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Central Institute of Brackishwater Aquaculture

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Annual Report

2010-11

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(भाकृअनुप/ICAR)
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Preface

The complexities and dynamics in brackishwater aquaculture is the biggest challenge greatly affecting the economics of this sector. Keeping this in mind, the research efforts of CIBA has been towards reducing the risks and increasing the profitability of the farmer. To this end, the institute has toiled to develop economically viable technologies in relation to seed, feed, grow-out culture practices, disease control measures and marketing strategies as relevant to the different eco-climatic regions of India.

In the year that went by, I am proud to say that CIBA has addressed shrimp culture in high saline waters in the west coast of India and has successfully demonstrated in the state of Gujarat the possibility of a winter crop of banana shrimp in high saline and low temperature conditions. Under the National Agriculture Innovation project, our scientists are working on an effective livelihood enhancement package for small farmers by way of integrating animal husbandry, aquaculture, apiculture and agriculture for small farmers in Sunderbans in West Bengal. Besides this, all efforts have been made to popularize a low cost – low input organic shrimp farming technology for small scale farmers in the Sunderban region.

No less effort was invested to ensure species diversification and as a result of which the Institute witnessed a breakthrough in ornamental fish breeding. For the first time in India, scientists of our institute were successful in artificially spawning the ornamental fish spotted scat (*Scatophagus argus)*. With pond grown cobia (*Rachycentron canadum*), successful captive maturation was achieved. With regard to artificial feed, an imported pilot scale extruder feed mill which can produce floating, slow sinking and sinking pellets of varying diameter from 1.2 to 9.0 mm was successfully installed at the feed mill of CIBA at Muttukadu Experimental Station. These specialized extruded feeds will cater to the farming of brackishwater finfish especially high value fish like Asian seabass. Even as the Institute is in the forefront in developing technologies for sustainable shrimp/fish culture, scientists have not failed to keep a strong focus on environmental issues. This is seen from our findings that shrimp aquaculture has not impacted mangroves and the institute's strategic work on developing adaptive measures to face climate change.

As we embark on the silver jubilee year of the institute, the mark that CIBA has made in brackishwater research and technology development would not have been possible but for the support, encouragement and guidance received from Dr.S.Ayyappan, Director General, ICAR and Secretary, DARE. We are thankful to Dr.(Mrs.) B. Meenakumari, Deputy Director General (Fisheries) who has been a source of constant encouragement and support. We thank Dr.Madan Mohan, Assistant Director General (M.Fy.) for his constant support. During the current year, the institute benefited from the able guidance of Dr.S.D.Tripathi, Chairman and members of the Research Advisory Committee. We have benefited greatly from the interactions we have had with the various stakeholders for which we thank them profusely. Last but not the least I wish to thank all the scientists and staff of CIBA for their zeal and interest to work as a team on priority areas of work keeping the focus on farmers.

A.G. Ponniah
Director

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कार्यकारी सार

पर्यावरण अनुकूल एवं लागत प्रभावी टेकनौलोजी

- आधारित श्रिम्प बीज उत्पादन तेकनीक विकसित करने केलिए लार्वीय टंकियों में सूक्ष्मजीवाण्विक इनपुट के पत के निर्धारणों के साथ दो आशाजनक का मूल्यांकन किया गया और विभिन्न महीनों एवं विविध लार्वीय चरणों के बीच लार्वीय उत्पादन के कार्य के रूप में परिवर्तिता देखी गई।
- यार्ड में चलाए गए परीक्षणों में काई वृद्धि के विविध अधोस्तलों के मूल्यांकन से सूजित हुआ कि खुली रस्सी तथा बाँस, श्रिम्प-वृद्धि एवं काई के विकास की दृष्टि से एक उपयुक्त अधोस्तल है।
- काई केलइ अधोस्तल आधार के तौर पर अविपाटित एवं विपाटित बाँस के साथ चलाए गए ऑन-फार्म टाइगर श्रिम्प ताल आधारित परीक्षणों 1390 कि.ग्रा/हेक्टयर उत्पादन एवं 8 संख्या/वर्ग मी की (स्टॉकिंग) संचयन घनत्व (घनता) 22 ग्रा. ए बी डब्ल्यू की तुलना में नियंत्रण ताल का औसतन शारीरिक वज़न 26 ग्रा. के साथ 1640 कि.ग्रा. हेक्टयर के उच्चतर औसतन उत्पादन में परिणत हुआ। इसी तरह, अधोस्तल (फार्मिंग) खेती प्रणाली में एफ सी आर में 29% उन्नति सुधार करने से अधोस्तल में उपलब्ध प्राकृतिक खाद्य का बेहतर उपयोग देखा गया।
- जैव-फ्लोक एवं जैव-उपचार के उत्पादन केलिए विविध कार्बोहाइड्रेट की तुलना की गई और लगत के आधार पर, उत्पादित जैव-फ्लोक का परिमाण एवं अमोनिया, चाशनी (सीरा) एवं आटा कार्बोहाइट्रेड के स्रोत के विकल्प हैं जिनहें जैव-फ्लोक उत्पादन के लिए श्रिम्पताल में प्रयुक्त किया जा सकता है।
- टाइगर श्रिम्प द्वारा जैव-फ्लोक के प्रयोग से बढती वृद्धि की परिणति के पुष्टीकरण केलिए किशोरों (1.5 ग्रा.) तथा वयस्कों (प्रौढ़ों) को जैव-फ्लोक विकास केलिए सीरा के आपुरक स्रोतों से उपचार किया गया जो क्रमशः किशोरों और वयस्कों के अतिरिक्त शारीरिक वज़न 30% और 12.5% पाने में परिणत हुआ।
- श्रिम्प बहिस्राव उपचार ताल (ई टी पी) में प्रयुक्त की जा रही वर्तमान प्रथाओं के मूल्यांकन से सूचित हुआ कि कुल निथरीय और ठोस सान्द्रता 48 घण्टों के अन्तर्गत शन्तोषजनक (स्वीकार्य, ग्राह्य) स्तर तक पहुँच गई जबकि उपापचयकों एवं पोषकों के निराकरण (अपनयन) में यह प्रणाली प्रभावी नहीं रही।
- कम एवं उच्च खारा श्रिम्प खेती केलिए विशेष चारा विकसित करने हेतु, 40 पी पी री पर टाइगर श्रिम्प के वृद्धि निष्पादन पर आहार विपिड स्तर को प्रभाव का मूल्यांकन किया गया और 6.85% लिपिडवाले श्रिम्प आहार में लिपिड मूल्य उल्लखनीय तौर पर उच्चतर वृद्धि में, परिणत हुआ। आयन परगायता में डॉस्फोलिपिड्स की महत्वपूर्ण भूमिका रही है और कम लेसिथिनस्तर (1.0%) की तुलना में 2.0 और 2.5% पथ्य (आहार) सोचा लेसिथिन स्तर पर पोषित श्रिम्प में उल्लेखनीय उच्चतर वजन की प्राप्ति देखी गई। कम खारावाले आहार में, 8% लिपिड और 2% लेसिथिन निहित चारा सर्वोत्तम है।
- तालाब आधारित परीक्षणों में, श्रिम्प में पोषक उपयोगिता में बढोत्तरी लाने हेतु अधोस्तल विशेष फ्राइब्रोलिटिक एनज़ाइमों का प्रयोग उत्पादन खर्च ख/कि. ग्रा. कम करता है। इस परीक्षण से यह दर्शाया गया कि अधोस्तल विशेष फाइब्रोलिटिक एनज़ाइम के संपूरण के साथ सम्मिलित पादप प्रोटीन स्रोतों से प्रतिस्थापित करते हुए श्रिम्प आरंभक चारा में मत्स्य चूर्म का स्तर 10.0% के स्तर तक कम किया जा सकता है और वर्द्धित आहार में 7.5%।

बृहत् खास्थ्य प्रबंधन

- आंध्राप्रदेश एवं तमिलनाडु के कृषकों से 11 फार्म स्तरीय जैव सुरक्षा उपायों को अपनाया गया जिससे सूचित हुआ कि दोनों राज्यों में अपनामे के स्तर में उल्लेखनीय तैर पर अन्तर है। आंध्रप्रदेश में अपनाने कम रहे जिससे सूचित होता है कि अधिक जागरूकता कार्यक्रमों की ज़रूरत है।

- निमज्जन द्वारा नोडावाइरस संक्रमण हेतु समुद्रीबैस लार्वे के उपचार में ताप-हनित नोडावाइरल टीका का मूल्यांकन किया गया और निष्कर्षों से सूचित हुआ टीकान लगाए की मामले में कुल मार्त्यता की तुलना में टीका लगाए किशोरों की उत्तरजीविता-दर 91% थी।

- मोनोडोन स्लो ग्रोथसिन्ड्रोम (एम एस जी एस) में लेइम सिंह वाइरस (एल एस एन वी) की भूमिका की मौखिक रूप से भोजन देने एवं सहवास सं पृष्टि की गई। मौखिक रूप से भोजन देने से 10 हफ्तों में आकार गहरे रंग विवर्णन के साथ 100% सकारात्मक में परिणत हुए और संक्रमित वर्ग में सरे चार महीनों की परीक्षणात्मक अवदि के अन्त तक 90% मृत्युदर देखी गई। सहवास परीक्षणों ने 12% हफ्तों में 100 सकारी दर्शायां।

- लार्वीय श्रिम्प में संदीप्तशील बैक्यीरियाई रोज के जैव नियंत्रण हेतु की शक्यता के साथ वाणिज्यिक हैचरियों में चलाई गई जाँच बहुत ही आशाजनक रही और अध्ययन सूचित करते हैं कि बेहतर परिणाम निकाल सकते हैं।

- औषधीय पौधा विथियाना सोमनिफेरा का 0.5 ग्रा/कि.ग्रा. चारा की सान्द्रता में प्रयोग से व्यक्त हुआ कि प्रयुक्त श्रिम्पों में वृद्धि एजेंट की भूमिका यह अदा कर सकता है। जीवाणु-रहित एवं कुल हेमोसैट काउन्ड में उल्लोखनीय सुधार के साथ।

- प्रवाह निस्यंदन प्रणाली का प्रयोग करते हुए जल नमूनों में डब्ल्यू एस एस वी की स्क्रीविंग केलिए प्रणाली का विकास सबसे पहली बार संभव हुआ है।

- श्रिम्ब वाइरस एम बी वी के खिलाफ दुगुना स्ट्रैडड आर एन ए (डी एस आर एन ए) का प्रयोग करते हुए ऐन्टिवाइरल थेरापी के विकास के लिए एम बी वी पी 74 जीन एवं एम बी वी रिंग सूपर जीन की गुणविशेषताओं का पालन किया गया। इन एम बी वी जीनों को लक्ष्य बनाते हुए एवं एम बी वी के संक्रामण को नियंत्रित करते हुए डी एस आर एन ए की क्षमता (प्रभावोत्पादकता) की जाँच केलिए टाइगर श्रिम्प भ्रूणों को प्रयोग करते हुए एक जैव आमापन का डिज़ाइन किया गया। इस जैव-आमापन से सूचित हुआ कि P74 जीन आर एन ए आई - आधारित एम बी वी ऐन्टिवाइरल रोगोपचार के विकास हेतु एक बेहतर लक्ष्य है।

- समुद्रीबैस केलिए बैक्टीरियाई टीका - द्रव्य (वैक्सिन) (वाइब्रियो ऐंगुइलैरम) के विकास केलिए बाहरी बैक्टीरियाई झल्लिका प्रोटीन की गुणविशेषता पहचानी गई और टीका द्रव्य (वैक्सिन) की तैयारी केलिए पुनः संयोजी प्रोटीन का इस्तेमाल किया जाएगा।

अत्यधीक वृद्धि और वर्द्धित रोग प्रतिरोधशक्ति

- एवं तालाब में बढाए गए (पालन-पोषण किए) पी. मोनोडोन के विविध पक्वन चरणों के दौरान पक्वन संबंधी स्त्रीजातीय विशिष्ट जीनों के पृथवकरण, गुणविशेषताओं एवं रुख की प्रोफीणल बनाई गई।

- पुंजातीय पक्वन से जुडे, टाइगर श्रिम्प में जीनों की गुणविशेषताओं ने वृषण-पक्वन एवं विकास में लगे शक्य जीनों के बारे में जानकारी उपलब्ध कराई।

- ट्रैस माप से परिकलित सात आकलित प्रामाणिक (विहित) कार्यों के आधार पर टाइगर श्रिम्प नमूनों के आठ प्राकृतिक संचयों को अलग किया जा सकता है।

- डब्ल्यू एस एस वी संक्रामण मे बच जानेवाले श्रिम्प में डब्ल्यू एस एस वी अव्यक्तता एवं पी ए पी जीन रुख देखे गए। डब्ल्यू एस एस वी संक्रामित कोशिकाओं में अथस्तता एवं परपोषी प्रतिक्रिया हेतु आणविक तंत्र के स्पष्टीकरण (की व्यख्या) परपोषी कोशिका - वाइरस के पारस्परिक प्रभाव पर प्रकाश डालेगा और विशिष्ट ऐन्टिवाइरल थेरापी के विकास को सुकर बनाएगा।

प्रजातियों एवं प्रणालियों की विविधता

- शिशु समुद्रीबैस के अनुकूलतम चारा आकार एवं चारा देने की आवृत्ति निर्धारित की गई तथा जाँच-परिणामों से सूचित होता है कि 30-50 ग्रा. डैहिक भारवाले शिशु समुद्रीबैस केलिए दिन में दो बार आहार देना अनुकूलतम है था 15 ग्रा. के आकारवाले शिशु समुद्रीबैस के लिए अनुकूलतम चारा का आकार 30 मि.मी. और 30 एवं 60 ग्रा. केलिए वह करीब 4.5 मि. मी. आकार की गुटिका होगी।

- डब्ल्यू/डब्ल्यू आधार पर 0 से 20% स्तर पर मीट एवं बोनमील (एम बी एम) स्थान पर मत्स्यचूर्ण की बढलाई के प्रभाव का समुद्रीबैस के किशोरो मूल्यांकन किया गया बैर जाँच-परिणाम सूचित करते हैं कि पज़न की प्राप्ति (%) उल्लेखनीय तारे पर अनुकूलतम रही और अन्य स्तरों की मुलना में, 10% बदलाई आहार पर उच्चतर रही।
- खारा जल मत्स्यों की आहार-नली से अलगाई आशाजनक बैक्टीरिया से इन विट्रो तन्तु एवं खर्च अवक्रमण एवं विविध पादप संघटकों के प्रोटीन में वृद्धि संभव है। यह पाया गया गि बैसिलस सब्टिलस एवं बैसिलस एस पी के मिश्रण से अपूरित आहार किशोर समुद्रीबैस में उच्चतर वृद्धि, उत्तरजीविता, प्रोटीन क्षमता अनुपात एवं निम्नतर एफ सी आर में उल्लोखनीय तौर पर परिणत हुआ।
- पूर्ववर्ती वर्ष के दौरान की यार्ड जाँचों के आधार पर विकसित 37.6% प्रोटीन एवं 15.8% वसा वाला फार्म में बनाया चारा कृषक के तालाब में प्रदर्शन केलिए लिया गया। संवर्धन के 318 दिनों बाद, मत्स्यों का संग्रहण किया गया और समुद्रीबैस ने 865 ग्रा. औसत दैरिक भार प्राप्त किया था। फार्म में बनाए चारा का प्रयोग 1.98 के एफ सी आर के साथ 61.4% उत्तरजीविता की उत्तर दर में यह सूचित करते हुए परिणत हुआ समुद्रीबैस के संवर्धन के लिए फार्म में बनाया चारा व्यवहार्य है।
- मुट्टुकाडु के होल्डिंग सुविधाओं में ले गए एवं भण्डारित 5-20 कि.ग्रा. आकाखाले वाइल्ड मत्स्यों के साथ प्रजनक तालाब स्थितियों के अधीन कोबिया का कैप्टीव परपक्वन पाना संभव रहा। तीन मामलों में, सफल अंडजनन देखा गया, लेकिन निषेचन एवं उत्तरजीविता कम रही।
- बनाना श्रिम्प के साथ चलाई ऑन-फार्म जाँचों से सूचित हुआ कि गुजरात क्षेत्र के लिए बनाना श्रिम्प की रेक्ती लाभदायक है।
- 15,000/- हेक्टयर की भण्डरण सान्द्रता पर शिशु ग्रेमुल्लेट को पालने की तकनोलजी विकसित की गई 10.55 ग्रा. के आरंभिक लार्वीय आकार वाले उन्हें निषेचन पालन प्रणाली के साथ आहार देते हुए 150 दिनों की अवधि के पालन के लिए वाले 83% उत्तरजीविता के साथ 98 ग्रा. तक बढाना संभव रहा।
- ग्रे मुल्लेट नर्सरी की देखभाल के लिए लागव प्रभावी आहार के विकास हेतु स्थानीय तौर पर उपलब्ध संघटकों का प्रयोग करते हुए वसा के दो चरणों के साथ प्रोटीन के पाँच स्तरों का मूल्यांकन किया गया और यह पाया गया कि 9% लिपिड के स्थान 27 प्रोटीन ने अन्य मिश्रण वर्गों की अपेक्षा बेहतर वृद्धि निष्पादन और निम्नर एफ सी आर दर्शाया है।
- पोखर (टंकी) में पलित पेर्लस्पांट नर्सरी केलिए तकनोलजी समान आकारवाले 1200-3500 प्रति बैच की उच्छतर पोना आउटपुट में परिणत हुई।
- चारों जाँच से शिशु पेर्लस्पॉट को बढाने केलिए निर्मय पर पहुँचे कि 35-40% प्रोटीन और 7.5% लिपिड अनुकूलतम है।
- संचित करने लायक आकारवाले बीज को अपनी जीविका चलाने के विकल्प के रूप में समुद्रीबैस के पालन के लिए उद्यमियों को प्रोत्साहित करने के उद्देश्य के साथ एक कृषक के तालाब में जाँच की गई और कृषक द्वारा 2,000 वर्ग मीठा के तालाब जल के व्याप्त क्षेत्र से ₹ 1.52 लाख के लाभ के साथ ₹ 4.32 लाख की सजस्त वसूली की गई।
- पुनःसंचरण प्रणाली के अधीन एशियन समुद्रीबैस का वार्षिक प्रजनन का आगेवैधीकरण किया गया चक्रण यह सूचित करते हुए कि यदि लवणता एवं/या तापमान में उतार-चढाव लाए बिना गुणवतायुक्त समुद्रजल उपलब्ध कराया जाय तो समुद्रीबैस को वर्षभर प्रजनित किया जा सकता है, यहाँ हुए कि नवंबर-फरवरी के कमीवाले महीनों में भी अंडजनन प्राप्त किया जा सकता है।
- कृत्रिम संसोचन एवं लार्वीय पालन के ज़रिए सफल अंडजनन के साथ आलंकारिक मत्स्य स्कैट (स्कैटोफेगस आरगस) में।
- ग्रेमुल्लेट पर ऑन-फार्म जाँच ने स्पष्टतया यह प्रदर्शित किया है कि 390 से 515 ग्रा. अनिम वजनवाडे केलिए उटन/हेक्टयर से भी ज्यादा उत्पादन प्राप्त किया जा सकता है।

आर्थिक तौर पर महत्वपूर्ण खारा जल संपदाओं का उपयोग

- आरोगजनक विब्रिओ अलजीनोलिटिकस से कार्षिक तौर पर महत्वपूर्म जीन, आइसो कोरिसमेट अइसोमेरर्स, फॉस्फोषिकिमेट कार्बोक्सिविनाइल ट्रान्सफेरेस, आल्फा अमिलेस एवं अजुरिन जो शाकनाशी एवं रोगजनक प्रतिरोधिता प्रदान करते हैं, पहचाने गए और प्रोटीन पाए गए।

- तालाब आस्राव (विसर्जन) जल न्यूनीकरण (प्रशमन) केलिए प्रयुक्त शक्य सूक्ष्मजीव अलगाए गए और माइट्रीकरण - विनाइट्रीकरण जैवफिल्टर जो आमोनिया, नाइट्राइड एवं नाइट्रैट के पूरे अपनयन के लिए (बयोफिल्टर) याथ ही साथ नाइट्रीकरण एवं विनाइट्रीकरण केलिए शक्य है, इन जीवाणुओं से डिज़ाइन किया गया।

सामाजिक-आर्तिक विश्लेषण और नीति न योजन को समर्थन

- खाराजल जीव पालन केलिए जिला स्तर पर सहायता हेतु प्राथमिक एवं गैप सूचना के साथ पूर्व तट के तटीय जिलों के दिसेबेस जी आई एस प्लाटफॉर्म पर विकसित किए जा रहा है।
- नव प्रस्तुत वन्नमेई के हस्तन के लिए राज्य मात्स्यिकी पदाधिकारियों की क्षमता बढाने हेतु अप्रैल 2010 के दौरान गुजरा, आंध्रप्रदेश एवं तमिलनाडु राज्यों की तटीय जलकृषि प्राधिकरण एवं सी आई बी ए द्वारा संयुक्त रूप सुग्रहिता कार्यक्रम आयोजित किए गए।
- रिमॉट सेन्सिंग दित्ते और जी आई एस औजारों का प्रयोग करते हुए यह प्रमाणित करना संभव हुआ कि जलजीव पालन का विकास कृष्णा मैन्ग्रोवस की लगत पर नहीं हुआ है। इस अध्ययन ने स्पष्टतः यह स्थापित किया कि 4253 हेक्टयर में होकर कृष्णा डेल्टा (नदीमुख-भूमि) फैल गई और मैन्ग्रोव्सवाले रिज़र्व जंगलों में श्रिम्प के खेत विद्यमान नहीं थे।
- अत्यधिक चरम जलवायविक परिस्थितियों, चक्रवात लैला का श्रिम्प जलजीव पालन पर प्रभाव का मूल्यांकन किया गया और अध्ययन, प्रभाव की सख्ती को हल्का करने एवं कृषि के बराबर शहत उपाय उपलब्ध कराने केलिए सरकार द्वारा सुयोजित उपायों की ज़रूरत सूचित करता है।
- कृष्णाजिला, आंध्रप्रदेश के अन्तर्स्थलीय एवं तटीय क्षेत्रों के 300 कृषकों के व्यापक कृषक सर्वेक्षण के ज़रिए जलवायु परिवर्तन (सी सी) प्रभाव के प्रति श्रिम्पकृषकों के अवबोधन मनोवृत्ति एवं अपनानेवाली क्षमता निर्धारित की गई।
- एन ए आई पी परियोजना के अधीन जल संभरण एवं मत्स्य पालन केलिए 36 शुद्धजल तालाब के साथ भू-रूप निर्माण के तहत 7.638 हेक्टयर क्षेत्र विकसित किए गए 48 खारा जल तालाबों से 8.63 हेक्टयर क्षेत्र, एवं धान-व-मत्स्य खेती 33 खाई एवं शुद्धजल तालाबों से 7.266 हेक्टयर क्षेत्र विकसित किए गए। मत्स्यों का नर्सरी में पालन 1,40,000 शिशुमछली। हेक्टयर के उत्पादन के साथ 3.08 हेक्टयर क्षेत्र में 53 कृषक तालाबों में सफलतापूर्वक किया गया। तटीय निम्नीकृत क्षेत्र वैकल्पिक फसलों के रूप में सूरजमुखी, मूँग एवं तिलकी 193 लाभग्राहियों के स्वाभित्ववाले 16 हेक्टयर क्षेत्र में खेती की गई फसल पोषक प्रबंधन के अधीन, जिंक (जस्त) तथा बोरोन की 23.41 हेक्टयर क्षेत्र की खरीए धान फसल में प्रयोगार्त लाभग्राहियों को अपूर्ति की गई। इसके अतिरिक्त, मथुमक्खी पालन, केंचुआंकपोस्टिंग, मशरूम खेती एवं बकरी पालन को चुने का गाँवों में बढ़ावा दिया गया।
- मोबाइल फोल के ज़रिए श्रमिप कृषकों को सूचना के प्रसारण केलिए एक प्रणाली विकसित करने हेतु तमिलनाडु के नागपट्टिनम जिले में उसकी आवश्यकता संबंधी मूल्यांकन चलाया गया और सूचना की ज़रूरत की रेकिंग चलाई गई।
- जलजीवपालन तकनोलजियों के अन्तरण की गुजाइश पर न्यू पेरुंगुलसूर, चेन्नई के जनजातीय 'इसकर' महिला एस एच जी के बीच मूल्यांकन चलाया गया और ज्वार पोषित तालाबों के केकडा को बोरा बनाने को अपने जीवनयापन के विकल्प के रूप में लिया था।
- महिला एस एच जी को तीन कुवारा जल एवं संवर्धित तकनोलजियों के अन्तरण क कार्य के संबंध में ये प्रभाव देखे गए कि एन जी ओ इन एस एच जी को अपनाने एवं वित्तीय सहायता उपलब्ध कराने केलिए आगे आ गए हैं, बैंकों द्वारा उपलब्ध कराए जानेवाले प्रधानों के आधार पर बचत से ये ग्रूप प्रदर्शन सके हैं, 'अनिचमलर' डब्ल्यू एस एच जी द्वारा कट्टूरगाँव में 'फिश फूड आउटलेट' खोला गया है और एक और डब्ल्यू एस एच जी को अपने एन जी ओ के माध्यम से एक नोरवीजियन मत्स्य खाद्य संसाधन कंपनी से अपने मत्स्य खाद्य उत्पादों केलिए विपणी आईए प्रापत हुए है।
- भारत में समुद्रीबैस की खेती को बढावा देने केलिए विपण एवं मूल्य त्रृंखला सुधार अध्ययन के अधीन कुल 1463 नमूनों का संग्रहण किया गया। पश्चिम बंगाल एवं ओडिया के पूर्व तटीय राज्यों तथा कोलकत्ता, बैंगलूर तथा मुंबई के मेट्रो में और कुछ हद तक चेन्नई में माँग के साथ समुद्रीबैस की कुल वार्षिक घरेलू माँ उपभोक्ता सर्वेक्षण के आधार पर 22,000 टन निकली। प्रोज्क्ट कृष्य क्षेत्र जो विकसित किया जा सका था, वह 10,000 हेक्टयर था और बीज के संबंध नें करीब 25 दशलक्ष बीज प्रतिवर्ष की सम्मिलित उत्पादन क्षमता के साथ करीब 10 से 15 समुद्रीबैस हैचरियाँ को बढावा दिया जा सकता है और चारा अपेक्षा करीब 35000 से 40000 टन प्रतिवर्ष से सकता है।

Executive Summary

Environment friendly and cost effective technologies

- In order the develop probotic based shrimp seed production technique, two promising probiotics were evaluated along with determinations of the pathways of microbial input into larval tanks and the variability observed as function of larval production across different months and different larval stages.

- Evaluation of different substrates for periphyton growth in yard trials indicated that untwisted rope and bamboo seem to be a suitable substrate in terms of shrimp growth and periphyton development.

- On-farm tiger shrimp pond based trials with whole bamboo and split bamboo as substrate base for periphyton resulted in a higher average production of 1640 kg/ha with 26g average body weight (ABW) compared to that of the control ponds with 1390 kg/ha production and 22g ABW from stocking density of 8 nos./m^2. Also, 29% improvement in FCR in the substrate based farming system showed better utilisation of natural food available in substrate.

- Comparison of different carbohydrate sources for production of biofloc and bioremediation was made and based on cost, volume of biofloc produced and capacity to reduce ammonia. Molasses and wheat flour were the choice carbohydrate sources to be used in shrimp ponds for biofloc production.

- In order to confirm that use of bioflocs by tiger shrimp would result in increased growth, juveniles (1.5g) and adult (15g) were treated with supplementary source of molasses for biofloc development which resulted in additional body weight gain of 30% and 12.5% in juveniles and adult respectively.

- Evaluation of the current practices being used in shrimp Effluent Treatment Pond (ETP) indicated that the total settleable and solids concentration reached to an acceptable level within 48 hours, whereas the system was not effective for metabolites and nutrients removal.

- In order to develop specific feeds for low and high saline shrimp farming, effect of dietary lipid level on growth performance of tiger shrimp at 40 ppt was evaluated and a lipid value in shrimp feed of 6.85% lipid resulted in a significantly higher growth. Phospholipids play an important role in ion permeability and significantly higher weight gains were observed in shrimp fed with 2.0 and 2.5% dietary soy lecithin level compared to lower lecithin level (1.0%). With regard to low saline regime diet, feed containing 8% lipid and 2% lecithin is optimum.

- In pond based trials, use of substrate specific fibrolytic enzymes for enhancing nutrient utilisation in shrimp led to reduced cost of production to ₹ 9/kg. This trial showed that inclusion level of fish meal may be brought down to the level as low as 10.0% in the shrimp starter feed and 7.5% in the grower ration by replacing it with combined plant protein sources along with substrate specific fibrolytic enzymes supplementation.

Comprehensive health management

- Adoption of farm level biosecurity measures were analysed with 11 farmers from Andhra Pradesh and Tamil Nadu which indicated that the adoption levels significantly varied between the two states with non-adopters more in Andhra Pradesh suggesting the need for more awareness programmes.

- Heat-killed nodaviral vaccine was evaluated in treatment of seabass larvae for nodavirus infection by immersion and the results indicated that the survival rate in the vaccinated juveniles was 91% compared to total mortality in non-vaccinated ones.

- The role of Laem Singh Virus(LSNV) in Monodon Slow Growth Syndrome (MSGS) was confirmed both by oral feeding and cohabitation. Oral feeding led to 100% positives by 10 weeks with dark discoloration and 90% mortality was observed by end of four and half months of experimental period in infected group. Cohabitation experiments showed 100% positives by 12 weeks.

- Trials in commercial hatcheries with potential of phages for biocontrol of luminescent bacterial disease in larval shrimp were very promising and the studies indicate that using a consortia of phages would lead to better results.

- Use of medicinal plant *Withania somnifera* at a concentration of 0.5 g/kg feed, revealed that it can play the role as an immunomodulation agent with significant improvement in growth, bacterial clearance and total haemocyte counts in administered shrimp.

- For the first time it was possible to develop the methodology for screening WSSV in water samples using tangential flow filtration system.

- In order to develop antiviral therapy using double stranded RNA (dsRNA) against shrimp virus MBV, characterization of MBV p74 gene and MBV Ring super family gene was carried out. To test the efficacy of dsRNAs targeting these MBV genes and controlling MBV infection, a bioassay was designed using tiger shrimp brooders. The biossay indicated that p74 gene is a better target for developing RNAi-based MBV antiviral therapeutics.

- In order to develop bacterial vaccine *(Vibrio anguillarum*) for seabass, outer bacterial membrane protein was characterized and the recombinant protein would be used for vaccine preparation.

Faster growth and increased disease resistance

- Isolation, characterization and expression profile of female specific genes related to maturation during different maturation phases in the wild caught and pond reared *Penaeus monodon* was carried out.

- Characterization of genes in tiger shrimp linked to male maturation provided information about potential genes involved in testicular maturation and development.

- Eight natural stocks of tiger shrimp samples could be discriminated based on seven estimated canonical discriminant functions computed from truss measurements.

- Both WSSV latency and PAP gene expression were observed in shrimp surviving WSSV infection. Elucidation of the molecular mechanisms for latency in WSSV infected cells and the host response would give an insight into the host cell–virus interaction and facilitate the development of specific anti-viral therapy.

- Under bio-prospecting of genes and allele mining for salinity stress, identification of differentially expressed genes under low and high salinity conditions was carried out.

Diversification of species and systems

- Optimal feed size and feeding frequency for seabass fingerlings were determined and the results indicate that feeding two times a day is optimal for seabass fingerlings of 30-50g body size and optimal feed size for 15g size seabass fingerlings is 3.0 mm and for 30 - 60g it will be about 4.5 mm size feed pellet.

- The effect of replacement of fishmeal with meat and bone meal (MBM) at 0% to 20% level on w/w basis was evaluated in the juveniles of seabass and the results indicate that the weight gain (%) was significantly optimal and higher at 10% replacement diet compared to other levels.

- *In vitro* fibre and starch degradation and increase in protein of different plant ingredients was possible with promising bacteria isolated from the gut of brackishwater fishes. It was found that the diet supplemented with mixture of *Bacillus subtilis* and *Bacillus* sp. resulted in significantly higher growth, survival, protein efficiency ratio and lower FCR in seabass juveniles.

- The farm made feed with 37.6% protein and 15.8% fat which was developed based on yard trials during the preceding year was taken up for demonstration in a farmer's pond. After 318 days of culture, the crop was harvested and seabass had attained an average body weight of 865g. Use of farm made feed resulted in a survival rate of 61.4% survival with an FCR of 1.98 indicating that use of farm made feed for seabass culture is feasible.

- It was possible to achieve captive maturation of cobia under broodstock pond conditions with 5-20 kg sized wild fishes which were transported and stocked in the holding facilities at Muttukadu. Successful spawning was observed in three cases, however fertilization and survival was low.

- On-farm trials with banana shrimp indicate that banana shrimp farming is a profitable winter crop for Gujarat region.

- Grey mullet fingerling rearing technology was developed at a stocking density of 15,000 nos./ha. With initial larval size of 0.55g it was possible to grow them to 98g with 83% survival for a rearing duration of 150 days under feeding and fertilization regimes.

- For development of cost effective feed for grey mullet nursery rearing, five levels of protein with two levels of fat using locally available ingredients were evaluated and it was found that 27% protein with 9% lipid showed better growth performance and lower FCR than the other combination groups.

- The technology for pearlspot nursery rearing in tanks resulted in a higher fry output of 1200-3500 per batch with uniformity in size.

- To grow pearlspot fingerling from feed trials it was concluded that 35-40% protein and 7.5% lipid is optimal.

- With the objective of encouraging entrepreneurs to take up rearing seabass fry to stockable size seed, as a livelihood option, a trial was carried out in a farmer's pond and the revenue realized by the farmer was ₹ 4.32 lakhs with a profit of ₹ 1.52 lakhs from a pond water spread area of 2,000m^2.

- The year round breeding of Asian seabass under recirculation system was further validated and spawning could be obtained even in the lean months of November – February indicating that if quality sea water without fluctuations in salinity and/or temperature could be provided, seabass could be bred throughout the year.

- Breakthrough in ornamental fish scat (*Scatophagus argus*) was achieved with successful spawning through artificial fertilization and larval rearing.

- On-farm trial of monoculture of grey mullet has clearly demonstrated that it is possible to attain a production of over 3 t/ha for a growing period of one year with final weight of 390 to 515g.

Utilization of economically important brackishwater resources

- From non-pathogenic *Vibrio alginolyticus*. agriculturally important genes, Isochorismate isomerase, Phosphoshikimate carboxyvinyl transferase, Alpha amylase and Azurin that impart herbicide and pathogen resistance have been identified and the proteins have been expressed.

- Potential microbes used for pond discharge water mitigation were isolated and a nitrification-denitrification biofilter that is capable of simultaneous nitrification and denitrification for complete removal of ammonia, nitrite and nitrate was designed with these microbes.

