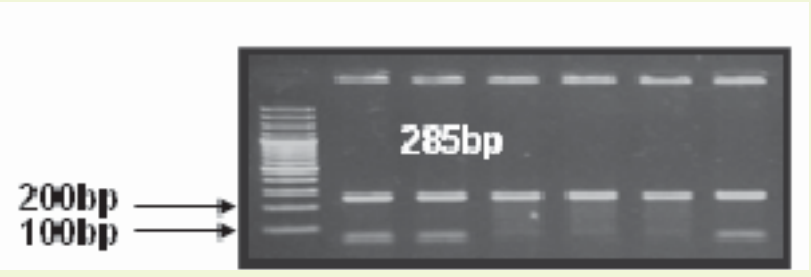


Fig . 51. Amplication of invA gene in *Salmonella* isolates

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

Principal Investigator : Dr.S.V.Alavandi

Location of the project : Chennai

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

Bioremediation of effluents from shrimp farms

Among a pool of 240 isolates recovered from various brackishwater samples, 150 isolates showed the nitrification activity, and among them 22 efficient strains were short listed based on oxidation of ammonia, nitrite, hydroxylamine and aerobic denitrification properties and overall efficiency, for further analysis. Some were found to have aerobic denitrification activity and utilized organic and inorganic nitrogen. Out of 22 strains, 16 were identified based on the 16S rRNA gene sequence analysis. These 16 strains have been submitted to NBAIM Culture Collection in February 2008 and the 16S rDNA sequence data have been submitted to GenBank. The heterotrophic nitrifying bacteria were identified to belong to the various phylotypes such as *Rhodococcus sp, Kytococcus sp, Virgibacillus sp, Agromyces sp, Alcaligenes sp, Bacillus spp, Micrococcus sp,* and *Pseudomonas spp.* MPN tests were carried out for determining the heterotrophic bacterial numbers using standard methods and the MPN index/100ml was also determined.

Among the pool of chemolithotrophic ammonia oxidizing bacteria isolated during the previous years, scale-up of two efficient cultures, one each of ammonia oxidizing bacteria and nitrite oxidizing bacteria are being carried out over a period of nine months by batch cultivation methods for use in laboratory scale bioreactor studies.

Nine Chemolithotrophic nitrite oxidizing bacteria were isolated and identified to belong to the genera *Nitrococcus* and *Nitrobacter* by physiological and microscopic studies. *Nitrobacter* spp were confirmed by PCR.

NFDB funded project

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

Principal Investigator : Dr. T.Ravisankar

Location of the project : Chennai

Co-Investigators : Dr.M.Krishnan and Dr.M.Kumaran

This network project was started in January 2008 with the major objective to assess market opportunities for fisheries sector in India. The structure, conduct, performance and expansion over the years of four Chennai city fish markets (Kasimedu, Moolakothalam, Chindadripet and Saidapet) were studied and documented. Successful innovative marketing models, in the region of Tamil Nadu and Andhra Pradesh were also studied. Producers' responses on these innovative marketing arrangements were recorded and the factors for their success were analyzed.

Market structure, performance and conduct

Chennai city extends to a sprawling 180 km^2 area and it is 350 years old. One seventh of Tamil Nadu population *i.e.,* about 70 lakh people live in Chennai city and its suburbs and it also feeds a visiting population about 5 to 10 lakh people every day. Chennai offers a good scope for expanding domestic marketing of fish with large population with sufficient personal income to spend on fish. It has presently five major wholesale cum retail fish markets and 150 medium and small sized neighbourhood fish markets. Chennai wholesale fish markets sourced fish from across the country's major fish markets like Howrah and Calicut. Either specific varieties of fish arrives regularly and/ or seasonally filling the demand supply gap for the particular fish variety arising due to ban on fish capture from the seas of east coast. 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 spread across the city. These stores source their fish from fish farms of Andhra Pradesh, Tamil Nadu and capture fish landing centres from Tamil Nadu, Andhra Pradesh and Kerala.

Case studies on innovative marketing arrangements

1. Collective marketing tie-up with traders in Tamil Nadu

Involvement of farmers association in shrimp marketing in Thambikottai Keelakkadu shrimp cluster in Tiruvarur district of Tamil Nadu was studied. During disease occurrence occasions the association assured the affected farmers in-writing that they will be compensated to the maximum possible extent. The bleaching cost was totally borne by the association. Till date a sum of Rs.20 lakh was paid as compensation to 20 ponds @ one lakh per pond last year in this cluster. The association invite quotations from buyers for negotiating with them to fix a price for the shrimp produced in the cluster. However, the price was not binding on the members. Whomsoever be the buyer a 'stamped agreement' was signed and given to the association by the farmers who are selling their produce to that buyer that a sum of agreed amount per kg of shrimp sold should be detected at buyers office for the association fund to compensate the affected farmers and for managing the common resources. Such detected amount was deposited in the bank as three member joint account to ensure safety and also for arriving at unanimous decisions.

2. Marketing of the cultured shrimp at the farmers' association premises in Andhra Pradesh

Tungutur Aqua Farmers Association (TAFA) was formed in the year 2004 by the farmers operating in the Paleru and Moosi creeks in the Tungutur mandal of Prakasam district to reduce exploitation in weighing and count (shrimps/kg) of shrimps. The association constructed its own office premises with laboratory and washing-cum-weighing yard to clean and weigh the harvested shrimps. The association charges 60 pasie per kg of shrimp up to 50 counts as its service charge for washing and weighing from the buyers. Weighing is done in the presence of an association office bearer, concerned farmer and the trader. After weighing, the produce was iced and taken for processing buy the trader. Shrimps >50 counts were not charged anything for washing and weighing. The association provides 'market intelligence' to its members but it has not directly involved in price fixation/negotiation. Unlike the previous case, TAFA had not interfered in the collective management of shrimp cluster including disease management and there was no collective effort to prevent the spread of the disease. The association is only an advisory body in case of culture operations.

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	On farm training in brackishwater aquaculture	1-6 June 2007	19
2	Seabass seed production and culture	17-26 August 2007	4
		2-11 January 2008	1
3	Shrimp hatchery management for quality seed production	12-26 September 2007	8

Trainees of brackishwater aquaculture at Kakdwip

Seabass training at Muttukadu

6. TRAINING AND EDUCATION

HUMAN RESOURCE DEVELOPMENT

International

Name & Designation	Training Programme	Place of Training	Duration
Mr.J.Joseph Sahaya Rajan Technical Officer (T-5)	Advanced training on "Application of PCR for improved shrimp health management in the Asian region" under ACIAR funded project.	Aquatic Animal Health Laboratory, Geelong, Australia.	20 September. to 8 November, 2007
Dr. P. Ravichandran Head, CCD	To study the field level arrangements in the importation and culture of *L.vannamei* in Vietnam and Thailand	Thailand and Vietnam	25-29 March 2008
Dr. A.G. Ponniah Director	To study the introduction of *L.vannamei*	Thailand and Vietnam	27-29 March 2008

National

Name & Designation	Training Programme	Place of Training	Duration
Dr.A.G.Ponniah Director	Vigilance administration and management	Central Rice Research Institute, Cuttack	16-18 April 2007
Mrs.P.Mahalakshmi Scientist (SS)	Project formulation, implementation and evaluation	Administrative Staff College of India (ASCI), Hyderabad	16-27 April 2007
Dr.S.M.Pillai Principal Scientist	Strategic analysis for competitive advantage	Indian Institute of Management (IIM), Bengaluru	23-27 July 2007
Dr.P.Ravichandran Head, CCD	Organisational growth and strategic human resources management	IIM, Bengaluru	22-24 August. 2007
Dr.(Mrs.)M.Poornima Scientist (SS)	Genome and protein based veterinary diagnostics	Madras Veterinary College, Chennai	6-26 September. 2007
Dr.M.Krishnan Principal Scientist	Supply chain management	IIM, Bengaluru	10-12 September. 2007
Dr.T.Ravisankar, Senior Scientist	Supply chain management	IIM, Bengaluru	10-12 September. 2007
Dr.K.K.Krishnani Senior Scientist	Nanotechnology and nanomaterials	National Institute of Advanced Studies, Bengaluru	10-15 September. 2007
Dr.J.K.Sundaray Senior Scientist	Perspectives and current trends in bioinformatics	Centre for Cellular and Molecular Biology (CCMB), Hyderabad	13-18 September. 2007

Dr.A.R.Thirunavukkarasu Head, FCD	Creativity, re-invention and self enhancement for practicing mangers	IIM, Bengaluru	8-12 October. 2007
Dr.N.Kalaimani Principal Scientist	Finance and decision making	IIM, Bengaluru	22-26 October. 2007
Dr.K.K.Krishnani Senior Scientist	Waste management for R&D labs in biotechnology	Indian Institute of Technology, Chennai	27 September. to 1 Oct. 2007
Dr.(Mrs.)P.Nila Rekha Senior Scientist	Groundwater flow and transport modeling	LaGa Systems Pvt. Ltd., Hyderabad	6-8 November. 2007
Shri M.S.N.Murty Administrative Officer	Managerial effectiveness	IIM, Kolkata	26-30 November. 2007
Dr. K. Ponnusamy Senior Scientist	Agri entrepreneurship promotion and development	National Institute of Agricultural Extension Management (MANAGE), Hyderabad	10-14 December. 2007
Shri S. Nagarajan Technical Assistant (T-4)	Macromedia flash	Arena Animation, Chennai	18 October. 2007 to 1 Jan. 2008
Dr.T. Ravisankar Senior Scientist	Managing digital resources using open source software	University of Agricultural Sciences, Bengaluru	21-25 Janaury. 2008
Dr. (Mrs.) R. Saraswathy Scientist (SS)	GIS based decision support systems for sustainable agriculture	NAARM, Hyderabad	1-21 February. 2008
Dr.V.S.Chandrasekaran Senior Scientist	Science and Law	ASCI, Hyderabad	25-29 February. 2008
Dr.Vinaya Kumar Katneni and Dr.R.Ananda Raja Scientists	Molecular biology techniques for personnel involved in aquaculture / marine biology.	CCMB, Hyderabad	20 February. to 18 April 2008
Dr.S.A.Ali Principal Scientist	Management development programme on Managing public-private partnerships for agricultural research	IIM, Lucknow	3-8 March 2008
Dr.N.Kalaimani Principal Scientist	Management development programme on PME for agricultural research	IIM, Lucknow	24-28 March 2008

About 55 participants have participated in in-house training programme on Computer Applications during 5 November to 12 December 2007 which was conducted twice a week.

Students project work

Final year M.Sc./B.Tech/B.E. students (12) from different colleges and Universities were guided by CIBA scientists for short term projects related to brackishwater aquaculture.

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

- M.Sc. Biotechnology students (15) from the Biosys-Bio-Tech. Pvt. Ltd., Centre For Research and Development, Chennai on 30 May 2007.
- B.F.Sc. Final year students (28) from the College of Fisheries, Mangalore on 6 June 2007.
- B.Tech. Biotechnology second year students (24) from the Adhiyaman College of Engineering, Hosur, Tamil Nadu on 7 August 2007.
- B.F.Sc. students (14) from the Department of Fisheries Engineering, College of Fisheries, Nellore on 10 August 2007.

- B.Sc. Microbiology students (29) from the Coimbatore Malayalee Samaj College, Chinnavedampatti, Coimbatore on 11 August 2007.
- M.Sc. Marine Biology students (30) from the Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai on 11 September 2007.
- M.Sc. Zoology students (35) of JBAS (SIET) College for Women, Chennai, on 5 February 2008.
- Participants (86) of the National Level Training cum Workshop on "GIS and Marine Biodiversity" organized by Department of Advanced Zoology and Biotechnology, Loyola College, Nungambakkam, Chennai on 28 February 2008.

7. AWARDS AND RECOGNITIONS

- Appreciation letter received from Dr.S.Ayyappan, Deputy Director General (Fy.), ICAR for year round breeding and seed production of seabass towards diversification of coastal aquaculture.
- Dr.K.Ponnusamy and Dr.K.Ambasankar received the first Best Paper Award for the article entitled "Technological interventions for socio-economic enrichment of dairy farmers" published in Indian Journal of Dairy Science, 2006, 59(1):33-36.
- Dr.K.K.Krishnani, Senior Scientist received the Best Poster Award for the paper entitled "Targeting functional genes for the combined strategy of nitrification and denitrification in coastal aquaculture" at the International Conference on "New Horizons of Biotechnology" at Trivandrum during 26-29 November 2007.
- Dr. K.Ponnusamy, Senior Scientist, was awarded third prize for the essay titled, "Combating female foeticide in India" in state level essay competition conducted by Tamil Nadu State Social Welfare Board on 30 September 2007.

Dr. K. Ponnusamy receiving prize from Smt. Rajini Patil, Chairman, Central Social Welfare Board on 30.09.2007

DBT Overseas Associateship Award

- Dr. C.P. Balasubramanian Senior Scientist underwent training on "Genetic and endocrinological basis of reproduction in penaeid shrimps" at the University of California, USA during 18 February to 18 August 2007.
- Dr.S.Kannappan, Senior Scientist participated in the training programme on 'Extraction and characterization of marine bio-active compounds for brackishwater aquaculture applications' at the Plant Cellular & Molecular Biology Division, Ohio State University, Columbus, USA during 18 February 2007 to 17 February 2008.
- Dr.M.Shashi Shekhar, Senior Scientist underwent training on 'Antiviral silencing of RNAi (interference) and identification of antiviral factors for pathogenic virus in shrimps at the University of Hawaii, Honolulu, Hawaii, USA during 15 January to 13 April 2008.

Ph.D. Programme

Name	Thesis title	University	Date of award	Guide
Dr.(Mrs.) M.Poornima Scientist (SS)	Molecular epidemiology of foot and mouth disease isolates from Andhra Pradesh	Sri Venkateshwara Veterinary University (SVVU), Tirupati	5 October 2007	Dr. M.Satyanarayana Chetty, Professor, Department of Veterinary Microbiology, SVVU, Tirupati
Shri V.Stalin Raj SRF	Studies on the removal of nitrogenous toxicants, heavy metals and pesticides from coastal water	University of Madras, Chennai	16 March 2007	Dr.K.K.Vijayan, Senior Scientist, CIBA, Chennai
Shri V.Thillai Sekar SRF	Molecular characterization of the virulent factors of *Vibrio harveyi* and *Enterobacter cloacae,* pathogenic to the Indian grey mullet *Mugil cephalus*	University of Madras, Chennai	12 July 2007	Dr.T.C.Santiago, Principal Scientist, CIBA, Chennai
Shri S.Paul Pandi SRF	Characterisation of immunostimulated shrimp with respect to biochemical changes	University of Madras, Chennai	17 Nov. 2007	Dr.C.Gopal, Principal Scientist, CIBA, Chennai

8. LINKAGES AND COLLABORATION

The Institute had linkages with the following:

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 / State Agriculture Depts.

- College of Fisheries, University of Agricultural Sciences, Mangalore
- College of Fisheries, Sri Venkateswara Veterinary University, Muthukur
- Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi
- West Bengal University of Animal and Fisheries Sciences, Kolkata
- CCS Haryana Agricultural University, Hisar
- Navsari Agricultural University, Navsari, Gujarat
- Tamil Nadu Veterinary and Animal Sciences University, Chennai
- Dept. of Horticulture, Govt. of Tamil Nadu, Chennai.
- Dept. of Animal Husbandry, Govt. of Tamil Nadu, Chennai.
- Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli
- University of Madras, Chennai

Govt. of India

- Ministry of Agriculture, New Delhi
- National Fisheries Development Board, Hyderabad
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Coastal Aquaculture Authority, Chennai
- Ministry of Commerce, New Delhi
- Marine Products Export Development Authority, Cochin
- Department of Biotechnology, New Delhi
- Department of Science and Technology, New Delhi

State Fisheries Departments/BFDAs

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

International

NORAD, Norway

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. PUBLICATIONS

- CIBA Annual Report for the year 2006-2007.
- Hand book on fisheries institutions. CIBA special publication No. 31.
- Shrimp hatchery management for quality seed production. CIBA special publication No. 32.
- Brackishwater aquaculture technologies – Livelihood option for coastal women Self Help Groups (in Tamil) (No.33). CIBA special publication No 33.
- Improved hatchery technology for Asian Seabass *Lates calcarifer* (Bloch). CIBA special publication No. 34.
- Training Calendar for the year 2007-2008 and 2008-2009.

DVDs

- E-Learning module on mud crab fattening *(Scylla tranquebarica)* in Telugu.
- Health management for sustainable aquaculture

ARTICLES IN REFEREED JOURNALS

Alavandi, S.V., T.D.Babu, K.S.Abhilash, N. Kalaimani, N. Chakravarthy, T.C.Santiago and K.K.Vijayan. 2007. Loose shell syndrome causes low level mortality in India's black tiger shrimp. *Global Aquaculture Advocate,* 10 (3): 80-81.

Ambasankar, K., S.Ahamad Ali and J.Syama Dayal. 2007. Effect of dietary supplementation of phosphorus on growth and phosphorus excretion in Indian white shrimp *Fenneropenaeus indicus* (Milne Edwards). 54 (3): 305-310.

Azad, I.S., J.Syama Dayal, M.Poornima, S.A.Ali. 2007. Supra dietary levels of vitamins C and E enhance antibody production and immune memory in juvenile milkfish, *Chanos chanos* (Forsskal) to formalin-killed *Vibrio vulnificus. Fish Shellfish Immunology,* 23 (1):154-63.

Chrisolite, B., S.Thiyagarajan, S.V.Alavandi, E.C.Abhilash, N.Kalaimani, K.K.Vijayan and T.C.Santiago. 2008. Distribution of luminescent *Vibrio harveyi* and their bacteriophages in a commercial shrimp hatchery in South India. *Aquaculture*, 275:13-19.

Garg, S.K., Ashok Kumar, A.R.T.Arasu, Anitha Bhatnagar, S N Jana and U K Burman. 2007. Effect of peryphyton and supplementary feeding on growth performance and nutrition physiology of Nile Tilapia, *Oreochromis niloticus* and pearlspot, *Etroplus suratensis* under polyculture. *J. Appl.Aquacult.,* 19 (3): 19-45.

Jayanthi M., L. Gnanapzhalam and S. Ramachandran,. 2007. Assessment of impact of aquaculture on mangrove environments in the South East Coast of India using remote sensing and geographical information system (GIS). *Asian Fisheries Science,* 20:325-338.

Jayanthi, M., M.Muralidhar and S.Ramachandran. 2007. Impact of shrimp farming on the soil characteristics of Vellar Coleroon estuary complex, Tamil Nadu. *Indian J.Fish.,* 54 (2): 179-187.

Jayanthi, M. and P.Nila Rekha. 2006. Assessment of changes in Kolleru lake in Andhra Pradesh due to the development of aquaculture using satellite data. *J. Indian Soc. Coastal Agri. Res.,* 24 (1) : 41-43.

Jayanthi, M., S.Ramachanadran, P.Nila Rekha and M.Muralidhar. 2006. Environmental impact of shrimp aquaculture in Pichavaram, Tamil Nadu. *J. Indian Soc. Coastal Agri. Res.,* 24 (2) : 247-249.

Kalaimani, N., N.Chakravarthy, R.Shanmugham, A.R.Thirunavukkarasu, S.V.Alavandi and T.C.Santiago. 2008. Anti-oxidant status in embryonic, post-hatch and larval stages of Asian seabass *(Lates calcarifer). Fish Physiol. Biochem.,* 34: 151-158

Krishnani, K.K. and S.Ayyappan. 2006. Heavy metals remediation of water using plant and lignocellulosic agrowastes. Rev. Environ. Contaminat. and Toxicol., 2: 188: 64-85.

Krishnani, K.K., P.Ravichandran and S.Ayyappan, 2008. Microbially derived off-flavor from geosmin and 2-methylisoborneol: sources and remediation. *Rev. of Environ. Contaminat. Toxicol.,* 194: 1-27.

Krishnani, K.K., V.Parimala, B.P.Gupta, I.S.Azad and M.S.Shekhar. 2006. Bioremediation of nitrite from brackishwater using lignocellulosic waste - Bagasse. *Asian Fisheries Science.* 19(4): 429-444.

Krishnani, K.K., V.Parimala, B.P.Gupta, I.S.Azad, Xiaoguang Meng and Mathew Abraham. 2006. Bagasse assisted bioremediation of ammonia from shrimp farm wastewater. *Water Environ. Res.,* 78: 938–950.

Kumaran. M, M.Alagappan, S.Raja, D.D.Vimala, C.Sarada, V.S.Chandrasekaran and N.Kalaimani. 2006. Research-extension linkage in coastal aquaculture. *J. Indian Soc. Coastal Agri. Res.,* 24(2), 295-298.

Kumaran. M, S.Raja, M.Alagappan, D.D.Vimala, C.Sarada, V.S.Chandrasekaran and N.Kalaimani. 2006. Extension methodology for sustainable coastal aquaculture, *Ibid,* 330-333.

Li. Y, K.Wongprasert, M.S.Shekhar, J.Ryan, L.Dierens, J.Meadows, N.Preston, G.Coman, and R.E.Lyons. 2007. Development of two micro satellite multiplex systems for black tiger shrimp *Penaeus monodon* and its application in genetic diversity study for two populations. *Aquaculture,* 266: 279-288.

Mahalakshmi, P., B.Shanthi, M.Krishnan, D.Deboral Vimala and C.Sarada, 2008. Awareness and utilization of computers by shrimp farmers. *Fishery Technology.* 45 (1): 121-126.

Muralidhar, M., B.P.Gupta and P.Ravichandran. 2006. Status and environmental impact of shrimp aquaculture in East Godavari District, Andhra Pradesh. *J. Indian Soc. Coastal Agric. Res.,* 24(2), 241-246.

Muralidhar, M., B.P.Gupta, R.Saraswathy, Abey Varampath Abraham and A.Nagavel. 2006. Has tsunami affected the quality of seawater and backwaters? Case studies in and around Chennai. *Ibid,* 386-390.

Muralidhar, M. and B.P.Gupta. 2007. Quality of water discharged from shrimp hatcheries and its impact on surrounding coastal environment. *Indian J. Fish.,* 54 (2), 189-94.

Nila Rekha, P. and M.Jayanthi. 2006. Adaptability of mangroves in shrimp farm discharge water. *J. Indian Soc. Coastal Agri. Res,* 24 (2): 285-288

Nila Rekha, P., N.K.Ambujam and M.Jayanthi. 2006. Status of heavy metals in soils of paper mill effluent irrigated fields. *Ibid,* 70-73.

Panigrahi, A. and I.S.Azad. 2007. Microbial intervention for better fish health in aquaculture: the Indian scenario. *Fish Physiol. Biochem.,* 33: 429-440.

Parimala, V., K.K.Krishnani, B.P.Gupta, R.Ragunathan, S.M.Pillai, P.Ravichandran. 2007. Removal of ammonia and nitrite from coastal water using low cost agricultural waste. *Bull. Environ. Contaminat. Toxicol.,* 78 (3-4): 288-293.

Ponnusamy, K. and Jancy Gupta. 2005. Agro-eco system profile of farmers in different coastal farming systems. *J. of Extension Education.* 17 (3 & 4): 3826-3831.

Ponnusamy, K., Jancy Gupta and B.S.Chandel. 2006. Economic perspective and extension strategies for promoting organic farming. *Haryana Econ. J.,* XXVI (1 & 2): 46-50.

Ponnusamy, K. and Jancy Gupta. 2006. Credit utilisation, decision-making pattern and marketing behaviour of farmers in different coastal farming systems. *Agricultural Situation in India.* LXIII (8): 479-484.

Ponnusamy, K., M.Jayanthi and M.Kumaran. 2006. Farmers participatory assessment of biological control measures in rice based coastal agro-eco system. *J. Indian. Soc. Coastal agric. Res.* 24 (2): 320-321.

Ponnusamy, K. and Jancy Gupta. 2007. Factors associated with sustainable livelihood parameters in different enterprise combinations. *Indian Vet. J.,* 84 (12): 1289-1291.

Ponnusamy, K. and Jancy Gupta. 2007. Information processing and sharing behaviour of IFS farmers. *Indian Journal of Extension Education.* 43 (1 & 2): 71-75.

Ponnusamy, K. and Jancy Gupta. 2007. Fisheries based farming system for sustainable livelihood of coastal farmers. *Indian J. Fish.,* 54 (3): 327-331.

Ponnusamy, K. and C.Karthikeyan. 2006. Contract farming of sugarcane in Tamil Nadu. *Indian Journal of Extension Education.* 42 (3 & 4): 32.35.

Saraswathy, R., S.Suganya and P.Singaram. 2007. Environmental impact of nitrogen fertilization in tea eco system. *J. Environ. Biol.,* 28 (4): 779-788.

Saraswathy, R. and R.N.Adhikari. 2006. Particle size distribution of eroded soil under simulated rainfall condition. *Agric.Sci.Digest.* 26 (1): 19-22.

Saraswathy, R. and P.Singaram. 2006. Nitrogen transformations in acidic hilly soil under tea cultivation. *Crop Research*, 32 (3): 365-369.

Saraswathy, R., S.Suganya and P.Singaram. 2007. Environmental impact of nitrogen fertilization in tea eco system. *J. Environ. Biol.,* 28 (4): 779-788.

Shanthi, B. and M.Jayanthi. 2006. Empowering fisherwomen in coastal sectors-a strategy for improving farming. J. *Indian Soc. of Coastal Agri. Research,* 24 (2): 306 – 309.

Shekhar, M.S., G.Gopkrishna, C.Gopal, S.M.Pillai and P.Ravichandran. 2007. Sequence comparison of mitochondrial 16s rRNA gene segment in penaeids. *Asian Fisheries Science,* 20: 205-216.

Thillai Sekar, V., T.C.Santiago, K.K.Vijayan, S.V.Alavandi, V.Stalin Raj, J.J.S. Rajan, M.Sanjuktha and N.Kalaimani. 2008. Involvement of *Enterobacter cloacae* in the mortality of the fish, *Mugil cephalus*. *Let. Appl. Microbiol.,* 46 (6), 667–672.

Vimala, D.D., M.Kumaran and M.Krishnan. 2006. Communication behaviour of shrimp farmers. *J. Indian. Soc. Coastal agric. Res,* 24 (2), 334-337.

Vimala, D.D., S.Ramachandran, P.S.Swathilekshmi and M.Kumaran. 2006. Shrimp seed – A critical problem faced by shrimp farmers – A cross sectional analysis. *Ibid,* 338-340.

BOOKS AND BOOK CHAPTERS

Ayyappan, S. and M.Jayanthi. 2007. Sustainable aquaculture for export with reference to environment and engineering In: Sustainable aquaculture for augmentation of export with special reference to environment, engineering and value addition (Eds.C.Saha, B.C.Mal and P.S.Rao) The Institution of Engineers, Kolkatta. pp.1-7.

Jayanthi, M. 2007. Remote sensing and GIS: A planning tool for brackishwater aquaculture In: GIS in earth resource management (Eds T.Ramkumar and S.Vasudevan), Annamalai University, Chidambaram. pp. 73-82.

Jayanthi, M. 2008. Advanced spatial tools for integrated coastal resources management in hyper remote sening and spectral signature database management system (Eds. S.Rajendran, S.Arvindan and T.Jeyavel Rajakumar), Annamalai University, Chidambaram. pp. 209-217.

Kalaimani, N. and A.G.Ponniah. 2007. Significance of international codes in the trans boundary movement of species and quarantine policy in Indian fisheries Sector. In Indian fisheries – A progressive outlook (Eds. K.K.Vijayan, P.Jayasankar and P.Vijayagopal) Central Marine Fisheries Research Institute, Kochi. pp.104-127.

Pillai, S.M. 2008. Hatchery seed production. In. Physiology of reproduction, breeding and culture of tiger shrimp *Penaeus monodon* (Fabricius). (Eds. A.D.Diwan, S.Joseph and S.Ayyappan). Narendra Publishing House, New Delhi. pp.171-196.

Pillai, S.M. and P.Ravichandran. 2008. Farming and culture practices. In. Physiology of reproduction, breeding and culture of tiger shrimp *Penaeus monodon* (Fabricius). (Eds. A.D.Diwan, S.Joseph and S.Ayyappan). Narendra Publishing House, New Delhi. pp. 197-216.

FISHERIES POLICY BRIEFS

Ravisankar, T., V.S.Chandrasekaran and M.Krishnan. 2007. Need for land and water use policy for coastal aquaculture. Policy Briefs, July 2007 Central Institute of Fisheries Technology, Cochin. 3 p.

Ravisankar. T., V.S.Chandrasekaran and M. Krishnan. 2007. Traditional practices to be considered in the evolution of new land and water use policy for coastal aquaculture. Policy Update, 3, Central Institute of Fisheries Technology, Cochin, September 2007. 3-4 p.

Ravisankar. T., V.S.Chandrasekaran and M. Krishnan. 2007. An ideal land and water use policy for coastal aquaculture. Policy Update, 3, Central Institute of Fisheries Technology, Cochin, November 2007. 3 p.