Socio-economic analysis and support to policy and planning

- To assist in district level planning for brackishwater aquaculture, database on coastal districts in the East Coast with primary and secondary information is being developed on a GIS platform.

- To increase the capacity of state fisheries officials to deal with the newly introduced vannamei shrimp, sensitization programmes were jointly conducted by CIBA and Coastal Aquaculture Authority in the states of Gujarat, Andhra Pradesh and Tamil Nadu during the month of April 2010.

- Using remote sensing data and GIS tools, it was possible to prove that aquaculture development was not at the cost of Krishna mangroves. The study clearly established that mangroves have increased in Krishna delta by 4253 ha and shrimp farms were not present in the reserve forests having mangroves.

- Impact of extreme climatic events, Cyclone Laila on shrimp aquaculture was assessed and the study indicates the need for planned adaptation measures by the Government to mitigate the severity of impact and to provide relief measures on par with agriculture.

- Shrimp farmer's perceptions, attitudes and adaptive capacities towards climate change (CC) impacts were determined through an expansive farmer's survey of 300 farmers from inland and coastal areas of Krishna District, Andhra Pradesh.

- Under the NAIP project, 7.638 ha has been developed under land shaping programme with 36 nos. of freshwater ponds for water harvesting and fish culture, 8.63 ha has been developed with 48 nos. of brackishwater ponds, and 7.266 ha has been developed with 33 nos. of trench and freshwater ponds for paddy-cum-fish cultivation. Nursery rearing of fish (carps) was successfully conducted in 53 farmer's ponds covering 3.08 ha with production of 1,40,000 nos. of fingerlings/ha. As alternate crops for coastal degraded area, sunflower, green gram and sesame have been cultivated in 16 ha belonging to 193 beneficiaries and under crop nutrient management, zinc and boron was supplied to the beneficiaries for application in kharif paddy crop in 23.51 ha. In addition, a number of alternate livelihoods like bee keeping, vermicomposting, mushroom cultivation and goat rearing were promoted in the three identified villages.

- In order to develop a system for disseminating information to shrimp farmers through mobile phones, a need assessment was carried out in Nagapattinam district of Tamil Nadu and the ranking of the information needs was made.

- An assessment was made among tribal Irrular women SHGs at New Perungalathur, Chennai on the scope of transferring aquaculture technologies and crab fattening in tide fed ponds as a livelihood option.

- With regard to the work on transferring three brackishwater and allied technologies to women SHGs, the impacts observed were that NGOs have come forward to adopt these SHGs and provide financial assistance, banks are providing loans based on the savings that these groups were able to demonstrate, a 'Fish Food Outlet' was opened at Kattur Village by 'Anichamalar' WSHG and another WSHG received market orders for their fish food products from a Norwegian fish food processing company through their NGO.

- Under the marketing and value chain improvement study for promoting seabass farming in India, a total of 1463 samples were collected along the supply chain points. The total annual domestic demand of seabass, based on consumer survey worked out to 22,000 t with a high demand in east coast states of West Bengal and Orissa and in the metros of Kolkata, Bangalore and Mumbai and to some extent in Chennai. The projected farming area that could be developed was 10,000 ha and with regard to seed, about 10 to 15 seabass hatcheries with a combined production capacity of about 25 million seed per annum could be promoted and the feed requirement could be around 35,000 to 40,000 t per year.

3

Introduction

Global shrimp production as well as trading values and volumes have grown significantly in the past 20 years. With this rapid growth, there has been a concurrent and increasing demand for improved sustainability of shrimp aquaculture, social acceptability, and improved quality and safety of products produced by the sector. In India, shrimp farming has its roots in the traditional brackishwater aquaculture practices followed in the *bheries* of West Bengal and the *pokkali* fields of Kerala. The Consortium on Shrimp Farming and the Environment formed in 1999 had the objective to identify issues around shrimp farming and broadly advise on better management of the shrimp farming sector. The consortium supported a wide range of case studies and stakeholder consultations concerning various shrimp farming issues, with a global scope, bringing together a unique set of experiences on shrimp farming development and an information base for responsible development. Experience has shown that well designed and implemented BMPs (Better Management Practices) can support producers to i) increase efficiency and productivity by reducing the risk of shrimp health problems, (ii) reduce or mitigate the impacts of farming on the environment, (iii) improve food safety and quality of shrimp farm product and iv) improve the social benefits from shrimp farming and its social acceptability and sustainability. The Central Institute of Brackishwater Aquaculture (CIBA) is assiduously working on these cardinal principles for sustained shrimp farming and the orderly development of the sector.

Brackishwater aquaculture covers an approximate area of 1,25,000 ha, or 43% of the total aquaculture area, and approximately equals 75% of the area under freshwater aquaculture. India is endowed with 1.2 million ha brackishwater area for development of aquaculture.

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

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

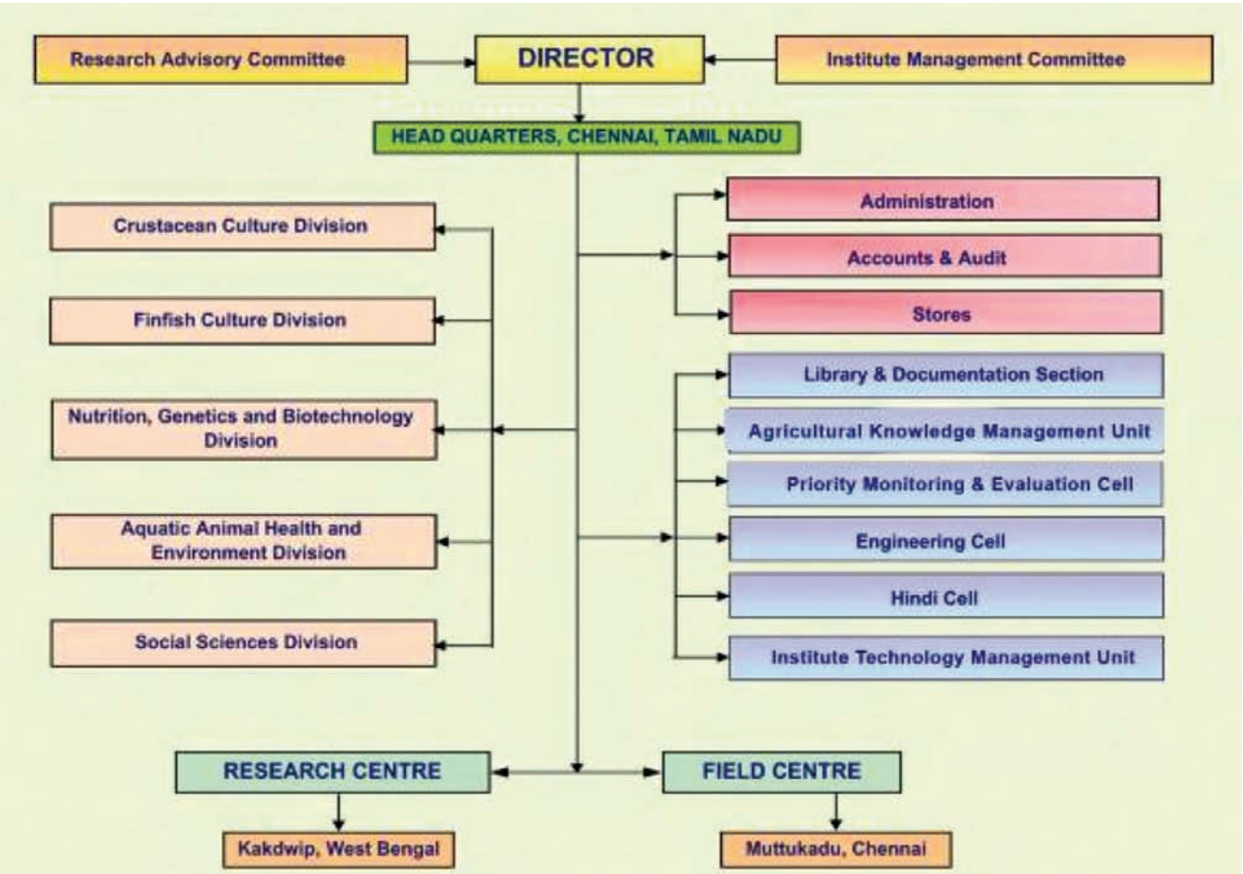
The research activities of the Institute are carried out under five Divisions, *viz*.,

- 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 diverse in nature, starting from basic research to applied and adoptive research which was carried out under 12 in-house and 31 externally funded projects during 2010-11.

ORGANISATION CHART



Headquarters

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Financial Statement 2010-11 **(₹ in lakhs)**

Sub-Head	BE	RE	Actual Expenditure
Plan			
Travelling Expenses	20.00	20.00	20.00
HRD	5.00	5.00	5.00
Contingency	225.00	225.00	225.00
Works	170.00	170.00	170.00
Equipments	80.00	73.93	73.93
Information Technology	16.00	16.00	16.00
Others	8.00	8.00	8.00
Library	21.00	21.00	20.99
Furniture and Fixture	5.00	11.07	11.07
Total	**550.00**	**550.00**	**549.99**
Non-Plan			
Establishment	869.00	887.94	843.80
O.T.A	0.00	0.15	0.15
Travelling Expenses	6.00	6.00	6.00
Research & Operational	10.00	13.35	13.35
Administrative expenses	45.00	89.85	89.85
Miscellaneous	0.00	-	0.00
Pension	55.00	62.50	61.11
Loans & Advances	3.00	7.00	5.67
Total Non-Plan	**990.00**	**1089.69**	**1042.82**

Revenue generation **(₹ in lakhs)**

Year	Target	Achievement
2010-11	22.00	26.92

Official Language Implementation Programme

The Institute organized the Hindi Pakhwada celebrations from 1st-15th September, 2010. As part of the celebrations, Essay and Question-Answer competitions in Hindi were conducted at the Institute and winners were awarded cash prizes. During the year, four Official Language Implementation Committee meetings were held and the usage of Hindi in official correspondences, bilingual use of Hindi and English in files and publications in Hindi were reviewed. Hindi Day was celebrated on 14.10.2010 and a lecture on Official Language implementation was delivered by the Chief Guest and the Director, CIBA gave away prizes to the winners of the competitions. Hindi Divas was celebrated at Kakdwip Research Centre on 29.09.2010.

Hindi day celebrations at Headquarters

Staff position

The details of the number of positions sanctioned, filled and remaining vacant as on 31.3.2011 are as follows:

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	1	-
Head of Division	2	2	-
Principal Scientist	1	1	-
Senior Scientist	10	4	6
Scientist	52	40	12
Technical Assistant	30	27	3
Administrative Officer	1	1	-
Finance & Accounts Officer	1	0	1
DD (OL)	1	0	1
Assistant Administrative Officer	3	3	-
Junior Account Officer	1	1	-
Personal Secretary	1	1	-
Personal Assistant	2	2	-
Stenographer Gr. III	1	2	1 (excess)
Assistant	7	6	1
Senior Clerk	3	3	-
Junior Clerk	5	6	1 (excess)
Supporting Staff	60	42	18
Total	**182**	**142**	**40**

4

Research Achievements

CRUSTACEAN CULTURE DIVISION

Project Title (Institute)	Improvement of shrimp production and productivity through quality seed production and diversification into other shrimp species

Closed recirculation system for induced maturation of tiger shrimp

Two experimental runs were conducted in order to evaluate the efficiency of closed recirculation system (RS) in comparison with classical water exchange system with the reproductive performance of tiger shrimp *Penaeus monodon* as the criterion. In the first experiment, wild caught broodstocks of *P. monodon* were stocked in the maturation tanks in the ratio of 2 female : 1 male. A total of 20 females and 10 males were distributed between the two systems. The water quality data during the experiment showed that the difference in pH, temperature and salinity in both RS and water exchange system was not appreciable. The average ammonia and nitrite concentrations were higher in the water exchange system when compared with the recirculation system. During the three weeks of experimental period, a total of five spawnings were observed, with 37.5% in the recirculation system compared to the water exchange system. The male reproductive quality was evaluated by the number of animals with melanized spermatophores. Percentage of males with melanized spermatophores was higher in conventional water exchange system. This result indicates that closed recirculation system can support reproductive performance of the broodstock at commercially acceptable levels.

Transmission dynamics of WSSV in tiger shrimp

In order to understand the vertical transmission of White Spot Syndrome Virus (WSSV), 64 shrimps were tested. Out of these two females were second step PCR positive and one was first step PCR positive. The WSSV second step PCR positive animals were unilaterally eyestalk ablated to study the maturation process. The first step PCR positive female was killed and tissues were diagnosed for WSSV using histopathology and PCR. Although gills and pleopods were first step PCR positive, the ovary was second step PCR positive. Light microscopical observations of ovary did not reveal any histopathological alterations due to WSSV, and further, the data was not conclusive in that WSSV blocks the ovarian maturation of females. Owing to the rarity of spawning of WSSV infected female *P.monodon*, the vertical transmission of WSSV is extremely difficult to prove in shrimp. In order to circumvent this difficulty, the mudcrab (*Scylla olivacea*), a crustacean model organism was taken, wherein it is easy to induce maturation and spawning. A total of 14 females caught from Pulicat Lake were challenged with WSSV and infection was confirmed both by nested and Real Time PCR. The animals were infected, and eight animals were ablated, three uninfected and ablated and three infected and ablated kept as control. After five month experimental period, none of the animals or uninfected controls spawned and no mortality was recorded. Failure in spawning may not be due to WSSV infection. All the animals were dissected and ovarian stages were macroscopically classified. Out of the eight infected animals, only five animals had reached advanced ovarian stages. The ovarian tissues are being processed for *in situ* hybridization to detect WSSV.

Isolation and characterization of female specific genes related to maturation

The presence of cortical rods and cortical rod protein is the biomarker for the final oocyte maturation in penaeid shrimp. Further, these structures/proteins fail to express frequently in pond-reared penaeids, and, therefore, low reproductive performance in pond reared animals is generally attributed to the dysfunction in the synthesis or expression of this protein. An attempt was therefore made as a first step to characterize mRNA of cortical rod protein (thrombospondin, a major component of the protein), and its expression profile during different maturation phases in the wild caught and pond reared *P. monodon*. Preliminary studies indicate that cortical rod protein is expressed even in the early vitellogenic phases. Conversely, cytological/ morphological structures of cortical rods are found only in the ripe or early ripe ovaries (Fig. 1 a & b). The expression profile of three mRNA transcript, female specific protein (FS), *P. monodon* ovary specific transcript 1 (pm-ost1) and thrombospondin (cortical rod protein), during the natural maturation phase of *P. monodon* were studied. All the studied transcripts showed up regulation only in the early maturation phase (Fig. 2).

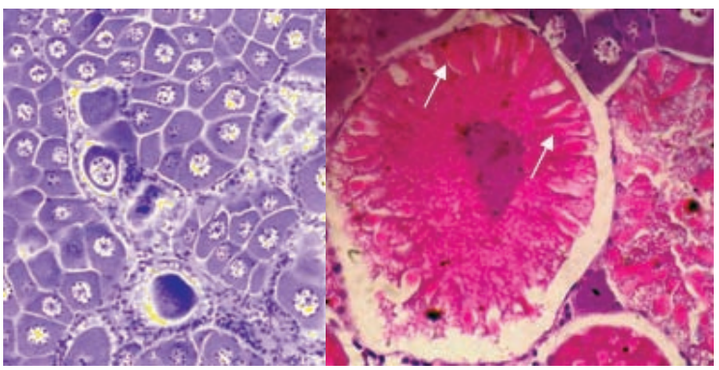


Fig. 1. Cortical rod protein expression in *Penaeus monodon* a) early vitellogenic ovary b) cortical rod ovary (white arrows indicate the cortical rods)

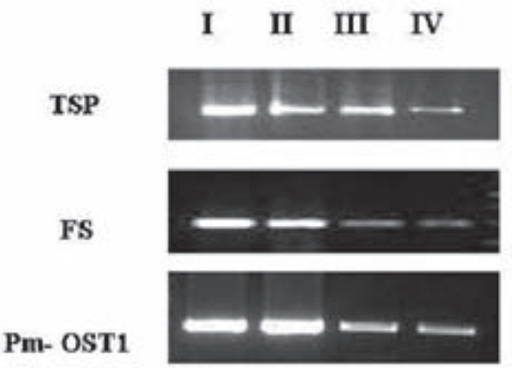


Fig. 2. Expression profile of mRNA transcripts in *Penaeus monodon* (lane I to IV represents different maturation phases)

Effect of formulated diet on spermatophore quality of tiger shrimp

To evaluate the effect of formulated maturation diet on spermatophore quality in male *P. monodon*, three combination of feeds *viz.*, fresh feed (clam meat), formulated and a mix of fresh and formulated diet were used. Spermatophore quality was evaluated by spermatophore weight, sperm count, melanization and presence/absence of spermatophore. Initial baseline data of spermatophore weight and sperm count were not significantly different among treatments. In animals fed with fresh diet, sperm concentration was higher than the initial value, whereas in other treatments sperm concentration was found to be slightly lower than the initial concentrations. During the one week of experiment, no cases of melanization and absence of spermatophore were noticed. Owing to the high mortality of animals, experiments could not be extended for four weeks as planned. However, the present study indicates the possibility of partial replacement of natural diet with formulated diet.

Pathways of microbial input into larval tanks

In order to understand the major sources of microbial load into hatcheries, counts of total bacteria and *Vibrio* spp. were monitored during the cycles of larval shrimp production of *Fenneropenaeus merguiensis* (Table 1).

Table 1. Total bacteria and *Vibrio* count in *Fenneropenaeus merguiensis* larval shrimp production cycle

Hatchery input	Total bacteria count (TBC) (CFU per ml)	Total vibrio count (TVC) (CFU per ml)
Intake water	3-5 x 10^2	0-500
Live feed	3-6 x 10^9	1.2-8.5 x 10^7
Algal feed	2-6 x 10^6	0.05 to 4 x 10^4
Formulated feed	2-3 x 10^2	nil
Maturation tank water	6-8 x 10^6	2-4 x 10^2
Larval rearing tank water	0.8-15 x 10^4	1.2-2.3 x 10^2
Live animals (PL20)	3-9 x 10^8	4-6 x 10^3

Among the various hatchery inputs, live feed was found to have higher and variable Vibrio counts. Low levels of microbial load in larval rearing tanks as compared to unfiltered seawater during the seed production indicate that the build up of the microbial load as a function of the inputs.

High density microbial population was observed during the onset of winter compared to warmer season during seed production in the LRT section (Fig. 3 a & b). Towards the end of the larval rearing as the postlarvae were weaned to artificial diet like flakes, Vibrio counts showed an increase. However, the *Vibrio* prevalence was lower than the limit usually present in commercial hatcheries. Commonly encountered Vibrio isolates were: *Vibrio parahaemolyticus, V. vulificus* and *V. alginolyticus.*

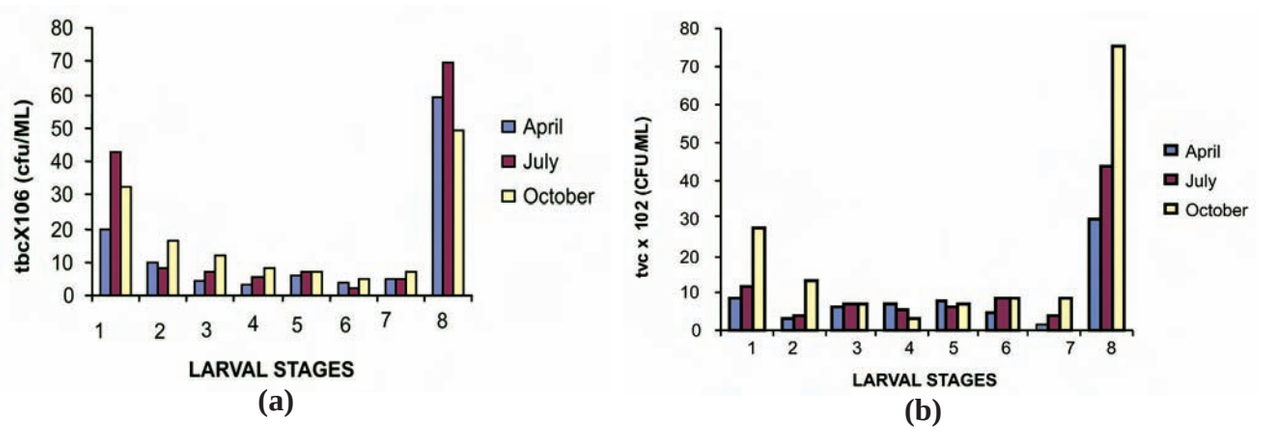


Fig. 3. Bacterial count during *Fenneropenaeus merguiensis* seed production a) total count b) total vibrio count (1-Eggs, 2-Naupli, 3-Zoea, 4-Mysis, 5-PL1, 6-PL7, 7-PL17, 8-PL19)

Probiotic based shrimp seed production

In a series of experiments, five widely used commercial probiotics were evaluated for their effect on growth, survival rate and immune parameters in postlarvae. The experiment was carried out with an initial stocking of 70,000 nauplius of *P. monodon* in 500 L tank in triplicate with and without probiotic application. Two commercial probiotics of a reputed brand were given at 1-2 ppm dose starting from zoea stage on a daily basis, followed by application on alternate days in the PL stages up to PL12 stage. At the end of the experimental period, a significantly higher survival rate was obtained in the probiotic treated group (59.0%) compared to that of the control group (41.7%). Confirmatory trials standardizing the dose and frequency of application are underway.

For the development of a technique for probiotic based shrimp seed production, a set of experiments were conducted involving allochthonous probiotic strains, *Lactobacillus rhamnosus* (JCM 1136) and yeast *Saccharomyces cerevisiae* (IAM 14383T), best known for their probiotic properties. Seed production of tiger shrimp *P. monodon*, was carried out with probiotic interventions, optimizing

the dose of probiotic bacteria and a dose of 10^5 to 10^6 CFU/ml was found to be better. These experiments revealed a positive influence of these probiotics on larval development, metamorphosis and survival of the shrimp larvae. Probiotic treated seeds performed better in terms of growth and survival (Fig. 4 a & b) of the postlarvae as compared to that of the control when treated with *S. cerevisiae* and survival when treated with *L.rhamnosus* (Fig. 5). More confirmatory experiments are to be continued to explore the strain specific advantage of their use.

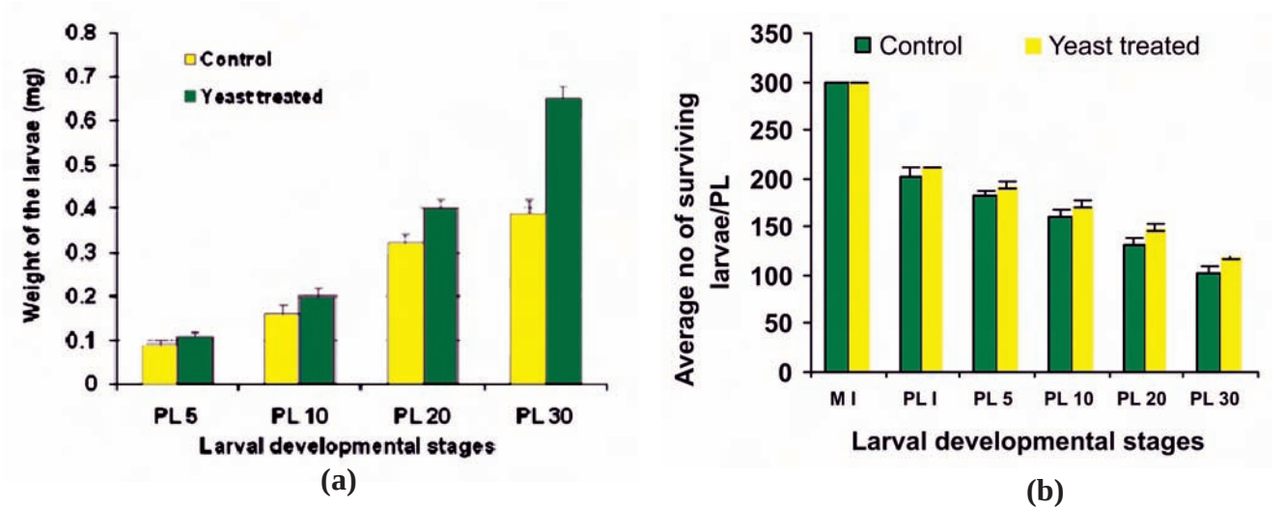


Fig. 4. Probiotic (*Saccharomyces cerevisiae*) based *Penaeus monodon* seed production a) weight b) survival rate

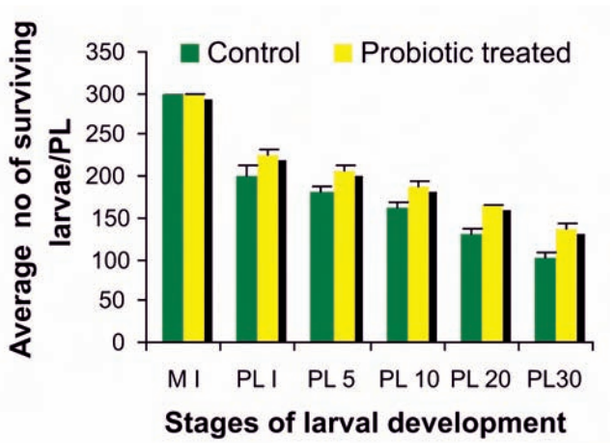


Fig. 5. Survival of *Penaeus monodon* postlarvae in probiotic (*Lactobacillus rhamnosus*) treated tanks

Culture of vannamei-Capacity building of fisheries extension officials

With increasing areas coming under *Litopenaeus vannamei* culture it was felt that there is a need for capacity building for a better understanding of both the technical and regulatory aspects of its culture. Therefore sensitization programmes on 'Introduction and culture of *L. vannamei'* were jointly conducted by CIBA and CAA with NFDB support for Fisheries Extension Officials (FEOs) in the states of Gujarat, Andhra Pradesh and Tamil Nadu during the month of July 2010.

To evaluate the sensitization programme, research design of before-stimulus-after methodology was adopted. A questionnaire on technical aspects of *L.vannamei* farming and the regulatory guidelines was given at the beginning and at the end of the sensitization programme. In the pre-sensitization

stage, about 62 respondents (68.88%) possessed 34.66% of awareness on *L.vannamei*. However, in the post sensitization stage 82 out of 90 respondents (91%) had an awareness level of 66% and above. As a whole the sensitization has contributed for 24.5% increase in the awareness levels of the FEOs on *L.vannamei* (Fig. 6). The overall increase in the awareness levels of FEOs on *L.vannamei* scientific aspects was 24.1% and 24.9% with regard to *L.vannamei* regulatory guidelines.

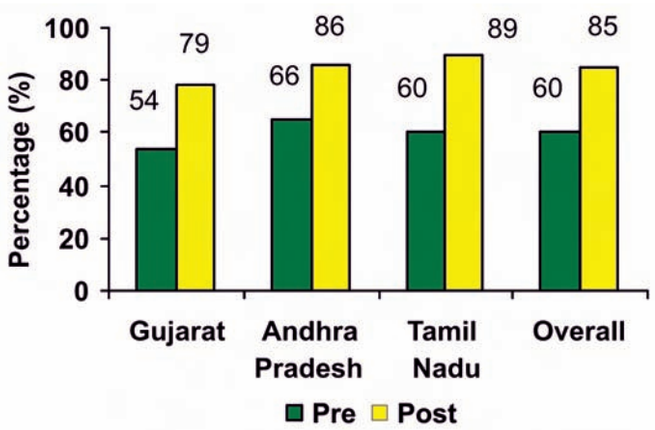


Fig. 6. Pre and post levels of awareness on *Litopenaeus vannamei* among Fisheries Extension Officers

Culture of vannamei: Monitoring physico-chemical and biological parameters

Since *L.vannamei* culture is relatively new to India and there is no data on the physico-chemical and biological parameters of pond culture, a study was undertaken to collect the basic information. Two ponds were selected for continuous monitoring of *L. vannamei* culture at Sathurangapatnam near Kalpakkam. Each pond has an area of 0.5 ha and the stocking density was 60 /m^2. Survival rate was 89% and 47.25% in first and second ponds respectively. Both the ponds had a FCR of 1:1.1 and production was 12,000 kg and 7,882 kg/ha respectively. During culture, pH ranged from 8.09 to 8.22. Salinity increased with the culture period and mean value was around 6.7 ppt. The mean values of TDS and TSS were 5.1 ppm and 205 ppm respectively. There was no carbonate alkalinity and bicarbonate alkalinity as $CaCO_3$ was around 34 ppm. Metabolite values were within the permissible limit throughout the culture period. The mean value of TAN concentration at surface was around 0.91 ppm and nitrite-N was around 0.561 ppm. Nutrients like nitrate, phosphate and silicate increased with culture period. Nitrate concentration ranged from 0.315 ppm to 2.78 ppm. Magnesium values (175 ppm) were higher than calcium (60 ppm) concentration. The average values of Chlorophyll concentration during the culture was 59 ug/l. The observations indicate that the level of calcium is low and supplementing it would improve the growth of the shrimp. At this level of stocking and the management measures followed with the use of probiotics, the nutrients like ammonia, nitrite, nitrate and phosphate are all well within the permissible limits.

Culture of vannamei - Effectiveness of farm discharge water treatment system

With the introduction of *L. vannamei*, stocking densities of upto 60 no./m^2 is permitted and the Effluent Treatment Pond (ETP) or discharge water treatment system (DWTS) as it is more appropriately called has become mandatory for all the farms culturing the species, irrespective of their size. The efficiency of DWTS was evaluated in two *L. vannamei* farms (Tuni in Andhra Pradesh and Sirkazhi in Tamil Nadu) approved by CAA and the details are given in Table 2.

Table 2. Water and soil quality of *Litopenaeus vannamei* farm discharge water treatment system

Parameters	Farm 1*	Farm 2**
pH	7.28-7.57	7.62-8.67
Salinity (ppt)	5-16	17-27
Total ammonia nitrogen (ppm)	0.542-2.654	0.4971.543
Chemical oxygen demand (ppm)	44-80	38-72
Soil organic carbon (%)	0.36-1.38	0.12-0.84

*Tuni, Andhra Pradesh; **Sirkazhi, Tamil Nadu

The discharge water from the harvest ponds in both the farms was pumped into the DWTS. The water samples were collected once in two hours for the first 12 h period and then once in 4 h for the remaining period and were analysed for the parameters prescribed for the discharge water. The pH and salinity of water in DWTS ranged from 7.28 - 7.57 and 5-16 ppt in Farm 1 and 7.62 - 8.67 and 17-27 ppt in Farm 2. Total settleable solids concentration decreased to 0.1 ml/l after 10 h in Farm 1 and after 36 h in Farm 2. The study showed that total suspended solids concentration in DWTS reached the acceptable level within 48 hours, whereas the system was not effective for metabolite and nutrients removal. The results need further validation by including more number of DWTS of farms culturing *L. vannamei*.

Pumping of shrimp farm discharge water into DWTS

Measurement of total settleable solids at the farm site

Culture of polychaete worms

Studies on the habitat preference of polychaete *Marphysa gravelyi* was carried out in yard experiments with three combinations of soil types a) Loamy soil, b) Sand:Loam 1:1, and c) Sandy soil. Fifty adults of average size of 2.8 g were stocked in each tank of 100 l in triplicate. At the end of 180 days culture, 42 nos. attained the maximum growth with an average weight of 2.14 g in sand and loam soil, followed by 28 nos. with an average size 1.78g in loamy soil and 18 nos. with average weight of 1.65 g in sandy soil. The study indicates that polychaetes prefer sandy loam soil possibly due to its richness in organic matter.

In order to understand whether culturing polychaete would decrease or increase their nutritive value, proximate composition of adult polychaetes collected from the wild (lagoon) and after 120 days of culture, were analyzed. The crude protein was slightly lower in cultured polychaete samples (10.97%) compared to wild (12.14%) whereas crude fat is higher in cultured sample (1.76%) compared to wild (1.15%). The most essential polyunsaturated fatty acids eicosapentaenoic acid (11.36 & 12.21%) and docosahexanoic acids (4.32 & 4.29%) were nearly same in wild and cultured polychaete worms, respectively. The composition did not vary significantly, however, the cultured worms had a higher percentage of lipid compared to wild suggesting that through dietary manipulation, the lipid profile could be improved which would help in improving gonadal maturation and egg quality.

Adoption of biosecurity measures

The data collected from Tamil Nadu and Andhra Pradesh on the adoption of 11 biosecurity measures were analysed. The adoption levels significantly varied between the two states with non adopters more in Andhra Pradesh than Tamil Nadu for most of the biosecurity measures. Andhra

Pradesh farmers need to be sensitized in adoption of biosecurity measures when compared to Tamil Nadu farmers for reducing frequent disease outbreaks. Farmers of both the states are unaware of the importance of proper disinfection procedures for the workers and visitors coming into the farm. Further there was no compliance regarding waste water treatment in both the states. However, with the shift in species cultured from *P.monodon* to *L.vannamei*, biosecurity protocols have become mandatory and it is being strictly regulated by CAA.

District level planning for brackishwater aquaculture

Development of district level planning for brackishwater aquaculture is aimed at providing information on the available resources within a district as well as to identify problems so that action plans to address the problems present in aquaculture sector could be developed. As the first step, a database on coastal districts in the East coast is being developed with the primary information such as total land area, farm area developed, area under culture, available potential area, coastal length and ecologically important ecosystems; and secondary information such as demographic details, general administrative arrangement, climate, rainfall, ground water quality, hydro-geological characteristics and infrastructure facilities. Information was collected from different sources for the coastal districts of Tamil Nadu (12), Andhra Pradesh (9), Orissa (7) and West Bengal (3).

Issues and problems at different levels such as policy (leasing, license for export, testing prior to export, market), farmers (species, disease, electricity) and infrastructure facilities were identified. Apart from common problems for aquaculture in all coastal districts such as disease problems, the need for standardized rate for different counts of shrimp produced, electricity subsidy, insurance against natural disasters, revival of abandoned farms, need for land leasing policy, need for disease resistant varieties and desilting of canals, some of the specific problems pertaining to each state were also identified. In Tamil Nadu, closure of bar mouth for several months led to limited water availability and water quality problems. In West Bengal traditional approach is firmly ingrained such that farmers are reluctant to take up scientific farming and availability of quality inputs is scarce. In Orissa, even with a 480 km long coast line, the net potential area available for shrimp culture is less than a 100 km stretch when regulations regarding Chilka lake, national parks/ sanctuaries, turtle grazing grounds and mangrove forests are taken into account. Limited scope is available for shrimp hatchery development due to heavy freshwater influx and muddy sea bed conditions. The district boundary maps of 31 coastal districts in four East coast states were delineated using GIS tools and it is proposed to develop the coastal district database on a GIS platform.

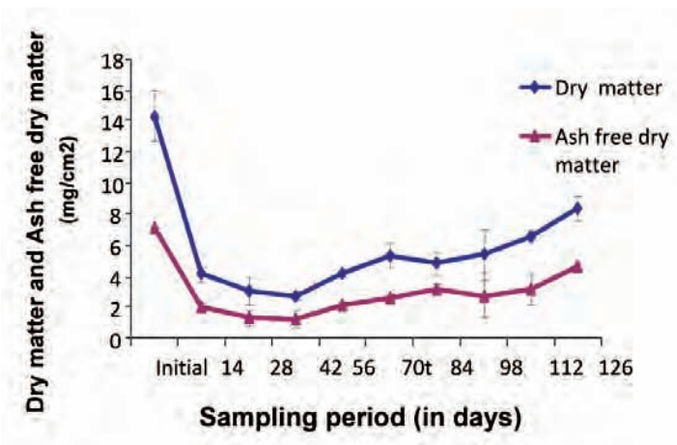


Fig. 7. Periphyton biomass in terms of dry matter and ash free dry matter (mean ± SD)

Periphyton based culture of tiger shrimp

To evaluate the effect of substrate on periphyton based *P.monodon* culture, experimental pond trials with whole bamboo and split bamboo as substrate were carried out for 130 days duration at a stocking density of 8 nos./m^2. The performance of the shrimp in terms of production, average body weight and feed conversion ratio are given in Table 3. A higher average production of 1640 kg/ha with 26 g average body weight was obtained in the treatment ponds compared to that of the control ponds with 1390 kg/ha production with 22 g ABW from stocking density of

8 nos./ m^2. On an average, 17.9 % improvement in terms of production and 18 % gain in average body weight was observed in treatment group compared to control. Also, 29% improvement in FCR in the substrate based farming system showed better utilisation of natural food available in substrate. However, no difference in survival was observed between the treatments.

Table 3. Production details of *Penaeus monodon* in periphyton based ponds with (P) and without (C) bamboo subtrate

Ponds No.	Area (m^2)	P/C	Production (kg)	Production (t/ha)	Survival rate (%)	ABW (g)	FCR
1	1840	P	356	1.90	87.0	27.7	0.85
2	2750	P	379	1.38	72.0	24.0	1.40
Average				1.64	79.5	26.0	1.15
3	2750	C	377	1.37	71.0	24.0	1.50
4	3750	C	532	1.41	88.0	20.0	1.47
Average				1.39	79.5	22.0	1.48

Level of periphyton biomass

The periphyton biomass in terms of dry mater (DM), ash free dry matter (AFDM) and pigment concentrate growing on bamboo substrate were determined every fortnight following standard methods (APHA, 1992) and the results are presented in Fig. 7. The mean values for DM, AFDM per unit surface area are 5.9 ± 0.7 and 3 ± 0.4 mg/cm^2 respectively. Steady decline in periphyton biomass during the culture period could be attributed to grazing by the shrimp and the higher rate of preference of periphyton by the juvenile shrimp than adult *P. monodon*.

The study clearly indicates that periphyton based shrimp farming can be used to increase shrimp production and reduce the cost of production in commercial culture systems.

Substrate based shrimp pond

Periphyton on bamboo substrate

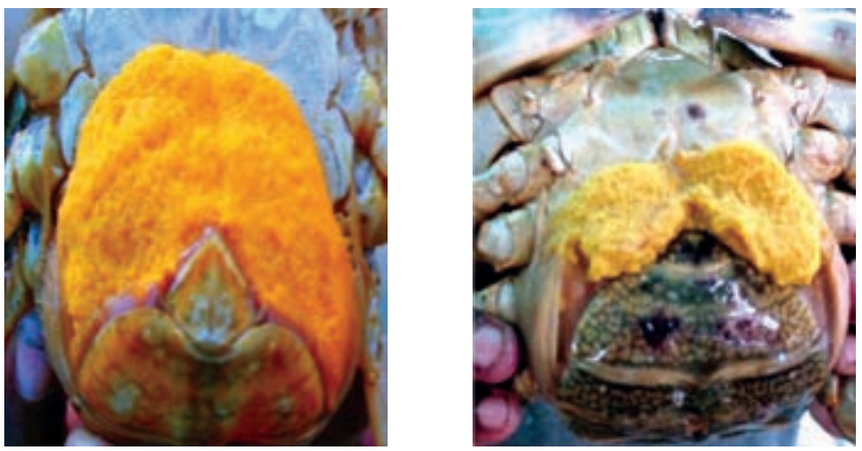
A haul of harvested tiger shrimp

Project Title (Institute)	Development of nursery and grow-out culture package for mudcrabs (*Scylla* spp.)

This project aimed to develop a reliable protocol for the development of hatchery and nursery rearing of mudcrab *Scylla serrata*. Experiments were conducted further to refine the broodstock management protocol, larval rearing and nursery techniques.

Broodstock development of mudcrab *Scylla serrata*

Owing to the variability in hatchery performance and less predictability of using intact spawners, a small scale broodstock development protocol using unilateral eyestalk ablation was developed for *S. serrata*. Further, the feasibility of using small containers (500 l capacity) with individual rearing *vs*. communal rearing was evaluated. Sand-filled basins were used instead of using a complete sand substratum, and this modification provided relative ease to clean the tank, and the same tanks were used for incubation once the animals spawned. The experimental design was satisfactory to follow individual spawning cycle of *S. serrata*. Of the 11 females stocked in the system, six animals spawned (54.5%), and only one female moulted and died. Latency period, the time taken for spawning after eyestalk ablation, is highly variable (between 12 and 41 days) whereas incubation period ranged from 12 to 14 days. Of the six animals that spawned, the berry of the two animals was yellowish and unhealthy.



Female berried mudcrab (The left image shows healthy and right image shows unhealthy eggs)

Development of large scale larval rearing protocol for mudcrabs

Rearing experiments and mass production of *S. serrata* juveniles were carried out to develop a protocol for small scale mudcrab hatchery. Two batches of experimental hatchery runs were carried out to identify the effect of tank volume (500 L vs 5000 L) on final survival. Rearing tanks were stocked at a density of 100 zoea/L, and in the initial 10 days the larvae were fed with rotifer (*Brachionu*s spp) at a density of 10-15 individuals/ml. From day 5 onwards, freshly hatched *Artemia* nauplii (heat killed) were provided along with rotifer @ 1 no./ml. The density of *Artemia* nauplii was progressively increased up to 5 nauplii /ml at the final phase of the rearing cycle. Cultured microalage species (*Chlorella* spp) was introduced daily into the tanks to provide green water effect and support the rotifer population in the tanks. For the first four days, water was not exchanged, thereafter 20-50% of water was exchanged. Survival rate was 1% and 1.5%, which is nearly similar to those published in literature. In both trials, the best survival was obtained in larger volume, and 2500 megalopa/1stcrab instar were produced. Larval development as a function of time and survival rate at each phase of development is depicted in Fig. 8. Each data point represents the time in which the majority of individuals sampled (n=10-20) metamorphosed to the next stage.

Development of nursery rearing protocol for mudcrab

As a continuation of the experiment carried out during the last two years, an experiment was conducted using *S. serrata* crab instar (C4-C5) to evaluate the effect of stocking density during the

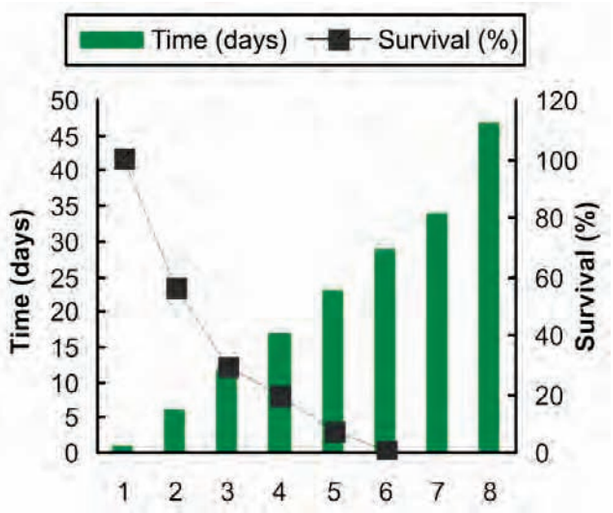


Fig. 8. Development of *Scylla serrata* larvae as a function of time and survival (1-Zoea 1, 2-Zoea 2, 3-Zoea 3, 4-Zoea 4, 5-Zoea 5, 6-Megalopa, 7-megalopa/crab instar, 8-crab 3 -4)

was no significant difference in the growth of crabs stocked at different densities with an over all mean of 23.8 g.

Confirmation of species status of Indian mudcrabs

There has been some ambiguity about the taxonomic status and nomenclature of Indian species. The larger morph or 'green morph' of mudcrab has been named as *Scylla tranquebarica*, and the small morph or 'red morph' is named as *S. serrata*. The morphological and biological characteristics of these two species are not in agreement with the latest classification of *Scylla* genus. To resolve this, detailed morphological and molecular studies were carried out using the specimens obtained form several localities of Indian sub continent. Initially the specimens were grouped into two groups (*S. tranquebarica* and *S. serrata*) according to the classification of Kathirvel and Srinivasagam (1992). Later it was found that the green morph (*S. tranquebarica*) comprised a cryptic morph, which is a less abundant and morphologically distinct mainly in the adult male population. Therefore, for initial analysis three tentative morphs were created: *S. tranquebarica* 1, *S. tranquebarica* 2 and *S. serrata*. All the morphometric variables, and mean values for the ratios fall within the data published by Keenan *et al.* (1998) for three species of mudcrab *Scylla*: *S. tranquebarica, S. serrata*, and *S. olivacea*. Further, mean

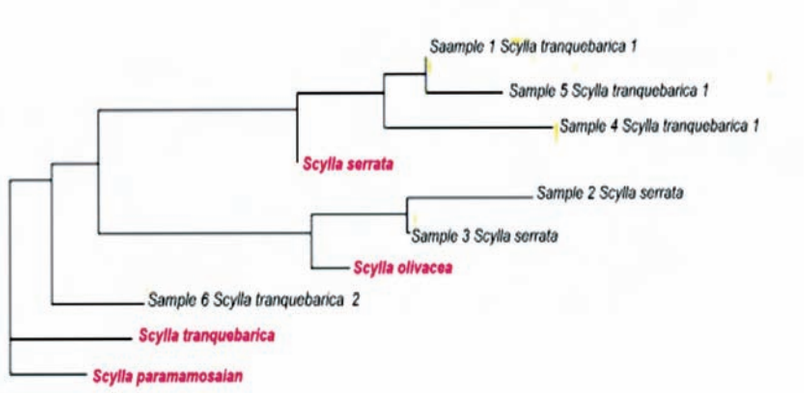


Fig. 10. Phylogenetic relationship of six representative *Scylla* species (The GenBank references are given in red font)

nursery phase. Mudcrab C4 -C5 stages with an average bodyweight of 0.4g were obtained from RGCA, MPEDA and reared in 100 m^2 earthen pond for two months. Two different stocking densities were tested (5 and 10 per m^2). Crabs were fed with minced fish meat in excess for the first 15 days and later increased to 1.0 kg per pond. After two months of rearing survival of crabs stocked at 5 individuals per m^2 was higher (51.9%) compared to crabs stocked at 10 per m^2 (47.8%), but there

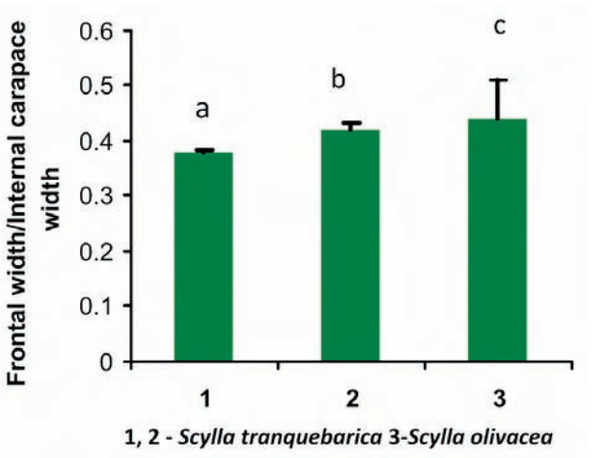


Fig. 9. The ratio of frontal width to internal carapace width of three morphs of mud crabs (superscript a b c denotes that the means are significantly different).

values for the ratio FW/ICW clearly indicate the existence of three species of mudcrabs (Fig. 9) as suggested by Keenan *et al* (1998). However, the morphometric data of *S. tranquebarica* 1 matches with those of *S. serrata* described by Keenan. The *S. tranquebarica 2* matches with *S. tranquebarica* and *S. serrata* corresponds to *S. olivacea*. In order to further confirm using molecular markers, partial 16s r DNA was amplified using same primers and PCR conditions as those described in Somboonna *et al* (2010) (Fig. 10). The phylogenetic tree was constructed using mitochondrial 16s rDNA sequences of reference *S.serrata, S. olivace*a, *S. tranquebarica* and *S. paramamosain*. The adult specimens of *S. serrata* and *S. tranquebarica* have two conspicuous spines on the outer margin of the carpus of the chelipeds while spines are not obvious in *S. olivacea*. *S.serrata* has obvious polygonal markings on the body and all the legs whereas in *S. tranquebarica* these are restricted to the last two legs.

Molecular data on the gene further confirmed the existence of three species and its valid nomenclature is: *S. tranquebarica* 1 is *S. serrata, S. tranquebarica* 2 is *S. tranquebarica and S. serrata* is *S. olivacea*.

Three species of *Scylla* (from left to right): *Scylla serrata, Scylla tranquebarica* and *Scylla olivacea*

Project Title (Institute)	**Development of techniques to quantify the impacts scenario between environment and aquaculture using remote sensing and GIS**

Impact Assessment of aquaculture development on Krishna mangroves

To assess the impact of aquaculture on Krishna mangroves, remote sensing satellite data of Landsat Thematic Mapper (1986) and Linear Imaging Self scanning Sensor (LISS) III 2009 were used (Fig. 11 a & b). Krishna mangroves are located in the coastal plains of Krishna delta between the latitude of 15° 42' – 15° 55' and the longitude of 80° 42' – 81° 01' spread across Krishna and Guntur districts and includes Sorlagondi Reserve Forest (RF), Nachugunda RF, Yelichetladibibba RF, Kotta palem RF, Molagunna RF, Adavuladivi RF, and Lankivarnidibba RF. Reserve forest boundaries and ground control points were delineated from the Survey of India topographic maps. The land use pattern was derived from the satellite data using ERDAS Imagine 9.1 and Arc GIS 9.3 (Fig. 12 a & b). In the georeferenced images, the smooth bright red colour indicates dense mangrove forests. Regular square or rectangular shaped blocks in dark blue or bluish grey are aquaculture farms. The wide spread red color in landward side are agriculture lands and the yellow line indicates the reserve forest boundary. From the remote sensing images, it was possible to delineate different land classes such as mangroves, agriculture, aquaculture, mudflats, coastal vegetation and sand.

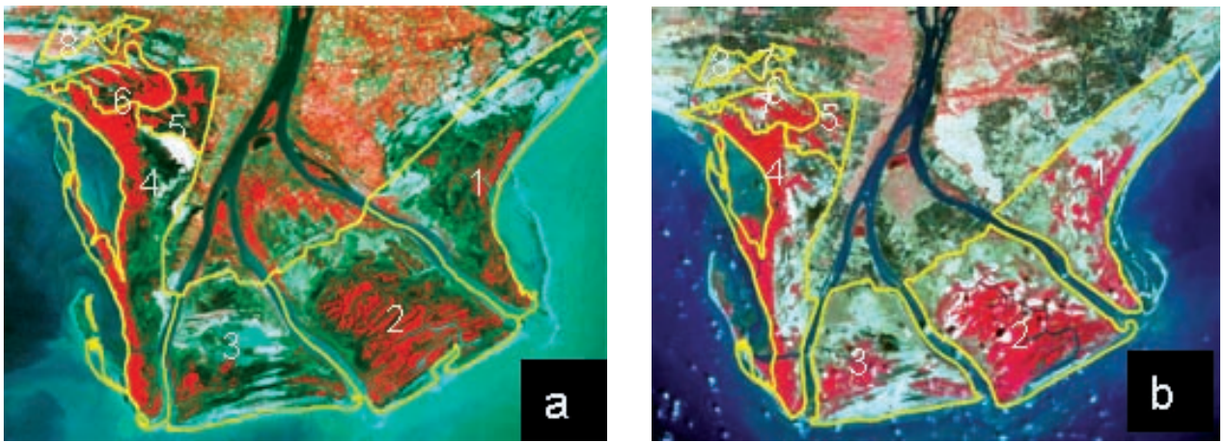


Fig. 11. Krishna delta mangroves a) Landsat TM image-1986 b) IRS P6 LISS III-2009 (1. Soriagondi , 2. Nachugunda 3. Yelichetla Dibba 4. Lankevani Dibba 5. Molagnda 6.Kottapalem Bit No.1 7. Kottapalem Bit No.2 8. Aduvuladivi)

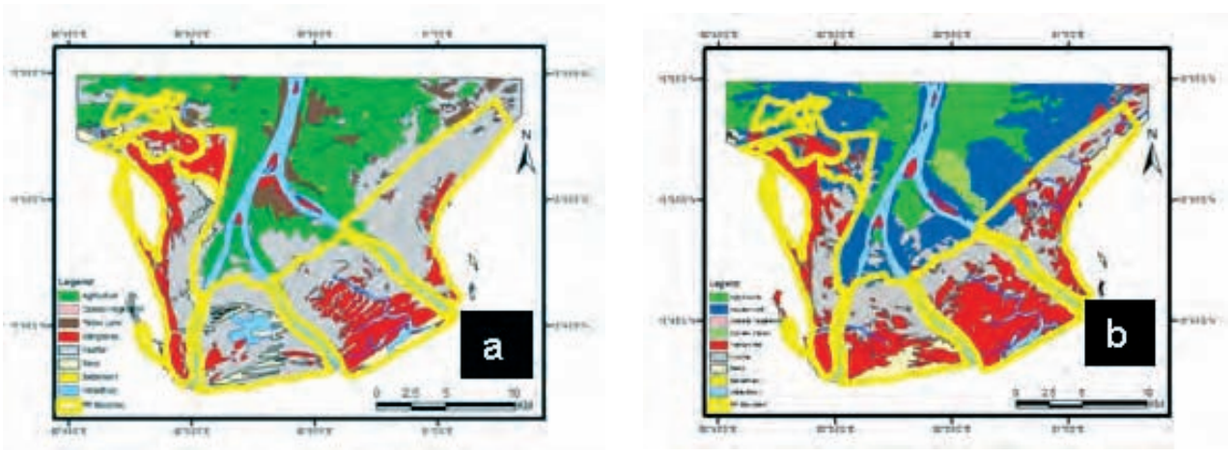


Fig. 12. Landuse pattern in Krishna delta a) before aquaculture development in 1986 b) after aquaculture development in 2009

GIS analysis indicated that mangrove area has increased three times in 2009 (11686 ha) when compared in 1986 (7433 ha). As seen from Fig. 12 a & b the area of shrimp farm development as of 2009 has been outside the reserve area. Aquaculture farms did occupy some of the areas in Molagunta RF, Kottapalem RF Bit 1 and 2, Adavuladivi RF and the northern part of the Lankivanidibba RF in 2009. During the ground truth verification, it was found that shrimp farms with in the RF boundary were demolished and mangrove regeneration has started in most of the places. The present study has clearly established that mangroves have increased in the Krishna delta by 4253 ha and shrimp farms were not present in the reserve forests with mangroves.

Methodology to assess the impact of long term climate change on aquaculture

Long term climate change is indicated to lead to rise in sea level and the resultant inundation would submerge coastal shrimp farming area. For developing a methodology to asses this impact, Space Radar Topography Mission data was used to derive Digital Elevation Model (DEM) of the coastal areas on Nagapattinam district. The DEM created for Nagapattinam and adjoining areas indicated that large flat coastal lands existing on par with Mean Sea Level expected due to sea level rise. The real extent of submergence and its impact on shrimp culture will be evaluated after further modeling sea level rise.

Assessment of potential impact of shrimp farming on the coastal aquifer

To assess the impact of shrimp farming on coastal aquifer, simulation studies using visual MODFLOW software were conducted. The boundary extent of 68.7 sq. km in the lower Vellar subwatershed was selected. The input parameters to the model *viz*., well location, water depth and ionic characteristics were collected from the study area. The litholog obtained showed that the geological strata in the study area was of three sub layers with different porosity and hydraulic conductivity. The model was calibrated with the water level data obtained from PWD. The groundwater flow model and the velocity vector were obtained. The observed head at Porto Novo is 3.55 m and the calculated head is 3.02 m implying that the reliability of the model is high. The transport modeling was done to evaluate the rate of movement of ions in the groundwater system and the chlorine concentration was taken for transport modeling. The study showed that the transport of ions was limited to the first layer indicating that shrimp farming had no impact on the coastal aquifers.

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

Culture of banana shrimp

Banana shrimp, *Fenneropenaeus merguiensis* was evaluated as an alternate species during summer and winter crops in the brackishwater farm at Danti - Umbharat Centre of the Navsari Agricultural University, Gujarat. A dependable supply source of adult broodstock of *F. merguiensis* was located in Tamil Nadu coast at Keelathotham and surrounding villages of Adirampattinam Taluk in Thanjavur District. The brooders were collected off shore from about 8-10 km at a depth of 6-9 m using gill net from an out board engine fitted boat. The peak season of availability of broodstock is March to October and a total 183 broodstock (36 males and 147 females) was collected. 43 females were induced matured and a total of 10.67 lakh PL15 were produced. Postlarvae of 12-18 mm/15-22 mg (PL20) were transported to the farm site within 16 hours. The farm has all the biosecurity infrastructure such as two reservoirs of 0.14 ha each, bird and crab fencing and discharge water treatment pond of 0.06 ha. Four ponds of 0.15 ha (1500 m^2) water spread area each was prepared for stocking the PL20 as per the standard culture protocols.

The details of treatments and production of summer crop are given in Table 4 and pond 2 and 3 served as controls. The performance of CIBASTIM was not conspicuous in high density (20 nos./m^2) ponds whereas in law density ponds (10 nos./m^2) the survival and production were comparatively higher in CIBASTIM treated pond compared to control (6.6 % increase in production). There was no difference in average survival (69%) between the two stocking density, but the average body weight (ABW) at the time of harvest was comparatively more in low density ponds (15.29 g) than high density ponds (14.19 g).

Table 4. Treatment and production details of the summer crop of banana shrimp

Production details of the summer crop	**Treatment ponds**			
	1	**2**	**3**	**4**
Stocking density (Pl/m^2)	20	20	10	10
CIBASTIM	Yes	No	No	No
DOC (days)	130	130	165	165
Average body weight (g)	13.89	14.49	15.87	14.71
FCR	2.45	2.73	2.28	2.12
Survival (%)	68.28	70.44	64.26	73.89
Production (kg/ ha)	1897	1957	1020	1087

The stocking for winter crop was carried out in the last week of November @ 10 PL/m^2 in the four ponds. CIBASTIM was applied in ponds 1, 3 and 4 from the fourth day of stocking and sugarcane bagasse in kadappa stone blocks was placed in ponds 1, 2 and 4 (ond 2 is control) after 60 DOC. The treatments and production details of winter crop are presented in Table 5.

Table 5. Treatment and production details of the winter crop of banana shrimp

Production details	Treatment ponds			
	1	2	3	4
Stocking density (no./m^2)	10	10	10	10
CIBASTIM	Yes	No	Yes	Yes
Bagasse	Yes	Yes	No	Yes
DOC (days)	139	136	139	136
Average body weight (g)	16.85	17.72	14.22	18.41
Survival rate (%)	85.99	63.49	57.34	38.38
FCR	2.64	2.19	2.58	2.43
Production (kg/ha)	946.67	1200.00	666.67	706.67

The survival rate was high (86%) in pond 1 followed by pond 2 (63.5%) and bagasse treatment was common in both the ponds. Pond 4 with both the treatments CIBASTIM and bagasse had the lowest survival of 38.4 %, but the ABW was high (18.4 g) compared to other treatments. Bagasse treatment resulted in more ABW of animals compared to control which might be due to the availability of periphyton to the animals on the bagasse substrate.

There was not much difference among the pond treatments and summer and winter crops with respect to pH, and Ca:Mg ratio. The pH, salinity and alkalinity values ranged from 7.62 to 8.77, 12 to 45 ppt and 112 to 216 ppm during summer crop and 7.65 to 8.55, 21 to 41 ppt and 120 to 284 ppm during winter crop, respectively. TAN and nitrite N values were high and NO_3:PO_4 ratio was less in high density ponds during summer crop which might be the reason for poor performance compared to low density ponds. During winter crop, NO_3:PO_4 ratio was more and the better pond environment with less TAN values in bagasse treatment ponds might have contributed to better ABW. Soil pH did not vary much between the treatments in both summer and winter crops. But organic carbon content in soil was comparatively high in ponds with 20 PL/m2 during summer crop, whereas all the bagasse treated ponds during winter crop registered more organic carbon content. The high organic carbon content will lead to reduced condition in the soil and will lead to decrease in DO.

The wastewater from the farm ponds during both the crops was discharged into ETP pond and it was used for irrigating *Salicornia* crop in the adjacent plot. The results indicated that the production of banana shrimp with biosecured aquaculture was more successful during winter crop for Gujarat region as indicated by the growth parameters and that low stocking density (10 PL/m^2) culture was more economical.

L. vannamei culture practices in Gujarat

A survey was conducted to assess the practices followed in *L.vannamei* culture in different farming areas of Gujarat. The survey indicated that stocking density ranged from 30 - 70 PL/m^2. Though DOC in all the farms was more are less similar, the ABW of animals varied from 17-43 g. All the farms had similar FCR of about 1.2 to 1.4 (Table 6).

Table 6. Culture details of *Litopenaeus vannamei* in three farms in Surat and Navsari

Culture details	Farm 1*	Farm 2**	Farm 3*
Water spread area (ha)	10	26	4
Average pond area (ha)	0.8	0.6-1.0	1.0
Salinity (ppt)	15-35	15-60	18-39
Stocking density (PL/m^2)	30-35	52	70
Culture duration (days)	130-140	100-158	138-158
Period of culture	Mar-Jul	Jan-Jul	June-Oct
ABW (g)	25-28	19-30	17-43
Survival (%)	75-90	93	94
FCR	1.20-1.40	1.28	1.26-1.40
Production (t/ha)	6.0-7.0	10.6	19.5-23.6

*Surat, **Navsari

Establishment of aquaculture laboratory

A molecular diagnostic laboratory was established during the current year at Soil and Water Management Unit of Navsari Agricultural University. Equipments related to microbiological examination and for the molecular diagnosis of shrimp diseases such as PCR were installed. This facility will be useful for the analysis of the samples in the experimental ponds of the NAU and to provide the diagnostic services to the farmers of the neighbouring areas.

Harvested banana shrimp

Salicornia irrigated with shrimp farm discharge water

Project Title (MoWR)	Hydro geochemical impacts of shrimp farming on coastal watershed

Delineation of coastal watershed boundary and mapping of shrimp farm clusters

Reconnaissance survey of the shrimp farming area in Vellar- Colleron sub watershed, Chidambaram Taluk, Cuddalore district was conducted to delineate the boundary of the study area. Mini and micro watershed boundary in the sub basin has been collected from Agricultural Engineering Department, Govt. of Tamil Nadu. Secondary data *viz*. soil texture, geology, hydrogeology, rainfall, etc pertaining to the sub watershed were obtained from government departments to identify the representative groundwater sampling locations. The existing groundwater sources *viz*. bore well, dug well, open well, hand pump in the subwatershed have been ascertained with the already collected secondary data. The mapping of shrimp farming clusters is being done in GIS using the toposheet and satellite data.

FINFISH CULTURE DIVISION

Project Title (Institute)	Development of technology for quality seed production of commercially important brackishwater fishes under control conditions

Seabass broodstock development and breeding

Domesticated seabass stock from F_3 generation (80 nos.; 2.5 - 4 kg) were maintained in RCC tanks and ponds. To introduce new genetic material and to evaluate the breeding performance of domesticated and wild populations, fresh stock of 50 nos. from wild catch (2 - 7 kg) and 20 nos. reared in a freshwater pond at Bhimavaram (2.5 - 4 kg) were quarantined. A total of ten breeding trials, six using domesticated stock (three were of natural spawning without hormonal administration and three were through exogenous hormone administration) and four using the newly added wild stock were carried out. These preliminary results indicate that performance in terms of number of eggs per spawning, fertilization and hatching rate is better in fresh stock (0.8 to 1.2 million eggs; between 50 and 80% fertilization rate; and 70 and 95% hatching rate) compared to that of domesticated stock (0.2 to 1.0 million eggs; 5 and 90% fertilization rate; 40 and 90% hatching rate). This needs to be confirmed with more trials. The year round breeding of Asian seabass under recirculation system was further validated and spawning could be obtained even in the lean months of November - February indicating that if quality sea water without fluctuations in salinity and/or temperature if provided, seabass could be bred throughout the year.

Seabass larval rearing

Larvae were reared following protocols developed in previous years with the modification of zero water exchange up to 6th day to reduce abiotic stress in the larval rearing tanks. After introduction of larvae, green water and filtered sea water were added to the extent of 10% daily and the water exchange was restored from 7th day to the extent of only 40%. For 30 days rearing period, the larval survival rate varied from 24 to 63% in the case of larvae obtained from fresh wild stock whereas for domesticated stock, the survival rate was between 18 and 48%. The over all average survival rate was 52%. The protocol for weaning of fish fry to formulated diet was standardized. Introduction of formulated diet in addition to *Artemia* nauplii was started from day 18 - 20 and after a week, the fry were totally weaned to the inert diet.

Seabass nursery rearing

As a confirmation of earlier trials conducted to develop a technology for nursery rearing in RCC tanks, fry obtained from the hatchery were reared to advanced /fingerling stage (5 - 7 cm) following the earlier standardized protocols of water exchange, feeding and regular grading. Over a rearing period of 40 - 45 days, the survival rate varied between 68% and 72%. The cost of production of fingerling reared in RCC tanks worked out to be ₹ 4.80/no.

With the objective of encouraging the entrepreneurs to take up rearing seabass fry to stockable size seed as a livelihood option, technology developed by CIBA on rearing of seabass in net cages (hapas) was transferred to the farmer at Kottur, Mannargudi Taluk, Thiruvarur Dist. Seabass fry produced in the hatchery was supplied to the farmer and stocked @ 400 nos./m^3. The average survival rate obtained by the farmer was 62%. The size of the fingerling after 40 days of rearing varied between 12 and 14 cm. The total expenditure incurred by the farmer for rearing 50,000 nos. of fry was ₹ 2.8 lakhs which included cost of hapa net cages, feed, water supply fuel charges, labour charges, etc. Seedlings were sold for a price ranging from ₹ 12 to 15. The revenue realized by the farmer was ₹ 4.32 lakhs with a profit of ₹ 1.52 lakhs from a pond water spread area of 2,000 sq.m.

Nursery rearing of seabass as a livelihood option

Grey mullet broodstock development and breeding

Land based stock maintained in the ponds and RCC tanks were further strengthened with addition of sub adult and adult fishes and a total of 120 fishes in the size range of 0.6 - 1.4 kg were maintained in the holding tanks and ponds. Of the captive stock, 30% were found to be maturing during September-November, however in many cases, the ova diameter was only around 200 - 300µ. Eighteen breeding trials with exogenous intramuscular hormone administration with HCG @ 1000 - 1500 IU/kg body weight and/or pituitary extract @ 2mg/kg body weight as a priming booster dose in fishes with egg diameter more than 470µ were carried out. Mostly, the response was negative. Though males were in oozing condition, there was poor response in females even with exogenous hormone administration. In one trial, where the female fish attained ova diameter around 570µ, a different hormone protocol was followed with a priming dose of pituitary extract @ 2mg/kg body weight followed by HCG@ 1000 IU/kg body weight and after 24 hours of pituitary extract injection, LHRH-a as a resolving dose @ 50µg/kg body weight was again administered. Successful ovulation with extended belly was observed after 24 hours of LHRH-a hormonal administration. Artificial fertilization through stripping was tested and though fertilization was effective, it was very low (1%) with poor larval hatching and survival.

Since there were difficulties in breeding mullet, studies on reproductive hormonal profile of mullet were initiated. To get baseline values, the reproductive hormonal profile of gravid female and oozing male from wild collections was analyzed for reproductive hormones. The matured male was 700 gm in size and the female was 1468 g with the ovary size of 500 g and egg diameter of 600µ. Males were in oozing condition. The testosterone concentration was around 120 mg/dl in the case of male and it was 40 mg/dl in the case of female. However, the 17b esteriodial content was around 18 mg/dl in the case of females.

Pearlspot broodstock development and breeding

Juvenile fishes (450 nos.; 9.9 - 73 g) obtained from Kerala, Andal Perumbakkam, Pulicat and Muttukadu back waters were acclimatised and reared to large sizes in three rigid mesh cages of 3 X 1 X 1 m (3 cubic meters) and similar sized hapas.

The fishes were fed with pellet feed daily at 5% body weight in feeding trays. Mature pearlspot breeders (48-98 g) were selected and transferred to two specially prepared breeding tanks (RCC, 20 tonnes capacity) at the rate of 10 spawners per tank with a sex ratio of 2M : 3F. The tanks were maintained as flow-through systems with soil base and clay tiles were suspended for egg attachment.

A total of five spawnings occurred 20 -25 days after fish release during August and September 2010 with each batch containing more than 1200 eggs. Batches of 8 - 12 day old hatchlings (seed) each numbering 145 - 800, could be collected separately. The present system differed from the breeding system developed at Kerala Agricultural University Regional Research Center, Kumarakom in 2009 with respect to density of brooders/ m^2, sex ratio and salinity. A higher fry output of 1200- 3500 per batch with size uniformity was achieved with this system compared to the earlier system.

Pearlspot broodstock development

Pearlspot larval rearing

The collected hatchlings were reared indoors in 250 litre FRP tanks. Feeding was initially with *Artemia* nauplii which was gradually replaced with *ad-lib* micro-particulate feed. Hatchery-reared seed attained 0.3 g in one month, 0.67 g in two months and over 2 g in three months with survival rates of more than 95%. As part of further improving the indoor nursery rearing system for pearlspot, a trial was conducted at KRC to evaluate the effect of stocking densities of 150, 300 and 450 nos./m^3 (SD 150, SD 300, SD 450) and presence of soil base (SB) of 5 cm on growth and survival of pearlspot fry with an average weight of 0.39 g in FRP tanks of dimension 0.17 m^3. There were three tanks per treatment. Low cost feed (CP 30-32%, ₹ 18/kg) in 1 mm size was provided in feed pots in the rearing tanks.