POPULAR ARTICLES

Ahamad Ali, S., J.Syama Dayal, K.Ambasankar, M.Kathirvel, S.K.Pandian, C.P.Balasubramanian, G.Venugopal, K.Muralimohan and P.Rami Reddy. 2008. Farming of mud crabs: First ever application of feed pellets with reassuring results. *Fishing Chimes.* 28,(1): 143-144.

Chandrasekaran, V.S. 2008. The other side of the sharks. *Processed Food Industry,* 11 (3):31-33.

De, D., T.K.Ghoshal, J.K.Sundaray, A.Panigrahi and M.Natarajan. 2007. Bagda chingrir krittim khadya prastuti o khadya parichalan byabostha (Feed preparation and feed management for tiger shrimp culture). *Annadata,* Vasundhara Publications, Hyderabad, 1(4): 29-31.

Krishnani, K.K., B.P.Gupta, S.M.Pillai and P.Ravichandran. 2006. Environmental challenges and management in coastal aquaculture. *Matsyagandha* (Fisheries & Environment), CMFRI, Cochin, 69-74.

Kumaran, M. 2007. Valamana iral valarpirkku sirandha melanmai muraigal (Good management practices for sustainable shrimp culture), *Sea Queen,* 3 (2): 29-33.

Ponnusamy, K. and T.K.Walli. 2007. Contract dairy farming versus dairy cooperatives - Relative strengths and weaknesses. *Indian Dairyman.* 59 (4): 53-60.

Shanthi, B. 2007. Women fellows of the Jamsetji. Tata National Virtual Academy (Nva) in aquaculture. *Sea Queen,* 1 (7) : 37–40.

Shanthi, B., M.Krishnan, V.S.Chandrasekaran, C.P.Balasubramaniam, S.Kannappan and M.Sureshkumar. 2007. Awareness campaign for coastal women Self Help Groups. *Sea Queen,* 1 (9) : 42-43.

Vimala, D.D., M.Kathirvel and S.K.Pandian. 2007. Kazhi nandu kolukavaithal (Tamil), *Sea Queen,* 2 (5) 31-32.

Vimala, D.D. 2007. Payerchi (Tamil). *Sea Queen,* 2 (7) 33.

Vimala, D.D. 2008. Training – an effective tool for technology transfer. *Sea Queen,* 1 (11) 28-29.

ABSTRACT AND PROCEEDINGS

Ambasankar, K., S.Ahamad Ali and J.Syamadayal. 2007. Effect of dietary and supplementary phosphorus on growth and excretion in the tiger shrimp *Penaeus monodon* . *In: 7th Indian Fisheries Forum,* (date), UAS, Bangalore. pp.141-150.

Bindhuja, M.D., K.Revathi, C.Gopal, M.Meenakshi, A.V.Abraham and M.Muralidhar. 2007. Changes in zinc concentration during ovarian maturation in the Indian white shrimp, *Fennneropenaeus indicus* (H.Milne Edwards,1837). *In: National Conference on Biosecured Aquaculture – An Eco-friendly Approach,* BAAE'07, 28–29 June 2007, Fisheries College and Research Institute, Tamilnadu Veterinary and Animal Sciences University, Thoothukudi. AG 4.

Bindhuja, M.D., C.Gopal, K.Revathi, M.Meenakshi, A.V.Abraham and M.Muralidhar. 2007. Copper concentration in different tissues during ovarian development of Indian white shrimp, *Fenneropenaeus indicus. Ibid,* AG 5

Chandrasekaran, V.S., A.G.Ponniah and T.Ravisankar. 2007. Policy perspectives for brackishwater aquaculture and mariculture, with special reference to west coast of India. *National Workshop on Responsible Fisheries and Sustainable Aquaculture Perspectives for West Coast States,* 21-23 June 2007, ICAR Complex, Goa.

Gupta, B.P. and M.Muralidhar. 2006. Case studies on the impact of shrimp farms discharge water on the quality of receiving waters. *In: National consultation on water management in Fisheries and Aquaculture* organised by Association of Aquaculturists, Bhubaneswar, Orissa and Inland Fisheries Society of India, Barrackpore, West Bengal held at NAAS, NASC complex, Pusa, New Delhi, 23-24 June 2006. Abs. No. NCW-56, p.69.

Jagan Mohan, S., C.Gopal, P.Ravichandran, S.M.Pillai and S.Rajamanickam. 2007. Effect of different larval diets on growth and survival of captive bred Kuruma shrimp *M. japonicus. In: National Conference on Biosecured Aquaculture – An Eco-friendly Approach,* BAAE'07, 28–29 June 2007, Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi, Abs. No. ANH 5.

Kailasam, M., A.R.Thirunavukkarasu and J.K.Sundaray. 2008. Induced breeding techniques and culture of brackishwater fin fishes with special reference of Asian seabass *Lates calcarifer. In: State Level seminar on Recent trends in Environmental Biotechnology.* 13 March 2008, Jamal Mohammed College, Tiruchirappalli Tamil Nadu. pp.74-77.

Kailasam, M., P.Stalin, N.Tamil Selvam, S.Selvaraj, J.K.Sundaray, A.R.T.Arasu and P.Shiranee. 2008. Biodiversity of rotifer *(Brachionus plicatilis)* populations along the east coast of India. *In: International conference on biodiversity conservation and management,* 3-6 February 2008 at CUSAT, Cochin, Kerala. Abs. p.51.

Krishnan, M. and A.G.Ponniah. 2008. Microfinancing fisheries development. *In: National Conference on Status, constraints and scope for fisherfolk development through microfinance,* 14-15 February 2008, Department of Fisheries Resources and Economics, Fisheries College and Research Institute, Tamilnadu Veterinary and Animal Sciences University, Thoothukudi. Abs.pp.10-11.

Krishnan, M., A.G.Ponniah, S.M.Pillai and T.Ravisankar. 2008. Structural changes for development of domestic markets for fish in India. *In: Souvenir. National Workshop on Development of strategies for domestic marketing of fish and fishery products,* 7-8 February 2008, College of Fisheries, Nellore. Abs. pp.34-39.

Krishnan, M., B.Shanthi, S.M.Pillai. 2008. Perceived avenues and systemic externalities in market led farming systems in brackishwater aquaculture. *In: Seminar on Institutional interventions for the development of market led farming systems in Tamil Nadu.* 17-18 March 2008, Centre for Agricultural and Rural Development Studies, TNAU, Coimbatore. Abs.3.p.7.

Krishnani, K.K., M.S.Shekhar and B.P.Gupta. 2007. Characterization of nitrifying bacteria in the coastal aquaculture. *In: 8th Asian Fisheries Forum,* 20-23 November 2007, Kochi. p.287.

Mahalakshmi, P., D.D.Vimala and M.Krishnan. 2007. ICT as a tool for women's empowerment in coastal areas: Experiences and observations. *In: 8th Asian Fisheries Forum,* 20-23 November 2007, Kochi., Abs. No.GPO 019, p.9.

Muralidhar, M. and N.Kalaimani. 2006. Chemical hazards in aquaculture grow-out and application of HACCP. *In: Manual on Application of HACCP principles to shrimp production and marketing.* pp.67-73.

Muralidhar, M., B.P.Gupta, S.M.Pillai, C.Gopal, C.Sarada and A.Nagavel. 2006. Carrying capacity estimation of source water bodies for optimization of shrimp aquaculture development – Case study in the Polekuru Island, East Godavari District, Andhra Pradesh. *In: National Consultation on Water Management in Fisheries and Aquaculture,* 23-24 June 2006, organised by Association of Aquaculturists, Bhubaneswar, Orissa and Inland Fisheries Society of India, Barrackpore, West Bengal held at NAAS, NASC Complex, Pusa, New Delhi.. Abs. No. NCW 57, p.70.

Nila Rekha, P., M.Jayanthi, S.M.Pillai and P.Ravichandran. 2007. Hydro geochemical status in shrimp farming areas using GIS. *In: 8th Asian Fisheries Forum,* 20-23 November 2007, Kochi, India, Abs. p.187.

Panigrahi, A., J.K.Sundaray, T.K.Ghoshal and D.De. 2007. Biosecure zero water exchange system technology of shrimp farming for better monitoring of the coastal ecosystem. *In: International Symposium on Management of Coastal Ecosystem: Technological Advancement and Livelihood Security.* 27-30 October 2007, Kolkata.

Panigrahi, A., Kiron Viswanath, Goro Yoshizaki and Shuichi Satoh. 2007. Probiotics for sustainable aquaculture: Investigation into the molecular immuno-modulation induced by probiotic bacteria through real time PCR. *In: International Symposium on Management of Coastal Ecosystem: Technological Advancement and Livelihood Security,* 27-30 October 2007, Kolkata.

Pillai, S.M. 2007. Biosecurity in shrimp seed production. *In: National Conference on Biosecured Aquaculture – An Eco-friendly Approach,* BAAE'07, 28–29 June 2007, Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi, pp.28-39.

Ravichandran, P. 2007. Introduction of HACCP principles in shrimp farming for prevention of diseases and food safety. *Ibid* p.

Shanthi, B., M.Krishnan and V.S.Chandrasekaran. 2008. Gender empowerment – new frontiers in aquaculture development. *In: National Conference on Status, Constraints and Scope for Fisheries Development Through Microfinance,* 14-15 February 2008, Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi . p 40.

Shekhar, M.S., G.Gopikrishna and P.Ravichandran. 2007. Development of Digoxigenin labeled probe of Macrobrachium rosenbergii nodavirus. *In: 8th Asian Fisheries Forum,* 20-23 November 2007, Kochi. pp.30-31.

Shekhar, M.S. 2007. Viral diseases of finfish in India. *In: International Conference on Emerging and re-emerging viral diseases of the tropics and the sub-tropics.* 11-14 December 2007, New Delhi. p.96.

Vimala, D.D., P.Mahalakshmi and M.Krishnan. 2007. Fast-track bridging the digital divide: Opportunities seized and awaiting at Puducherry Village Knowledge Centres. *In: 8th Asian Fisheries Forum.* Abs. No. FSP 004 P 389

Vimala, D.D. and S.Ramachandran. 2007. Gender equity in coastal aquaculture - a reality. *In: 8th Asian Fisheries Forum.* Abs. No. GPO 019 p.9.

OTHERS

GenBank Sequences

Sl. No.	GenBank accession no.	No. of gene sequences	Year of submission	Gene	Authors
1.	DQ307207 to DQ307248	42	2007	Penaeus monodon microsatellite sequences.	Li,Y., Wongprasert,K., Shekhar,M.S., Ryan,J., Dierens,L., Meadows,J., Preston,N., Coman,G. and Lyons,R.E.
2.	EU104363 to EU104367	4	2007	Ammonia monooxygenase (amoA) gene	Krishnani,K.K., Shekhar,M.S. and Gupta,B.P.
3.	EU156172 to EU156174	3	2007	Ammonia monooxygenase (amoA) gene	Krishnani,K.K., Shekhar,M.S., Gopikrishna,G. and Gupta,B.P.
4.	EU284710 to EU284712	3	2007	Nitrous oxide reductase gene	Krishnani,K.K., Shekhar,M.S., Gopikrishna,G. and Gupta,B.P.

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 *Penaeus monodon,* development of culture practices for Marsupenaeus japonicus 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 *(Scylla spp.)*	Shri M.Kathirvel, 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.C.P.Rangaswamy 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.M.Natarajan Principal Scientist

EXTERNALLY FUNDED PROJECTS

NORAD		
12.	Genetic improvement of *Penaeus monodon* (tiger shrimp) through selective breeding for growth and white spot disease resistance	Dr.P.Ravichandran Principal Scientist
ICAR AP Cess Fund Projects		
13	Evaluation of nutritive value of different strains of rotifers (Brachionus spp.) and their suitability for larviculture of Asian seabass *Lates calcarifer* (Bloch)	Dr.M.Kailasam Senior Scientist
14	Development and demonstration of hatchery and culture technology for the banana shrimp, *Fenneropenaeus merguiensis* as an alternate species for shrimp aquaculture	Dr.S.M.Pillai Principal Scientist
15	Investigation on loose shell syndrome among farmed tiger shrimp *Penaeus monodon*	Dr.S.V.Alavandi Senior Scientist
16	Development of low fish meal feeds for shrimp aquaculture	Dr.J.Syama Dayal Senior Scientist
17	The assessment of losses in shrimps in brackishwater aquaculture due to diseases	Dr.N.Kalaimani Principal Scientist
18	Molecular characterization and analysis of virulence factors in pathogenic *Vibrio harveyi* isolates from shrimp larviculture systems	Dr.S.V.Alavandi Senior Scientist
Department of Biotechnology (DBT) Projects		
19	Gene expression in Penaeus monodon and Penaeus indicus in relation to microbial infection and environmental stress	Dr.T.C.Santiago Principal Scientist
20	Characterization and development of diagnostics for viral nervous necrosis in seabass *(Lates calcarifer)* and mullet *(Mugil cephalus)*	Dr.K.P.Jithendran Principal Scientist
21	Development of substrate specific fibrolytic enzymes for enhancing nutrient utilization in shrimp	Dr.K.Ambasankar Senior Scientist
22	Development and application of CMG family recombinant hormones, their antagonists and RNAi technique for induced maturation and spawning of *Penaeus monodon*	Dr.C.P.Balasubramanian - Co-PI Senior Scientist
23	Enrichment of aquafeed with cellulolytic and amylolytic microbes isolated from digestive tract of brackishwater fishes	Dr.Debasis De Scientist (SS)
24	Development of antiviral therapy using double stranded RNA (dsRNA) against shrimp viruses, WSSV, MBV and HPV	Dr.T.C.Santiago Principal Scientist
25	Diversification of livelihoods among women SHGs through coastal aquaculture technologies	Dr.B.Shanthi Senior Scientist
Network Projects		
26	Mega seed project on “seed production in agricultural crops and fisheries”	Dr.S.M.Pillai, Nodal Officer, Principal Scientist
27	Impact assessment of fisheries research in India	Dr.T.Ravishankar Senior Scientist
28	Application of micro organisms in agriculture and allied sectors - microbial diversity and identification	Dr.T.C.Santiago Principal Scientist
29	Application of micro organisms in agriculture and allied sectors - agrowaste management, bioremediation and microbes in post harvest processing	Dr.S.V.Alavandi Senior Scientist
National Fisheries Development Board		
30	Exploring market opportunities for fisheries sector in India	Dr.T.Ravishankar Senior Scientist

11. CONSULTANCY / COMMERCIALISATION OF TECHNOLOGY

- Matrix (CIBAX-1) for immobilization of probiotic bacteria technology commercialized to Shrimpex Biotech Services, Chennai at the cost of Rs.50,000/- on non exclusion basis.
- Micro-brackishwater analysis Kit, commercialized to Shrimpex Biotech Services, Chennai with initial payment of Rs.1.1 lakh and 2% royalty.
- Services were provided to farmers through the regular analysis of soil and water samples from the shrimp ponds.
- CIBA crab pellet feed for fattening water crabs was assessed by undertaking demonstrations in farmers' fields.
- Shrimp feed additives: The Vitamin & Mineral Mixtures developed by CIBA for penaeid shrimp have been transferred to M/s. Marine Technologies, Chennai for commercial production and marketing.