Table 7. Performance of pearlspot fry under different stocking densities (SD) with and without soil base (SB)

Parameter	Stocking density (nos.)			Soil base		Significance		
	150	300	450	With	Without	SD	SB	SDxSB
Final BW (g)	$6.7^{c} \pm 0.30$	$4.5^{b} \pm 0.21$	$3.8^{a} \pm 0.19$	$4.9^{a} \pm 0.70$	$5.2^{a} \pm 0.83$	*	NS	NS
Survival (%)	$96.3^{b} \pm 1.85$	$90.3^{b} \pm 3.78$	$77.2^{a} \pm 9.18$	$77.9^{a} \pm 5.71$	$97.9^{b} \pm 0.84$	*	*	*

Means followed by the same superscript do not differ significantly. *P<0.05, NS = Non-significant.

In terms of growth, the best stocking density was 150 nos./m^3 while survival under stocking densities of 150 and 300 were not statistically significant (Table 7). At stocking densities of 450, the reduction in final body weight and survival were significant ($P<0.05$). Presence of soil base was found non-essential for nursery rearing of pearlspot fry since the results indicated that the soil negatively influenced the survival percentage except that the colour with fishes reared in tanks with soil base were darker (Fig. 13).

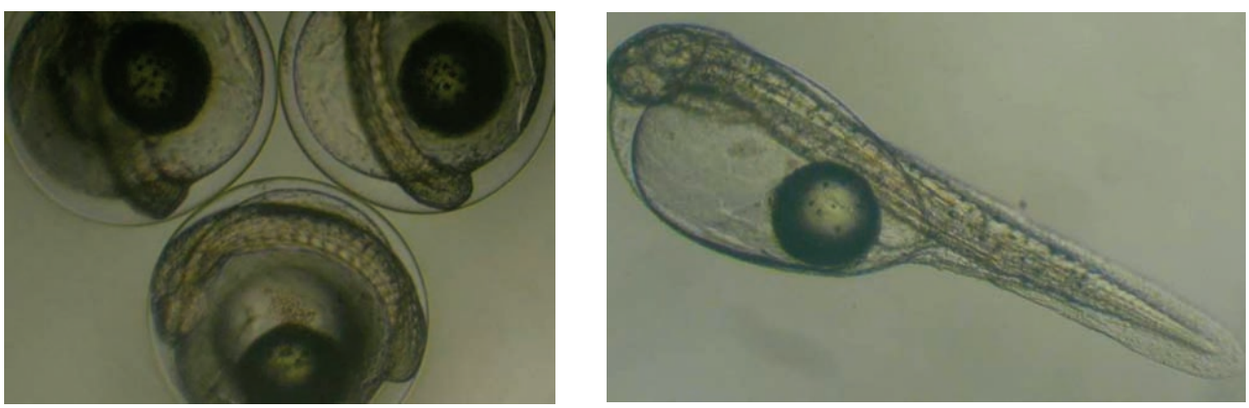
SD150 SD300 SD450

Fig. 13. Variation in size and colour of pearlspot as a function of stocking density (SD 150, SD 300, SD 450) and use of soil base

Smaller sized seed (<5 g) @ ₹ 1, while the bigger sized seed (> 5 g) @ ₹ 2 were sold to local farmers. In terms of economics of nursery rearing, stocking density of 300 nos./ m^3 was found to be better.

Ornamental fish broodstock development and breeding

Captive broodstock (78 nos. 48 - 254 gm) of brackishwater ornamental fish scat (*Scatophagus argus*) were maintained in an earthen pond with hideouts to avoid stress. During February-March mature fishes were observed and a gravid female (200 g) with ova diameter of 426µ was selected for breeding trials. Female fish was administered exogenous HCG hormone @ 300 IU/kg body weight and after 24 hours second dose of HCG was administered at the same rate. After 24 hours of 2^{nd} dose of HCG administration, LHRHa was administered @ 100 µg/kg body weight for females and half of the dose for males (86 and 120 g).



Ornamental fish scat a) Neurula stage **b) Newly hatched larvae**

After 48 hours of hormonal administration, ovulation was observed. Though males were in oozing condition, the quantity of the milt was not sufficient and the fertilization rate was only 20%. The total number of eggs obtained was around 18,000 and the average size of the fertilized egg was 740µ. After the incubation (time for egg development of 19 hours), the egg hatched out and the hatchling size was 1.62 mm and the hatching rate was 40 %. Larvae (900 nos.) were reared by feeding with rotifers following green water technology. By 25 dph, larvae attained the size range of 7-9 mm with a survival of 66.7%.

The brackishwater ornamental 'moon fish', *Monodactylus argenteus* (120 nos; 20-100g) were maintained in a pond and in FRP tanks. Fishes were fed with formulated diet @ 3% of body weight. During August, male fishes in the size range of 40 g were found to be in oozing condition. However, female fish with maturing oocyte of only 200µ was noticed.

Project Title (Institute)	**Refinement of fish culture technologies in brackishwater eco-system**

Grey mullet fingerling rearing

In an earlier trial, a stocking density of 15,000 nos./ha was found as the optimum density for advanced grey mullet fingerlings rearing. With this optimum stocking density, the effect of fertilization and feeding was evaluated in an on-station trials conducted at KRC of CIBA as given below, (i) With fertilisation: Fertilisation of the ponds with cowdung, urea and single super phosphate. Initial application was done seven days prior to fish stocking and intermittent application was continued at 15 days interval, (ii) Feed alone: Low cost formulated feed composed of rice bran, mustard oil cake, wheat flour, fish meal and vitamin-mineral mixture with 27% CP and 6% lipid, in powder form for first one month, then as pellet form for next four months given in feed trays, (iii) Combination of both feed and fertilization : The rearing duration was 150 days, with three ponds per treatment and initial larval size of 0.55 g (36.03 mm). Feed and fertilization was found to be the best rearing system in terms of final bodyweight (Table 8). Though the survival was higher in the treatment with feed and fertilization, the difference with other treatments was not statistically significant. In the rearing systems with fertilization alone, feed alone and feed and fertilization, the cost of production averaged ₹ .92,300, ₹ 1,06,250 and ₹ 1,28,300 respectively.

Table 8. Performance of advanced grey mullet fingerlings under three rearing systems

Rearing systems	Final ABW (g)	Survival (%)
Fertilization	40.67^{a}±0.72	77.95±1.40
Feed	52.04^{a}±1.37	76.41±2.01
Feed & fertilization	98.48^{b}±3.90	83.20±2.67

Means followed by different superscripts differ significantly (P<0.05)

Harvested grey mullet fingerlings

Monoculture of grey mullet at farmer's ponds

On-farm trials of grey mullet monoculture were taken up in three farmers' ponds located at Uttar Chandanpiri and Madanganj, Namkhana, South 24 Parganas, West Bengal (Table 9). After proper pond preparation, stocking was made with advanced grey mullet fingerlings of 157 ± 11 mm (42.2 ± 2.1 g). In the first pond, commercial feed was used (CP floating feed, ₹ 30/kg) @ 4 kg/d while in the other two ponds conventional rice bran and mustard oil cake mixture (1:1) was used @ 2% BW daily.

Table 9. Monoculture details of grey mullet in farmer's ponds

Pond No.	Pond area (ha)	DOC	Survival (%)	ABW (g)	Production (kg/ha)
1*	0.05	380	82	515±55	4223
2**	0.11	350	85	420±24	3570
3**	0.04	350	88	390±22	3432

*Uttar Chandanpiri, **Madanganj

Two ponds were harvested after 350 days of culture and average body weight of 420±24g and 390±22 g with 85% to 88% survival was observed. The total production in these ponds was 3432 and 3570 kg/ha. In the third pond after 380 days, fish were harvested with ABW of 515±55 g and survival of 82% contributing to 4223 kg/ha production.

Similarly another on-farm trials were conducted at two farmers' ponds in Kamarhat, Kakdwip (0.04; 0.075 ha) and were stocked with grey mullet juveniles (160±15 mm; 48.5±3.4 g) at 10,000 no./ha in November 2010. In four months the stocked fish had attained size range of 210 to 250 g. The result has clearly demonstrated that it is possible to attain a production of over 3 ton/ha/yr. with final weight ranging from 390 to 515 g.

Haul of milkfish

Milkfish grow-out culture demonstration

On-farm trial of milk fish grow-out culture was carried out in a farmer's pond at Uttar Chandanpiri, Namkhana. Initially nursery rearing was carried out in two 300 m^2 ponds for 40 days at a stocking density of 1,60,000 nos./ha and fed with floating feed. After 40 days, fishes with ABW of 20±2 g were transferred to grow-out pond of size 0.8 ha with stocking density of 10,000 nos./ha. Fishes were fed with commercial 5 mm floating feed @ 2-3% body weight twice a day. After 210 days, fishes were harvested with 350g ABW and yield of 2 ton/ha was achieved.

Pearlspot fingerling rearing

In order to develop the technology for rearing of advanced fingerlings of pearlspot in indoors, about ~ 2 g size were reared in two FRP tanks of capacity 250 L (6 Nos) and 500 L (6 Nos) at a stocking density of 10 nos/tank (60 nos./treatment) for 46 days. The fishes were fed with pellet feed containing 38% CP and 5% lipid at a feeding rate of 5% body weight in two instalments.

In 250 L tanks the fishes grew from an initial weight of 2.13g to a mean weight of 6.54g in 46 days (207 % weight increase) with a survival of 95%. In comparison, the 500 L tanks yielded slightly faster growth from 2.27g to 8.45g (272% weight increase), the survival being 77%.

As part of developing the technology for pearlspot grow-out in net cages, the effect of static (weekly water exchange) and flowing water on growth (static 14.5 +1.76 g; flow-through 14.1+ 2.00 g) was evaluated in a short term trial of 32 days, with duplicate cages for each treatment and with 30 fishes per cage. The initial biomass in each cage was between 400 - 430 g/m^3 and the fishes were fed 3mm feed pellets containing 38% crude protein and 5% lipid at the rate of 5% body weight per day. Survival was poor in static water conditions. Weight increase was to the extent of 40.5% in running water conditions compared to 25.8% weight increase in static conditions (static 18.2 +3.31 g; flow-through 19.8+ 3.9 g).

Grow-out culture trial of pearlspot fish in cages

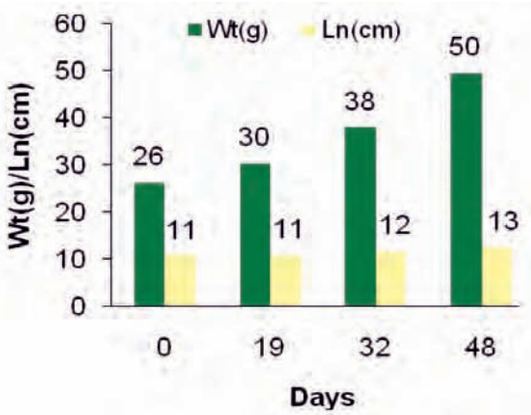


Fig. 14. Growth of pearlspot in cages within ponds

On-station grow-out culture trial of pearlspot fish in cages was carried out using with cages made of rigid PVC mesh of dimentions 3 X 1 X 1 m (3 cu.m). Each cage was stocked with 40 nos. of pearlspot juveniles of size 26.28 ± 4.12 g; 10.97 ± 0.57 cm (initial biomass = 1000 g / cage (350 g / m^3). The fishes were reared for a period of 42 days during which they were daily fed pellet feed @ 5% in trays. The fishes grew to twice their original size during the culture trial from 26g to 50 g in 1½ months. At this rate of growth the stocked pearlspot fish could attain sizes of about 100 g in 155 days. The growth of pearlspot in cages is depicted in Fig. 14.

Effect of periphyton substrates on pearlspot growth

In order to evaluate the effect of periphyton substrates on growth of pearlspot in cages, a trial was conducted with pearlspot juveniles (3.55 g) in cages (1 x 0.75 x 1 m) stocked at the rate 30 numbers per unit. The four treatments were conducted with 1)Bamboo strip substrate without feed, 2) Coconut shell substrate without feed, 3) Feed without substrate 4) Feed with bamboo strip substrate (Fig.15). Commercial carp feed was used. After 90 days, higher specific growth rate (upto 30 days) was recorded when bamboo substrate and feed were provided indicating the ability of pearlspot to utilise periphyton efficiently in the early stages *i.e.* below 10 g size. Specific growth rates of 1.2 and 1.5% day^{-1} were observed on providing coconut shell substr ate and bamboo strip substrate respectively indicating the ability of periphyton to support the growth of pearlspot. After 30 days, providing bamboo with feed gave similar specific growth rate as feed alone. Higher specific growth rate was observed on providing bamboo strip substrate relative to coconut shell substrate indicating that bamboo is a superior and considered to be an excellent periphyton substrate.

Secondary aquaculture in ETP

To evaluate the potential of seaweed for secondary aquaculture in hatchery effluent treatment ponds (ETP), seaweed culture was carried out with floating rafts. The 3m X 3m floating rafts were seeded @ 50g/m^2 with about 30 kg of *Kappaphycus alvarezi* and three submerged rafts were seeded with *Gracilaria edulis* (20 kg total). All seaweed species were sourced from Mandapam. Growth was

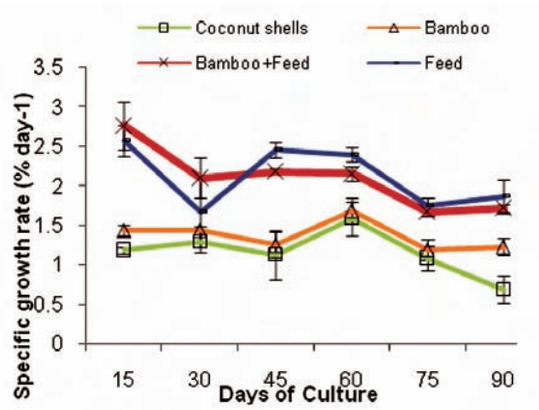


Fig. 15. Effect of four different treatments on specific growth rate of pearlspot

Seaweed grown in hatchery ETP

relatively good for *K. alvarezi* in the 2 and 3 compartments away from the mouth of the ETP. On an average, the growth increment recorded was 220g / m^2 for a period of 4 months in the 3rd compartment and 330g/ m^2 in the 2nd compartment. The growth was very poor in the first compartment. Very few samples of *G. edulis* could be retrieved and it seemed to indicate that this species cannot tolerate the high sedimentation and turbidity of the ETP water.

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

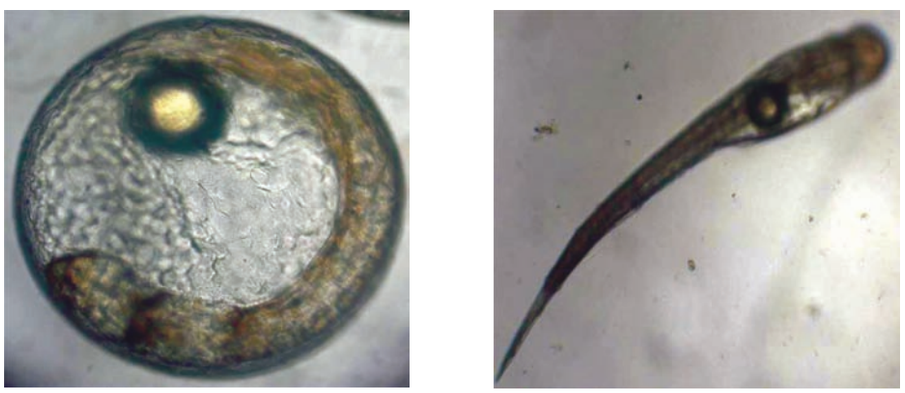
Development of captive broodstock and captive maturation of cobia

Cobia of 5-20 kg caught from the wild are quarantined for a week's duration and transported to holding facilities in pond and RCC tanks. Fishes were held in pond/RCC tanks at the stocking density of 1 kg/m^3 and feeding was done with forage fishes like tilapia and oil sardine @ 5% of the body weight. Water exchange was carried out @ 30% per day in the pond and 70% per day in the tank. Fishes maintained from March 2010 in the pond showed progressive maturity from October. One fish weighing 15 kg fish attained full maturity in December at the size of 18kg with ova diameter of 0.701 mm. Oozing males in the size range of 8.0 kg - 15.0 kg were also obtained.

Induced breeding and fully mature ovary in cobia

Induced breeding

A female fish with ova diameter of 0.7mm was administered HCG @ 300 IU/kg intramuscularly as priming dose. After 36 hours resolving dose of LHRH-a hormone @ 10µgm/kg body weight for female and a single dose of LHRH-a for males at half the rate that of female was administered. Successful spawning was observed after 20 hours of hormonal administration with about one million eggs, but



Larval development of cobia

the fertilization was only 30%. This success proved that cobia broodstock can be maintained and matured in earthen ponds and this will greatly simplify hatchery operation. In one trial, *in vitro* fertilization was attempted to understand the possibilities of artificial propagation through stripping to synchronize the fertilization. Successful embryonic development and hatching was observed. The newly hatched larvae measured 2.9 mm.

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

Demonstrated the techno-economic viability of nursery rearing of seabass fry to fingerlings in the farm sites (Ramudupalam, Andhra Pradesh, Sirkazhi, Tamil Nadu and Saphale, Maharashtra) with a survival rate of 58 to 72%, producing uniform size juveniles of 60-80g in the pre grow-out system and grow-out culture of seabass in pond culture system using formulated sinking pellet developed by CIBA. During nursery rearing from fry to fingerlings in hapas, average survival rate of 62% was obtained. In pre grow out trials @ 10,000/ha, a survival rate of 60% in 3 months was observed with the size of the fish in the range of 150-300g. At Sirkazhi site, polyculture of crab and seabass in mangrove integrated ecofriendly farming system is in progress, where fishes are fed with formulated feed and crabs are fed with low cost forage fishes.

Project Title (DBT)	**Development of viral vaccine against noda virus and infectious pancreatic necrosis virus**

Pathogenicity of nodavirus to Asian Seabass

As a first step in order to understand the pathogenicity of the nodavirus in different stages of Asian seabass, experiments were designed and carried in laboratory conditions. After ascertaining the pathogenicity and confirming the infection of nodavirus, the vaccinated larvae/fry/juveniles were challenged to understand the efficacy of the heat killed viral vaccine by both oral and immersion methods. For the oral protocols, the *Artemia* nauplii were immersed for 12 hours in the viral concentration of TCID 50 Log 10 x 10^7. The viral infected nauplii were fed to the larvae/juvenile in three split doses for one day. For the infection through immersion, the larvae/juveniles were allowed to be in the virus loaded sea water TCID 50 Log 10 x 10^7 for a period of 3 hours and the water level was increased in the rearing media. The infection was monitored and the mortality due to infection after 5, 10, 15, 20, 25, 30 days of post viral infection was also analyzed. The results indicated that the intensity of pathogenicty is progressive and duration dependent. The mortality was faster in fish fry of more than 20 days old compared to that of early stages. The pathogenicity trials show that the infection is more through contact than through feed.

Vaccination trials with heat killed nodavirus

In the challenging trials, 9 dph larvae were vaccinated with the heat killed vaccine supplied by the collaborating centre. In the immersion method, the larvae were allowed to be in the vaccine concentration of TCID 50 Log 10 x 10^7 for a period of 3 hours. In the oral method, the vaccine was applied through the Artemia nauplii following the protocols adopted for pathogenicity studies. As a preliminary trial, larvae were vaccinated with single dose, however, the juvenile/larvae did not survive and the response was same as that of infected larvae. The frequency for vaccination was at an interval of 5 days for 3 doses. The vaccinated fry were challenged with virus infected water and feeding with virus infected *Artemia* nauplii. Over a period of 30 days observation, the mortality rate was significantly reduced compared to that of control where the larvae were not vaccinated. In the immersion method, the survival rate is 90.66% in the vaccinated juveniles when compared to 100% mortality in non-

vaccinated ones. Under vaccination by oral means, the survival rate was 89.80% in the vaccinated one and 36.66% in the non-vaccinated ones. When vaccination was done through oral means and later challenged, the survival rate was 90.33%. The results indicated that the heat killed nodaviral vaccine may be useful in the treatment of seabass larvae for nodavirus infection.

AQUATIC HEALTH AND ENVIRONMENT DIVISION

Project Title (Institute)	Diseases of finfish and shellfish in brackishwater aquaculture: Diagnostics, prophylaxis and therapeutics

Screening for emerging diseases

Samples of small (n=110) and large sized shrimps(n=45) from Monodon Slow Growth Syndrome (MSGS) affected ponds (40 nos.) in Tamil Nadu, Andhra Pradesh and Maharashtra were screened for Laem Singh Virus (LSNV) by reverse-transcriptase polymerase chain reaction (RT-PCR). The incidence of LSNV was 82% and 64% in small and large sized shrimps respectively. Bioassay experiments on transmission of LSNV in shrimp showed 100% positives by 10 weeks by oral feeding and size variation was observed (infected group : 7.96 ± 3.76 g and control group : 11.71 ± 1.3g in weight), dark discoloration and 90% mortalities by end of four and half months of experimental period in infected group. Cohabitation experiments in shrimp (Infected group n=50; control group n=15) showed 100% positives by 12 weeks (Fig. 16). It was observed that size variation (infected group: 8.26 ± 3.58 g and control group: 12.54 ± 1.23g in body weight) and 65% mortalities by end of five and half months of experimental period in infected group. Screening of brood stock samples (n=315) collected from Andamans, Tamilnadu, Orissa and Maharashtra for LSNV showed 68.50% prevalence in *P.monodon*. The studies indicate that horizontal and vertical transmission of LSNV is possible.

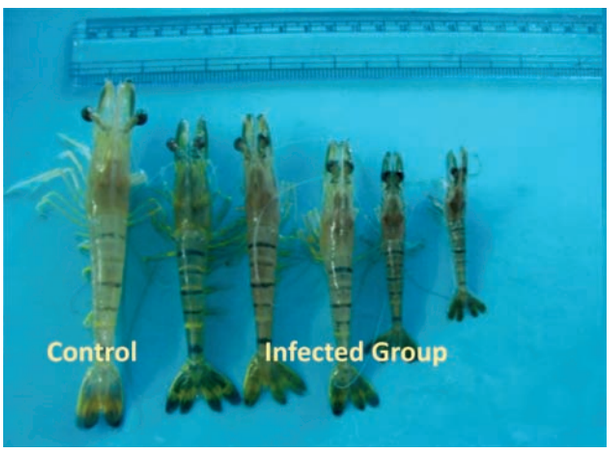


Fig. 16. Induction of slow growth syndrome in tiger shrimp

L. vannamei samples from four farms in West and East Godavari districts were tested for WSSV, YHV and TSV and found negative. Six out of ten broodstock samples were found positive for LSNV. Shrimp (*P.monodon)* farms experienced WSSV out breaks. Twenty five samples from 20 shrimp farms near Vasishta Godhavari and Antarvedi (near mouth of Godavari) were found positive for WSSV by nested PCR. Screening of S. *tranquebarica* samples (n=60, cultured: 55 and wild: 5) from Biyyaputippa, near Vemuladevi and Modi near L.B Charla villages in West Godavari district showed 21.8% WSSV prevalence in cultured crabs. The crab farms located near the shrimp farms affected with WSSV experienced chronic moralities and emergency harvesting of both shrimp and crabs was done in affected areas indicating that WSSV outbreak risks are equally applicable for crab and shrimp farms.

Seabass (19), mullet (2) and milk fish (6) samples from pond/cage/pen culture farms located in Kerala, Tamil Nadu and Orissa were screened by nested PCR using published primers and found to be negative indicating that iridovirus was not a significant problem in cultured farm fish when compared to wild fish samples which were found positive for iridovirus. In continuation of this, positive samples from the previous year study were subjected to histological and electron microscopic investigation.

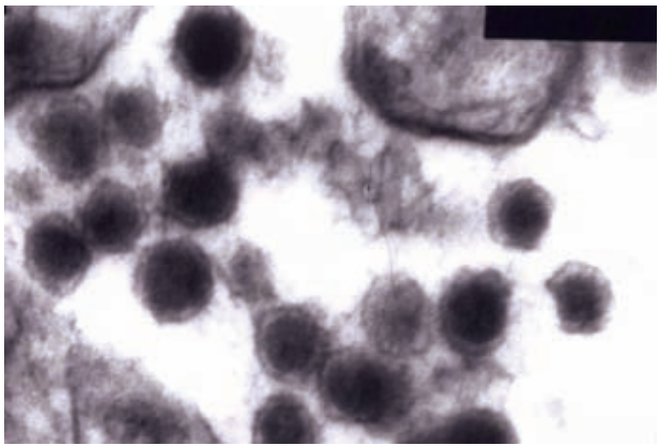


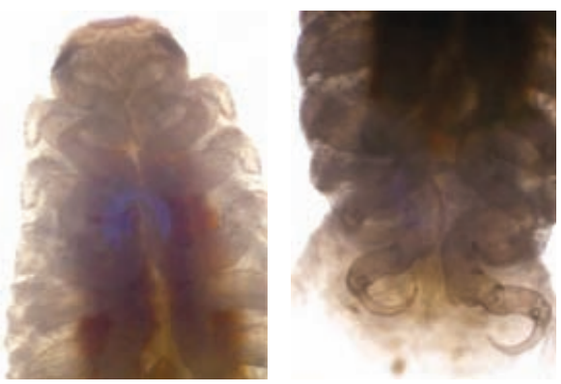
Fig. 17. Transmission electron micrograph of iridovirus (1,00,000x)

Histopathological screening of liver, spleen and brain samples of fish showed typical lesions related to iridovirus infection like focal necrosis, enlargement of nucleus and clearing of cytoplasm. The electron microscopic study revealed that the cytoplasm of infected cells was filled with fine electron dense granules (Fig. 17). The nuclear membranes were intact but the nucleoplasm showed clear patches of areas with small electron dense particles. Exceptionally the nuclear membrane was ruptured and the electron dense particles were observed flowing out like release of viral particles. Numerous hexagonal particles could be seen in the cytoplasm as well as associated with membrane bound structures measuring around 120 mm diameter from apex to apex. The study indicates that iridovirus shows ubiquitous presence in wild fishes but it is not a significant problem in farmed fish.

Screening for parasites in finfishes

Multiple parasitism of heavy infestation with adult and various life cycle stages of crustaceans (*Caligus epidemicus* Hewitt, 1971 and *Lernanthropus shishidoi* Shiino, 1955) and monogeneans (*Dactylogyrus* sp.) were observed on mullet (*M. cephalus*) gills. Multiple parasitism in mullet broodstock fish associated with a spinal cord abnormality were investigated. Another case of pearlspot juveniles with symptoms of dark coloration and progressive mortality revealed heavy infestation with multiple parasites. Isopods in buccal cavity, *Caligus* and monogeneans on gills were diagnosed. Mortality could be controlled by isolation and treatment with 100 ppm formalin for one hour.

***Caligus epidemicus* and *Dactylogyrus* sp. from gills of mullet**



Isopods infection in buccal cavity of pearlspot

Phage therapy to control vibrio

To evaluate the potential of phages for biocontrol of luminescent bacterial disease in larval shrimp, three experimental trials were conducted in hatcheries and the trials indicated encouraging results which have to be confirmed with further trials. The experimental set up comprised of 30,000 zoea-1 of *P. monodon* in 500L aerated tanks with routine commercial protocols. Ten ml mixture of four promising phages identified earlier, with a count of $5x10^7$ was administered on first day. Total

vibrio counts and luminescent bacterial counts were recorded daily until they reached PL6 stage (Fig. 18 a & b). The total bacterial counts and vibrio counts were found to be similar in both treated and control tanks. Peak bacterial load was observed on days 4 and 5 with bacterial counts of the order of 1.4 x 10^5. It was observed that the luminescent bacterial (LB) counts were found to be less than 20 per ml in the treated tanks, whereas in the control tanks, they occurred in relatively high numbers after 8th day and reached a peak on 11th day with counts of the order of 3 x 10^4 per ml. Survival of PL6 in control tanks was 2500, whereas that in the treated tanks was marginally better (3000). Treatment with phage was repeated on 11th day with the same dose, since LB counts were observed to increase. It is planned to carry out similar phage therapy trials in actual hatchery tanks using a consortia of phages after building facilities for the mass production of phages in fermentors.

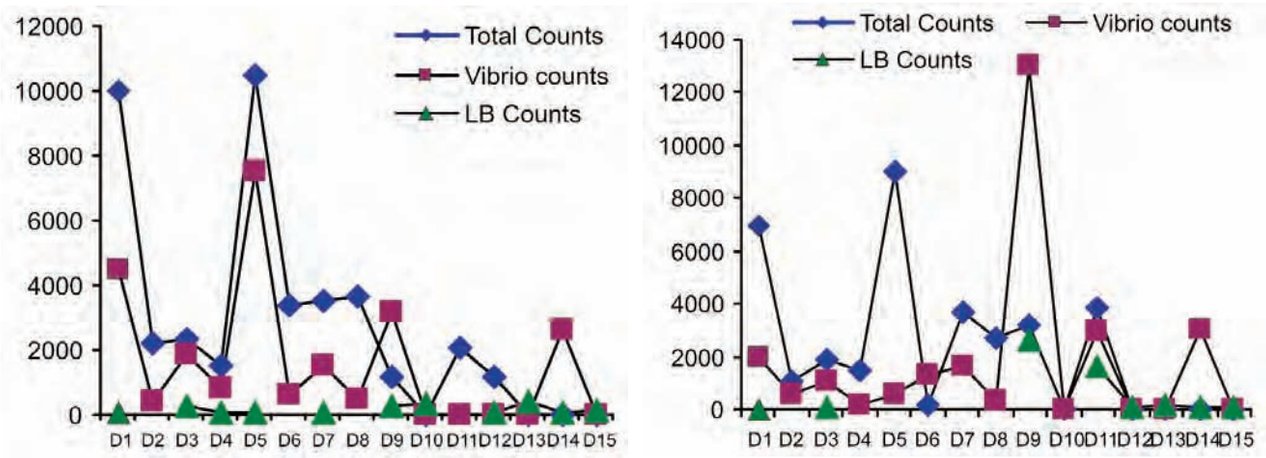


Fig. 18. Total bacterial counts, vibrio counts and luminescent bacterial counts in tanks treated with a) phages and b) control tanks

Use of medicinal plant as an immunomodulating agent

The potential to use the medicinal plant *Withania somnifera* as an immunomodulating agent for shrimp viral disease was evaluated. *W. somnifera* was fed at 0.25, 0.5, 0.75 and 1.0 g/kg feed daily for 5 weeks to five groups of animals in triplicates with weight 9.26±2.27 g. Parameters like, pH, salinity, temperature, nitrite and ammonia in water were monitored on a regular basis and were found to be in optimum range. Total bacterial counts and total vibrio counts in tank water and total hemocyte count, bacterial clearance assay, proPO assay were carried out. The study indicates that at a concentration of 0.5 g/kg feed, the extract induced significant improvement in growth, bacterial clearance and total hemocyte counts in administered shrimp (Table 10). Dose dependent improvement in the proPO activity

Table 10. Effect of feeding different concentrations of *Withania somnifera* on growth and immunological parameters (mean ± SD)

Parameters	Concentration in feed (g/kg)				
	Control	0.25	0.50	0.75	1.0
Percentage body weight gain over control (g)	--	12.5	22.5	20.5	21.5
Bacterial clearance (log10 bacteria cleared)	7.41±1.97	28.91±5.99	58.01±8.75	43.05±10.53	38.95±8.85
Total hemocyte count (x10^6/ml)	1.20±0.32	1.68±0.30	1.88±0.37	1.81±0.26	1.78±0.39
Total PO activity (units/min)	0.12±0.03	0.14±0.03	0.16±0.02	0.18±0.05	0.19±0.04

was observed till 0.75 g/kg. In another study, *P.monodon* larvae fed with *W. somnifera* enriched *Artemia* nauplii showed improved survival, enhanced tolerance to salinity and formalin stress (Fig. 19). Ability of the drug to induce resistance to challenge with pathogenic Vibrio bacteria and WSSV needs to be studied.

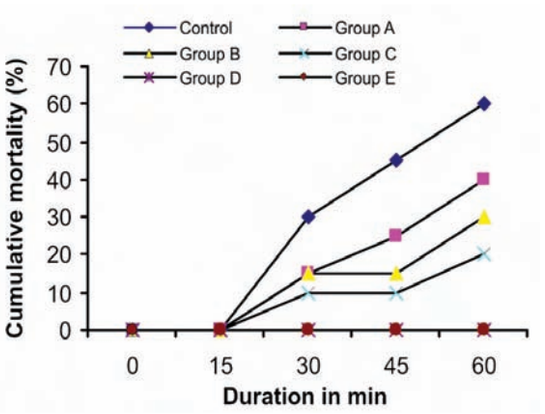
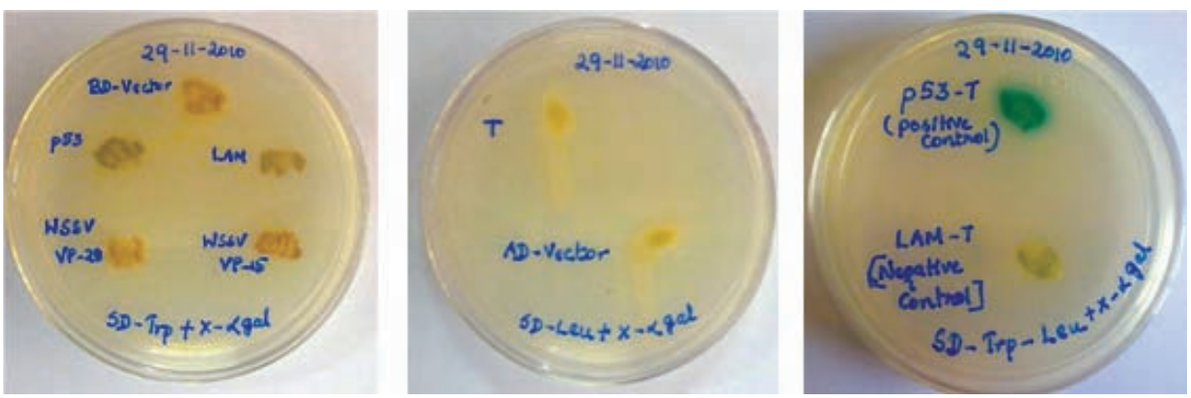


Fig. 19. Cumulative mortality in Penaeus monodon larvae fed with enriched artemia nauplii to formalin stress

Search for WSSV interacting proteins in tiger shrimp

To study the virulence mechanism and develop a treatment approach, a search for WSSV interacting proteins in *P. monodon* by Yeast Two-Hybrid (Y2H) technique was carried out. The first phase of the work was to investigate the important host proteins that interact with White Spot Virus proteins and to study the virus life cycle, it's replication in the host and virulence mechanism. This would provide a clue for the treatment approach to be adopted. Two of the WSSV proteins, VP28 and VP15, are selected as baits to do the library screening against the host gill and hemocyte proteins. The bait proteins have been PCR amplified and cloned to DNA binding domain vector pGBKT7. After sequence verification, both the baits were subjected to autoactivation test by testing the expression of *MEL1* reporter gene. Both VP28 and VP15 did not show autoactivation (Fig. 20 a,b & c) indicating that the bait used is suitable for library screening which would be carried out in the future.