12. RAC, IMC, SRC AND IJSC MEETINGS

RESEARCH ADVISORY COMMITTEE (RAC)

The Research Advisory Committee was constituted by ICAR (Council's order F.No.18-2/2004-ASR-I dated 10 June 2004) for a period of 3 years from 25 July 2004 with the following members.

Dr.N.R.Menon Former Director, School of Marine Sciences Cochin University of Science and Technology Fine Arts Avenue, Ernakulam, Cochin 682 016	Chairman
Dr.Rakesh Bhatnagar Professor, Centre for Biotechnology Jawaharlal Nehru University, New Delhi 110 067	Member
Dr.(Mrs.) Katre Shakunthala Professor, Department of Zoology Bangalore University, Bangalore 560 056	Member
Dr.P.Keshavanath Director of Instruction, College of Fisheries, Mangalore 575 002	Member
Dr.A.G.Ponniah Director, CIBA, Chennai	Member
Dr.S.M.Pillai Principal Scientist & OIC, Technical Cell, CIBA Chennai	Member Secretary

12th RAC Meeting

The 12th Meeting of the Research Advisory Committee was held on 26 April 2007 and the major recommendations were as follows:

- Repository information on brackishwater and position paper on brackishwater aquaculture have to be prepared compiling all data from environmental related studies.
- Alternate species should be identified aiming at the west coast. Scientific information should be collected and database should be strengthened to convince the farmers.
- Focus should be intensified on disease, disease free broodstock of shrimps/fish, breeding and culture.
- Package of practice should be developed on the culture of mud crab.
- Gender issues in aquaculture should be addressed.
- Diversification of species and system are to be given greater importance in research.
- Establishment of a research center in the west coast, upgrading the existing facilities in Kakdwip and maintaining scientist to technical ratio (1:1.5) are to be done immediately.
- The role of micro nutrients on source water bodies also should be considered while assessing the carrying capacity.
- Environmental hot spots along the aquaculture areas/ coast line should be identified and assessed.

The Research Advisory Committee of CIBA was re-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 members.

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

Dr.Apurba Ghosh Ex-Principal Scientist & Project Coordinator All India Coordinator Project 23, Gora Chand Road, Kolkatta 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 13th Meeting of the re-constituted Research Advisory Committee was held during 24-25 January 2008. The major recommendations are:

- The manpower needs to be strengthened both at headquarters and Kakdwip to effectively address the problems in brackishwater aquaculture and to find solutions.
- Regional research stations should be increased and one in West Coast is a priority to address the issues and disseminate the findings across the country.
- Mechanism to transfer the larval rearing technique of seabass to entrepreneurs / progressive farmers needs to be evolved.
- Grow-out culture of seabass to be standardized using live forage, different trash fishes as well as CIBA pellet feed.
- The comprehensive package of practices for culture of *F. merguiensis* and *M. japonicus* to be prepared and disseminated to farmers.
- Nursery rearing techniques and design of grow-out systems for mud crab farming should be standardized.
- Collaborative program with an NGO in Kolkatta to promote seabass culture in freshwater system using live tilapia as forage to be taken up.
- Mugil cephalus breeding programme should be intensified.
- More fish species should be taken up for ornamental aquaculture.
- To build a repository of information on environmental parameters in relation to brackishwater aquaculture.

- On shrimp pond management, extension literature to be made available so that better management practices will be able to reduce the continued disease risks from WSSV.
- Field trials should be carried out for bioremediation of shrimp farm discharge water and its effectiveness in comparison to effluent treatment ponds.
- In developing integrated aquaculture practices, location specific emphasis needs to be incorporated.
- Pamphlet on soil and water quality requirement for shrimp ponds should be prepared in different languages to be disseminated to farmers.
- Investigations of the specific shrimp health issues under zero water exchange system.
- Characterization of LSSV (virus) and establish Cell Culture laboratory.
- Investigations on maturation of shrimp including the use of recombinant vitellogenin should be taken up.
- Ministry of Agriculture, Govt. of India should be approached with a proposal for a realistic estimation of the potential area available in the coastal states for the expansion of brackishwater aquaculture based on remote sensing and GIS method developed in CIBA. .
- Economic studies on domestic marketing and supply chain management to tide over international price crash to be undertaken.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

The Institute Management Committee was re-constituted by ICAR vide letter F.No.6-25/2003 IA-VI, dated 15 December 2004 for a period of 3 years with effect from 8.12.2004 as follows:

Director CIBA, Chennai	Chairman
Assistant Director General (M.Fy.) Indian Council of Agricultural Research, New Delhi	Member
Director of Fisheries Government of Tamil Nadu, Chennai	Member
Director of Fisheries Govt. of Andhra Pradesh Tank Bund Road, Hyderabad	Member
Dean Fisheries College and Research Institute Tamil Nadu Veterinary and Animal Science University Tuticorin, Tamil Nadu	Member
Dr.S.N.Mohanty Principal Scientist, Central Institute of Freshwater Aquaculture Bhubaneswar	Member
Senior Finance & Accounts Officer Central Marine Fisheries Research Institute, Cochin, Kerala	Member
Administrative Officer CIBA, Chennai	Member Secretary

The 30th and 31st meetings of Institute Management Committee of CIBA, Chennai was held on 27 April 2007 and 6 December 2007 respectively.

STAFF RESEARCH COUNCIL (SRC)

The 20th Meeting of the Staff Research Council was held during 28 – 30 April 2007. The major recommendations of the meeting are :

- Evaluation of the adoption of better management practices.
- Requirement of information on extensive farming systems and organic farming
- Interaction with SIPPO to understand the level of principles adopted at Kakdwip to designate as organic farming.

20th SRC Meeting

- More trials are needed to compare the efficiency of artificial pellet feed over conventional feed for mud crab.
- Megalopa may be produced for experimental purpose. When crab seed is available from other sources, hatchery seed production should be stopped..
- A new project on "Aquaculture farm appraisal and impact assessment using remote sensing and GIS" has been approved and studies related to mangroves need to be highlighted.
- Seed production of *M. cephalus* should be standardized and a technology package has to be brought out.
- Low input culture techniques for mullets and pearlspot should be developed.

- Technology package for culture of seabass should be developed.
- More focus should be given for the culture of other commercially important brackishwater fishes.
- In the absence of pond facility for rearing broodstock of milkfish and mullets, the possibility of using the pond of M/s Pancham Aqua may be explored under public-private partnership mode.
- Soil taxonomy of Nagapattinam district should be taken up instead of Kanchipuram district for better understanding of the role of soil quality in shrimp aquaculture.
- More attention to be paid to nursery and grow out feed.
- The resistance to WSSV genetic variable has to be further studied.

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:

Director, CIBA	Chairman
Dr.A.R.Thirunavukkarasu, PS & Head, FCD	Member
Dr.P.Ravichandran, PS & 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 A.Manoharan, UDC	Secretary
Shri R.Subburaj, Technical Assistant (T-4)	Member
Shri R.Balakumaran, Technical Assistant (T-2)	Member
Shri A.Sekar, UDC	Member
Shri V.Jeevanandham, S.S.Gr.II	Member
Shri M.Pichandi, SS Gr. I	Member

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

13. PARTICIPATION IN CONFERENCES / MEETINGS / WORKSHOPS / SYMPOSIA

Particulars	Organizers	Duration
Dr.A.G.Ponniah, Director		
10th Meeting of Coastal Aquaculture Authority	Coastal Aquaculture Authority (CAA), Chennai.	18 May 2007
Discussions with Director, CIFT and MPEDA for collaborative research programmes under NAIP.	CIFT, Kochi	24-25 May 2007
Meeting of the Directors of ICAR Fisheries Research Institutes	S.V.University, Tirupathi	9-10 June 2007
Meeting on "Recirculation Technologies applied to fish and crustacean species"	Society of Aquaculture Professionals, Chennai.	13 June 2007
MPEDA norms for hatchery registration.	Coastal Aquaculture Authority, (CAA), Chennai	18 June 2007
National Conference on "Biosecured Aquaculture – An Eco-friendly approach"	Fisheries College & Research Institute, Thoothukudi	28-29 June 2007
Workshop on "Brackishwater Aquaculture Production Systems and Environmental Management" under Indo-US Agricultural Knowledge Initiative.	CIBA & CASI, Chennai	10-11 July 2007
ICAR, Directors' Conference	ICAR, New Delhi	16-18 July 2007
Twelfth meeting of the National Committee on Introduction of Exotic Aquatic Species into Indian waters	Krishi Bhavan, New Delhi.	19 July 2007
11th Meeting of the Coastal Aquaculture Authority	CAA, Chennai	6 August 2007
1st Meeting of the Registration Committee on Aquatic Genetic Resources	NASC, New Delhi.	8 August 2007
International Seminar on "Growth and Development of Animal Industry in India" under Indian Animal Husbandry Expo 2007	Pragati Maidan, New Delhi.	17 August 2007
Meeting to finalize the XI Plan EFC of CIBA	ICAR, New Delhi	27-30 August 2007
PCR – Intercalibration for accreditation of PCR Laboratories	MPEDA, Chennai	8 September 2007
17th Meeting of the Board of Directors of TNFDC	Secretariat, Chennai	24 September 2007
Aqua India 2007	Society of Aquaculture Professionals, Chennai	28-29 September 2007
Meeting to discuss XI Plan Collaborative Programme for development of Brackishwater Aquaculture in Gujarat.	Navsari Agricultural University	3 October 2007

4th Meeting of the DBT Task Force Committee	DBT, New Delhi	10-11 October 2007
12th Meeting of the Coastal Aquaculture Authority	CAA at Chennai.	23 October 2007
Special Interactive Workshop on 'Administrative and Financial Matters'	NIANP, Bangalore	26-27 October 2007
Meeting of the Estimates Committee of Lok Sabha with the officials of ICAR, CIBA & KVK, Kattupakkam, TANUVAS	Chennai	3 November 2007
Appraisal Meeting of NORAD Project	ICAR, New Delhi	5 November 2007
8th Asian Fisheries Forum	Asian Fisheries Society (Indian Branch) at Kochi	20-23 November 2007
National Agriculture Innovation Project (NAIP) Presentation Meeting	PIU, NAIP, ICAR, New Delhi	10-11 December 2007
General Body Meeting of the National Fisheries Development Board (NFDB)	NFD at Kochi.	5 January 2008
Workshop on "Microbial & Enzymatic Technology in Aquaculture: Scope for mutual cooperation with Indian Research Institutes & Consultants"	Novazymes South Asia Pvt. Ltd., Bangalore.	7 January 2008
13th Meeting of the Coastal Aquaculture Authority	CAA at Hyderabad.	9 January 2008
1st Meeting of the Sub-committee constituted to formulate guidelines for farming *L.vannamei* and norms for setting up multiplication centre	CAA, Chennai	10 January 2008
XXI meeting of the ICAR Regional Committee No.VIII	CTCRI, Trivandrum	11-12 January 2008
2nd Meeting of the Sub-committee constituted to formulate guidelines for farming of *L.vannamei* and norms for setting up of multiplication centre	CAA, Chennai.	22 January 2008
International Conference on Biodiversity Conservation and Management – BIOCAM 2008	Cochin University of Science and Technology, Kochi	6 February 2008
4th Governing Council Meeting of NaSCA.	Kakinada	15 February 2008
Meeting to finalize the guidelines for farming of *L.vannamei*	CAA, Chennai	28 February 2008
28th Meeting of the Tamil Nadu State Fisheries Research Council.	IMAGE, Chennai	29 February 2008
Combined EFC meeting of CMFRI & CIBA	ICAR, New Delhi	2-5 March 2008
Broad Subject Matter Area (BSMA) Committee Meeting	CIFE, Mumbai	12 March 2008
14th Meeting of the Coastal Aquaculture Authority	CAA, Chennai	14 March 2008

5th Meeting of the DBT Task Force on Aquaculture and Marine Biotechnology	DBT, New Delhi	17 March 2008
Seminar on "Marine Fisheries Research in India – Present status and future direction"	MRC of CMFRI, Chennai	25 March 2008
Dr.A.R.Thirunavukkarasu, Head, FCD		
First Meeting of the Expert Committee on preparation of Guidelines of Research Results	National Biodiversity Authority, Chennai	13 June 2007
Meeting on Aquaculture- Problems of the aquafarmers facing with fall of shrimp rate and improvement of domestic marketing infrastructure facilities	NFD, Hyderabad	31 July 2007.
Farmers' Meet	State Bank of India, Agri Business Unit, Chennai at Karaikal	23 July 07
Chandrakala Memorial Lecture of Indian Science Academy, New Delhi	National Institute of Ocean Technology, Chennai	12 November 2007
8th Asian Fisheries Forum	Asian Fisheries Society (Indian Branch) at Kochi	20-23 November 2007
Workshop on Innovation in Inland Saline Water Aquaculture in India	New Delhi	28 November 2007
Dr.P.Ravichandran, Head, CCD		
National conference on Biosecured aquaculture-an eco-friendly approach	Fisheries College and Research Institute, Thoothukkudi	28-29 June 2007
8th Asian Fisheries Forum	Asian Fisheries Society, (Indian Branch), Kochi.	20-23 November 2007
Dr.S.M.Pillai, Principal Scientist		
Project discussion meeting on ICTs for responsible aquaculture development providing safe and quality produce to the global consumers	CIBA, Chennai	5 April 2007
Interaction meeting with farmers at Bilimora, Gujarat during the harvest of *F.merguiensis*	CIBA, a Bilimora, Gujarat	8-9 May 2007
National Conference on "Biosecured aquaculture-an eco-friendly approach"	Fisheries College and Research Institute, Thoothukkudi	28-29 June 2007
Farmers Meet	Kakdwip Research centre of CIBA, Kakdwip	4 July 2007
XI Plan EFC meeting	ICAR, New Delhi	27-31 August 2007
Review meeting of the mega seed project on "Seed production in agricultural crops and fisheries"	CIFA, Bhubaneswar	24-25 September 2007