(a) **(b)** **(c)**

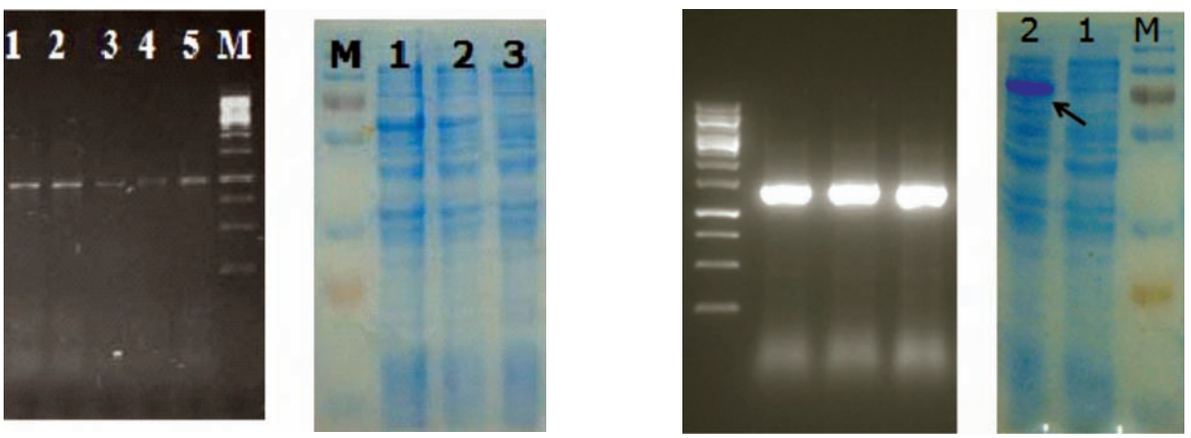
Fig. 20. Autoactivation test for VP28 and VP15 of WSSV a) individual proteins in binding domain vector (includes VP15 and VP28) b) activation domain vector do not show autoactivation (colourless) c) a typical interaction study indicating positive interaction (blue colour) and negative interaction (colourless)

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

Amplification of important genes from microbes

Isochorismate isomerase, converts chorismic acid to salicylic acid. Salicylic acid is a naturally occurring plant metabolite that induces pathogenesis-related (PR) proteins and triggers the systemic

acquired response (SAR). The Isochorismate isomerase gene was amplified from *Vibrio alginolyticus* and cloned into pET32A vector system and transformed into *E.coli DH5α*. Over expressed proteins by induction of 1mM IPTG were confirmed by SDS PAGE. (Fig. 21 a & b). The herbicide-resistant gene Phosphoshikimate carboxyvinyl trasnsferase was amplified from *Vibrio alginolyticus*. The resulting 1281bp PCR purified fragment was cloned into pET32A vector system and transformed into *E.coli DH5α*. The recombinant plasmid was transformed into *E.coli BL21* expression host and was over expressed by induction with 1mM IPTG. The complete ORF of Alpha Amylase gene was amplified from *Vibrio alginolyticus*. The gene consists of 1380 bp. The resulting 1380bp PCR purified fragment was then digested with *Bam*HI and *Hind* III and cloned into pET32A vector system and transformed into *E.coli DH5α*. Amylase isolated from bacteria, fungi, are used in textile industry as softening agents for starched clothes. It is also used in making bread and to break down complex sugars such as starch (found in flour) into simple sugars (Fig. 21 c & d). The complete ORF of lipase gene was amplified cloned and expressed from *Chromobacterium violaceum*. The recombinant protein was purified using Ni affinity column chromatography. Lipase activity was estimated using Roche Automatic Analyzer by quantitative kinetic determination method at different pH and temperatures. The complete ORF of azurin gene was amplified from *Vibrio alginolyticus*. The resulting 440bp PCR purified fragments were cloned in to pET32A vector system and transformed in to *E.coli DH5α*. The recombinant plasmid was transformed into *E.coli BL21* expression host and was over expressed by induction with 1mM IPTG. Twenty five bacterial isolates including two recombinant plasmids of chitinase and catalase gene have been deposited in NBAIM culture bank.



(a) **(b)** **(c)** **(d)**

Fig. 21. Isochorismate isomerase gene from *Vibrio alginolyticus*. a) amplification b) SDS PAGE showing over expression (Lane M-Marker, Lane2- Expression of Isochorismate isomerase gene in E. coli BL21 expression host after third and first hour of IPTG induction, Lane3-Expression isochorismate isomerase gene of in BL21 expression host before IPTG induction)

Amylase gene from *Vibrio alginolyticus* c) amplification d) SDS PAGE showing over expression (Lane M- Marker, Lane-1 Expression of Amylase Gene in BL21 E. coli expression host before IPTG induction, Lane2- Expression of Amylase gene in E.coli BL21 expression host after third hour of IPTG induction.

From non-pathogenic *Vibrio alginolyticus* which is abundantly found in brackishwater ecosystem, agriculturally important genes that impart herbicide resistance and pathogen resistance to plants have been identified and the proteins have been expressed. This study reveals that microbes present in brackishwater ecosystem can be exploited for use of agriculture. Preliminary studies have shown that azurin protein expressed by *V.alginolyticus* can be used for controlling viruses that affect shrimp aquaculture.

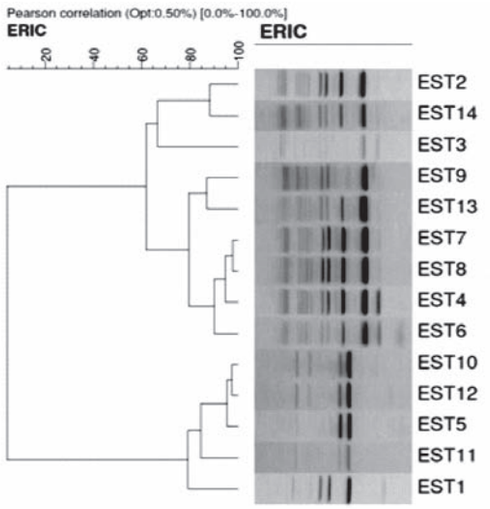


Fig. 2. Molecular characteriza-tion of *Salmonella typhi*

Molecular characterization of the isolates of *Salmonella typhi*

A total of 42 brackishwater samples were analyzed for the presence of *Salmonella typhi* and 14 samples were positive which indicates the high prevalence of *S. typhi*. All the isolates were confirmed using biochemical and molecular sero typing by multiplex PCR method targeting four genes. All the isolates were also confirmed with specific anti sera. Molecular characterization of the isolates was carried out using ERIC PCR and analysed using DNA finger printing software (Fig. 22). About 14 isolates of *S. typhi* have been grouped into two major clusters with 60% similarity. Similarity of ERIC-PCR fingerprints among *S. typhi* strains isolated from widely separated geographical regions revealed existence of a limited number of clonal groups. This is the first study in India to use ERIC PCR for molecular characterization of *S. typhi* from brackishwater.

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

The objective of the project is to develop a bioremediation tool for mitigation of ammonia and nitrite in shrimp hatchery and for ammonia, nitrite and sulfide in shrimp grow-out ponds. As a first step towards meeting the objective, potential microbes that could be used for mitigation were isolated and a nitrification-denitrification biofilter was designed with these microbes.

Development of nitrification-denitrification biofilter

Chemolithotrophic nitrifiers, aerobic denitrifiers, heterotrophic nitrifiers, chemolithotrophic and heterotrophic sulfur oxidizers were isolated and evaluated for their efficiency to oxidize ammonia, nitrite and sulphide *in vitro*. Occurrence of Anammox bacteria in traditional and intensive shrimp culture ponds (with high DOC) was confirmed using PCR-DGGE analysis. Eight denitrifying isolates were confirmed to carry out denitrification under aerobic conditions using RT-PCR of *nos*Z gene. Two chemolithotrophic sulfur oxidizing bacteria were identified based on 16S rRNA gene sequence analysis. A total of 4 isolates of *Beggiatoa* sp. have been isolated and identified from brackishwaters of Tamil Nadu. Fourteen heterotrophic sulfur oxidizing bacteria (HSOB) were confirmed for their activity *in*

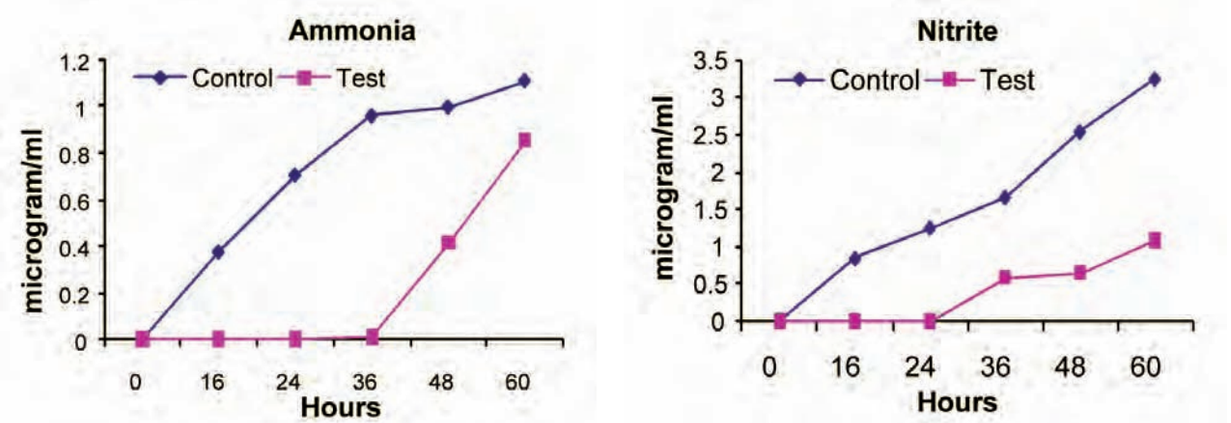


Fig. 23. Evaluation of nitrification-denitrification biofilter in a laboratory aquarium

vitro. Efficient isolates were used to construct nitrifying-denitrifying biofilters that are capable of simultaneous nitrification and denitrification for complete removal of ammonia, nitrite and nitrate (Fig. 23). Such biofilter systems could be exploited for better management of water quality Nitrifying-denitrifying biofilters were designed, assembled and found to efficiently remove ammonia and nitrite completely in lab scale aquaria. This biofilter set up needs to be up scaled to mitigate ammonia from larger volumes of water.

Project Title (DBT)	**Horizontal transmission and infectivity of White Spot Syndrome virus in brackishwater aquaculture ecosystems**

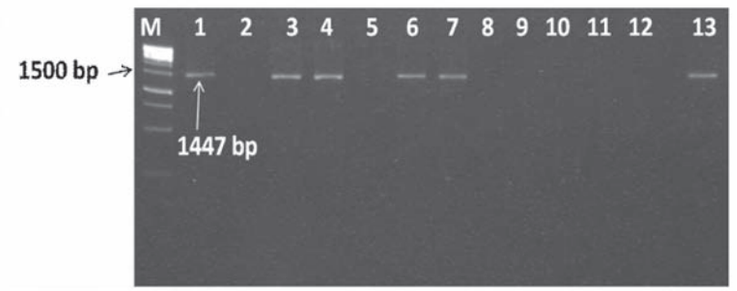


Fig. 24. Detection of WSSV in 13 water samples from shrimp grow-out ponds and hatcheries

The project aims to understand the horizontal transmission of WSSV in aquaculture ponds. Protocols for concentration of viruses in pond water were standardized using tangential flow filtration system and water samples from various shrimp culture ponds and hatcheries were processed using TFF. Occurrence of WSSV, IHHNV, HPV and MBV was examined in these samples (virus concentrates) by standard PCR protocols. WSSV could be detected in five out of eighteen of samples (viral concentrates) comprising two hatchery samples, two grow out pond samples and one ETP sample (Fig. 24). IHHNV, HPV and MBV could not be detected in any of these samples. Seven samples each of shrimp, sediment and plankton collected from shrimp ponds with no incidence of WSSV were also screened for all the four DNA viruses, and it was found that two shrimp samples were infected with MBV and one with IHHNV. The study shows that TFF could be used to concentrate viruses from water and specific viruses could be detected in such viral concentrates by conventional PCR.

Project Title (DBT)	**Development of antiviral therapy using double stranded RNA (dsRNA) against shrimp viruses, WSSV, MBV and HPV**

Construction of MBV genomic DNA library

MBV infected postlarvae (PL) of *Penaeus monodon* were collected from various hatcheries located along the east coast of Chennai. From the hepatopancreas of MBV infected shrimp, the virus was isolated by ultra centrifugation using cesium chloride (CsCl) gradient. The viral DNA appeared as a single band which was equivalent to 23 kb confirming that the fraction collected after ultracentrifugation contains MBV particles. There are very few sequences of MBV submitted in GenBank due to paucity in genomic studies related to MBV. Hence in this study a genomic DNA library of MBV was constructed to generate more sequence data of MBV. By cloning of digested MBV DNA, 840 colonies were obtained. Ten colonies that had inserts > 300 bp were initially sequenced using T7 promoter and terminator primers.

Characterization of MBV p74 gene

One clone of 700 bp, designated MBV4 which had an ORF that matched the p74 envelope protein gene of baculoviruses, when subjected to sequence homology search via. BLAST, exhibited a maximum homology with envelope protein p74 of *Lymantria dispar* MNPV. The p74 is essential for oral infectivity of occlusion derived virus (ODV) and has been proposed to play a role in midgut

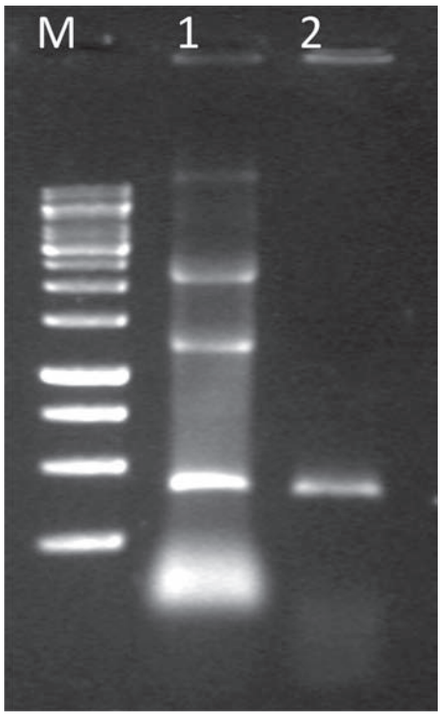


Fig. 25. Biosynthesis of dsRNA corresponding to MBVp74 gene in the RNase III deficient bacterial strain HT115(DE3) (Lane M : Marker [1kb])

attachment and/or fusion. ODV envelope protein p74 is essential to ODV infectivity. The p74 protein is translated from a late viral transcript between 16 and 20 h post-infection (p.i.). The sequence of putative MBV p74 gene was determined and suitable primers were designed to amplify this gene of 380 bp. The MBVp74 gene was cloned in pLITMUS28i vector and the positive clones designated as pLITMUSp74 were confirmed by restriction digestion using *Eco*RI enzyme. The pLITMUSp74 was transformed in the RNaseIII-deficient *E. coli* strain HT115 (DE3) for synthesis of dsRNA corresponding to this gene on a large scale (Fig. 25). The dsRNA corresponding to full ORF of MBVp74 [380 bp] induced by IPTG in the bacterial strain HT115 (DE3) and isolated by total nucleic acid extraction is shown in Lane 1 and the co-precipitating bacterial genomic DNA and ssRNA were removed by treatment with DNase I and RNase A respectively is shown in Lane 2.

Characterization of MBV Ring super family gene

RING-finger (Really Interesting New Gene) domain is a specialized type of Zn-finger of 40 to 60 residues that binds two atoms of zinc; defined by the 'cross-brace' motif C-X2-C-X(9-39)-C-X(1-3)- H-X(2-3)-(N/C/H)-X2-C-X(4-48)C-X2-C; is probably involved in mediating protein-protein interactions and identified in proteins with a wide range of functions such as viral replication, signal transduction, and development. An ORF of 797 bp encoding the MBV Ring superfamily protein was identified from the MBV genomic DNA library and sequenced. Suitable primers were designed to amplify this gene. The amplified product was cloned in the pLITMUS28i vector and the positive clones designated as pLITMUSp74 were confirmed by PCR screening with the gene specific primers. The plasmid was initially transformed in the *E. coli* DH5á and then in the RNase III-deficient strain HT115 (DE3) for dsRNA synthesis.

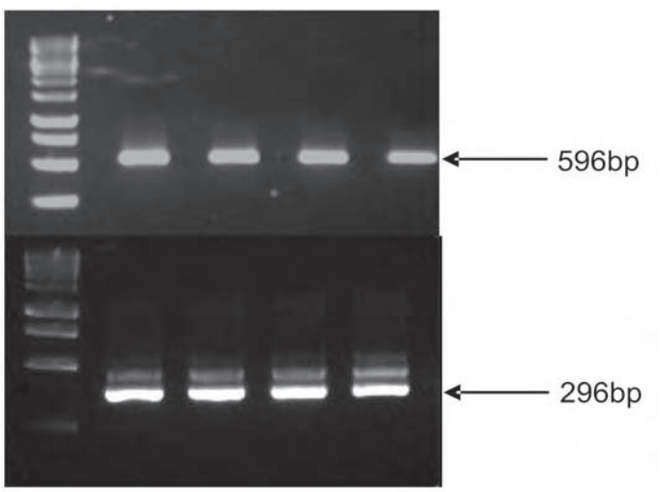


Fig. 26. MBV diagnostic PCR (Lane M: 1 kb DNA marker, Lanes 1-4: MBV infected shrimp DNA a) First step PCR b) Nested PCR reaction of the same samples)

Primers for detection of MBV in shrimp

A set of primers for nested PCR were designed from MBV gene Acc No. EU246944 from GenBank for diagnosis of MBV infection. To test the efficacy of the primers, DNA was extracted from MBV infected shrimp postlarvae (PL) and subjected to PCR. All samples gave the expected amplicon of 596 bp in the first step and 296 bp in the nested reaction (Fig. 26).

Bioassay of dsRNA in silencing MBV multiplication in shrimp

To test the efficacy of dsRNAs targeting MBV genes p74 and ring superfamily in controlling MBV infection, a bioassay was designed using *P. monodon* brooders. For

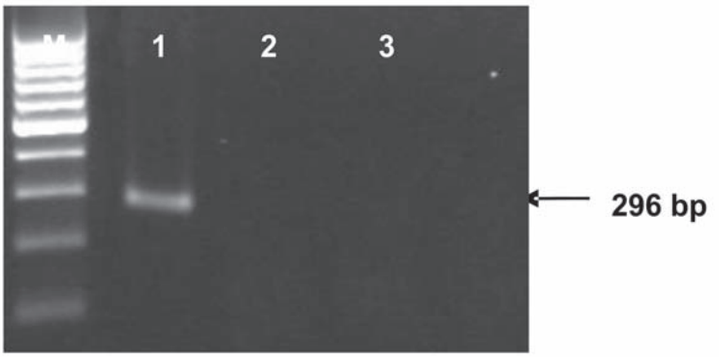


Fig. 27. test group injected with dsRNA corresponding to p74 gene (lane M: 100 bp DNA marker, lane 1: 3rd day, lane 2: 5th day, lane 3: 7th day lane 4: 9th day)

challenge studies, MBV inoculum was prepared from tissues of severely infected *P. monodon* PL. The dilution that produced PCR-detectable infection within 4-7 days was chosen for further experiments. Wild *P. monodon* brooders weighing 80 - 110 g found to be negative for MBV by the nested PCR protocol described above were maintained in triplicates of 5 animals each separately with continuous aeration. Totally four such groups were set up in triplicates, i.e. two test groups each receiving one type of dsRNA, one positive control group which received only MBV and no dsRNA and one negative control group which was not infected with MBV and did not receive any dsRNA. MBV extract was injected intramuscularly in the third segment of the abdomen of each animal in the dilution mentioned above. After 24 h, 10 µg per gram body weight of dsRNA in TN buffer (50 mM Tris pH 7.5, 100 mM NaCl) was injected intramuscularly. Shrimps were collected at regular intervals (every 48 h from the day of MBV injection - considered as day 1) and tissues were preserved in 95% ethanol at 4 °C for DNA extraction. The animals were observed for 10 days.

DNA was extracted from the preserved tissues and subjected to MBV diagnostic PCR. Only those samples which were negative in the first step were subjected to nested PCR. The samples collected from the positive control group on day 3 was nested PCR positive and subsequent samples collected from this group on days 5, 7 and 9 were first step positive for MBV. The negative control was negative during the course of the experiment. The test group injected with dsRNA corresponding to ring superfamily gene was nested PCR positive for the presence of MBV in samples collected on days 3, 5 and 7 and first step PCR positive on day 9, there by indicating that targeting this gene is not effective in controlling viral multiplication. The test group injected with dsRNA corresponding to p74 gene was nested PCR positive on day 3 and subsequent samples collected from this group on days 5, 7 and 9 were negative for MBV thereby indicating that this gene is a suitable target for developing RNAi-based MBV antiviral therapeutics (Fig. 27).

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

Characterization of outer membrane protein of *Vibrio anguillarum*

For preparation of whole cell inactivated bacterial antigen, the following steps were carried out: Formalin inactivation of whole cell *Vibrio anguillarum* was used for raising the polyclonal antibodies and stored at -20°C. From whole cell heat in-activated bacteria, bacterial cell surface antigens, outer membrane proteins (OMP), extra cellular proteins (ECP) and lipopolysaccharides (LPS) were isolated. Immunogenicity has been determined using the polyclonal anti serum, by immunoblotting and ELISA. With purified ECP at 250ng/ml concentration, ELISA readings were taken (Fig. 28) and immuno blotting of ECP was carried out. Similarly ELISA readings were recorded and Immuno blotting OMP and LPS was carried out.

Cloning and expression of *Vibrio anguillarum* outer membrane proteins were carried out. The outer membrane consists predominantly of phospholipids, LPS and integral membrane protein. These

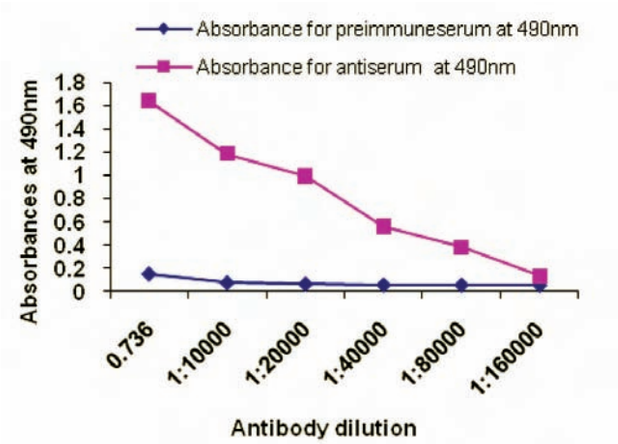


Fig. 28. Indirect ELISA of extra cellular proteins of *Vibrio anguillarum*

make up almost 50% of the outer-membrane mass. The outer-membrane protein profiles contain one major OMP in the molecular size range of 35-45kDa. Cloning and expression of these outer membrane protein genes pave the way for finding the epitope present in the surface of the *V.anguillarum* pathogen. This gives the solution for finding the better epitope and a good vaccine candidate against *Vibrio anguillarum*. The outer membrane protein OMP26la was amplified from the DNA sample of serotype O1 with the primer having the restriction enzyme site (forward with Eco R1) and (reverse primer with Ava1) the amplified product of 800bp was cloned into PET32a and then transformed into bacterial strain DH5á and was expressed in expression strain BL21 (Fig. 29 a & b). This recombinant protein will be compared with the native OMP for its immunogenecity and used for vaccine preparation.

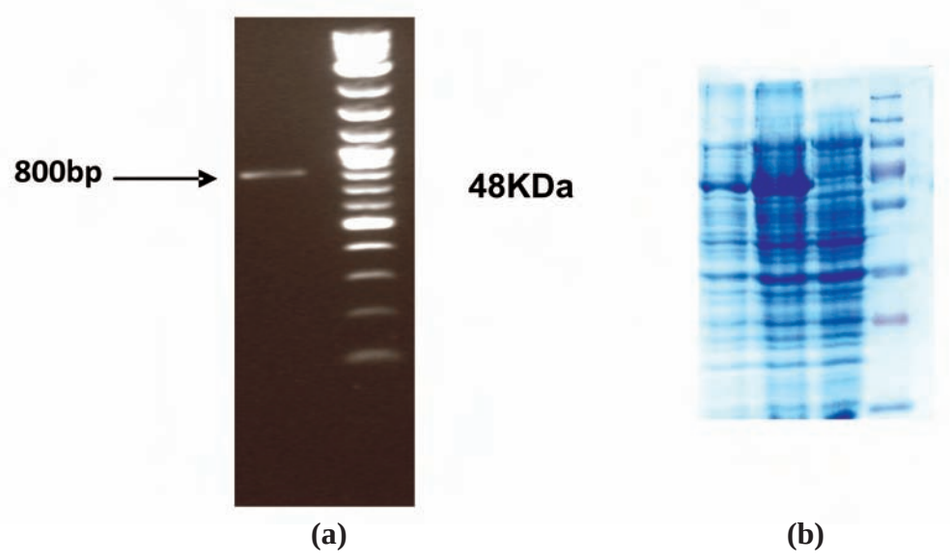


Fig. 29. Outer membrane protein (OMP26La) of *Vibrio anguillarum* a) PCR amplified fragment (800bp) b) expression of BL21

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

The betanodaviruses are an important, emerging group of viruses causing highly destructive disease Viral Nervous Necrosis (VNN) or Viral Encephalopathy and Retinopathy (VER) in almost 40 marine fish species worldwide. Early diagnosis of the disease is critical for any farming operations. In this context, a study had been initiated to characterize betanodavirus infection and to develop suitable diagnostics in seabass and mullet fishes. An earlier study revealed that betanodavirus is widely distributed sub-clinically along the east coast of India in different species of marine fishes. About 18.5 % of the total analysed fishes (n=243) gave positive result for virus by (nested) RT-PCR. The cultured fish such as seabass, mullet and milkfish etc. revealed 8% infection in the form of sub-clinical infection.

Mixed viral infections of farm fish species - A rare occurrence

Three cases of fish has been found infected with mixed infection of viruses ie. betanodavirus and iridovirus in the same fish. All of them were farmed fish; two independent cases of seabass (*Lates calcarifer*) fingerlings from Bhimavaram (Andhra Pradesh) and second case of adult milk fish (*Chanos chanos*) from a polyculture pond from Kakdwip (West Bengal). This is the first report of co-infection of two different species of viruses affecting same fish host from sub-clinically affected seabass and milk fish in India.

Sequencing of RNA2 of betanodavirus isolates from India

Full length/near full length amplification of betanodavirus RNA2 from the infected fish samples were undertaken. The (near) full length RNA2 sequence was 1434 bp in length containing a single ORF spanning across nt 27-nt 1043, coding for viral coat protein of 338 aminoacids. The viral RNA2 sequences obtained from Asian Seabass was deposited in NCBI Genbank (Accession no. GU592791, GU953669, GU826693, GU826692). This is for the first time in the country, 1434 bases long complete sequence information of RNA2 of betanodavirus (12 isolates) from different finfish species (seabass, milk fish) belonging to various geographic locations were generated. The molecular phylogenetic analysis revealed that the genotype of betanodavirus in India showed resemblance to red-spotted grouper nervous necrosis virus (RGNNV) prevalent in many fish species cultured in the Asian region.

Development of diagnostics for Viral Nervous Necrosis

A reverse transcription-Polymerase Chain Reaction (RT-PCR) based diagnostic assay developed earlier was tailored as a diagnostic kit for early detection of VNN caused by betanodavirus in finfish. Primers were designed based on the molecular genomic information of Indian strains of betanodaviruses. A prototype kit was designed for potential field application. The assay system was found to be specific, sensitive, convenient and cost-effective. The main features of the assay system are user friendly reaction buffers, custom designed gene specific primers and better performance. The kit offers a rapid, specific and sensitive detection system based on the amplification of the coat protein gene of the virus genome segment RNA2. The assay has been validated extensively using field samples from clinically and sub-clinically infected fish from wild and culture facilities across the country (Fig. 30). The kit can be used for routine diagnosis of disease, besides as a management tool to screen broodstock, larvae, and even trash fish used as feed in fish hatcheries and selective breeding programme for pathogen free stock

Betanodavirus assay prototype kit

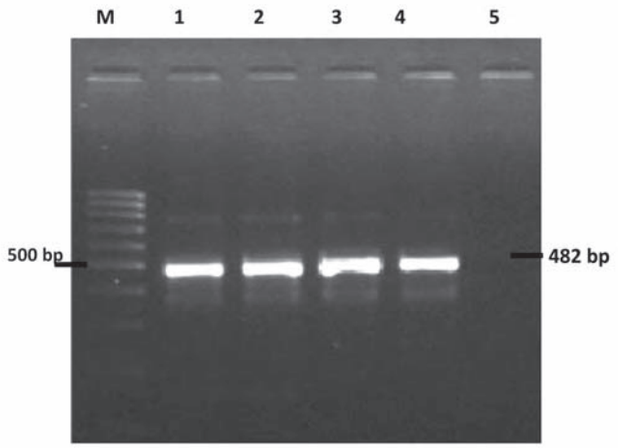


Fig. 30. Diagnosis of VNN using Betanodavirus assay kit (Lane M-100 bp ladder, Lane 1 -Sample 1, Lane 2 -Sample 2, Lane 3 -Sample 3, Lane 4-Positive control, Lane 5-Negative control)

development in freshwater, brackishwater and marine ecosystem. This IPR enabled kit is the first of its kind indigenously developed in the country and is a good substitute for imported technology in terms of cost effectiveness and easy availability.

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

With the objective of standardizing development of primary shrimp organ cultures, six different media were tested with the heart, hepatopancreas and gill tissues for explant culture. The attachment was good in case of heart followed by gill explants. The morphology of the heart and gill cells was fibroblast-like. The explant survived for 15-20 days. The intact cell sheet of first passage was formed by 3 -7 days and could be maintained for 15-20 days. Sub culturing of explant cultures for three passages was possible on media with hemolymph supplementation. The haemocyte primary cultures were observed to be spherical in shape and cells persisted in culture up to seven days. On subculturing, the cells appeared pyknotic by third passage. Primary cell culture from the ovary tissue could be established. Cultures containing epitheloid cells with 90% confluence could be obtained from immature ovarian tissue. Further work on WSSV adaptation in primary ovarian and hemocyte cultures and confirmation of WSSV in cell cultures by nested PCR, western blotting and Real Time - PCR are in progress.

Project Title (Institute)	**Technology development for environmental management in brackishwater aquaculture**

Bagasse as biostimulator in shrimp pond

For biostimulation purposes, cost is an important criterion for selecting a substrate, when combined with the interest in byproducts recycling, led us to evaluate lignocellulosic bagasse material as a biostimulator. The present work is a continuation of the earlier trials and experiements were carried out this year in aerated and zero water exchange tiger shrimp cultured ponds in Tamil Nadu (44-77 days) and Gujarat for (57-63 days). Bagasse supported the biofilm formation, and maintained ammonia and nitrite within optimum levels and enhanced the shrimp production. Higher shrimp production was achieved and this could partly be attributed to the biofilm of nitrifying consortia and periphyton formation on the bagasse, as periphyton is known to be a natural food for shrimp.

To check if use of bagasse would have an impact on total plate count (TPC) of bacteria and total Vibrio count these were estimated in soil, water and bagasse biofilm on 30^{th} day of the treatment and harvest day. In soil and water samples of control and treatment ponds and on bagasse biofilm, *Vibrio* spp. were 10^2-10^3 order of magnitude. There was no significant difference in total Vibrio counts between control and the treatment ponds. The values of TPC in water did not differ significantly between treatments and control. The bacterial count on bagasse (no./g) increased gradually, reaching the highest value on the harvest day. The bacterial density per unit of substrate was much higher than that in water.

Nitrifying bacteria in shrimp ponds on the biofilm over bagasse have been detected and quantified using molecular techniques. Out of 4 shrimp farms in Tamil Nadu, only in three, PCR positive results were observed. In the PCR negative sample, nitrifying bacterial population was found to be very less, which is mainly because of undetectable autotrophic nitrifying bacteria in samples originally collected from this pond. Ammonia removal was also not effective in this pond due to less numbers of nitrifying bacteria. The highest numbers of nitrifying bacteria were found to be in other two shrimp ponds, and this could be attributed to the effective removal of ammonia due to enhancement of nitrifying bacteria

through bagasse. More controlled pond trials have been planned to understand the mechanism by which bagasse influences ammonia and nitrite-nitrogen levels in shrimp ponds.

Comparison of carbohydrate source for bioremediation and production of biofloc

Five different carbohydrate source *viz*. molasses, sugar, arrowroot, wheat flour and glycerol were compared for their efficiency in the production of biofloc and removal of ammonia in a yard trial. Ammonium sulphate was used as the nitrogen source and carbon nitrogen ratio was maintained at 10. The experiment was conducted in 100 L tanks in triplicate provided with constant aeration. The initial ammonia nitrogen concentration and microbial load was 10.2 mg/l and 15-40 x 10^4 CFU/ml respectively. A significant reduction in NH_3-N was observed from 10.2 mg/L to 4.2 mg/L within 24 h (Fig. 31). Thereafter no apparent reduction in NH_3-N was observed upto 96 hr. Significant difference was observed among the treatment groups for production of biofloc, (measured as biofloc volume) with maximum production while using wheat flour followed by molasses and arrowroot (Fig. 32). The production of biofloc was correlated with total microbial count which was observed to be maximum in wheat flour (240 x 10^6 CFU/ml) followed by molasses (65 x 10^6 CFU/ml) and arrowroot (25 x 10^6 CFU/ml). Though both molasses and sugar have similar monosaccharide composition, their biofloc forming ability was different indicating that type of carbohydrate and its physical properties, influence biofloc forming ability. In the present experiment NH_3-N reduction pattern was similar in all the treatment groups, indicating that the type of carbohydrate does not influence the final ammonia nitrogen concentration at carbon: nitrogen ratio of 10 with constant aeration. Based on cost, volume of biofloc produced and capacity to reduce ammonia, molasses and wheat flour would be the choice carbohydrate source to be used in shrimp ponds for biofloc production.

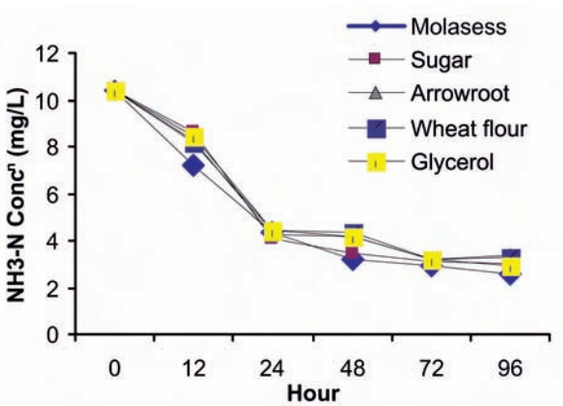


Fig. 31. Effect of carbohydrate substrate and on NH_3-N

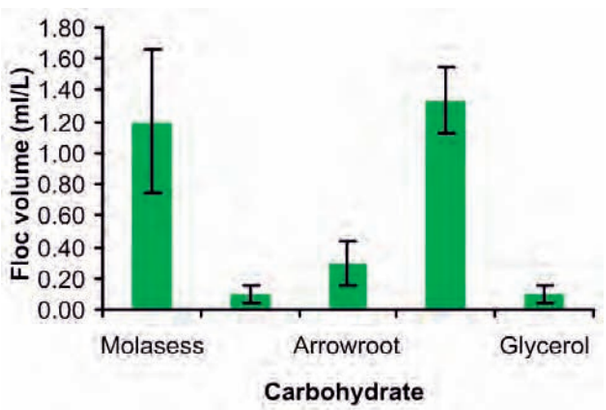


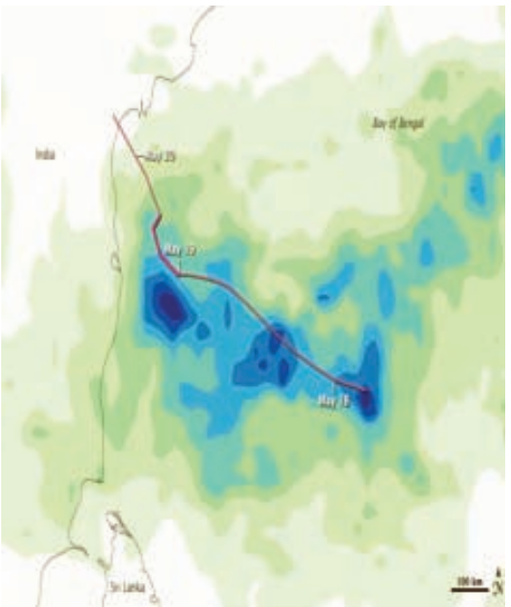
Fig. 32. Effect of carbohydrate source on time biofloc

Impact of extreme climatic events on shrimp aquaculture - Cyclone Laila

Shrimp aquaculture is vulnerable to extreme climatic events such as flood, drought and cyclones whose frequency and intensity are expected to increase due to climate change. To asses the impacts of extreme climatic events on shrimp farming, impact of cyclone Laila was studied in Prakasam District, Andhra Pradesh. Cyclone Laila struck Andhra Pradesh and Tamil Nadu coast (Fig. 33 a) during May 17-20, 2010 and its damage was severe in Prakasam District. Indian Meteorological Department (IMD) designation for this cyclone was severe cyclonic storm (BOB 01) and Joint Typhoon Warning Center (JTWC) designation was 01B. It is the first cyclonic storm to affect southeastern India in May since the 1990 Andhra Pradesh (AP) cyclone. The colour-coded image showing the path of cyclone (Fig. 33 b) revealed the areas that received the heaviest rainfall of 300 or more mm (dark blue), lowest rainfall of less than 37.5 mm (pale green). The storm track is indicated by a pink line. The thicker, darker

portion of the line shows the storm intensification on May 19 that caused flooding and damage along its path.

(Source: Maps of India)



(Source: IMD)

Fig. 33. Laila cyclone a) affected areas b) pathway

A total rainfall of 60 cm was received in a single day and 40 cm in less than 12 h in the district. Shrimp farming areas like Maddipadu, Ongole and Kothapatnam received the highest rainfall of 51, 32.3 and 25.8 cm respectively on a single day and Rivulets like Gundlakamma, Addavagu and Pothurajukalva were flooded. The water depth in source waters for shrimp farming increased from 12' to 20' in Buckingham canal and 3 to 10' in Mudigundi and Gundlakamma drains. Heavy gusty winds with speed of 115 to 125 km per hour damaged the infrastructure in the farms. The ponds were inundated in less than 12 hours and the flood water reached a height of 10- 15' over the pond bunds. In the district, 362 ha of shrimp farming (both tiger shrimp and vannamei) area was affected severely and 100-120 DOC stock was lost. Fisheries Department estimated a loss of 362 lakhs @ ₹ One lakh per hectare. Siltation to an extent of 1-2 feet was observed on the pond bottom and an increase in turbidity was observed. A sudden decrease in salinity of source waters from 48- 50 ppt to 18 - 20 ppt was registered and it was reported that the use of this water created stress to the shrimps in upland ponds that were not flooded. It is conclusive from the present and previous studies that heavy gusty winds and extremely heavy rainfall/tidal waves associated with cyclones and storm surges damaged the infrastructure in shrimp farms and the standing shrimp stock was lost due to inundation of ponds. This indicates the need of planned adaptation measures by the Government to mitigate the severity of impact and to provide relief measures on par with agriculture.

Energy requirement for aeration in shrimp farming

Under the Institute's efforts on climate change, to understand the contribution of shrimp aquaculture to global warming potential (GWP), the carbon foot print measurement (CFPM) is being studied. One of the elements studied under CFPM is the energy demand of aerators used in different shrimp farming systems with varying stocking density. This requirement per kg of production varied from 1.28 to 3.23 HP (Table 10). The high energy requirement for aeration demands more fossil fuel consumption and it is critical to enhance the efficiency of aerators to minimize their contribution to

GWP. Further, studies would be carried to understand the contribution of different inputs in shrimp farming systems to GWP through life cycle assessment and to suggest mitigation measures.

Table 10. Energy requirement for aeration in different shrimp culture systems with varying stocking density

Pond No.	Stocking density (PL/m^2)	Aerators used (HP/hr)	Energy consumed (HP)	Production (tonnes)	Energy used (HP/kg)
1	22	10	8400	2.60	3.23
2	15	4	3072	2.40	1.28
3	15	4	3408	2.06	1.75
4	18	4	4144	1.94	2.13
5	12	5	4550	2.09	2.10
6	16	8	4800	1.80	2.66
7	12	5	3750	1.34	2.79
8	18	4	4320	2.43	1.77

This range indicated that the possibility of energy reduction by better management strategies in energy utilization and subsequently reducing CHG from aquaculture The study on energy utilization for all aquaculture sector processes at hatcheries, farms and processing units for different type of species cultured will be taken up to assess the total CFP from brackishwater aquaculture.

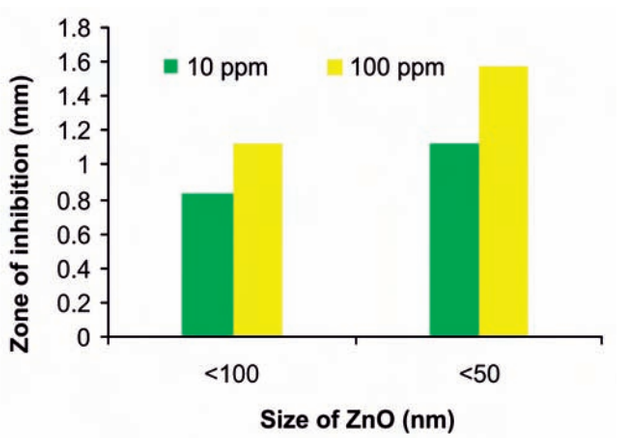


Fig. 34. Antibacterial activity of ZnO nanoparticles as a function of size and concentration

Nano-remediation in aquaculture

As a part of the Institute's efforts to understand the potential application of nanotechnology in brackishwater aquaculture, two types of zinc oxide (ZnO) nanoparticles with and without poly vinyl alcohol (PVA) were prepared and particles of two different sizes (< 50 and < 100 nm) of ZnO were procured. Both the prepared and procured nanoparticles were confirmed by its X-Ray diffraction pattern using XRD. Chemical characterization of the prepared nanoparticles was done by Energy-Dispersive X-ray spectroscopy (EDX) method to confirm the proportion of atoms/ compounds present in the sample. Procured Zinc oxide nanoparticles were evaluated for their inhibitory effect on *Vibrio harveyi* by comparing with bulk at different concentrations and sizes for antibacterial activity. Minimum Inhibitory Concentration (MIC) showed that ZnO nanoparticles have anti bacterial property (Fig. 34). The efficiency of ZnO nanoparticles is directly proportional to concentration and inversely proportional to size. Nanoparticle of <100 nm has 29% more efficiency over bulk whereas nanoparticle of < 50 nm has 74% more efficiency over bulk under 10 ppm concentration. Under 100 ppm concentration, efficiency increased by 39% in <100 nm and by 91% in < 50 nm size.

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

In order to assess the shrimp farmer's perceptions, attitudes and adaptive capacities towards climate change (CC) impacts, an expansive farmer's survey of 300 farmer's was carried out in inland and coastal areas of Krishna District, Andhra Pradesh in addition to focus group discussions and

stakeholder workshop conducted during last year. The sample size of 300 farmers covered 243 from societies and 57 non-society farmers from inland and coastal areas in four major shrimp farming mandals in the district viz., Nagayalanka, Koduru, Machilipatnam and Bantumilli. This is approximately 10% of the total population of farmers engaged in aquaculture and the farmers for the survey were selected in each mandal following the randomization procedure. Further sub-grouping indicated that out of society and non-society farmers, 81 and 74 per cent were from coastal area and 19 and 26 per cent were from inland area, respectively. Conversely, out of coastal and inland area farmers, 83 and 75 per cent were from society and 17 and 25 per cent were non-society, respectively.

The climate change events perceived were irregular season (IRS), high temperature (HTEM), cyclones (CYC), heavy rains (HR), flood (FLD) and drought (DRT). Cyclones, floods and heavy rains affected shrimp aquaculture more in economic terms and led to a loss of production by 100 to 400 kg per ha (Table 11). The cost of implementing these measures was compared with the level of success. Maximum adaptation cost was observed for CYC followed by FLD and IRS for society and coastal farmers, whereas it was in the order of CYC, FLD and HR for non-society farmers and HR, FLD and CYC for inland farmers. Though the adaptation measures identified for a particular CC event was similar in inland and coastal shrimp farming areas, they differed in their association with the level of success. All the categories of farmers indicated that the requirement of financial support, insurance and relief fund in case of extreme climatic events would increase their adaptation capacity. A very strong focus by Govt. Departments, research organizations and NGOs on building general adaptive capacity could help the shrimp aquaculture communities to cope up with new challenges.

Table 11. Production and economic loss due to climate change events perceived by shrimp farmers in Andhra Pradesh

Climate change event	Production loss (kg)		Economic loss (Rs)	
	Coastal	Inland	Coastal	Inland
Irregular season	20-42 ($30.8^{c} \pm 5.7$)	21-42 ($30.47^{b} \pm 5.5$)	6800-14910 ($10500^{d} \pm 1988$)	6930-14490 ($10400^{b} \pm 1873$)
High temperature	10-20 ($16.13^{a} \pm 3.8$)	10-20 ($14.79^{a} \pm 4.2$)	3300-7100 ($5506.44^{a} \pm 1323$)	3300-7100 ($5064.8^{a} \pm 1455$)
Cyclone	300-400 ($316.5^{f} \pm 34.8$)	100-160 ($115.8^{c} \pm 20.3$)	99000-142000 ($108000^{g} \pm 12104$)	33000-54400 ($39600^{c} \pm 7058$)
Heavy rain	90-160 ($116.5^{d} \pm 19.5$)	100-160 ($125.7^{d} \pm 14.2$)	31950-56800 ($39800^{e} \pm 6798$)	35500-56000 ($42900^{d} \pm 5035$)
Flood	220-400 ($311^{e} \pm 44$)	200-400 ($251.66^{e} \pm 52.1$)	72600-142000 ($106000^{f} \pm 15262$)	66000-102000 ($86000^{e} \pm 18100$)
Drought	10-30 ($21.8^{b} \pm 5.2$)	10-30 ($20.16^{a} \pm 3.8$)	3000-10650 ($7252.38^{abc} \pm 1790$)	3000-9000 ($6270^{a} \pm 1197$)

The range and mean + SD are given. Means having different superscripts are statistically significant, $P < 0.05$

Project Title (ICAR)	**National Initiatives on Climate Resilient Agriculture (NICRA) - Impact of climate change on aquaculture and mitigation opitions for minimizing green house gases from aquaculture sector**

NICRA project was launched on 2nd February, 2011 with the main objective to develop and popularize climate resilient technologies in agriculture including live stock and fisheries addressing the vulnerable areas of the country. The objectives of CIBA component in NICRA project are to develop an understanding of the impact of global climate change on key parameters that would alter and negatively impact aqua farming in coastal states, to assess the significance of green house gases

emission in the aquaculture supply chain and to develop mitigation measures for aquaculture sector through carbon sequestration and pond management interventions. Preliminary survey was conducted in Gujarat State to identify the farmers and locations for conducting the focus group discussion meetings and stakeholder workshop to understand the perceptions and adaptation of shrimp farmers towards climate change. A prototype of green house gas collection sampler for the collection of green house gases from aquaculture ponds was fabricated and is being tested. Questionnaire to collect the energy consumption details from hatcheries and farms was developed and the survey was started from shrimp hatcheries in Andhra Pradesh and Tamil Nadu. The data collected from all the sectors in aquaculture supply chain would be subjected to Life Cycle Assessment.

Fabricated green house gas collection sampler

Farmer's expansive survey on shrimp farmer's perceptions and adaptations in Krishna District, Andhra Pradesh

Project Title (DBT)	Development and evaluation of green water technology for aquaticbioremediation in coastal aquaculture

Antagonistic bacterial formulation against vibrio

Vibrio spp. especially the luminous *V. harveyi*, have been implicated as the main bacterial pathogens in shrimp. Probiotic technology provides a solution to these problems, wherein selected probiotic strains are added in the shrimp pond to displace normal deleterious bacteria. Crude extract of bioactive compounds from antagonistic bacteria isolated from greenwater system of coastal aquaculture was found to have antibacterial activity against shrimp pathogenic bacteria ie. *V. harveyi*. These organisms have been immobilized onto the matrix prepared from tapioca powder for formation of antagonistic formulation and could be used against pathogenic bacteria in aquaculture and related aquatic environments. For six bacterial isolates (four *Pseudomonas spp*., *Alcaligenes faecalis* and *Bacillus cereus*), 16S rRNA sequences were submitted to GenBank. A patent has been submitted to DBT, New Delhi.

Demonstration of greenwater technology in shrimp farmer's ponds

Milkfish and tiger shrimp harvested from the greenwater technology demonstration pond

Field demonstration of greenwater technology

Greenwater technology which works on the probiotic and bioaugmenting effect of beneficial bacteria in slime produced by the finfish kept in shrimp ponds, has successfully been demonstrated in five different zero-water exchange shrimp ponds in Tamil Nadu. Approximately 150-350 numbers of 0.75 - 1.7g (3.5-5.8 cm) milkfish seed were stocked in the pens installed in shrimp ponds. Farmers have not applied any commercially available microbial products / probiotics in the trial treatment ponds throughout the culture period. In one of the shrimp ponds, finfish have grown up to 38 g, 74 g and 140 g after 30, 60 and 90 days of culture respectively and after partial harvest, finfishes were transferred to reservoir ponds. *Vibrio* counts were found to be less in the treatment ponds (10^1-10^3) as compared to the control ponds (10^2-10^4). Integration of milkfish has decreased *Vibrio* counts with the result of higher shrimp production in the treatment ponds (2.4-3.2 t/ha) as compared to the control ponds (1.9-2.4 t/ha).

NUTRITION, GENETICS AND BIOTECHNOLOGY DIVISION

Project Title (Institute)	Development of cost effective feeds for brackishwater fish and shrimp through specific dietary nutrient optimizations and alternative feed ingredients

Development of cost effective feeds for pearl spot nursery rearing

The major difficulty encountered in the farming of pearlspot is the very long nursery period required to obtain stockable fingerling size of 20-25g, due to very slow growth during nursery phase. In this context, the potential for dietary interventions to cut short the duration and improve the growth rate from fry to fingerling stage was evaluated.

The effect of five varying levels of protein on growth of pearlspot fry was studied using wild pearlspot fry (n = 225; 1.64±0.02 g). Five experimental diets were prepared containing 40, 35, 30, 25 and 20% protein with the total lipid content of around 6.0% in the all the diets, using conventional ingredients such as soybean meal, fishmeal, corn meal, cereal flour, wheat bran, fish oil and vitamins and minerals. The feeding trial with experimental feeds was carried out for a period of 45 days in FRP tanks at 15 fry per tank with three replicates for each treatment. Results of the feeding trial indicated that body weight of the fry increased as the level of protein content increased in the diet. The highest final body weight was obtained in the group fed with highest protein (40%) and the growth of this group did not differ significantly with the growth of the group fed with 35% protein diet. Similarly weight gain, SGR, DGC and FCR were also significantly better in 40 and 35% protein containing feeds fed group compared to the rest of the diets. Survival was significantly lower in diets containing 20 and 25 % protein. Based on the results, it may be concluded that 35-40% protein in diet of pearlspot fry is optimal and the significantly higher weight gain with 40% protein diet may be exploited for faster growth of the fry to stockable size.

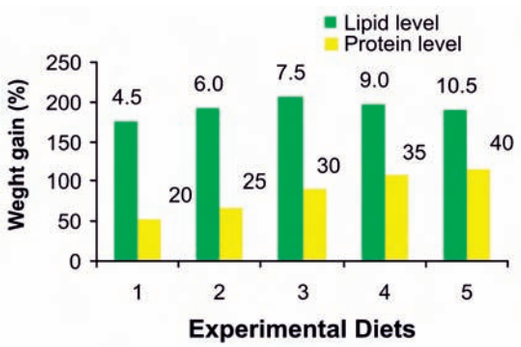


Fig. 35. Effect of varying levels of five dietary protein (20, 25, 30, 35, 40%) and lipid level (4.5, 6, 7.5, 9 and 10.5%) on weight gain (%) in pearlspot fry

The effect of varying levels of lipid on growth of pearlspot fry was studied using 225 wild pearlspot fry (n =225, 1.00±0.011g). Based on the earlier experiment the control feed was prepared to contain 40% protein without any supplemental oil and lecithin. To this control diet, supplemental fish oil and lecithin (ratio of 4:1) were added

at 0,1.5,3.0,4.5 and 6.0% level and thus five experimental diets were prepared having a total lipid content of 4.5,6.0,7.5,9.0 and 10.5% at a constant protein level of 40%. The feeding trial with experimental feeds was carried out for a period of 45 days in FRP tanks at 15 fry per tank with three replicates for each treatment. The results indicated that there is a progressive increase in body weight, weight gain up to 7.5% lipid content in the diet after which a plateau was observed indicating that it was not beneficial when the lipid content in the diet was increased beyond 7.5%. Based on the results it may be concluded that 7.5% lipid in diet of pearlspot fry is beneficial in improving the growth of the pearlspot fry (Fig. 35).

Development of specific shrimp feed for low and high salinity farming

In an effort to develop specific feeds for high saline farming, it was earlier established that when protein levels ranged from 23 to 40% better growth was obtained at a protein level of 35%. During this period, the effect of dietary lipid level on growth performance of tiger shrimp under high saline conditions was evaluated. Lipids are extremely important in maintaining structural and physiological integrity of cellular and sub cellular membranes in addition to being a fuel source and energy reserve. During salinity adaptation, energy-demanding mechanisms for haemolymph, osmotic and ionic regulation in the haemolymph are activated. Thus, the main goal of this work was to verify the changes in dietary requirements of lipids in shrimp at 40 ppt salinity. Four experimental feeds were prepared with varying lipid levels (5.22-7.78%) and tested on juvenile tiger shrimp, in a 60 day feeding trial at 40 ppt salinity. The experimental animals were acclimatized by increasing the salinity by 2 ‰ per day using crude common salt obtained from Kelambakkam salt pans. Significantly ($P<0.05$) higher weight gains were observed (Table 12) in shrimp fed with 6.02 and 6.85% dietary lipid level compared to lower lipid level (5.22%) and higher lipid level (7.78%). FCR and survival % were not significantly different between the treatments. The lipid value in shrimp (Fig. 36) fed with 6.85% lipid is significantly ($P<0.05$) higher (12.88%) compared to 5.22% lipid fed shrimp (11.87%). The EPA (Eicosapentaenoic acid) and DHA (Docosahexaenoic acid) values were also higher in shrimp (12.84 & 10.16% of fatty acids) fed this diet compared to diet with lower lipid level fed shrimp (9.71 & 9.53% of fatty acids) Table 12.

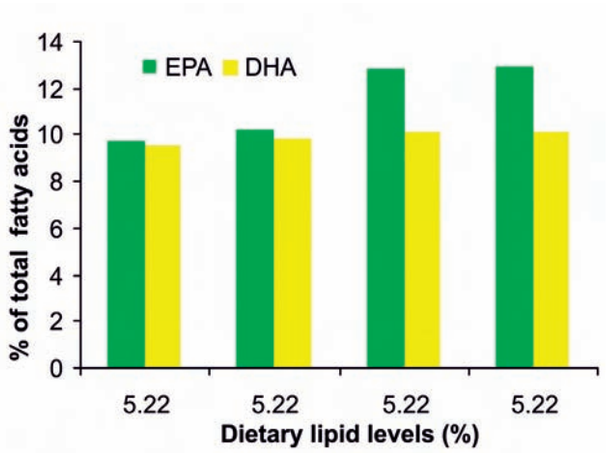


Fig. 36. Effect of dietary lipid levels (%) on shrimp EPA and DHA in high saline conditions

Table 12. Effect of dietary lipid level in growth performance (mean ± SE) of *Penaeus monodon* at 40 ppt

Parameters	Dietary Lipid (%)			
	5.22	6.02	6.85	7.78
Weight gain (%)	$329.93^{b} \pm 2.36$	$363.06^{a} \pm 5.46$	$359.14^{a} \pm 4.82$	$332.33^{b} \pm 2.71$
FCR	2.27 ± 0.058	2.17 ± 0.012	2.25 ± 0.041	2.25 ± 0.043
Survival (%)	73.33 ± 3.85	80.00 ± 3.85	82.22 ± 5.88	82.22 ± 2.22

Phospholipids play an important role in membrane structure, which ultimately affects ion permeability. They also play a dynamic role in the function of membrane-bound proteins and can modulate enzymatic activity which plays a major role in osmoregulation of shrimp. The main objective

of this experiment is to optimize the dietary phosho-lipid level in hyper osmotic stress in shrimp as these phospholipids control both 'limiting processes' acting on permeability properties of epithelial structures and 'compensatory processes' driving the active movement of water and ions which are the two mechanisms by which shrimp maintains osmoregulation. Four experimental feeds were prepared with varying soy lecithin levels (1.0-2.5%) and tested in juvenile tiger shrimp, in a 60 day feeding trial at 40 ppt salinity. Significantly ($P<0.05$) higher weight gain was observed (Table 13) in shrimp fed with 2.0 and 2.5% dietary soy lecithin level compared to lower lecithin level (1.0%). FCR was significantly higher at 1% lecithin feeding compared to higher levels and survival % was not significantly different between the treatments.

Table 13. Effect of dietary soy lecithin level in growth performance (mean ± SE) of *Penaeus monodon* at 40 ppt

Parameters	Dietary soy lecithin (%)			
	1.0	1.5	2.0	2.5
Weight gain (%)	$302.88^{c} \pm 7.80$	$344.82^{b} \pm 2.05$	$360.71^{a} \pm 3.25$	$372.21^{a} \pm 4.32$
FCR	$2.33^{a} \pm 0.046$	$2.13^{b} \pm 0.061$	$2.13^{b} \pm 0.058$	$2.11^{b} \pm 0.017$
Survival (%)	75.56 ± 5.80	75.56 ± 2.22	82.22 ± 5.88	82.22 ± 2.22

A feeding trial was conducted for 42 days to evaluate dietary lipid requirement of juvenile tiger shrimp in low saline (7-10 ppt) regime. Six isonitrogenous and isoenergetic practical diets containing six graded levels of lipid (T_1: 5%, T_2: 6%, T_3: 7%, T_4: 8%, T_5: 9% and T_6: 10%) were fed to shrimp juveniles. The experiment was conducted in 100 l FRP tank with six treatments and three replicates containing ten shrimp in each with an average body weight of 0.33 g. The performance of shrimp is tabulated in Table 14. It can be concluded that 8% lipid level in diet is optimal for tiger shrimp in low saline conditions (Table 14).

Second feeding trial of 45 days was conducted with diet containing 8% lipid and T_1 : 0%, T_2 : 0.5%, T_3 : 1.0%, T_4 : 1.5%, T_5 : 2.0% and T_6 : 2.5% lecithin. The performance of shrimp is tablulated in Table 15. From both the studies, it can be concluded that diet containing 8% lipid and 2 % lecithin is optimum in the diet of tiger shrimp juveniles in low saline regime.

Table 14. Performance of *Penaeus monodon* fed with different levels of lipid

Parameters	Treatments					
	T_1	T_2	T_3	T_4	T_5	T_6
Initial Body Wt. (g)	0.32±0.01	0.33±0.01	0.33±0.01	0.33±0.00	0.32±0.12	0.32±0.01
Final Body Wt. (g)	1.53±0.20	1.54±0.07	1.57±0.08	1.66±0.07	1.38±0.17	1.22±0.06
ADG (mg/day)	26.81±4.17	27.03±1.58	27.70±1.92	29.18±1.67	23.55±3.74	20.00±1.56
TWG	1.21±0.19	1.22±0.07	1.25±0.09	1.31±0.08	1.06±0.44	0.90±0.07
FCR	3.63±0.62	3.35±0.17	3.47±0.23	3.29±0.19	4.14±1.33	4.81±0.36

Table 15. Performance of *Penaeus monodon* fed with different levels of lecithin

Parameters	Treatments					
	T1	T2	T3	T4	T5	T6
Initial Body Wt. (g)	0.23±0.01	0.24±0.01	0.23±0.01	0.23±0.01	0.23±0.12	0.22±0.00
Final Body Wt. (g)	0.99±0.01	1.02±0.4	1.02±0.07	1.08±0.07	1.15±0.3	0.95±0.06
ADG (mg/day)	16.78±0.11	17.26±0.95	17.41±1.41	18.81±1.53	20.52±0.58	16.22±1.28
Total weight gain (%)	0.76±0.01	0.78±0.04	0.78±0.06	0.85±0.07	0.92±0.03	0.73±0.06
FCR	4.49±0.03	4.39±0.23	4.38±0.33	4.05±0.31	3.68±0.10	4.70±0.38

Development of cost effective feeds for grey mullet nursery rearing

Ten feeds with five levels of protein i.e. 27 %, 30%, 33%, 36% and 39% and each with two levels of fat i.e. 6 % and 9% was prepared using locally available ingredients. Wild grey mullet fry (0.88-0.91g) were acclimatized to pellet feed (27% CP and 6% lipid) for a week before the actual feeding of experimental diets. Fifteen grey mullet fry (ABW 0.88 to 0.92 g) were stocked in triplicate for the ten dietary treatments. Daily ration was divided into two equal parts and was fed at 10.00AM and 4.00PM to apparent satiation. After 42 days of trial, it was found that 27% protein with 9 % lipid combination showed better growth performance and lower FCR than the other combination groups.

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

Geographical and seasonal variations in nutrient profiles

The geographical and seasonal variations in the nutrient profiles of brackishwater shrimp and finfishes were analysed for building a base line data base for brackishwater species. Wild samples of tiger shrimp, *P. monodon*, Indian white shrimp, *F. indicus*, Asian seabass, *L. calcarifer* and grey mullet, *M. cephalus* were collected from Andhra Pradesh, Kerala, Tamil Nadu and West Bengal from February 2010 to March 2011. Farmed samples of *L. calcarifer* were obtained from Andhra Pradesh, Tamil Nadu and West Bengal. Comparing approximately 1 kg and 2 kg size groups of Asian seabass indicate that crude fat content increases with the size of the fish. The cultured fish has a higher crude fat content compared to wild of similar size (Table 16). Similarly higher crude fat was noticed in 750 g size compared to 250 g size grey mullets. The crude fat values were highly variable with seasons and the higher fat values were observed in cold dry season compared to hot-dry season. Similar results were observed for Indian white shrimp. The proximate composition of both cultured and wild tiger shrimp were analysed and the crude fat values were higher in farmed tiger shrimp compared to wild shrimp.

Table 16. Nutrient profiling of wild and cultured *Lates calcarifer* and wild *Mugil cephalus* (g/ 100 g edible fish) [mean ± SE]

Species	Size group (kg)	Length (cm)	Weight (g)	Moisture (%)	Crude Protein (%)	Crude fat (%)	Ash (%)
L. calcarifer (wild)	1	41+ 1.9	1111+57.75	73.6+1.15	21.4+0.40	2.2+0.54	1.8+ 0.32
	2	55.0+0.74	1955+64.3	72.1+0.69	20.8+0.79	4.1+0.26	1.4+0.12
L. calcarifer (cultured)	1	41.6+1.34	1012+44.1	72.6+0.77	20.8+.35	4.4+0.15	1.4+0.09
M. cephalus (wild)	0.25	27.1+1.08	240+28.4	75.0+0.51	21.3+0.31	0.8+0.18	1.3+0.08
	0.75	42.1+0.47	738+60.8	74.0+0.39	20.7+0.21	3.3+0.25	1.2+0.16

The seasonal variations of fatty acid profiles indicated higher saturated fatty acids especially, palmitic acid (C16) in summer months in both tiger shrimp and Indian white shrimp. The fatty acid profiles of tiger shrimp collected from wild and culture farms indicated variations especially in Linoleic acid (C18 :2 n-6) which is more than 4 times higher in cultured shrimp (>10%) compared to wild (~ 2.3%) reflecting the dietary influence. Mineral analysis of both finfish and shrimp indicated that they are a rich source of phosphorous and potassium (~ 250 mg/ 100g edible portions). Mullet is a rich source of iron (4 mg/ 100 g edible fish) and manganese (110 µg/ 100 g edible fish) compared to Asian seabass and shrimp. However, for zinc (mg/100g edible portion), Asian seabass (1.87) and shrimps (1.4) are a better source than mullet (0.21). Mullet roe lipid concentration increased from 7.23 to 16.73% with the increase in size and maturity.

Analysis of protein solubility and functional properties of Asian seabass meat

The protein solubility of Asian Seabass fish meat was analyzed. Protein solubility varied from 0.08 to 0.99 in distilled water, 0.28 to 0.71 in hot distilled water, 0.47 to 0.63 in 5 % NaCl, 0.39 to 1.35 in 0.1N NaOH and 0.48 to 1.27 in 1N NaOH. With every 500µl addition of 0.0165N of HCL the pH was brought down to 4.0. It is quite evident that protein from seabass fish meat is highly soluble leading to better emulsification. Therefore, the meat can be used in any food system. The functional properties of seabass fish meat powder were determined for a period of 45 days. The bulk density results suggest that there is an increase from 1st day to 30th day and then the values were constant from 30th day that may help in storage, processing, packaging and distribution. Wettability results were excellent for 1st day and 45th day. This property would potentially benefit for preparation of fat free products. Fat absorption capacity (FAC) results revealed that there was 105 on 0th day which came down to 100 on the 15th day and thereafter increased by 1 unit on 30 to 45th day. This indicates that FAC of seabass fish would help in contributing to better taste. The water holding capacity showed a decreasing trend from 0th day to 45th day that would utilimately help in minimizing protein denaturation.

Project Title (Institute)	**Outreach on fish feeds**

Optimal feed size and feeding frequencies for seabass fingerlings

An experiment was carried out to find out the suitable feed size for better growth and nutrient utilization in seabass fingerlings. Wild seabass fingerlings were weaned to CIBA formulated feed and used in this 60 days' experiment. Three groups of animals in the size range of 15g, 30g and 60g were taken and each group was fed with three different size of feed pellet (2, 3, 4.5 mm) @4-6% of the body weight and fed twice daily in the morning and evening.

This experiment was designed in a completely randomized design with three treatments for each fish size group and each group had three replicates. Results reveal that all the three size groups of fish accepted the three sizes of feed pellet. Weight gain indicates that animals in 30g and 60g size showed better weight gain when fed with 4.5mm pellet while the smaller size group (15g) showed a reduction in weight gain in groups fed with 4.5mm feed pellet. Based on the results it can be concluded that the optimal feed size for 15 g size seabass fingerlings is 3.0mm and for 30 and 60 grams it would be about 4.5 mm.

In order to find out the optimal feeding frequencies for seabass fingerlings an experiment was conducted for 45 days using wild seabass fingerlings (30.06 g). One hundred and eighty animals were randomly distributed into twelve 1000 L FRP tanks containing 15 animals per tank. CIBA seabass feed was fed @5-6% of body weight until satiation for one hour and given at four feeding frequencies (once, two, three and four times/day) at 07.00, 11.00, 15.00 and 19.00 hours**.** Results indicated that highest weight gain was noticed in the treatment group fed two times a day (52 %) closely followed by the group fed three times a day (48 %). However when the feeding frequency was increased beyond three, there was a tendency for early evacuation of gut contents that resulted in a lower weight gain. This observation was corroborated by calculating FCR. Analysis of FCR trend signifies that as the frequency of the feeding increases the FCR also increases (2.66 for four times/ day) indicating that the nutrients are not completely utilized by the animals fed more than two times. Interestingly the group fed one time a day showed a better FCR (2.04) than the rest of the group. This result indicates that feeding two times a day is optimal for seabass fingerlings with 30-50gram body size.

Pilot scale extruder - parameters standardization for different types of feed

Feed processing using the pilot scale extruder is being standardized for preparation of slow sinking, sinking and floating feeds using the pilot scale twin screw extruder standard feed mix containing

35% CP. It was found that 28% additional moisture was optimal for this standard feed mix. Moisture levels above 28% resulted in blockage of feed materials in the conditioner, feeder and extruder. The effect of temperature (100°,110°,120°,130°,140°,150°,160° C) on product output indicates that increasing the temperature resulted in linear increase in pellet size and linear decrease in bulk density and a temperature of 150-160°C is optimal for getting better extrusion properties. Varying the speed (15,25,30,35 and 40X10 Hz) indicated that higher the speed, better the extrusion properties and 35-40 Hz is optimal for the standard feed mix. The effect of speed of cutter (5-30Hz) revealed that irrespective of the die size an average cutter speed of 10-15 Hz is optimal for uniform product size. Pre-conditioning in the form of steam cooking is improving the product output quality with better physical characteristics and these pellets are stable in water for more than 3 hours when compared to uncooked feed pellets wherein the stability was good up to 30 minutes only. Based on the previous trial it is inferred that addition of supplemental oil in seabass feed impairs the extrusion process and hence it was decided to add / coat the oil after extrusion. In this connection, several trials were made to standardize the coating of oil and the coating was standardized by preheating the oil at 70° and thereafter spraying with the specially developed nozzle.