Aqua India 2007-Progress through partnerships	Society of Aquaculture Professionals at Chennai	28-29 September 2007
Discussion with officials of Navsari Agricultural University, Navsari and to finalize the design and lay out of the brackishwater aquaculture farm at Danti.	Navsari Agricultural University, Navsari	12 February 2008
Review meeting of the ICAR Mega Seed project.	National Research Centre on Coldwater Fisheries at Bhimtal	22-23 February 2008
Seminar on "Marine fisheries research in India-present status and future direction"	Madras Regional Centre of CMFRI, Chennai	25-26 March 2008
Dr.T.C.Santiago, Principal Scientist		
Seminar on 'Coastal ecosystem'	Kolkatta	27-30 October 2007
8th Asian fisheries forum	Kochi	20-23 November 2007
Training workshop on 'Aquatic epidemiology, surveillance and emergency preparedness'	ICAR and NACA at CIBA, Chennai	3-7 September 2007
Dr.S.A.Ali, Principal Scientist		
First Training-cum-Workshop on "IP and Technology Management in ICAR System"	NAARM, Hyderabad	28-30 May 2007
Network Meeting on 'Finfish and shellfish nutrition'	ICAR, New Delhi	21-22 August 2007
Aqua India 2007	SAP, Chennai	28 -29 September 2007
8th Asian Fisheries Forum	Kochi	20-23 November 2007
Management Development Programme on Public Private Partnership for Innovation in Agriculture	Indian Institute of Management, Lucknow	3-8 March 2008
Dr.B.P.Gupta, Principal Scientist		
National consultation on water management in fisheries and aquaculture	Association of Aquaculturists, Bhubaneswar and Inland Fisheries Society of India, Barackpore at NAAS Complex, New Delhi	23-24 June 2006
Network project review meeting on National Risk Assessment programme for fish and fish products for domestic and international markets	NRC-CWF, Bhimtal, Uttaranchal	15-16 April 2006
Aqua-India 2007	SAP, Chennai	28-29 September 2007

Dr.C.P.Rangaswamy, Principal Scientist		
Meeting of the Nodal Scientists of the collaborating institute on the network Project on Germplasm Exploration, cataloguing and Conservation of Fish and Shellfish Resources of India	National Bureau of Fish Genetic Resources, Lucknow	30-31 October 2007
Dr.N.Kalaimani, Principal Scientist		
Programme on 'Priority setting Monitoring & Evaluation (M&E) in National Agricultural Innovation System'	Indian Institute of Management, Lucknow	24-28 March 2008
Training workshop on 'Aquatic epidemiology, surveillance and emergency preparedness' jointly organized by ICAR and NACA	Central Institute of Brackishwater Aquaculture, Chennai	3-7 September 2007
Dr.M.Krishnan, Principal Scientist		
Golden Jubilee Celebrations of the Faculty of Agriculture of the Annamalai University	Annamalai University	12-15 April 2008
Chaired a session in National Conference on Status, Constraints and Scope for Fisherfolk Development through Microfinance, FC& RI	TANUVAS, Tuticorin	14-15 February 2008
Chaired a session in National Workshop on Development of Strategies for Domestic Marketing of Fish and Fishery Products	College of Fisheries, Muthukur, Nellore, A.P	7-8 February 2008
8th Asian Fisheries Forum	Asian Fisheries society (Indian Branch) at Kochi	20-23 November 2007
Aqua India 2007	SAP, Chennai	28-29 September 2007
Workshop on 'Responsible Fisheries – Strategies and Practices'	MRC of CMFRI at Anna University , Chennai	26-27 March 2007
Dr.G.Gopikrishna, Senior Scientist		
Workshop under the ICAR-Worldfish Centre Collaborative Project on 'Genetic improvement of giant freshwater prawn *Macrobrachium rosenbergii* in India'	Central Institute of Freshwater Aquaculture, Bhubaneswar	17 March 2008
Dr.V.S.Chandrasekaran, Senior Scientist		
National Workshop on the Fisheries and Aquaculture Policy: Responsible fisheries and sustainable aquaculture perspectives for West Coast States	ICAR Complex, Goa	21-23 June 2007
Dr.K.K.Krishnani, Senior Scientist		
Hindi Conference / workshop	Rajbhasha Avam Prabandhan Vikas Sanstha at Goa	24-26 October 2007
8th Asian Fisheries Forum	Asian Fisheries Society (Indian Branch), Kochi	20-23 November 2007

Dr.M.Muralidhar, Senior Scientist		
Creating Public Awareness on Environmental Acts of Ministry of Environment & Forests, Govt. of India as applied to Coastal zone, Wetlands, Biosphere Reserves and so on.	SPICAM, Kakinada	5 August 2007
PCR – inter calibration for accreditation of PCR laboratories'	MPEDA, Chennai	8 September 2007
Aqua India 2007 "Progress through Partnership	Society of Aquaculture Professionals, Chennai	28-29 September 2007
Improvement of Domestic marketing for shrimp and fish production in India on	Andhra Pradesh Prawn Farmers Welfare Association, Nellore	20 December 2007
Dr.(Mrs.)B.Shanthi, Senior Scientist		
National Conference on Status Constraints and Scope For Fisher folk Development through Microfinance	Fisheries College and Research Institute, Thoothukudi	14–15 February 2008
Dr.M.Kailasam, Senior Scientist		
State level seminar on the recent trends in Environmental Biotechnology	Jamal Mohamed College, Tiruchirapally, Tamil Nadu	13 March 2008
Chandrakala Memorial Lecture of Indian Science Academy, New Delhi	National Institute of Ocean Technology, Chennai	12 November 2007
Dr.(Mrs.)D.Deboral Vimala, Senior Scientist		
8th Asian Fisheries Forum	Asian Fisheries Society (Indian Branch), Kochi	20-23 November 2007
Dr.M.Shashi Shekhar, Senior Scientist		
8th Asian Fisheries Forum	Asian Fisheries Society (Indian Branch), Kochi	20-23 November 2007
International conference on emerging and re-emerging viral diseases of the tropics and the sub-tropics	New Delhi	11-14 December 2007
Dr.J.K.Sundaray, Senior Scientist		
Expert consultation meeting on Aquatic Animal Physiology	Central Institute of Fisheries Education, Mumbai	2-3 November 2007
Chandrakala Memorial Lecture of Indian Science Academy, New Delhi	National Institute of Ocean Technology, Chennai	12 November 2007
Dr.J.Syama Dayal, Senior Scientist		
Network Meeting on 'Finfish and shellfish nutrition'	ICAR, New Delhi	21-22 August 2007
Dr. K. Ambasankar, Senior Scientist		
Network Meeting on 'Finfish and shellfish nutrition'	ICAR, New Delhi	21-22 August 2007
Aqua India 2007	SAP, Chennai	28 -29 September 2007

Dr.M.Kumaran, Senior Scientist		
Aqua India 2007	Society of Aqua Professionals, at Chennai	28-20 September 2007
As Expert Member in the 'Scientific Advisory Council' of the Krishi Vigyan Kendra (KVK), TANUVAS, Kattupakkam	TANUVAS, Chennai	14 December 2007
International Conference on 'Bio-diversity Conservation and Management (BIOCAM-2008)'	Rajeev Gandhi Chair on Contemporary Studies, CUSAT, held at CMFRI, Kochi	3-6 February 2008
Dr.K.Ponnusamy, Senior Scientist		
Aqua India 2007	Society of Aquaculture Professionals, Chennai	28-29 September 2007
National Workshop on Development of strategies for domestic marketing of fish and fishery products	College of Fisheries and Professional Fisheries Graduates Forum (PFGF) Mumbai at Nellore.	7-8 February 2008
Orientation Workshop for FET Coordinators	NAARM, Hyderabad	6-7 March 2008
Final Workshop of the Study on 'Status of Shrimp Farming in Krishna District, Andhra Pradesh, India and plans for its Revival" at Machilipattinam	Bay of Bengal Programme (BOBP), Chennai	26 November 2007
Dr.T.K.Ghoshal, Senior Scientist		
Mid-term review meeting of ICAR Regional Committee II	CIFRI, Barrackpore	5 February 2008
Dr.A.Panigrahi, Senior Scientist		
International Symposium on "Management of Coastal Ecosystem: Technological Advancement and Livelihood Security"	Kolkata.	27-30 October 2007
Mid-term review meeting of ICAR Regional Committee II	CIFRI, Barrackpore	5 February 2008
Introductory Workshop of NAIP Project entitled "Enhancement of the productivity of degraded soil and water for sustainable livelihood security of the farming communities of the coastal region"	CSSRI, RRS, Canning Town, West Bengal	19 February 2008
National Seminar on Aquaculture with special emphasis on Mariculture: Problems and Prospects in West Bengal	Vidyasagar University, Midnapore	26-28 March 2008
Dr.(Mrs.)P.Nila Rekha, Senior Scientist		
8th Asian Fisheries Forum	Asian Fisheries Society, Indian Branch, Kochi	20-23 November 2007
Mrs. P.Mahalakshmi, Scientist (SS)		
8th Asian Fisheries Forum	Asian Fisheries Society, Indian Branch, Kochi	20–23 November 2007
Aqua India 2007	SAP, Chennai	28-29 September 2007

National seminar on "Three years after Tsunami: A new life for fisher communities"	The Hindu Media Resource Centre of M.S.Swaminathan Research Foundation (MSSRF) at MSSRF, Chennai	26 December 2007
Awareness programme on Mud crab culture and fattening through video-conferencing	M.S.Swaminathan Research Foundation, Chennai	4 June 2007
Dr. (Mrs.) M.Poornima, Scientist (SS)		
National conference on "Showcasing cutting edge science and technology by Indian women scientists"	Department of Science and Technology at Vignan Bhawan, New Delhi	8–9 March 2008
Dr.R.Saraswathi, Scientist (SS)		
Workshop on Research Techniques in Cyanobacteriology & Workshop on Bioinformatics for Cyanobacteriologists	Bharathidasan University, Tiruchirapalli, Tamil Nadu.	19–30 March 2007
Aqua India 2007	Society of Aquaculture Professionals, Chennai	28-29 September 2007
Mr. G.Biswas, Scientist		
National Symposium on "Ecosystem health and fish for tomorrow"	CIFRI and IFSI, Barrackpore	14-16 December 2007
Introductory Workshop of NAIP Project entitled "Enhancement of the productivity of degraded soil and water for sustainable livelihood security of the farming communities of the coastal region"	CSSRI, RRS, Canning Town, West Bengal	19 February 2008
Dr.S.Sivagnanam, Technical Officer (T-6)		
National conference on Biosecured aquaculture-an eco-friendly approach.	Fisheries College and Research Institute, Thoothukudi	28-29 June 2007
8th Asian Fisheries Forum	Asian Fisheries Society, (Indian Branch), Kochi	20-23 November 2007
Mr. S. Suburaj , Technical Officer (T-5)		
National Conference on "Biosecured Aquaculture an Eco-friendly approach"	TANUVAS, Thoothukudi	28 – 29 June 2007

Lectures delivered

Dr.A.R.Thirunavukkarasu, Head, FCD	Broodstock development and seed production of brackishwater fin fishes	CAS program on Broodstock development, management and Breeding Plans for quality seed production at CIFE, Mumbai	11 March 2008
	Delivered a talk on Recent advancement in the technologies for the coastal aquaculture of fishes	CAS program on Recent advances in aquaculture at CIFE, Mumbai	19 January 2008
	Species diversification in aquaculture.	Farmer's meet at Navsari, Gujarat	28 January 2008
	Seabass seed production and culture.	Training programme on Composite Fish culture, KVK, Puducherry	16 February 2008
	Environmental stressor in aquaculture	Seminar on Sustainable aquaculture and Rural Development, Bharathiar University, Coimbatore, Tamil Nadu	28 February 2008
Dr.S.M.Pillai, Principal Scientist	Diversification in shrimp aquaculture and biosecurity in shrimp seed production	CAS in Marine Biology, Annamalai University, Parangipettai	9 February 2008
Dr.G.Gopikrishna, Senior Scientist	Broodstock development, management and breeding plans for quality seed production	CAS Training Programme, CIFE, Mumbai	26 February to 17 March 2008
Dr.K.K.Krishnani, Senior Scientist	Bioremediation and technology commercialization	Kemin Asia Pvt. Ltd. Chennai	15th November. 2007
	Bioremediation of priority aquatic pollutants at 48th Annual Conference of Association of Microbiologists of India	IIT Chennai	18-21 December 2007
Dr. K. Ponnusamy Senior Scientist	Training on New dimensions in fisheries extension organised for Fisheries Extension officials sponsored by NFDB	MANAGE, Hyderabad	1-30 December 2007

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, 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 KVK, Krishnagiri Dist.
- Member, Task Force Committee on Fisheries Development Mission – T.N. 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, 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)
- Member, Expert Committee on Repositories & Terms of Reference of National Biodiversity Authority
- Chairman – Sub-committee for formulation of guidelines for farming of crabs, lobsters and seabass of Coastal Aquaculture Authority
- Chairman, Study group to carry out the risk analysis/assessment on the introduction of *L.vannamei* into India.
- Committee for protection of fish germplasm through registration and documentation, constituted by ICAR.
- Sub-Committee for studying the potential and viability of culturing endemic and exotic species, constituted by DAHD&Fy., Ministry of Agriculture.
- Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur
- Broad Subject Matter Area Committee for assisting National Core Group for restructuring of Masters' and Doctorate Course Curricula & Syllabi, CIFE, Mumbai.
- Committee to study various aquaculture standards for inclusion in National Programme for Organic Production (NPOP), constituted by National Steering Committee for Organic Products, APEDA.

- National Advisory Committee of the 8th Asian Fisheries Forum held during 20-23 November 2007 at Cochin.
- Member - Advisory Board - National Seminar on "Aquatic resources management for productivity enhancement" in College of Fisheries, CAU, Lembucherra, Agartala, during 8-9 March 2008.
- Sub-Committee to formulate guidelines for farming of *L.vannamei* and norms for setting up of Multiplication Centres for production and supply of *L.Vannamei.*
- Chairman – Sub-committee to frame guidelines for registration of PCR laboratories, Feed manufactures/ suppliers and dealers, constituted by CAA.

Dr. P. Ravichandran, Head, CCD

- Member Secretary, Coastal Aquaculture Authority, Ministry of Agriculture, Government of India during 26.11.2007 to 30.04.2008.
- Committee constituted for Risk Analysis study for the introduction and culture of *Litopenaeus vannamei* in India.
- Committee constituted for drafting specific Guidelines for the introduction and culture of *L. vannamei* in India.
- 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 facility.