Alternate protein ingredients as a replacer of fishmeal

The effect of replacement of fishmeal with meat and bone meal (MBM) (0, 5, 10, 15 and 20% level on w/w basis) was evaluated in the juveniles of wild collected Asian seabass, *L. calcarifer* with an initial weight of 5.77 ± 0.14 g with three replicates for each treatment for 6 weeks. The results of the study (Table 17) indicate that the weight gain (%) was significantly ($P<0.05$) higher at 10% replacement diet compared to 20% replacement. The most limiting amino acids in MBM were isoleucine and methionine apart from other essential amino acids. With the increase of meat and bone meal level in the diet, the essential amino acid (%) decreased.

Table 17. Evaluation of different percentages of meat and bone meal (MBM) replacement of fishmeal

Test Diets (% of MBM)	Parameters WG (%)	FCR	Survival (%)
0	442.6^{c}±1.31	2.03^{a}±0.043	93±3.33
5	451.3^{c}±5.34	2.02^{a}±0.055	90±5.77
10	437.6^{c}±4.47	2.05^{a}±0.003	93±3.33
15	380.3^{b}±4.84	2.27^{b}±0.034	86±6.67
20	301.0^{a}±11.03	2.57^{c}±0.043	90±3.33

The effect of replacement of fishmeal with corn gluten meal was evaluated in seabass fingerlings (average initial body weight of 21.03±0.486). About 225 fingerlings were randomly distributed into 15 FRP tanks with a capacity to hold 1000 L with each treatment having three replicates and each replicate containing 15 animals. Corn gluten meal was included at 0, 5,10,15,20 and 25% level on w/w basis replacing fish meal and the effect of inclusion was studied for a period of 45 days (Table 18).

Table 18. Evaluation of different percentage of corn gluten meal replacement of fish meal

Diet (% of CGM)	WG (%)	ADG (mg/day)	Survival (%)	SGR	DGC	FCR
0	80.26	385.19	95.56	1.31	1.34	2.13
5	83.52	391.41	93.33	1.35	1.37	2.05
10	79.78	380.52	95.56	1.30	1.33	2.24
15	72.80	334.96	77.78	1.22	1.22	2.43
20	61.13	282.89	80.00	1.06	1.05	2.64

The results revealed that CGM can be included upto 10% in the diet of seabass without affecting growth and FCR. It is interesting to note that 5% CGM containing diet showed a higher weight gain than the control indicating the complementary effect of CGM when included at 5.0%. When the inclusion level is increased beyond 10% there is a progressive decrease in weight gain, ADG, SGR and DGC. Similarly FCR was better observed in 5.0% CGM containing diet while the 10.0% CGM and the control diet showed a comparable FCR. When the CGM was included above 10.0% the FCR values increased considerably.

Development of farm-made feeds

The farm-made feed with 37.6 % protein and 15.8 % fat which was developed based on yard trials during the preceding year was taken up for demonstration in a farmer's pond of 1400/m^2 area at Madanganj, Namkhana Block, South 24 Paraganas. The farm-made feed was prepared using locally available cost effective ingredients consisting of poultry offal, mustard cake, soybean cake, some low value fish and other essential ingredients. Wild seabass fry (initial weight 0.90 g) were weaned with farm-made feed for one month and weaned fry of 700 nos (average body weight 1.90 g) were stocked in a farmer's pond. Fishes were fed with semi moist form of the feed initially at the rate of 10 % body weight two to three times daily and gradually replaced by dry pellet feed (2 mm size) at the rate 4% body weight. Water quality parameters have been analyzed periodically every month. Salinity level varied from 6.0 to 18.1 ppt during the culture period. Water temperature, pH, ammonia nitrogen and nitrite nitrogen were within permissible levels through out the culture period. The growth pattern observed during the culture period is presented in Fig. 37.

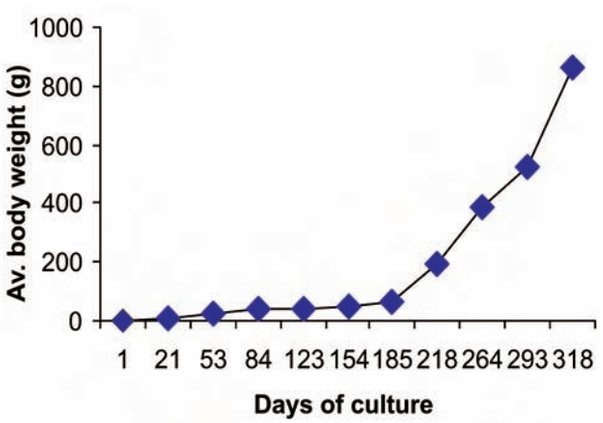


Fig. 37. Growth pattern of seabass fed with farm-made feed

After 318 days of culture, the crop was harvested and seabass attained a body weight ranging from 450 to 1300g with an average body weight of 865.0 ± 87.32 g. Use of farm-made feed for this culture resulted in a survival rate of 61.42% with a FCR of 1.98 indicating that use of farm-made feed for culture seabass is feasible.

A farm-made feed unit with a capacity to produce 200 kg per day was custom designed in such a way that the entire unit can be handled by women self help groups. The unit consists of Grinder, Siever, Mixer, Cooker, Pelletizer and Dryer. The unit was installed at Perungalathur in Kancheepuram district of Tamil Nadu. The feed mill is presently being used by the women self help group of Irrula tribes. They are producing feed to meet the requirement for ornamental fish broodstock and surplus is being sold for grow-out culture of other fresh water fishes**.**

Amelioration of anti nutritional factors

Glucosinalates (GSL) content in mustard seed was estimated in twelve samples collected from four different districts in West Bengal and the analysis revealed that the GSL content (µmol/g) varied from 129.48±0.08 to 220.52 ±0.20, however within the district, it is almost similar. This indicates that the GSL content varied depending on the location of the sample. Similarly, twelve sunflower oil cake samples from four different districts of WB showed that tannin content varied from 1.41 % to 1.81 % and the same trend of similar tannin content within the district and variable content among different districts was observed attributing variability to the type of oil cake and the location.

Demonstration of Seabass culture using formulated feed

Seabass culture using CIBA Bhetkiahar is being continued in three different states *viz*., Karwar in Karnataka, Sirkazhi in Tamil Nadu and Machilipatnam in Andhra Pradesh. In the first crop, it has been shown that seabass could be cultured successfully using CIBA developed feed with a production of 3-4 tons per ha with a FCR of 1.6-1.8. The second set of demonstrations are also progressing well.

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

For development of substrate specific fibrolytic enzymes for enhancing nutrient utilisation in shrimp, the customized enzyme mixture (CEM) developed during the preceding year of the project was used to evaluate its efficacy on growth and nutrient utilization in shrimp feeds containing plant protein sources. The evaluation was carried out in three different stages: (i) wet lab trials using individual and combined plant protein sources with CEM (ii) best performing combinations were subjected for verification trials in hapas (iii) validation in farmer's pond using the CEM supplemented shrimp feeds containing maximum plant protein sources. The selected eight ingredients viz., Soybean meal (SBM), Rapeseed meal (RSM), Sunflower oil cake (SFOC), Groundnut oil cake (GNOC), Cottonseed cake (CSC), Coconut oil cake (COC), Wheat bran (WB) and Rice bran (RB) were included at various levels in shrimp feed and was assessed in the growth cum digestibility trial using CEM. The maximum level of inclusion of each ingredient was arrived at taking into consideration digestibility and growth. Based on the results obtained in the individual ingredients, it was clear that they cannot replace the fish meal completely and the strategy for combination of various plant protein sources will help in the goal of realistic replacement of fish meal in practical shrimp feeds. Hence another set of experiments was conducted using different combinations of plant protein sources. The selected combinations were: (i) GNOC: RSM: SFOC; (ii) GNOC: RSM: COC; (iii) COC: GNOC: RSM: CSC; (iv) GNOC: SFOC: CSC: COC; and (v) RSM: SFOC: CSC: COC.

Among the five combination of plant protein sources tested, diets containing GNOC: RSM: SFOC and GNOC: RSM: COC combination showed promising results and these two combinations were selected for verification trials in hapas This trial was conducted in tiger shrimp juveniles weighing 1.0 g, for 60 days. Both the diets showed potential for replacement of fishmeal and the combination GNOC: RSM: SFOC was selected for field trial in farmer's pond. The field trial was carried out in a shrimp farmer's farm at Thirunagari village of Sirkazhi taluk in Nagapattinam District of Tamil Nadu. Two ponds with a water spread area of 0.5 ha were selected for this trial, one serving as a test pond and another as a control. The tiger shrimp seeds (PL15) were stocked in two 0.5 ha ponds at the density of 10/m^2. Uniform culture practices were followed for both the ponds and the only difference being the feed used. In the control pond, conventional shrimp feed containing 30.0% fish meal was used, while in the test pond, feed containing 10.0% fish meal in the starter feeds and 7.5% fish meal in grower and finisher feed was used. Both the ponds were harvested after 112 days of culture and the results showed a total production of about 1008 kg and 1039 kg of shrimp in the control and test pond respectively with an FCR of 1.6 and 1.52. The estimated survival was about 84.0% in the control pond and 77.0% in the test pond fed with maximum plant protein containing shrimp feed. The average body weight at harvest was 27g in test as against the 24 g in control.

The feed cost per kg of shrimp produced was considerably lower in test pond. (₹ 62 vs 56). The economic indicators reflect that the production cost of shrimp was about ₹ 167 per kg when fed with

the control feed compared to ₹ 158 obtained in pond fed with test feed and the cost of production of shrimp is reduced by ₹ 9 per kg. Results of the soil and water quality indicate that there is not much variation in various parameters when fish meal was replaced with plant protein sources supplemented with CEM. Enzyme supplementation helps in utilizing the bound nutrients and makes the feed more digestible resulting in better soil and water quality. Thus it has been proved that fish meal can be effectively replaced with plant protein sources with CEM supplementation. This trial showed that inclusion level of fish meal may be brought down to the level of 10.0% in the shrimp starter feed and 7.5% in the grower ration by replacing it with combined plant protein sources along with CEM supplementation.

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

Strain level identification of potential gut microbes using 16s rDNA sequence analysis

Thirty six aerobic bacterial colonies and eight anaerobic bacterial colonies isolated from the gut of brackishwater fishes were characterized and identified on the basis of their morphological, physiological and biochemical characteristics. Among them, two potential isolates from *L. calcarifer*, one from *M. cephalus* and three from *C. chanos* were identified with 16S rDNA sequence analysis methods.

***In vitro* fibre and starch degradation and increase in protein of different ingredients**

Among the thirty six aerobic bacterial colonies and eight anaerobic bacterial colonies isolated from the gut of brackishwater fishes, aerobic cellulolytic bacteria (isolate LC8), isolated from the gut of *Lates calcarifer*, and aerobic amylolytic bacteria (isolate CCx), and anaerobic cellulolytic bacteria (isolate CCan1), isolated from *Chanos chanos* were used for fermentation of seven locally available low cost fibrous feed ingredients (rice bran, sunflower cake, sesame cake, leucaena leaf meal, sugarcane bagasse, mustard oil cake and azolla). It was identified that 50-60% moisture, 48-72 hrs of incubation and 0.75 - 1.25% (v/w) inoculum was optimum for fermentation with LC8 with regard to protein enrichment and cellulose degradation. A moisture content of 50-60% & 48 hrs of incubation and 1.0-1.25% (v/w) inoculum was optimum in case of CCx and moisuture content of 50-60%, 72 hrs incubation and 0.75-1.25% (v/w) inoculum was optimum in case of CCan1. The LC8 could increase the protein level from 2.27 to 19.00 % and could reduce cellulose level 6.60 to 26.24 in different feed ingredients, CCx could increase the protein level from 2.11 to 10.46 % and could reduce starch level - from to 9.8617.02 % in different feed ingredients, whereas, CCan1, the anaerobic microbe could increase the protein level from 2.27 to 13.83 % and reduce cellulose level from 31.47 to 10.93% in different feed ingredients when fermented in optimum moisture levels for a optimum period.

Live bacteria supplemented feed - seabass growth performance

To study the effect of cellulolytic and amylolytic gut bacteria as a feed supplement on growth performance, nutrient digestibility and digestive enzyme activity of Asian seabass, two potential gut microbes, LC8 (*Bacillus* sp. LP1MB), potential cellulolytic bacteria and CCx (*Bacillus subtilis*) potential amylolytic bacteria were selected for the study. An isocaloric and isonitrogenous practical diet (control) was prepared using different low cost locally available ingredients and fed to fish juveniles of Group I. Fishes of group II, III and IV were fed with control diet supplemented with *Bacillus subtilis* (14.25 x 10^7 cfu/ml), *Bacillus* sp. LP1MB (2.94 x 10^7 cfu/ml) and mixture of both the microbes (*Bacillus subtilis* & *Bacillus* sp. LP1MB) at 1:1 ratio, respectively. Bacterial culture was supplemented @ 1% (v/w) of feed and mixed during feeding time. The feeding trial was

conducted for 30 days with four groups of wild juvenile *L. calcarifer* (3.70 g) in triplicates with 10 fishes per replicate in 12 fiber reinforced plastic tanks containing 100 L of water with continuous aeration.

It was found that the diet (group 4) supplemented with mixture of *Bacillus subtilis* & *Bacillus* sp. LP1MB resulted in significantly higher (P<0.01) growth (weight gain: 141.42 %), survival (91.50 %) and protein efficiency ratio (PER) and significantly lower (P<0.01) FCR (2.15) than that of other two diets. Dry matter digestibility, cellulose, hemicellulose, lipid and protein digestibility was also significantly (P<0.01) higher in group IV than that of groups I, II and III. Digestive cellulase, amylase and protease activity in the intestinal tract were also significantly (P<0.01) higher in group IV as compared to that of other three groups (Fig. 38). It could be inferred that feed supplemented with a mixture of *Bacillus subtilis.* (CCx) & *Bacillus* sp. LP1MB (LC8) improved growth performance, FCR and digestibility of Asian seabass juveniles (Table 19). This opens a promising area for further research to bring down the cost of feed for seabass culture.

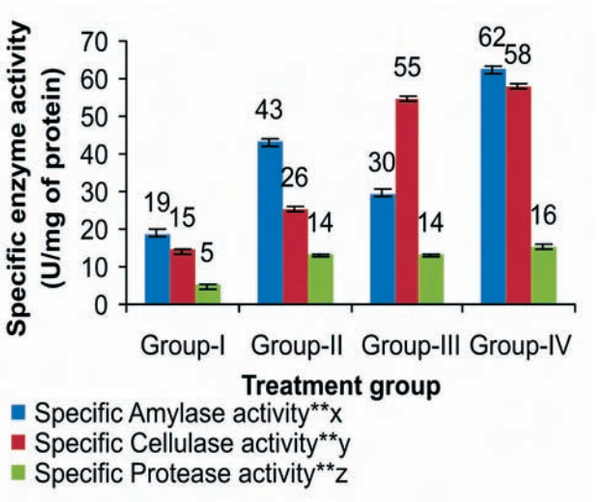


Fig. 38. Digestive enzyme activity in *Lates calcarifer* fed different live bacterial supplemented diets (X = µg of maltose liberated / mg of protein / min, Y = µg of D-glucose liberated / mg of protein / min, Z = µg of L-tyrosine liberated / mg of protein / min. Error bars show standard error among three replicates)

Table 19. Growth performance of Asian seabass fed with live microbial supplemented diet

Parameters	Treatment groups			
	Group I	Group II	Group III	Group IV
Initial body wt. (g)	3.7 ± 0.01	3.7 ± 0.02	3.7 ± 0.02	3.7 ± 0.02
Final body wt. (g)	7.2^{a} ± 0.04	8.2^{b} ± 0.08	8.4^{b} ± 0.05	8.9^{c} ± 0.11
Total wt. gain (g)	3.5^{a} ± 0.03	4.5^{b} ± 0.05	4.7^{b} ± 0.03	5.23^{c} ± 0.08
ADG (mg/d)	116^{a} ± 1.2	151^{b} ± 1.95	157^{b} ± 1.1	175^{c} ±2.9
Weight gain percent	94^{a} ± 0.8	122^{b} ± 0.8	127^{c} ± 0.5	141^{d} ±2.8
FCR	3.3^{a} ± 0.03	2.5^{b} ± 0.03	2.4^{c} ± 0.01	2.2^{d} ±0.03
SGR (%)	2.2^{a} ± 0.01	2.7^{b} ± 0.00	2.7^{c} ±0.00	2.9^{d} ±0.02
PER	0.78^{a} ± 0.01	1.02^{b} ± 0.01	1.06^{b} ± 0.01	1.18^{c} ±0.01
Survival (%)	71^{a} ± 4.16	83^{b} ± 4.16	85^{b} ± 0.00	92^{c} ± 0.00
Digestibility (%)				
Dry matter	89^{a} ± 0.2	92^{b} ± 0.2	92^{b} ± 0.2	94^{c} ± 0.2
Organic matter	90^{a} ± 0.2	92^{b} ± 0.1	93^{b} ± 0.2^{b}	95^{c} ± 0.2
Hemi cellulose	93^{a} ± 0.8	94^{b} ± 0.3	95^{c} ± 0.1	95^{d} ± 0.1
Cellulose	89^{a} ± 0.2	92^{c} ± 0.2	94^{b} ± 1.2	95^{b} ± 0.5
Crude protein	91^{a} ± 0.2	94^{b} ± 0.1	94^{c} ± 0.1	96^{d} ± 0.2
Crude lipid	97^{a} ± 0.1	98^{b} ± 0.0	98^{c} ± 0.1	99^{d} ± 0.0

Values followed by different superscripts in a row differ significantly (P<0.05)

Project Title (Institute)	Exploring candidate genes for economically important traits in brackishwater organisms using biotechnological and bio-informatic tools

Characterization of genes in tiger shrimp linked to male maturation

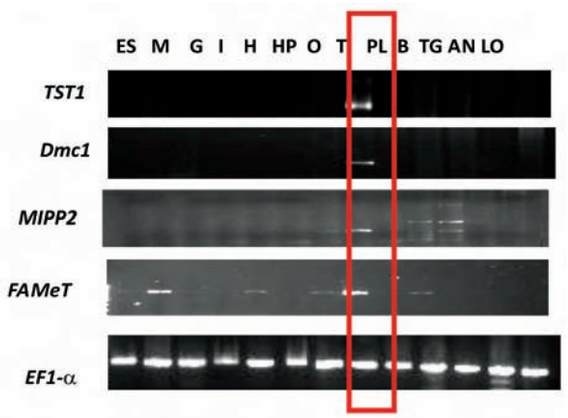


Fig. 39. Semi-quantitative PCR analysis of TST1, Dmc1, MIPP2, FAMeT and EF1-α expressiom in Penaeus monodon (ES=eyestalk, M=muscle, G=gills, I=intestine, H=heart, HP=hepatopancreas, O=ovary, T=testis, PL=pleopod, B=brain, TG=thoracic nerve chord, AN=abdominal nerve, LO=lymphoid organ)

The main objective is to identify and characterize genes in tiger shrimp that are functionally related to testicular development. Shrimp were collected from wild and total RNA was extracted from different tissues. The genes examined to analyze the role in male development included testis specific transcript of *P. monodon (TST1)*, multiple inositol polyphosphate phosphatase 2 (*MIPP2*) meiotic recombination protein DMC1/LIM15 homolog isoform 1 (*Dmc1*), farnesoic acid O-methyltransferase (*FAMeT*), insulin-like androgenic gland factor (*IAG*) and gonad inhibiting hormone (*GIH*). Among the genes analyzed *TST1*, *Dmc1* and *IAG* exhibited male specific expression while *MIPP2* transcript was present in the ovary and thoracic nerve cord in addition to testis. *FAMeT* mRNA transcripts were detected in eyestalk, muscle, heart, ovary, testis and brain though with varying intensity in expression as shown in Fig. 39. The results provide information about potential genes involved in testicular maturation and development. Further investigations are needed to comprehend their role in maturation process in *P. monodon*.

Expression of viral latency and shrimp immune genes with WSSV infection

Fifteen shrimp samples surviving a WSSV challenge and those that had survived a natural WSSV infection, were analyzed. These shrimp were screened for the viral genes associated with latency (ORF 366, ORF151 and ORF 427). The shrimp samples were also screened for expression of the gene encoding phagocytosis activating protein (PAP) for its possible role in immune response and protection.

ORF 366 was found to be expressed in all the shrimp samples analysed when compared with other WSSV latency associated ORF's. The PAP was found to be expressed in WSSV infected shrimp samples indicating PAP mediated host response for resistance against WSSV infection. Both WSSV latency and PAP gene expression were observed in shrimps surviving WSSV infection. Elucidation of the molecular mechanisms for latency in WSSV infected cells and the host response would give an insight into the host cell-virus interaction and facilitate the development of specific anti viral therapy.

Project Title (Institute)	Outreach on fish genetic stocks

Wild tiger shrimp samples were collected from Kakdwip (132), Paradip (60), Chennai (74), Tuticorin (22), Andamans (51) and Visakhapatnam (61). The digitized images of 553 samples that belong to first set of shrimp collected from all eight locations were utilized to generate truss morphometric measurements (30 truss measurements) using the softwares tpsUtil, tpsDig and PAST. These measurements were log transformed, corrected for the effect of size and standardized to zero

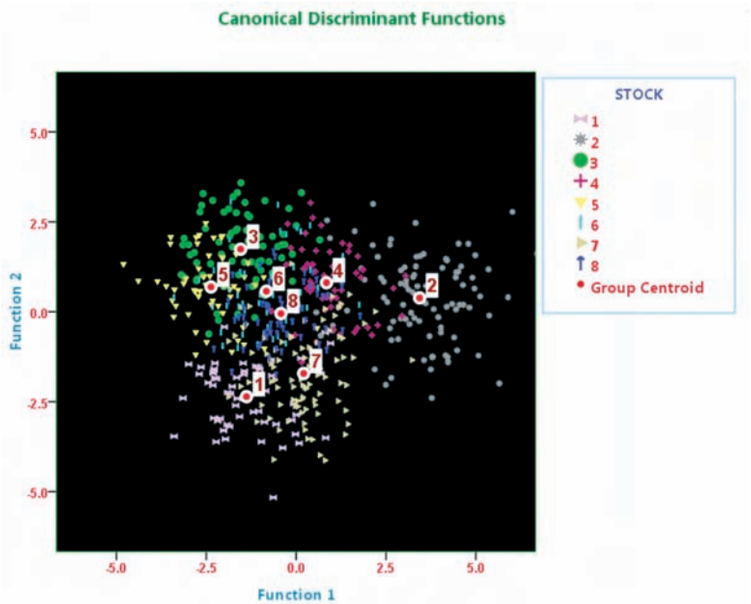


Fig. 40. Group centroids of all eight stocks of *Penaeus monodon* based on estimated discriminant functions
(Eight stocks 1 = Andamans; 2 = Chennai; 3 = Kakdwip; 4 = Kollam; 5 = Paradip; 6 = Ratnagiri; 7 = Tuticorin and 8 = Visakhapatnam)

mean and unit variance. A discriminant function analysis was performed on standardized morphometric distances. Out of 30 truss variables, three did not vary across stocks and were deleted for further analysis. All eight stocks could be discriminated based on seven estimated canonical discriminant functions (Fig. 40). All the seven functions were significant and explained a substantial amount of stock variability. The discriminant functions generated on shrimp with known stock identity could classify 87.7 % of shrimp correctly to the respective stocks. During cross-validation, 79.7 % of shrimp were correctly classified, indicating the usefulness of discriminant function developed from truss variables for stock identification.

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

Twenty four adult males and 28 female tiger shrimp from wild were collected from Palayar region of Tamil Nadu. Shrimp were kept for mating in the ratio of 2 adult females with 1 adult male in 5 ton tanks and 5 full-sib families could be produced. The post larvae were reared upto PL_{20} inside the hatchery and thereafter transferred to hapas in a pond as well as in FRP tanks. One hundred and sixty juveniles from 5 families were transported to the challenge test facility. The mortality started 36 hours post infection and continued for 3 days. The traits recorded for each juvenile were the time taken to death and wet weight at death after which the shrimp have been stored in -80°C freezer for DNA extraction. The protocol for extraction of DNA was optimized and the DNA from 64 shrimp of 1 family have been extracted and stored for dispatch to Norway for genotyping. The transcriptome of wild tiger shrimp from different locations along the East & West Coasts, Andaman Islands as also from shrimp that survived a very heavy infection of WSSV during culture, has been sequenced. The sequence data was obtained and the Norwegian counterparts have completed the assembly of sequence data from which more than 200,000 contiguous stretches of transcribed sequence could be identified.

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

RNA dependent RNA polymerase (RdRp), B2 and capsid genes of *Macrobrachium rosenbergii noda virus* (*Mr*NV) of Indian isolate were PCR amplified, cloned and sequenced. Expression of the *Mr*NV fusion recombinant proteins of RdRp (44.5 kDa), B2 (32.2kDa) and capsid (58.4kDa) was confirmed by Western blot analysis using anti-His mouse monoclonal antibodies (Fig. 41). Polyclonal antibodies specific to purified recombinant *Mr*NV capsid protein was raised in rabbit. The polyclonal antibodies showed specificity against the capsid protein of *Mr*NV by Western blot analysis. The protein

sequence analysis of the partial RdRp gene of *Mr*NV revealed the signature sequence along with the conserved core residues of the catalytic domain and indicated the presence of active sites, metal ion binding site and nucleic acid binding site residues. The Indian isolate of *Mr*NV showed high RdRp and capsid gene sequence homology with the other *Mr*NV geographical isolates. Secondary structure prediction analysis of the *Mr*NV capsid predicted it to be a DNA binding protein consisting of alpha helix (22.91%), extended strand (24.80%), beta turn (5.39%) and random coil (46.90%) regions. The secondary structure analysis would help in prediction of protein folding and the associated functional motifs of the viral capsid protein.

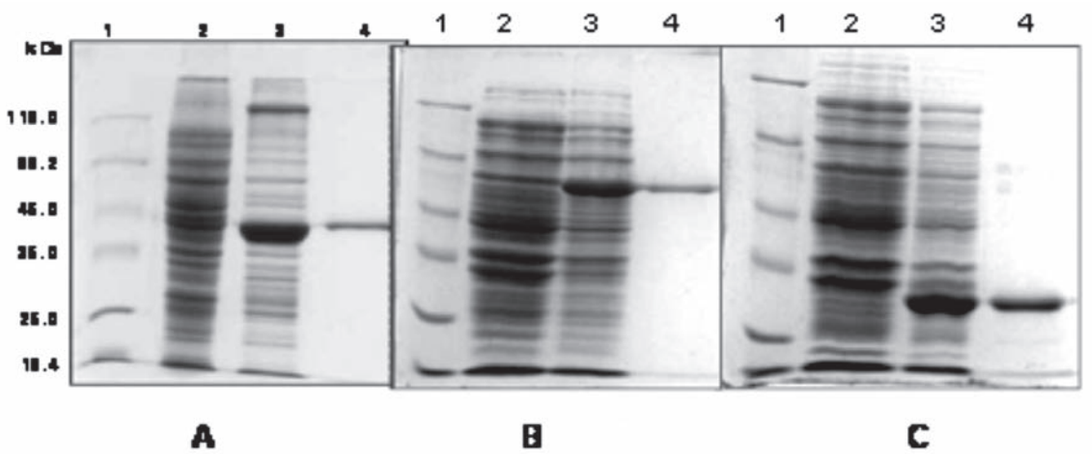


Fig. 41. Expression and purification of *Mr*NV recombinant proteins. (A) Lane 1. Protein molecular weight marker. Lane 2. Uninduced cells (negative control). Lane 3. IPTG induced *Mr*NV RdRp recombinant protein. Lane 4. Purified recombinant *Mr*NV RdRp protein (44.5kDa). (B) Lane 1. Protein molecular weight marker. Lane 2. Uninduced cells (negative control). Lane 3. IPTG induced *Mr*NV Capsid recombinant protein. Lane 4. Purified recombinant *Mr*NV Capsid protein (58.4kDa). (C) Lane 1. Protein molecular weight marker. Lane 2. Uninduced cells (negative control). Lane 3. IPTG induced *Mr*NV B2 recombinant protein. Lane 4. Purified recombinant *Mr*NV B2 protein (32.2kDa)

Project Title (NAIP)	**Bioprospecting of genes and allele mining for abiotic stress factors**

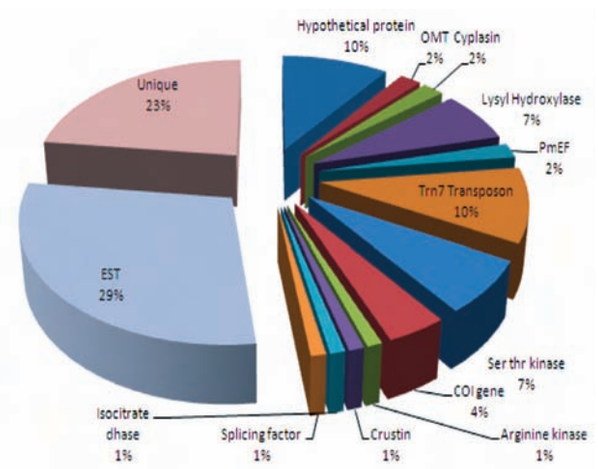


Fig. 42. The differentially expressed genes from tiger shrimp gill tissues under low salinity conditions (3 ppt)

Tiger shrimp gill tissues were used for the construction of Suppression Subtraction hybridization (SSH) library to identify the genes that are differentially regulated during low salinity stress. Some of the differentially expressed genes in shrimps acclimatized under low salinity conditions (3 ppt) revealed the genes linked to salinity stress such as Arginine kinase (*P. monodon* allegen, O - Methyl Transferase (OMT), *P. monodon*-Elongation factor, Cyplasin, Crustin, Isocitrate dehydrogenase, Lysyl Hydroxylase, Transposons (Trn7) and Serine threonine kinases. Hypothetical protein (10%) were also identified by BLAST sequence homology analysis and 23% constituted uncharacterized (no match with sequence database) genes. Identification of further differentially expressed genes under low

salinity conditions is in progress (Fig. 42). Construction of SSH library has been initiated to identify the genes that are differentially regulated during high salinity (55 ppt) stress.

Project Title (DBT)	Development of inhibitors for controlling quorum sensing lumniescence causing *Vibrio harveyi* in shrimp larviculture system

Garlic extract on virulence of vibrio

In order to develop inhibitors for controlling quorum sensing luminescence causing *Vibrio harveyi* in shrimp larviculture system, garlic extract as unfiltered and filtered were evaluated. *V. harveyi* was grown in LB medium with garlic extract as one of the media component at 100 mg/ ml (0.1g/ml). This inoculum was incubated at 30°C/5 days. The changes of various virulence factors produced by *V. harveyi* against garlic were estimated (Table 20).

Table 20. Changes in virulence factors produced by *Vibrio harveyi* against garlic extract

Virulence factors	Filtered garlic extract	Unfiltered garlic extract	Control
Thermo nuclease	Negative	Negative	Positive
Phospholipase	Negative	Negative	Positive
Phosphatase	Negative	Negative	Positive
Exo Polysachharide (OD)	0.5 to 0.7	0.5 to 0.7	1.8 to 2.4
Protease (OD)	0.01 to 0.02	0.01 to 0.02	0.04 to 0.13

Filtered garlic extract (100mg/ml) was treated with *V. harveyi* (1.86 OD) in LB medium. In the garlic treatment, the growth was observed to be less (0.5 OD) as compared to the control (2.0 OD) for a period of 5 days (Fig. 43).

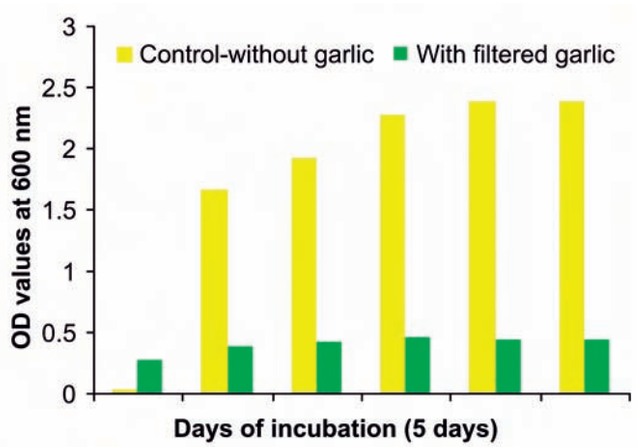


Fig. 43. Growth of *Vibrio harveyi* with filtered garlic extract

SOCIAL SCIENCES DIVISION

Project Title (Institute)	Growth, marketing and extension synergies in brackishwater aquaculture

Trend in growth of seafood exports from India

The total seafood export from India was studied using the monthly export data in terms of quantity, value and price collected for the period January 1995 to March 2010. The data were analysed to determine exports trends in terms of export growth, growth percentage and unit value realization.

Highest growth was observed in the year 2000 followed by 2006. Unit value realization in dollars remained the same over the years, where as the unit value in terms of rupees increased from 112.5 (1996) to 148.5 (2009). The product mix of seafood exports over years has been found to be decreasing for high value frozen shrimp and increasing for low value frozen fish and others items. With regard to the imports by countries like Japan and US it was found that India's position dropped from being the largest group (until 1995) to medium group (2000 onwards) of the total imports by Japan. In the case of import by the Unites States, India was in the small-medium group upto 2005 and fell to low group in 2009.

Logistic ARIMA (1,0,0)(0,1,1)s and ARIMA (0,1,2)(0,1,1)s NOINT time series models were developed for quantity (MT) and value (₹ Crores) of total marine exports from India by using monthly export data from 1996 to 2010 (Table 21). SAS Time Series Forecasting System used for the study forecasted the export trends up to March 2014.

Table 21. Year wise actual and predicted values using time series model for quantity and value of exports

Year	Quantity (M. tonnes)		Value (₹ Crores)	
	Actual	Predicted	Actual	Predicted
1996	353676	243657	3980	2692.5
1997	398977	384833	4661.6	4641.3
1998	313503	359462	4709.6	4948.3
1999	327205	356587	4757.4	4689.3
2000	421075	399896	6396.6	6057.0
2001	424320	426826	5917.3	6335.1
2002	497963	473938	7011.4	6702.8
2003	409728	461055	6021.9	6520.2
2004	450568	460433	6522.4	6283.9
2005	502597	500745	7137.5	7031.2
2006	603148	572832	8299.4	8053.8
2007	538997	570978	7624.9	8140.5
2008	595821	586918	8398.3	8060.0
2009	648838	629868	9635.4	9309.7
2010	678436	677950	10049	10982.0
2011	.	687159	.	11930.2
2012	.	709130	.	12905.5
2013	.	730756	.	13880.8
2014	.	751956	.	14856.1

Need assessment on species diversification

To evaluate the extension approaches required by the stakeholders for farming of diverse shrimp species, a macro survey covering various stakeholders involved in shrimp farming was carried out (Table 22). The aqua-consultants (n=41) who play a major role as private extension personnel in the shrimp farming sector in India, were interviewed from the three maritime states, *viz*., Tamil Nadu (n=12), Andhra Pradesh (n=15), and Gujarat (n=14) with the help of nodal persons / agencies in the respective states. In Tamil Nadu the locations covered were Pattukkottai, Ramanathapuram and Nagapatinam; in Andhra Pradesh the locations were Akividu, Bapatla and Ongole and in Gujarat it was Surat. The data were collected using open and close ended questionnaires and a well-structured interview schedule.