Dr. A.R.Thirunavukkarasu, Head, FCD

- Member, Screening committee of National Biodiversity Authority, Chennai for recruiting group A, B and C posts.
- Member, Interview committee of National Biodiversity Authority, Chennai for recruiting group A, B and C posts.
- Member, Board of studies of Botany and Zoology (PG) at University of Madras, Chennai.
- Member, External Technical Committee for the Government of Tamil Nadu for marine fin fish hatchery
- Member, Interview committee of National Biodiversity Authority, Chennai.

Dr.S.M.Pillai, Principal Scientist

- Member, Selection committee for recruitment of Assistant Project Manager, TASPARC hatchery, MPEDA, Visakhapatnam.
- Member, Sub-committee to review the guidelines for regulating Coastal aquaculture annexed to Coastal aquaculture Authority Rules 2005.

Dr. S. A. Ali, Principal Scientist

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

Dr.M.Natarajan, Principal Scientist

- Member, Sub-group on Inland Fisheries/Aquaculture under West Bengal State Fisheries Commission
- Chairman, Best Thesis Award Committee of Professional Fisheries Graduate Forum, Mumbai.

Dr. M.Krishnan, Principal Scientist

- Member, Committee for revision of syllabus for M.F.Sc. and Ph.D. (Fisheries Economics) of the Fisheries College and Research Institute, Tuticorin and Central Institute of Fisheries Education, Mumbai
- Member, Board for assessment of performance of teaching professionals in Karnataka Animal and Fisheries Sciences University, Bidar, Karnataka, India
- Member, Co-ordination committee, involved in the discussion, preparation of document and participated in the consultations with the Estimates Committee of Loksabha and ICAR held at hotel Le-royal meridian, Chennai during 2-3rd November, 2008.

Dr. K.K.Krishnani, Senior Scientist

- Protocol officer for Hindi Parliamentary Committee's visit to Chennai during 11-12 July 2007

Dr.M.Muralidhar, Senior Scientist

- Member of the team to inspect the facilities of M/S Sharat Industries Ltd., along with CAA.
- Committee member of the Institute to evaluate the present and revise the guidelines of Coastal Aquaculture Authority for brackishwater farming
- Organizing Secretary of the Indo-US workshop on "Brackishwater aquaculture production systems and environmental management" held at CIBA during 10-11, July 2007.

Dr. M.Kumaran, Senior Scientist

- Expert representing the University of Madras in the Board of Studies of Madras Christian College, Tambaram, Chennai, on the subject 'Marine Studies and Coastal Resource Management' for 2007-2009.

Team of Scientists

- Dr.T.C.Santiago, Principal Scientist , Dr. N. Kalaimani, Principal Scientist , Dr. S.V.Alavandi , Senior Scientist and Dr. M.Poornima, Scientist (SS) Inspected quarantine of *L.vannamei* brood stock imported by M/s.BMR, and M/s. Sharath Industries..
- Dr.T.C.Santiago, Principal Scientist, Dr. N. Kalaimani, Principal Scientist and Dr. S.V.Alavandi , Senior Scientist inspected quarantine of *P.monodon* post larvae imported by Moana Technologies, India.

15. WORKSHOPS / SEMINARS / MEETINGS ORGANISED BY THE INSTITUTE

TRAINING WORKSHOPS

The following workshops were organised by the Institute at Chennai:

Sl. No.	Programme	Date
1	Indo-US workshop on "Brackishwater aquaculture production systems and environmental management"	10-11 July 2007
2	AP Cess Fund project workshop on "Impact assessment of fisheries research in India"	2-3 August 2007
3	ICAR-NACA workshop on "Aquatic epidemiology, surveillance and emergency preparedness"	3-7 September 2007
4	Hindi workshop on "Official language rules, regulations, notings and draftings"	15 June 2008
5	Brainstorming workshop on "Prospects of Asian seabass farming"	29 August 2008

Brainstorming workshop on Prospects of Asian seabass farming

The Institute organised the following meetings:

- Project discussion meeting on ICTs for responsible aquaculture development providing safety and quality produce to the global consumers, at CIBA, Chennai, with the participation of CIFA & CIBA Scientists and Officials from NIC, New Delhi on 5 April 2007.
- Sub-Committee meeting to formulate guidelines for farming of mud crabs, lobsters and seabass, at CIBA, Chennai on 12 April 2007.
- Meeting of the hatchery owners and farmers representatives, organized by Prawn Farmers Federation, at CIBA, Chennai on 10 May 2007.
- NAIP - Project development meeting with stakeholders and partners of both private and public sectors, at CIBA, Chennai during 6-7 June 2007.
- Awareness meeting on CIBASTIM at Ponneri on 25 September 2007
- Brackishwater aquafarmers' meet at Ratnagiri along with Dr.B.S.Konkan Agricultural University, Ratnagiri on 4 October 2007
- Inauguration of the IP based Video Conferencing by the Director General, ICAR, followed by discussion with the Directors of ICAR Institutes on 30 October 2007
- Ring test for PCR intercalibration among the various PCR laboratories in India at CIBA, Chennai in November 2007.
- National Science Day was celebrated at CIBA, Chennai on 12 February 2008.

CIBA FOUNDATION DAY

- CIBA Foundation Day was celebrated on 12 June 2007 Dr. Gugan Jeyaraman, Professor from IIT, Madras delivered a talk on "Biotechnology in the Post-Genomics Era: Opportunities and Challenges". The retired scientists of CIBA were honoured.

FARMERS' MEET

A farmers' meet was conducted at Kakdwip Research Centre (West Bengal) on 4th July 2007 to popularize CIBA technologies to the local brackishwater fish farmers and to understand the current trends of brackishwater aquaculture in West Bengal. 120 farmers from Sagar, Namkhana, Pathar Pratima, Mathurapur and Kakdwip blocks participated in this meet.

Dr. M. Natarajan, Principal Scientist and Officer-in-Charge, Kakdwip Research Center of CIBA welcomed the farmers and other delegates. The meet was inaugurated by Shri Sukumar Bandyopadhaya, Prinicipal (Retd.), Sagar Mahavidyalaya, Sagar, 24 Parganas (South) and he spoke about essentialities of aquaculture research. Dr. S. M. Pillai, Principal Scientist, CIBA, Chennai delivered the presidential address. Dr. Parimal Paruya, Marketing and Recovery Officer, State Bank of India, Kakdwip and Dr. Kiran Lal Das, District Fisheries Officer (Marine), Diamond Harbour, W. Bengal offered facilitations.

In the technical sessions Dr. M. Natarajan, Principal Scientist, Dr. A. Panigrahi, Senior Scientist, Dr. T. K. Ghoshal and Dr. Debasis De, Scientists (Senior Scale) delivered lectures on different aspects of brackishwater aquaculture.

Question-answer session in the farmers' meet

Paticipants in the farmers'meet

Mr Tapan Mondal, Fish feed entrepreneur from Kamarpukur, Hooghly, West Bengal who has launched the feed "AQUASTAR" with help of CIBA technology explained the role of CIBA in popularising shrimp feed in West Bengal. Mr Balai Das, Progressive brackishwater fish farmer shared his experience about the success of paddy cum fish farming at Akshaya Nagar, Kakdwip with the technical support of CIBA

An open house discussion on crab, seabass, pearlspot and milk fish culture, white spot disease problem and on farm feed preparation was also organized. The participants then witnessed the harvest of banana shrimp *Fenneropenaeus merguiensis* and they were also shown the cage/pond culture of *Scylla serrata*. The entire proceedings of the farmer' meet was covered by Kolkata Doordarshan Kendra and Kakdwip based audio- visual media.

EXHIBITION

The Kakdwip Research Centre, CIBA participated in the following exhibitions

- Aqua Exhibition'07 organised by IIT, Kharagpur, West Bengal during 28-29 September, 2007.
- National Symposium cum Exhibition on Ecosystem Health and Fish for Tomorrow organized jointly by CIFRI and Inland Fisheries Society of India at CIFRI, Barrackpore during14-16 December, 2007.
- 8th Asian Fisheries Forum at Kochi during 20-23 November 2007.

Dr. Mangala Rai, Secretary, DARE & Director General, ICAR at CIBA stall during Asian Fisheries Forum Exhibition

Dr. A.G. Ponniah, Director, CIBA Interacting with visitors in CIBA stall

16. VISITORS

Following were the dignitaries visited CIBA:

Name of the Visitor	Date of Visit
Mr.N.Narasimha Rao, IAS, Commissioner of Fisheries, Govt. of Andhra Pradesh, Hyderabad	09.04.2007
Dr.C.D.Mayee, Chairman, ASRB, New Delhi.	12.04.2007 & 14.12.2007
Dr.G.D.Chandrapal, DAHD & Fy., Mr.S.Santhanakrishnan, Maritech, Chennai, Mr.Ajit Sinha Patil, Pancham Aqua, Mumbai.	12.04.2007
Dr.Dhirendra Kumar, Principal Scientist, CIFRI, Allahabad, Dr.K.Venkataramani, Dean, Fisheries College & Research Institute, Thoothukudi, Mr.V.S.Subramanian, FAO, NAARM, Hyderabad, Mr.Ajit Sinha Patil, Pancham Aqua, Mumbai.	27.04.2007
Mr.M.Buddha Prasad, Hon'ble Minister,AHD & F, Govt. of Andhra Pradesh, Dr.Priyadarshini Dash, IAS, Special Chief Secretary, AHD & F. Shri.N.Narasimha Rao, IAS, Commissioner of Fisheries, Dr.L.Mohan, Director of Animal Husbandry Andhra Pradesh.	01.06.2007
Mr.Joss Brooks, Pitchandikulam Forest Consultants, P.O.Auroville, Tamil Nadu.	15.06.2007
Dr.S.Ayyappan, Deputy Director General (Fy.), ICAR, New Delhi.	05.07.2007
Dr. Claude E. Boyd, Butler Cunnigham Eminent Scholar and Dr.David B. Rouse, Head, Department of Fisheries & Allied Aquacultures, Auburn University, Alabama, USA.	09.07.2007 to 12.07.2007
Vietnamese Delegation, Vietnam	09.07.2007
Dr.E.G.Silas, Former Vice-Chancellor, Kerala Agricultural University, Trichur	09.07.2007
Dr.M.V.Gupta, World Food Prize Winner, Hyderabad	06.11.2007
Dr.P.Natarajan, Professor, Rajiv Gandhi Chair, School of Environmental Studies, Cochin University of Science & Technology, Cochin; Dr.Apurba Ghosh, Ex-Principal Scientist & Project Coordinator, All India Coordinator Research (ICAR) Project, Kolkata, Dr.M.S.Shaila, Professor, Indian Institute of Sciences, Bengaluru, Dr.H.C.Joshi, Professor, Department of Environmental Science, Indian Agricultural Research Institute, New Delhi and Mr.Sudarsan Swamy, President, All India Shrimp Hatcheries Association, Visakhapatnam	24-25 Jan.2008
Mr.Shyam P Kunde, Director, Kaushalya Aqua, Maharashtra	29.01.2008
Mr. S. Chakraborty, Special Secretary, Department of Fisheries, Govt. of West Bengal	06.02.2008

17. PERSONNEL

DIRECTOR: DR.A.G.PONNIAH

HEADQUARTERS

SCIENTIFIC PERSONNEL

HEADS OF DIVISION

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

PRINCIPAL SCIENTISTS

Shri. M. Kathirvel
Dr. S. Kulasekarapandian
Dr. S.M. Pillai
Dr. T. C. Santiago
Dr. Syed Ahmed Ali
Dr. C. P. Rangaswamy
Dr. B. P. Gupta
Dr. N. Kalaimani
Dr. M. Natarajan
Dr. M. Krishnan
Dr. K. P. Jithendran w.e.f. (27.07.2006)
Dr. Azad Ismail Saheb (VRS on 20.8.2007)

SENIOR SCIENTISTS

Dr. G. Gopikrishna
Dr. C. Gopal
Dr. T. Ravishankar
Dr. V. S. Chandrasekaran
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. Deboral Vimala
Dr.(Mrs.)Shiranee Periera
Dr. M. Shashi Shekar
Dr. S. Kannappan
Dr. K. Ponnusamy
Dr. J.K. Sundaray
Dr.(Mrs.) P. Nila Rekha (from 03.12.2006)
Dr. K. Ambasankar (from 04.12.2006)
Dr. Syama Dayal (from 03.02.2007)
Dr. M. Kumaran (from 26.02.2007)

SCIENTISTS (SENIOR SCALE)

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

SCIENTIST

Dr. V.K. Katenani (joined on 18.10.2007)

TECHNICAL OFFICERS

T(7 – 8)

Shri R. Elankovan

(T – 6)

Dr. S. Sivagnanam
Shri D.Raja Babu

(T – 5)

Shri M. Shenbagakumar
Shri R. Puthiyavan
Shri. V. R. SenthilKumar
Shri M.G. Subramani
Shri M. Gopinathan Nair

(T – 4)

Shri S. Rajukumar
Shri Joseph Sahayarajan
Shri S. Stanline
Dr. A. Nagavel
Shri R. Subburaj
Shri S. Rajamanickam
Shri S. Nagarajan
Shri R. Rajashekaran

(T – 2)

Shri N. Ramesh
Shri S. Saminathan
Shri C. Ananthanarayanan
Shri N. Jagan Mohan Raj
Shri K. Paranthaman
Shri R. Balakumaran
Shri D. M. Ramesh Babu
Shri G. Thiagarajan
Shri K. Karaian

(T – 1)

Shri. K.V. Delli Rao

ADMINISTRATION AND FINANCE

Administrative Officer

Shri M.S.N. Murty

Finance & Accounts Officer

Shri .K.U.K. Menon (retired on 31.01.2008)
Shri. S. Krishnaswamy (joined on 13.02.2008)

Assistant Administrative Officer

Shri R.G. Ramesh

Junior Accounts Officer

Mrs. K. Nandhini

Assistant

Shri R. Kandamani
Smt. V. Usharani (w.e.f. 02.08.2004)

Personal Assistant

Smt.S.Nalini
Shri. K.G.Gopala Krishna Murthy

STENOGRAPHER,

Grade – III

Smt. K. Hemalatha
Smt. K. Subhashini

Upper Division Clerk

Shri S. Pari
Smt. E. Amuthavalli
Shri A. Manoharan
Shri A. Sekhar
Smt. E. Mary Desouza (w.e.f. 12.10.2007)

Lower Division Clerk

Shri P. Srikanth
Smt. R. Vetrichelvi
Shri. B.Palanivelmurugan
Smt. M.Mathuramuthu Bala
Smt. B. Prasanna Devi
Shri. R. Kumerasen

SUPPORTING STAFF

S.S.Gr.III

Shri P. Arumugam

S.S.Gr.II

Shri M. Santhosam
Shri N. Harinathan
Shri V. Jeevanantham
Shri K. Mariyappan
Smt. S. Shanthi
Shri K. Nithyanandam
Shri V. M. Dhanapal
Shri M. Subramani
Shri V. Kumar
Shri E. Manoharan

S.S.Gr.I

Shri C. Saravanan
Shri S. Kuppan
Shri M. Pichandi
Shri S. Selvababu
Shri D. Senthil Kumaran
Shri C. Raghu
Shri P.G. Samuvel
Shri M. Sakthivel
Shri R. Mathivanan
Shri A. Paul peter
Shri R. Indra Kumar
Shri G. Dayalan
Shri Kanaka Prasad
Smt. S. Premavathi
Shri. M. Sampath Kumar
Shri. J. Murugan (joined on 31.08.2007)

KAKDWIP RESEARCH CENTRE

Scientific Personnel

Senior Scientists

Dr. A. Panigrahi, OIC (up to 15.02.2008)
Dr. T.K. Ghoshal, OIC (from 16.02.2008)

Scientist (Senior Scale)

Dr. Debasis De

Scientists

Dr. R.Ananda Raja
Shri. Gouranga Biswas

Technical Personnel

(T – 5)

Shri. B.B. Roy (retired on 31.1.2008)

(T – 2)

Shri. P.S. Samanta
Smt. Chanda Mazumdar

ADMINISTRATIVE STAFF

Steno. Gr.II

Shri. S.K. Halder

Assistant

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

Upper Division Clerk

Smt. A.R. Panigrahi

SUPPORTING STAFF

S.S.Gr.IV

Snri. N.C. Jana (retired on 31.1.2008)
Shri. L.C. Manna (retired on 30.9.2007)
Shri. Prakash Ch. Saha
Shri. M.N. Biswas (VRS on 10.11.07)
Shri. A.K. Biswas

Shri. N.N. Mondal
Shri. N.C. Samanta
Shri. R.B. Das
Shri. G.H. Jana
Shri. S.D. Betal

S.S.Gr.III

Shri. K.P. Mondal
Shri. Pranesh Ch. Saha
Shri. Phani Gharami

S.S.Gr.II

Shri. P.P. Halder
Shri. A. Naskar
Shri. R.K. Roy
Shri. N.N. Jana
Shri. A. Gharami
Shri. K.P. Naskar
Shri. B.C. Paik
Smt. L.R. Bhuiya

S.S.Gr.I

Shri. U.K. Santra
Shri. B.L. Dhannuk
Shri. P.C. Das

ERSTWHILE PURI RESEARCH CENTRE STAFF REDEPLOYED TO CIFA, BHUBANESWAR

Technical Assistant

T – 2

Shri. P.C. Mohanty

SUPPORTING STAFF

S.S.Gr.III

Shri. Shyama Bhoi, (retired on 30.11.2007)
Shri. Baman Jally
Shri. M.C. Behera
Shri. Sudarsan Naik

S.S.Gr.II

Shri. Bijoy Bhoi,
Shri. Balaram Das
Shri. K.C. Samal
Shri. Maharaja Majhi
Shri. Premananda Bisoi

18. INFRASTRUCTURE DEVELOPMENT

The following major works were carried out during the year:

CIBA Headquarters, Chennai.

- PVC coated chain link fencing in northern side of the approach road to the Institute
- Wet laboratory / challenge test facility
- Established the Video Conferencing facility

Muttukadu Experimental Station of CIBA, Muttukadu

- Fresh water distribution system from main building to shrimp / fish hatchery
- Underground sump for sea water storage (25 t capacity)

19. LIBRARY, INFORMATION AND DOCUMENTATION

The Library acquired 174 new books during 2007-08. Subscriptions were made for 26 foreign journals for headquarters and 30 Indian journals for both headquarters and KRC library The libraries as on 31.03.2008 had a total holding of 2150 books, 1530 journal back volumes, 670 reprints / photocopies of papers, 1800 Reports / Bulletins and 4010 miscellaneous publications.

Exchange Services

The Library maintained exchange services with national and international organizations of mutual interest. It also maintained free mailing of Institute's Annual Report and other publications to research organizations, universities and other agencies.

Information Services

The library section extended information services to the scientific personnel of research organizations, university / college students, research scholars and other agencies / individuals through reference of books and journals. It also extended borrowing privileges to the scientists, staff and research scholars of CIBA.

Publications

Many new facilities have been created in the library for the better dissemination of scientific information for the advantage of its users. These are briefly outlined below:

On Line Access to Journals

LAN connectivity with internet facility was created in the library.

Free online access was provided by some foreign publishers to the subscribed journals. The following journals are available online.

1. Aquacultural Engineering
2. Aquaculture
3. Aquaculture International
4. Aquaculture Nutrition
5. ASFA Online Search
6. Asian Fisheries Science
7. Diseases of Aquatic Organisms
8. Fish and Fisheries
9. Fish Physiology and Biochemistry
10. Fisheries Science
11. Journal of Experimental Biology and Ecology
12. Journal of Fish Diseases
13. Journal of Marine Science and Technology
14. The Biological Bulletin

CD - ROM Databases

Library procured the following CD-ROMs/VCDs.

1. Fish Base 2004 - a publication of World Fish Centre
2. Reference Manager Version 11– an online search tool, reference database and bibliography maker
3. Manage Stress
4. Project Management Titles
5. Motivation & Teamwork
6. Presentation Skills
7. Effective use of time (VCD)
8. Communication (VCD)
9. Maps of India

4. Current Contents

The "Current Contents Service on Brackishwater Aquaculture" with the contents of foreign journals subscribed by CIBA, was compiled twice a year in the form of print and PDF versions. The compiled materials were communicated to the scientists in KRC of CIBA through e-mail.

CIBA - Institutional membership in other libraries

The Institute has renewed its membership to libraries of esteemed institutes like Indian Institute of Technology Anna University, Madras University and Central Leather Research Institute in Chennai to get access to the literature and other resources available in those libraries.

OTHER SERVICES

The Newsletters of NACA and other important publications of FAO available in electronic form were downloaded regularly and sent to the scientists through e-mail for their ready reference. These pdf files were also stored in local site for future reference.

The library also provided reprographic service (photocopying) to its users when needed. In addition to the Institute's scientists and staff, research scholars and students from several universities / colleges and research institutes, farmers and members from NGOs regularly visited CIBA library for reference work on brackishwater aquaculture and allied subjects.

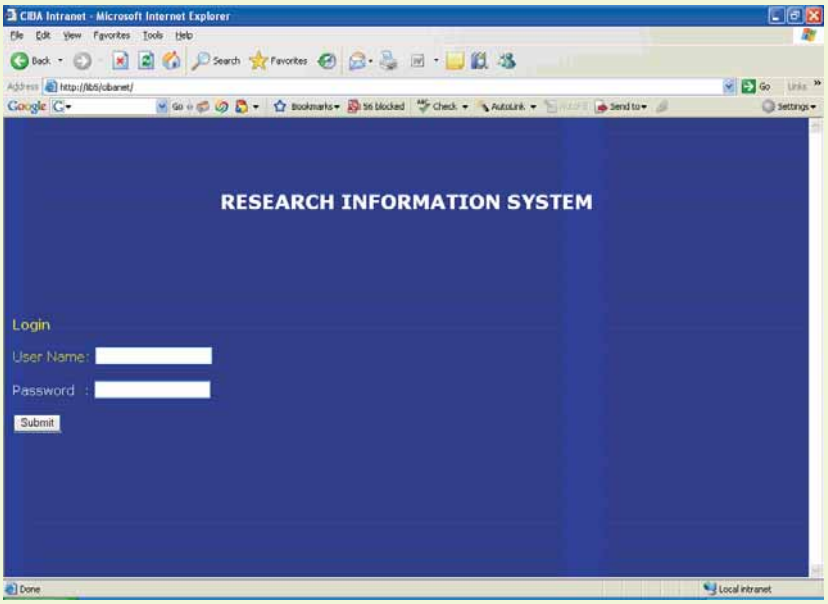
Hon'ble Shri. Mandali Budda Prasad, Minister of Fisheries, Govt. of Andhra Pradesh at CIBA library

Dr. T.P. Trivedi, ADG (ARIS) & Director, DIPA and Shri Hans Raj, Information System Officer, DIPA, ICAR, New Delhi at CIBA the library

RESEARCH INFORMATION SYSTEM (RIS)

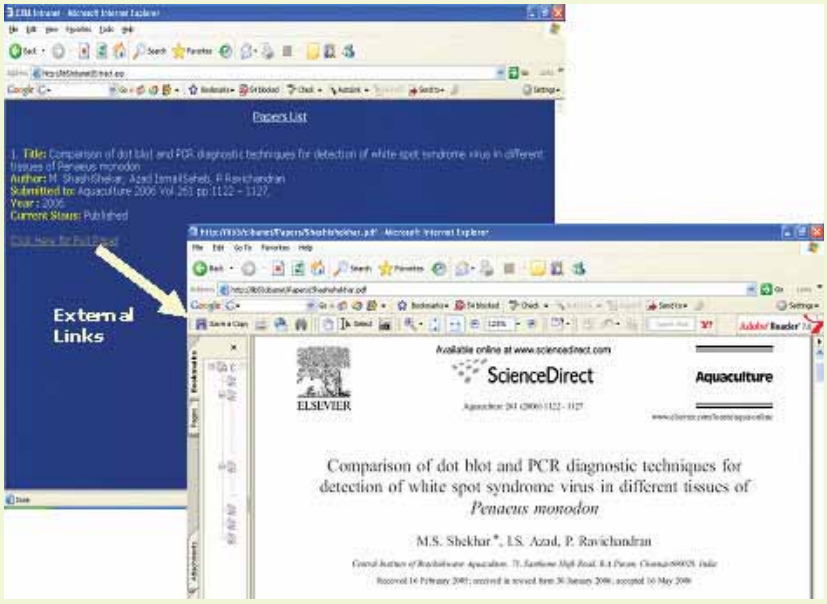
The Research Information System (RIS) is an application software / tool used to store and retrieve the information of all research papers, projects proposals and reports and special publications. The software / tool have been developed as an intranet facility using ASP as front end and MS-Access as back end with user friendly modules and it can be viewed like any other WebPages in the Internet Explorer.

The RIS contained three different search modules for research papers, projects proposal and reports and special publications. The search module was used to search and retrieve original



Front page of Research Information System

documents in PDF format based on user's keyword. The keywords can be combined with AND or OR logical operators. The keyword can be used to search either for all the fields or selected fields. It also contains advanced search option, which is useful when the user is uncertain about the information in specific field. The retrieved documents can be displayed on separate screen and, an external link can be provided for viewing the full selected documents. The RIS was demonstrated to the staff members of CIBA.



Retrieved document displayed on separate screen

2. प्रबंधक निष्कर्ष

खारापानी परयुक्त मछलियों के लिए एक प्रौद्योगिकी-आर्थिकी एवं व्यावहारिक तथा टिकाऊ पालन व्यवस्था का विकास करने और उक्त प्रौद्योगिकियों का हस्तांतरण विभिन्न पणधारियों के लिए लाभदायक बनाना ही केन्द्रीय खाराजलजीव पालन अनुसंधान संस्थान (सीबा)का महत्त्वपूर्ण उद्देश्य है। वर्तमान में संस्थान, पश्चिमी सफेद झींगा मछली *लिटोपेनेयिय वेनेमेई* शामिल करने में खतरा विश्लेषण अध्ययन और कृषि मंत्रालय, भारत सरकार और राष्ट्रीय मात्स्यिकी विकास बोर्ड के लिए *पेनेइयस मॉनोडॉन* के SPF ब्रूडस्टॉक विकास पर अध्ययन कर रहा है। वर्ष 2007-08 के दौरान संस्थान में किए गए महत्त्वपूर्ण उपलब्धियों काविवरण इस प्रकार है :-

- तालाबों में टाइगर झींगा *पेनियस मॉनोडॉन* और बनाना झींगा *फेन्नरोपेनियस मेर्ग्युइन्सिस* को प्राकृतिक रूप से परिपक्व करने और व्यावहारिक स्पॉनिंग के अनुसंधान कार्य सफल हुए। हैचरी के नियंत्रित परिस्थितियों के अंतर्गत *मॉर्सुपेनियस यापोनिकस* कुरुमा झींगा और *बनाना झींगा* को प्राकृतिक रूप से परिपक्व करने के अनुसंधान कार्य सफल हुए हैं ।

- संस्थान के तालाब में कुरुमा झींगा और किसान के तालाब में ***बनाना*** झींगा का उत्पादन क्रमश: 987 किलो/हेक्टेयर क्षेत्र और 903 किलो/हेक्टेयर रहा।

- काक्द्वीप में दो तालाबों में 6 no./m^2 की सघनता में *एफ. मेर्ग्युइन्सिस* का पालन भी किया गया। इस संदर्भ में 172 और 155 दिनों के पालन में 381 kg/ha और 525 kg/ha कुल उत्पादन प्राप्त हुआ है। झींगों के में 22g का अंतिम साइज़ प्राप्त हुआ और उनमें क्रमश: 28% और 40% की दीर्घकालिकता देखी गई।

- *स्कैल्ला सेर्रेटा* नामक मिट्टी के केंकड़े के ग्रोआऊट पालन में बड़ी सीपी के खाद्य पदार्थ के साथ 0.7 no./m^2 में 45 दिनों के पालन में 62.5g/प्रतिमाह की वृद्धि देखी गई। इनमें 64.8%.की दीर्घकालिकता पाई गई।

- *स्कैल्ला ट्रैंक्वेबैरिका* नामक मिट्टी के केंकड़े की बड़ी प्रजातियों का पालन मिट्टी के पतीलों में किया और बहुत ही छोटे 4700 केंकड़ों को मिट्टी के पतीलों में

रखा गया। 45 दिनों की अवधि में केंकड़े की औसत साइज़ 48.1mm हो गई, वज़न 21g पाया गया और उनमें 38% की दीर्घकालिकता पाई गई।

❖ अनुसंधान कार्यक्रम के एक भाग के रूप में *स्कैल्ला ट्रैंक्वेबैरिका,* मिट्टी के केंकड़े के नर्सरी फेज़-II में प्रौद्योगिकी के मान्यकरण में यह पाया गया कि तालाबों में बड़ी सीपी और व्यर्थ पदार्थ को खाद्य पदार्थ बनाते हुए 45 दिनों की पालन अवधि में (2-5 no./m^2) के निम्न और (13-19 no./m^2) की उच्च स्टॉकिंग सघनता में किए गए प्रायोगिक कार्यों में वृद्धि में कोई विशेष बढ़ोतरी नहीं देखी गई। तथापि, निम्न सघनता (45%) और उच्च सघनता (34%) की स्थितियों में इनकी औसत दीर्घकालिकता में काफी फर्क देखा गया।

❖ *पी मॉनोडॉन* के आनुवंशिक सुधार पर भारतीय-नॉर्वे सहयोग परियोजना के अंतर्गत आयोजित एक कार्यशाला में नॉर्वे प्रतिभागियों ने भाग लिया जिसमें इसकी विभिन्न प्रजातियों पर इकट्ठा किए गए डेटा में चुनौती परीक्षण और वाणिज्यिक प्रजनन का विश्लेषण किया गया। इन परिणामों से यह पता चलता है कि फसल के दौरान इन प्रजातियों में आनुवंशिक भिन्नताओं के कारण उनके शारीरिक वज़न और तालाबों में उनकी आम दीर्घकालिकता में काफी भिन्नता देखी गई। WSSV के प्रति दिखाए गए प्रतिरोध हेतु आकलित हेरिटबिलिटी (~ 0.01) बहुत कम था और विश्लेषण में WSSV के प्रति दिखाए गए प्रतिरोध के कारण कोई विशेष आनुवंशिक भिन्नताएँ नहीं दिखाई दीं। परिणामों से यह पता चलता है कि चयनित कार्यक्रम को और आगे बढ़ाया जा सकता है और आगे के परिणामों में वृद्धि में काफी प्रगति देखी जा सकती है।

❖ वायुशिफों की वर्तमान स्थिति और उनके नुकसान के कारणों की वर्तमान स्थिति निर्धारित करने के लिए IRS LISS III डेटा का इस्तेमाल करते हुए तमिल्नाडु के पुन्नकयल वायुशिफों में स्थित भूमि प्रयोग के पैटर्न को मैप किया गया और वायुशिफों की वर्तमान स्थिति का विश्लेषण किया गया।

❖ नियंत्रित परिस्थितियों के अंतर्गत पानी के नियमित बदलाव में 2-10 kg साइज़ और 5% के शारीरिक वज़न वाले सीबॉस के 70 कैद ब्रूडस्टॉक को रखा गया। मछली सभी महीनों में दफनाए जाने की स्थिति में पाए गए और 15 ppt के निम्न सलाइन स्थिति में भी दफनाए स्थिति में पाए गए। धीरे धीरे पानी की

सलाइनिटी को 28±2 ppt तक बढ़ाने से 6 मामलों में अक्तूबर-नवंबर के महीनों में स्पॉनिंग दिखाई दी। कुल 10 प्रजनन के प्रयोग चलाए गए और 3.94 लाख फ्रई पैदा किए गए।

- तैयार किए गए खाद्य पदार्थ के खाना पर 200 - 2000 no./m^3 की सघनता में 1.0 cm के स्टॉक में सीबॉस फ्रई के नर्सरी पालन में नर्सरी की टंकियों में 43 - 78% की दीर्घकालिकता देखी गई, हपस में 81 - 90% की दीर्घकालिकता और हैचरी टंकियों में 23 - 74% की दीर्घकालिकता पाई गई।

- नियंत्रित प्रजनन प्रयासों के लिए ब्रूडस्टॉक के विकास हेतु तैयार किए गए खाद्य पदार्थ के खाना पर नियंत्रित परिस्थितियों में 2 – 4 kg साइज़ के 30 दुधिया मछलियों को 3% के शारीरिक वज़न के दर पर रखा गया।

- विभिन्न सघनताओं में संस्थान के मुट्टुकाडु और काक्द्वीप के तालाबों में और तमिलनाडु के तम्बिकोट्टै में सीबॉस का ग्रोआऊट पालन किया गया और इसके परिणाम बहुत ही अच्छे रहे। संस्थान के तालाब और काक्द्वीप में स्थित किसान तालाबों में दुधिया मछली पालन भी शुरू किया गया।

- पहली बार *मुगिल सिफेलस* की परिपक्वता कैद स्थिति में पाई गई और हॉमोर्नल प्रकलन के माध्यम से स्पॉनिग किया गया। 30 दिनों की अवधि के बाद इल्लियों का पालन किया गया और इनका पालन अभी जारी है।

- जर्मप्लाज़म कैटलॉगिंग कार्यक्रम तथा देश में मछली और सीपीदार मछली स्रोतों के संरक्षण के एक भाग में पुलिकट और काक्द्वीप तालाबों में किए गए मछली जैव-वैविध्यता निर्धारण से यह पता चला कि परयुक्त मछलियों के लिए 56 प्रजातियों की संख्या पाई गई और पुलिकट तालाब में क्रस्टीशियन के 15 तथा काक्द्वीप में क्रस्टीशियन की 11 और परयुक्त मछलियों के लिए 74 प्रजातियाँ पाई गईं।

- अक्सर प्रकाश जीवाणुओं (LB) के कारण कई झींगा हैचरी बंद हो गए जिससे काफी आर्थिक हानि हुई है। पानी के स्रोत, रेत फिल्टर करनेवाला कागज़, नॉउप्लिस, ज़ोइया, मइसिस, झिल्ली पश्चात् पालन टैंक, परिपक्वन और स्पॉनिंग

के टैंक, ऑर्टमिया हैचिंग टैंक और एल्गल पालन टैंक पर आधारित एक विस्तृत अध्ययन के बाद यह निश्चित है कि झींगा ब्रूडर तथा परिपक्वन टैंक और स्पॉनिंग टैंक ही प्रकाश जीवाण्विक (प्रकाश के असर में आनेवाले जीवाणु) रोग के मूल स्रोत हैं।

- "ढीली सीपी स्थिति (LSS)" में एक विषाणु जैसे रोग पैदा करनेवाले एजेन्ट पाए गए और यह एक ऐसा रोग है जो भारत के किसानों में आर्थिक हानि पैदा कर रहा है। ट्रांसमिशन इलेक्ट्रॉन माइक्रोस्कोप परीक्षण और न्यूक्लिक अम्ल विश्लेषणों से यह पता चला है कि शुद्ध करने के एजेन्टों में विषाणुओं की प्रवृत्ति है। 'LSS' में इस विषाणु प्रवृत्ति के एजेन्टों की उपस्थिति, LSS प्रभावित झींगों से अलग किए जाने और स्वस्थ टाइगर झींगों में शुद्ध विषाणु जैसे एजेन्टों के साथ डाले जाने पर पता चला है।

- अत्यंत विपरीत विभिन्न पर्यावरणों में लगभ्र सौ जीवाणुओं को अलग किया गया और इकट्ठे किए गए जीवाणुओं को राष्ट्रीय कृषि प्रधान सूक्ष्म जीवाणु, मॉऊ में जमा किया गया है।

- उड़ीसा और पश्चिमी बंगाल के पश्चिमी तटवर्ती प्रदेशों में तथा गोआ और कर्नाटक के पूर्वी तटवर्ती प्रदेशों में खारापानी में पले झींगों में रोग के प्रभाव से आर्थिक हानि के प्रभाव का सर्वेक्षण किया गया। उत्पादन में हुई हानि 14,600 टन प्रति वर्ष बताई गई है और इससे 486.62 करोड़ रपयों की आर्थिक हानि देखी जाती है।

- वेट प्रयोगशाला प्रयोगों से यह सबूत मिलता है कि प्रभावित केंकडों से ही WSSV सहवास और मौखिक चारे के माध्यम से ही फैला है।

- एक संवेदनशील और सही आण्विक किट का विकास किया गया है और जलीय एवं कृषि पर्यावरण और वाणिज्यिक जैवसंवर्धकों में होनेवाले कीमोऑटोट्रॉपिक अमोनिया ऑक्सीडाइजिंग जीवाणुओं (AOB)की पहचान करने के लिए मान्यीकरण किया गया। *AmoA* का सीक्वेन्स किया गया है और जेनबैंक में रिलीज़ किया गया है।

- ❖ विनाइट्रिकारक जीवाणुओं के लक्षणों की पहचान की गई है जिसके लिए विनाइट्रिकारण के अंतिम स्तर में नाइट्रस ऑक्साइड को नाइट्रोजन तक कम करने के कैटेलिसिस में फंक्शनल *जीन-नाइट्रस ऑक्साइड रिडक्टैज़ जीन* (*nosZ*) को सीक्वेन्स किया गया और जेनबैंक में रिलीज़ किया गया।

- ❖ 8 हफ्तों के खिलाने के प्रयासों के परिणामों से यह पता चलता है कि वृद्धि और FCR पर समझौता किए बिना मछली के तेल के स्थान पर वनस्पति के तेलों का प्रयोग किया जा सकता है।

- ❖ नर्सरी में ऐशियाई सीबॉस इल्लियों में माइक्रो डायटों की परीक्षा करने के लिए प्रायोगिक कार्य किए गए और निम्न लिपिड डायट के प्रयोग से हुई शारीरिक वज़न की वृद्धि की तुलना में उच्च लिपिड माइक्रो डायटों के प्रयोग से उनके शारीरिक वज़न (1.83g बनाम 1.51g) में वृद्धि पाई गई। स्वच्छ पानी में माइक्रो डायटों के प्रयोग से काफी अधिक वृद्धि दिखाई दी और यह वृद्धि सामान्य नमक के 2% तक मिलाने तक देखी गई।

- ❖ कार्बनिक झींगा फीड में पौधे प्रोटीन स्रोत के औचित्य का विश्लेषण करने के लिए तेल बीजों के केक, सोयाबीन केक के 40-42% के अपरिपक्व प्रोटीन(CP) का प्रयोग किया गया और यह पाया गया कि वे कार्बनिक झींगा डायट में मछली मील के मुख्य भाग को प्रतिस्थापित किया जा सकता है।

- ❖ टाइगर झींगा पर यार्ड प्रायोगिक कार्यों में फीड प्रयोगों से यह पता चला कि वृद्धि और FCR पर समझौता किए बिना मछली खाद्य पदार्थों के स्थान पर अलग अलग रूप से 15% के स्तर पर गेहूँ ग्लूटन को शामिल किया जा सकता है और 10% के स्तर पर मक्कई ग्लूटन को शामिल किया जा सकता है।

- ❖ छोटे *एम. यापोनिकस* के दस परिवारों को 500 l FRP टंकियों में पाला जा रहा है। आठ जंगली और दो आंतरिक रूप से पाले गए लगभग 532 झींगों को दिखाए जानेवाले एलास्टोमर टैग लगाए गए। उक्त टैग युक्त झींगों में से 365 को 600m^2

केतालाब में स्टॉक किया गया। इन झींगों का शारीरिक वज़न 23.20 g हो गया जो उनके शारीरिक वज़न से 54% ज्यादा था।

- ❖ 120 टैग किए गए झींगों पर WSSV के चुनौती परीक्षण किए गए। दीर्घकालिकता डेटा से यह साबित होता है कि परिवारों में WSSV प्रतिरोध क प्रति कोई विशेष भिन्नता नहीं पाई गई।

- ❖ आन्ध्र प्रदेश के पूर्वी और पश्चिमी गोदावरी जिलों में एक्वाचौपाल मॉडल के कार्यान्वयन से मार्केटिंग की सेवाओं की गुणवत्ता परिवर्तन का मूल्यांकन किया गया। इन मूल्यांकनों से यह पता चलता है कि तुरंत भुगतान में काफी सुधार हुआ है, परिवहन की लागतों में कमी हुई है और समय पर सूचना मिल जाने की व्यवस्था से झींगा किसानों को लाभ प्राप्त करने में काफी सहायता मिली है।

- ❖ उत्तर प्रदेश के तीन जिलों में वारनासी के मॉडल के कृषि-क्लीनिकों के कार्य-निष्पादन का अध्ययन किया गया। तटवर्ती राज्यों में स्थित कृषि-क्लीनिकों के गहन विश्लेषण से यह पता चला कि जलीय क्लीनिकों की स्थापना के लिए हर जलजीव पालन में प्रमुख राज्य में प्रसिद्ध प्रशिक्षण संस्थानों की पहचान करना, निजी संस्थानों में कम से कम तीन साल के अनुभव युक्त मात्स्यिकी स्नातकों के चयन, प्रशिक्षण संस्थान द्वारा दो महीनों के प्रशिक्षण हेतु साक्षात्कार के दौरान सही उम्मीद्वारों का चयन, प्रशिक्षण पाठ्यक्रम में मार्केटिंग विस्तार कौशल पर ज्यादा ध्यान देना तथा उम्मीद्वारों के क्षेत्रों से ग्रामीण बैंक मैनेजरों को शामिल करने की ज़रूरत है।

- ❖ आन्ध्र प्रदेश और तमिलनाडु के जलजीव किसान संगठन और खाड़ी किसान संगठनों में झींगा जलजीव पालन में क्लस्टर खेती और उसके पहलुओं की सफलता पर अध्ययन किए गए। किसान के दलों ने बीजों के इकट्ठे खरीद, एक साथ स्टॉकिंग और निषिद्ध ऐन्टीबयॉटिक्स के प्रयोग से दूर रहना आदि पर ज़ोर दिया। वास्तविक देय उत्पाद, एकता, वचनबद्ध नेतृत्व, मज़बूत सामाजिक एकता आदि महत्त्वपूर्ण पहलू हैं जो इन संगठनों की सफलता को बनाते हैं।

- ❖ खारापानी प्रौद्योगिकियों के स्थानांतरण के लिए जलजीव पालन किसानों की बैठक, प्रदर्शनियाँ और कार्यशालाएँ आयोजित की गईं। तमिलनाडु में कडलूर के

चेल्लांगकुप्पम में सार्वजनिक-निजी साझेदारी परस्थित तालाबों में किसानों के लिए केंकड़ा पालन निरूपित किया गया। केंकड़ों को मोटा करने के लिए सीबा द्वारा विकसित पेल्लेट फीड को चेन्नई के पास पुलिकट तालाब के जमीलाबाद गाँव के SHG में सफलतापूर्वक निरूपित किया गया। दो घेरों में हर एक में नौ पानी के *एस. ट्रेंक्वेबेरिका* केंकड़ों (औसत वज़न 550 – 750 g) को स्टॉक किया गया और एक घेरे में स्थित केंकड़ों को पेल्लेट फीड खिलाया गया और दूसरे घेरे में स्थित केंकड़ों को परंपरागत व्यर्थ मछली खिलाया गया। पेल्लेट फीड खिलाए गए केंकड़े 24 दिनों में कठोर हो गए और उनके शारीरिक वज़न में 9.5% बढ़ोतरी पाई गई, जबकि व्यर्थ मछली खिलाए गए केंकड़े 26 दिनों में कठोर हो गए और उनमें 9% बढ़ोतरी ही पाई गई।