Table 22. Extension requirements for commercial culture of diversified shrimp species identified by consultants

	Needs identified by aqua consultants	Tamil Nadu			Andhra Pradesh			Gujarat
		1	2	3	1	2	3	1
1	Training course general / technical knowledge / seminar in *L.vannamei* farming	✓		✓		✓	✓	✓
2	Farmers meet / group discussion regarding *L.vannamei* farming	✓				✓		
3	Demonstration of *L.vannamei* farming	✓	✓		✓	✓		✓
4	Training in *L.vannamei* farming and marketing			✓		✓	✓	
5	Training in *L.vannamei* farming and biosecurity					✓	✓	✓
6	Field Visits to *L.vannamei* farming areas					✓		✓
7	Training / seminar / general Information in *F. indicus* farming		✓			✓		
8	Training in *M. japonicus* farming		✓					
9	Tiger shrimp only; no interest in culture for any other species		✓	✓				

Tamil Nadu: 1-Pattukkottai, 2-Ramnad, 3-Nagapatinam; Andhra Pradesh: 1-Akividu, 2-Bapatla, 3-Ongole; Gujarat: 1-Surat

As the farming of *L.vannamei* is expanding in the country, particularly in Andhra Pradesh, the extension requirements were more pertaining to *L.vannamei* than the other alternative species. In Ramnad and Nagapatnam areas of Tamil Nadu, where tiger shrimp *P.monodon* culture is still successfully done, the consultants opined that there was no need of any extension strategies for other shrimp species at present. In the case of banana shrimp *F.merguiensis* and kuruma shrimp *M.japonicus* the aqua consultants were not aware of the farming technologies of these species and therefore a need for awareness creation among the public, particularly among the consultants on seed production and grow out technologies of these species is the need of the hour.

Contract shrimp farming (CSF) Model

Contract Shrimp Farming (CSF) Model of M/S Oceanaa Edibles in collaboration with New India Assurance, State Bank of India /Indian Overseas Bank among Nagapattinam district Farmers was studied as a case study. The salient points noted from the case study of seven beneficiaries of CSF were as follows: (i) Total costs of a shrimp crop are ₹ 5 lakh ha/crop. But the bank loan sanctioned was only ₹ 3.2 lakh/ha. The credit gap is being bridged by farmers through loans obtained at higher interest. Hence the credit limit has to be revised. (ii) Insurance premium of ₹ 17,819 per crop (@4.5% of ₹ 3,59,000) cost of inputs was collected from farmers. The premium needs to be rationalized/ subsidized by government/ shared by contracting firm. (iii) The cost of labour and transport charges was ₹ 40,000/ ha / crop (iii) The culture duration extended as per firm's convenience. The feed intake was more at later stages during extension of culture duration and therefore this did not benefit the farmers. (iv) 'Ruling market price' was paid by the firm for the shrimps harvested. The farmers wanted a fixed pre-agreed price for their produce.

Livelihood options among women Self Help Groups

An assessment was made among 60 Irrular Women Self Help Groups (WSHGs) at New Perungalathur, Chennai. Tamil Nadu, who were practicing ornamental fish culture. Six varieties of ornamental fishes are being cultured. Fish traders from different places around Chennai come here to purchase these fishes. These WSHGs had undergone training at KVK of the TANUVAS, Kattupakkam near Chennai. This group has

been a successful group who received a bank loan under the Swarna Jayanthi Self Employment Scheme also. They have received 2 State Government awards.

Crab fattening in tide fed ponds is being practiced traditionally by 'Irrula' tribal community WSHGs at Kulathumedu, Pulicat, Tiruvallur District, Tamil Nadu. Crab fattening was practiced by these WSHGs in 5 ponds in an unorganized way. The size of water crabs stocked in the pond ranged from 600 g - 1000 g. Water crabs were purchased @ of ₹ 180 to 200 per kg and stocked in each pond @ 75 - 150 kg. Fattened crabs after a period of 20 - 30 days were harvested @ 50 - 125 kg per pond. Profit gained from each cycle was ₹ 5000.

Participation of women in crab fattening in tide fed ponds

Transfer of aquaculture technologies to WSHGs

Demonstration of 'Crab fattening in Tide Fed Pond' was conducted to 30 Irrular Tribal WSHGs at Kulathumedu, Pulicat, Tiruvallur district, Tamil Nadu. All technical support was given by CIBA and the demonstration programme was conducted with the help of the NGO named Annai Theresa Social Work Association (ATSWA). Help was also given to the beneficiaries to procure bank loans for this enterprise and thus ensuring the sustainability of this livelihood option. About 100 kg of water crabs were stocked in a pond (40ft x 30ft). After 23 days of culture period, 98 kg of hardened crabs were harvested. The profit gained was ₹ 10,000 for this demonstration.

Crab fattening by Irrular tribal women

Domestic Marketing of Aquaculture Produce - Women's role

Participation of women in the domestic fish markets, such as road side markets (4), retail markets (2), whole sale markets (2), in 24 Parganas (South) were evaluated. The literacy rate among women was low and only 13.15% of respondents were able to read and write in Bengali. The average family size was six, three adults and three children. The initial investment for beginning the trade raged from ₹ 200-2400. Loans from private money lenders financed the business for 89.21% of respondents and 10.52% had invested their family funds. The interest rate of daily purchase of fish from the middlemen varied from 7-10% depending on the time of repayment of loan. The respondents retailing in road side markets purchased an average of 10kg of fish for ₹ 200- 500, those in retail markets purchased 18-23 kg for ₹ 270-1000. The whole salers however purchased 40-50 kg for ₹ 2000-6000. Majority (92.10%) of respondents sell fish outside their area of residence. Some of them (5.20%) sell in the surrounding villages and others sell in the rural as well as urban areas.

Road side market at Kolkata

Women from 16 Benfish processing centres at Saltlake, Kolkata were evaluated. It was observed that they required training in the value added products fishing business, management aspects and entrepreneurship.

Though the income level of men was higher than the women, women's contribution towards the household activities was higher than that of men. They also expressed that their family members and local communities were given more respect as a result of their group membership, skills and income derived from Benfish.

Information transfer to farmers through ICT

Two mobile technology based models such as Fisher Friend Mobile Application (FFMA) and MobiAqua were evaluated. FFMA was developed by M.S. Swaminathan Research Foundation (MSSRF) in 2009 to disseminate fishing related information to fishermen through Village Knowledge Centers (VKCs) in Puducherry and three districts of Tamil Nadu viz., Nagapattinam, Rameswaram and Kanyakumari. The Fisher Friend Mobile is customized with a user-friendly control panel and it has reached 226 users covering 10-12 villages. MobiAqua (developed by A.A.O. Biotech, Chennai) is a SMS alert application which helps aquafarmers to reach buyers/sellers/traders etc. The advantages of MobiAqua is that it ensures an immediate transfer of information about the product, quick and easy access to the markets and thereby helps reduce the cost of marketing and procurement.

A survey was carried out with 56 users/fishers of FFMA, Nagapattinam District to understand the effectiveness of the mobile based dissemination system. Among the 56 fishers interviewed, four were women. The fisher mobile technology was also used by these women to convey the alerts or information received by way of this system to their spouses who were on the high seas. About 91.07% of the fisher beneficiaries opined that the latest government schemes, which were relevant to fishermen were disseminated through this application. Only 16.07% were attracted by market information. Audio clips of important announcements (8.92%) and regular clips of the day (5.35%) were given least preference by the respondents.

In order to develop a system for disseminating information to shrimp farmers through mobile phones, a need assessment was carried out in Nagapattinam district of Tamil Nadu and the ranking of the information needs is given in Table 23. The top most information needs of shrimp farmers were soil and water quality management, disease diagnosis, prevention and control, and details of license, subsidies and regulations. Based on the need assessment, the requested information will be disseminated through mobile phones.

Table 23. Ranking of information needs of shrimp farmers of Nagapttinam District, Tamil Nadu

Information needs	Rank
Soil and water quality management	I
Disease diagnosis, prevention and control	I
License, subsidies and regulations	I
Seed selection and stocking	II
Regulations of Coastal Aquaculture Authority	III
Schemes from central and state governments	III
Use of probiotics	IV
Credit facilities	IV
Marketing	IV
Group farming activities	IV
Feed and feeds management	V
Best Management Practices	VI
Site selection and farm construction	VII
Diversification of species	VII
Pond preparation	VIII
Culture details of L.vannamei	IX

Empowering farmer groups for sustainable shrimp aquaculture

In order to identify mechanisms of linking farmer groups with public institutions to promote the group farming concept, a survey of farmer groups (n = 33) and the four field level focus group discussions were organized with farmers. The important findings of the study were that self initiated clusters which had the full membership of the cluster exhibited higher group cohesiveness. However this depended on the homogeneity of the members, compulsory membership, group size, sense of ownership by members and equality of the members and it was irrespective of holdings and other social factors.

Based on the study, it is observed that an extension strategy to empower the farmer groups should have the farmers group as the 'interface' so as to to reach the primary producers (Fig. 44). It is essential that research and extension agencies should engage farmers groups as a 'field partner' for technology demonstrations and transfer of know-how. Extension agencies should organize 'farmer field schools' annually for science based capacity strengthening of farmers in each cluster. Farmers groups need to be strengthened by extending 'institutional credit support' and a facilitating mechanism like 'contract farming' should be evolved to access premium markets. Public institutions should facilitate in 'branding' the quality shrimps produced by farmers groups. The farmer groups should be helped to avail 'group certifications' from national and international aquaculture certifying agencies so as to to certify the respective cluster as 'a producer of safe and quality shrimp'. Institutional support for a 'farm to firm linkage' to access quality inputs and premium markets would be the most important step to ensure economic sustainability of these cluster groups.

Entrepreneurship motivation among fisheries graduates

To identify the skill gaps among fisheries graduates with regard to entrepreneurship development a survey was carried out with 35 post graduate students of allied fisheries subjects in Tamil Nadu. An Entrepreneurship Motivation Index (EMI) which comprised of personality traits viz., need for achievement, locus of control, risk taking propensity, tolerance for ambiguity, innovativeness, self-efficacy and information seeking behaviour as components was prepared and employed. The results

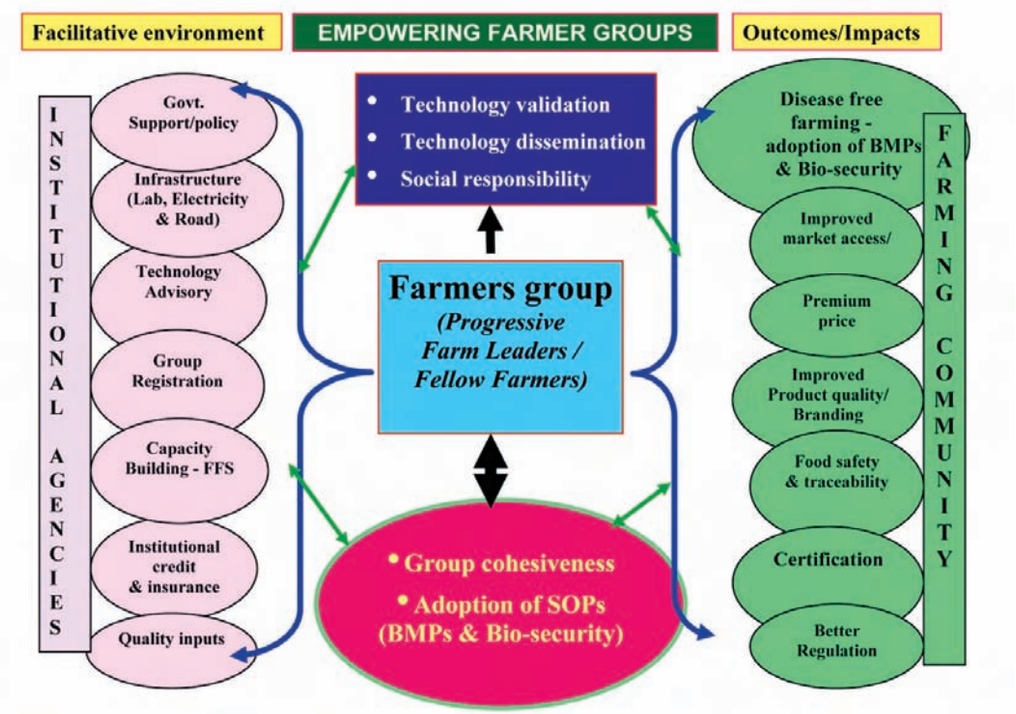


Fig. 44. Facilitative mechanisms needed to empower shrimp farmer groups and their prospective impacts

indicate that 62 % of the post graduate students exhibited a moderate entrepreneurship motivation with an EMI score of 79%, while 18 % of them had higher entrepreneurial motivation with a score of 85%. The study indicates that a government scheme for the self employment of fisheries students in the line of agri-clinics would be successful and the entrepreneurship development in fisheries need to be incorporated into the fisheries curriculum in order to develop the required entrepreneurship motivation among the outgoing fisheries graduates.

Documentation of brackishwater aquaculture farmer innovations

As an initial step to document and promote brackishwater aquaculture farmer innovations, a 'Brackishwater Aquaculture Farm Innovators Meet' was organized on 1st March 2011 at CIBA, Chennai. Eight farm innovators representing the states of West Bengal, Andhra Pradesh, Tamil Nadu and Gujarat were invited to share their innovative practices in brackishwater aquaculture. The innovative farming systems/ practices developed by them were: (1) Mono and ploy culture systems for fin fishes and tiger shrimp (*P. monodon*) in the Sundarbans area of West Bengal, (2) Organic fertilization in tiger shrimp culture ponds for bloom development/ sustenance of plankton population (3) Organizing farmer groups for collective compliance of BMPs for five consecutive years (4) Developing innovative aeration systems in shrimp aquaculture for better and effective pond management and the introduction of value chain approach to shrimp farming among the farming community (5) mudcrab (*S. tranquebarica* and *S.serrata*) farming in open large ponds (6) Innovative nursery rearing of Asian seabass with self designed nursery rearing ponds and feed management (7) Improving BMP and their, demonstration through 'satellite farming approach' in Surat, Gujarat the production and organizing farmer groups for a community approach, (8) Innovative farming of the fish Asian seabass along with forage fishes with nursery and grow out phases and popularization its culture in the Bhimavaram region of Andhra Pradesh.

Identification of optimal farming site - Multi-Criteria Decision Making

In order to select the optimal locations ('aquasites') from a large number of alternate locales for development of aquaculture farming, a logical procedure was designed using the combination of two MCDM methods, viz., Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) and Analytical Hierarchy Process (AHP). In this study, twenty seven sub-criteria were categorized into five broad heads of evaluation criteria such as water (9 sub-criteria), soil (7), support (4), infrastructure (5), and risk factor (2). The priority weights for sub-criteria within the evaluation criteria under consideration were determined using the AHP method and subsequently, these weights were used for identifying the optimal aquasites from a number of alternative locales based on the ranks assigned to them using the TOPSIS method. After collecting the required information from 15 randomly selected aquasites from the study area, Kalla mandal, West Godavari district, Andhra Pradesh, aquasites were first ranked by the combined TOPSIS-AHP method according to relative closeness value and then the same aquasites were ranked by observed average yield value per hectare (ha) for the last three crops. Spearman's rank correlation was used to assess the correlation between ranks obtained by the combined TOPSIS-AHP method and ranks obtained based on average yield. As the value of Spearman's rank correlation coefficient ρ obtained from the Spearman's rank correlation (0.896) was greater than the critical value of ρ (0.654; α=0.01), the null hypothesis was rejected. Therefore, the correlation between ranks obtained by the TOPSIS-AHP method and ranks obtained based on average yield was significant (a confidence level of 99 percent), meaning that this combined method is reliable for identification of optimal locations for aquaculture farming.

User perceptions of commercialised technologies

CIBA has developed the Micro Brackishwater Analysis Kit (MBAK) for estimation of ammonia and nitrite in shrimp ponds and commercialized this kit to a private entrepreneur in the year 2009. The

kit has been marketed in Andhra Pradesh and Tamil Nadu through a network of identified dealers. With the objective of assessing the level of adoption of MBAK and usage constraints, a survey of farmers (n = 20) was conducted in West Godavari and Krishna districts of Andhra Pradesh. The major source of information for buying water analysis kits were the dealers, who were considered the most reliable source of information and demonstration of the benefits of using this kit.

The respondents indicated their comparative perception on seven attributes viz, parameters analysed, handling ease, skill required, price, effectiveness and time taken to infer the level of ammonia of the product in relation to other products used by them on a five point scale. The MBAK scored highest points for price and number of parameter being analysed. Rank based Quotient (RBQ) was used to calculate the most influencing factors for purchasing MBAK. The eight factors taken into consideration were dealers influence, guidance by sales person, advertisement, peer group, brand loyalty, availability, relative price and credit facility. As per the RBQ values, the dealers influence and low price of MBAK were identified as the most influencing factors. Respondents were most satisfied for attributes like price, parameters analysis and easy availability. Correlation analysis indicated that there is no difference between farmer and dealer with respect to level of satisfaction on MBAK. MBAK was perceived as a better kit than others by 95% of respondents due to reasonable cost, ready availability and analysis of both ammonia and nitrite. All the farmers reported that they will purchase MBAK again e and will recommend the product to others.

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

The project was initiated with the objective of assessing the status of literacy, health and income of marine and inland fishers, fish farmers and workers in allied activities both in capture and culture systems. A random sample of 100 farmers was drawn in Challapalli and Nagayalanka mandals, Krishna district, Andhra Pradesh, to examine the trends in literacy, income and health of the shrimp farmers.

Literacy, health and income profile of shrimp farmers in Krishna district

In Krishna district of Andhra Pradesh, among the 421 family members, 192 members (45%) were illiterate and 229 (54%) were literate. Among the literates, 62 (15%), 137 (33%) and 30 members (7%) were educated upto primary, secondary and collegiate levels respectively. No dropouts were recorded among the literate family members of the shrimp farmers in Krishna district. This may be taken as an indication that shrimp farming activity is able to generate levels of income that enables the farmer to educate his family members well. According to field data collected, it appears that with the eradication of small pox from India, the vaccination for small pox has been discontinued. The others vaccinations *viz*., BCG, MMR, Oral polio vaccines are being given to all the sampled children of the shrimp farmers. Incomes were derived from various enterprises like fishery, agriculture, manual labour and other businesses. The weekly average income was ₹ 2019 per adult. The project also has covered the performance of other sub sectors in the specified parameters in freshwater aquaculture, reservoir fisheries, marine fisheries, processing and marketing sectors.

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

The objectives of the project were: to estimate market supply and demand for Asian sea bass in coastal states and metros; to identify the issues in seabass supply chain; to analyze the comparative economics of seabass and other aqua crop choices (shrimp, fin fishes and carps) and to identify strategies for increasing production and marketing of Asian seabass. A total of 1463 samples such as farmers

(268), wholesalers (270), retailers (316), vendors (289) and consumers (320) were contacted. Number of fish markets covered were 59.

Global supply and demand scenario

Based on secondary literature it was ascertained that the total global seabass production was 900 tonnes in 1950 and it rose to 142053 tonnes and production is hardly (0. 0012 %) of total global fish production in 2008 (FAO Fishstat, 2010). Marine production of sea bass was mainly reported from Indonesia, Thailand, Malaysia and Australia. Culture of seabass started in 1970s is now steadily growing globally and has already registered 10% growth. Taiwan alone produced 10287 tonnes in 2008 from culture. Indonesia and Israel produced smaller quantities. Australia produces 3000 plus tonnes of seabass from recirculating aquaculture systems but this was not indicated in the FAO Fishstat seabass data.

India supply and demand scenario

Indian seabass catch as estimated by CMFRI was 150 to 200 tonnes during 2007 and 2008. In the year 2010-11, the actual availability of marine capture and culture Asian seabass may be around 1000 to 2000 tonnes and this would be around 0.0003% of total fish production of the country. Table 24 shows that the frequency of fish purchase in an year is high in the states of Kerala (288), West Bengal(229), Orissa (201) and Andhra Pradesh (161) compared to other coastal states; total annual domestic demand of seabass could be 22000 tonnes at the maximum; high demand for seabass is observed in the states West Bengal and Orissa and in the metros of Kolkata, and Bengaluru and Mumbai (with Bengali migrant population) and to some extent in Chennai. It also highlighted that based on the non vegetation population, fish eating days and consumer demand calculated in days/annum to buy seabass, the estimated demand for seabass is 21572 tonnes.

Table 24. Estimated demand for Asian seabass in different states of India

State/City	NVP (in crores)	FED (no./ annum)	CD (days/ annum)	Demand (tonnes)
Orissa	3.84	201	48	1719
Andhra Pradesh	3.38	161	45	2300
Tamilnadu	4.49	96	15	1969
Kerala	3.25	288	12	327
Karnataka	3.70	144	25	2889
Maharashtra	7.67	120	35	4334
Gujarat	3.20	220	25	550
West Bengal	4.41	229	75	6071
Bengaluru	0.38	144	35	416
Hyderabad	0.39	161	50	295
Chennai	0.31	96	15	136
Kolkata	0.41	229	75	566

NVP- Non-veg population, FED - Fish eating days, CD-Consumer Demand

Area recommend for Seabass farming

Based on the demand, a farming area of around 10000 ha with average productivity of 2 tonnes/ ha could be promoted for Asian seabass culture. With regard to seed, about 10 to 15 seabass hatcheries with a combined production capacity of about 25 million seed per annum could be promoted in the East Coast states especially in Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. Seabass feed requirement could be around 35000 to 40000 tonnes per year and feed mills with extruders could be established to produce this quantity (Table 25).

Table 25. Recommended area for development of seabass farming in identified states with seed and feed requirements

States	Recommended area (ha)	Seed required (million)	Feed required (x 000 tonnes)
West Bengal	3035	7.58	12.14
Orissa	859	2.14	3.43
Andhra Pradesh	1103	2.75	4.41
Tamil Nadu	981	2.45	3.92
Kerala	147	0.36	0.58
Karnataka	1422	3.55	5.68
Maharashtra	2151	5.37	8.60
Gujarat	275	0.68	1.09
Total	9972	24.93	39.89

Regarding promotion of seabass among farmers, the comparative economics of productions was estimated for carp, seabass, tiger shrimp and scampi (Table 26). The study showed that lower crop duration, higher profits and ease of marketing were the main reasons that attracted farmers to tiger shrimp. Seabass could be ideal for locations where two shrimp crops in a year are not possible and in areas in high risk for viral disease attacks, and for resource poor farmers.

Table 26. Comparative economics of productions for carp, seabass, tiger shrimp and scampi

Parameters	Carp	Seabass	Tiger shrimp	Scampi
Average price (₹/kg)	64	201	283	213
Average yield (kg/ha)	3966	2760	2931	1213
Gross returns (₹ in lakhs)	2.60	5.53	8.29	2.59
Total input cost (₹ in lakhs)	1.63	2.70	6.16	1.93
Net profit (₹ per ha)	92671	283830	213067	66174
Benefit - cost ratio (undiscounted)	1.57	2.05	1.35	1.34
Break-even production (kg/ha)	2528	1345	2178	903
Production cost ₹ per kg	41.09	97.74	210.09	158.79
Profit margin ₹ per kg	22.91	103.26	72.91	54.21
Average duration in months	8.2	12.2	5.2	4.6
Profit margin ₹ per month	11301	23265	40974	14386
Risk of loss	Low	Low	49%	Medium

The project started on 1st April 2010 and was completed on 31st March 2011. The budget sanctioned was ₹ 13.60 lakhs.

Project Title (NAIP)	**Agro-web digital dissemination system for Indian agricultural research**

The objectives of the project were to identify the standards, develop uniform guidelines for content, management strategies and model templates for websites of ICAR institutes of all consortium partners to meet the requirements of the stakeholders; to design and develop an ICAR portal and integrate the websites of consortium partners; and to build the capacity of personnel in ICAR institutes to design and develope and manage websites. The achievements of the project are captured in the Table 27.

Table 27. Deliverables identified under the project and achievement with regard to updating CIBA website

Deliverables	Achievements
CIBA website revised and online databases updated	CIBA website was completely revised and information in online databases updated on daily basis
Fisheries Institutions - searchable address list/directory	An online database was hosted in CIBA website with details of more than 250 Institutions (research institutes, NGOs, fisheries magazines / journals publishers) with address, phone numbers, fax numbers, email ids, web site addresses.
Online Subscription	A web based facility was created for automated receipt/ subscription to announcement of CIBA Jobs, tenders, newsletter for register users
Multi user facility for content uploading and editing	A nodal person was identified from each divisions/sections and user ids and passwords are created for enabling multi user content management system
Complaints log-in system	A complaint log-in system was developed and loaded in intranet for users to login complaints related to computer breakdowns
Discussion forum	A discussion forum with moderator control is included in CIBA website and is under testing

The impact of the new CIBA web site is given in Table 28. It shows that the average web traffic increased by 342%. This is due to the increase of web traffic in the number of on-line databases (600%) followed by photographs (500%), video clips (500%), publications (483%), direct visitors (304%) and visitors (242%).

Table 28. Impact of improvement in CIBA website

Parameters*	2009-10**	2010-11***	Increase (%)
Total no of visitors per month	7,989	27,316	242
New visitors	5,326	14,889	180
Visits from countries abroad	33	87	164
Total pages visited	1.87	3.38	81
Average no of pages visited	1.67	3.38	102
Direct visits	1,936	7813	304
Number of online databases	0	6	600
Photographs	50	344	588
Video clips	0	5	500
Publications	120	700	483
All parameters' average			324

* Unit of parameters in Number ** March 15th 2009 to March 16th 2010; *** March 15th 2010 to March 16th 2011

This Project was started on 1st June 2008 and was completed on 31st March 2011 The budget released was ₹ 25.72 lakhs and ₹ 27.48 lakhs was utilized.

Project Title (DBT)	**Diversification of livelihoods among women SHGs through coastal aquaculture technologies**

Factors influencing adoption of brackishwater aquaculture technologies

In continuation of the work conducted during the last two years, a survey was conducted with 200 women beneficiaries to identify the factors which are influencing the adoption of brackishwater aquaculture technologies by the WSHGs in Tiruvallur and Kancheepuram districts.

With regard to crab fattening, 90% (Tiruvallur district) and 94% (Kancheepuram district) of the beneficiaries cited availability of brackishwater source as a primary reason for taking to crab fattening. With regard to feed preparation, majority (98%) of the beneficiaries of Tiruvallur district stated that availability of enough space for drying the feed materials was their primary concern. The most important factor that influenced the decision of the beneficiaries to adopt value-added fish products development technology were: the willingness of the WSHG members to cooperate with one another, followed by availability of space, raw materials and market linkages.

SWOT Analysis

The socio-economic data of women beneficiaries were analyzed by using SWOT analyses and results are presented below. Regarding strength**,** 90% of the respondents opined that their self confidence levels had gone up with the implementation of the project. The project interventions enabled proper resource availability (96%), enhanced community support (85%), and activated group participation (82%) among the beneficiaries. Among the weaknesses faced by the beneficiaries, factors such as lack of financial support for investment (96%), non-cooperation among the group members (85%), expectation of immediate profit (78%), were given the highest scores by the beneficiaries. Opportunities identified and their respective scores given by the beneficiaries were: availability of infrastructure (94%), support from research institution (89%), knowledge gained on alternative livelihoods (83%) and loan from financial institutions (76%). Among the actual threats faced by the beneficiaries, factors such as non-availability of inputs in time (89%), seasonal problems (84%), bank loan repayment (77%) and poaching problems (70%) scored high among the beneficiaries of both districts.

Socio-economic and Gender analysis

The socio-economic and gender analysis (SEAGA) programme of FAO was used to study the available resources in the village, structure of the village and the linkages among economic, environmental, social and institutional patterns that together constitute the developmental activities in the village, to analyze the livelihood opportunities and constraints for the development of villages, and to study the current situations in the selected villages and focus on planning for the future development of the community.

The salient points that emerged from the analysis were that: Men in the village concentrate on fishing, crab & shrimp farming, marketing of fish, agricultural management, net making, boat repairing etc. whereas women concentrate on fish sales both (fresh and dry fish), seaweed collection, wild shrimp collection, fish meal preparation, jellyfish processing and agriculture. In 2004, the tsunami has affected their properties and fishing boats, nets, etc. and therefore, there was a need for an alternative livelihood for the coastal populations. The brackishwater aquaculture technologies transferred to the coastal population, who were suffering in the post tsunami period, seemed to be a blessing for their living. Women were supported by men in the village for following activities like construction of crab pens, harvesting of crabs, fish transportation, watch yards, purchase of water crabs and sale of fattened crabs. Women made decisions regarding the generation and spending of money. During the summer season, women were involved in fish drying and during the rainy season, they enjoyed a great deal of leisure time. Lack of sustainable livelihoods is the an important problem for women because of their low literacy level, lack of knowledge/ awareness, and less access to resources. Diversification of livelihoods through the adoption of brackishwater aquaculture technologies with linkages to government institutions, NGOs, banks, research organizations and local community could provide the solution for this problem.

Impact of the project

During the project period, linkages were established between the beneficiaries of the project with NGO's like Duraiswamy Generation Social Education Association (DGSEA), Integrated Fisher folk Development Project (IFDP), Annai Theresa Social Work Association (ATSWA), Tambaram Community Development Society (TCDS), Madras Social Service Society (MSSS), M.S.Swaminathan Research Foundation (MSSRF) and Aquaculture Foundation of India (AFI) in Tamil Nadu. Financial linkages were created between the beneficiaries of the project and the banks. Based on their savings in the bank, Kattur WSHGs received ₹ 60,000-3,00,000 loan. Four successful women trainers were identified to train women in SHG's crab fattening technology and value added fish food products. A 'Fish Food Outlet' was opened at Kattur village by 'Anichamalar' WSHG and the Marikkolunthu' WSHG received market orders for their fish food products from Norwegian fish food processing company through their NGO.

Project Title (NABARD)	**E-extension strategy for ensuring knowledge led rural growth**

The project was sanctioned by NABARD in November 2010. The Project Monitoring and Reviewing Committee was constituted and the meetings were conducted at Nagapattinam. Thalaignayar village in Nagapttinam district of Tamil Nadu was selected as the project site with aqua farmers as the target group. The license secured shrimp farmers were identified as sample population. The sampling design was purposive random sampling. Two well structured questionnaires were developed in consultation with subject matter specialists and officials of Department of Fisheries. They were questionnaires for need assessments of information with regard to Best Management Practices and questionnaire for studying the information need assessment with regard to mobile phones. The two questionnaires were pre-tested for their reliability and content validity with 15 representative samples of respondents from the two districts of Tamil Nadu i.e Thiruvallur and Kanchipuram.

KAKDWIP RESEARCH CENTRE

Project Title (Institute)	**Enhancement of brackishwater aquaculture production of shrimp and fishes through economically viable and sustainable approach**

Evaluation of different substrates for periphyton growth

To know the pertinent environment for the development of periphyton in *P. monodon* culture in various substrates, yard trials were conducted for a period of 45 days with 1.8g juvenile *P. monodon* using different substrates like untwisted rope, bamboo, glass slide, PVC pipe, nylon webbing and also in a non-substrate system. All the treatments were executed in triplicate and assigned randomly in 18 FRP (100 L) experimental outdoor tanks. All tanks were fertilized with semi decomposed cattle manure, urea and triple super phosphate (TSP) @ 3000, 100 and 100 kg/ha, respectively. After fertilization, the tanks were left for 10 days to allow plankton development in the water column and periphyton growth on substrates, and subsequently stocked. It was found that the growth rate of juveniles was better in the substrate system compared to control group. In untwisted rope and in bamboo substrate systems, a higher final body weight of 4.5 ± 0.4 g and 3.9 ± 0.7 g was achieved respectively and in control group, the body weight recorded was 3.1 ± 0.3 g.

With regard to water quality parameters among the treatments, no significant difference in pH, salinity, alkalinity, Nitrate-N and Phosphate-P were observed among the treatments. However, there was a significant difference in Total Ammonia-N ($P<0.05$) and Nitrite-N ($P<0.01$) among the groups.

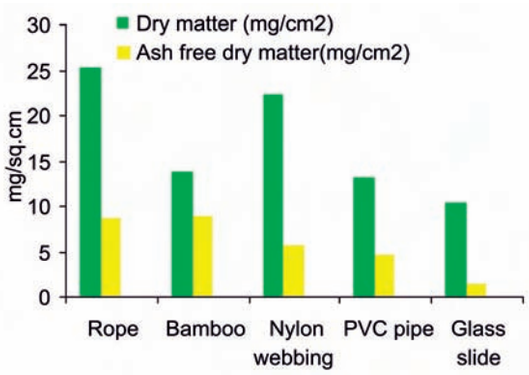


Fig. 45. The mean values for dry matter and ash free dry matter (mg/cm^2) in different substrates

Significantly higher Total Ammonia-N (134 ± 13.0) and lower Nitrite-N (11 ± 1.3) were noticed in control group compared to other substrate based systems.

Periphyton biomass in terms of dry matter and ash free dry matter for different substrate groups is given in Fig. 45. Highest dry matter of 25 ±8.7 mg/cm^2 was observed in untwisted rope followed by nylon webbing, (22.5±5.6 mg/cm^2). Untwisted rope and bamboo seems to be suitable substrate for shrimp growth and periphyton development. They provide a suitable substrate for animal grazing. Though nylon webbing showed good periphyton growth, shrimp growth was low compared to the bamboo based system. On visual inspection, it was observed that shrimps did not graze on this substrate efficiently.

Polyculture of finfish with tiger shrimp

Polyculture of brackishwater finfish and shrimp was conducted in three farmer ponds of 1.18 ha each at Uttar Chandanpiri, Namkhana. Ponds were stocked with grey mullet (4.5 g), pearlspot (4 g) and tiger shrimp (0.1 g) at 10,000, 1000 and 10,000 nos./ha respectively. Ponds were fertilized and limed at regular intervals and water exchange was carried out during high tides to maintain the pond environment. Commercial carp floating feed (₹ 30/kg) was used and applied in feeding zones encircled with nylon net keeping bottom open for movement of fish. Tiger shrimp was harvested after 150 days and it attained ABW of 42 g contributing to 50-55 kg/ha production. After 300 days, grey mullet and pearlspot attained ABW of 570 g and 100 g, respectively (Fig. 46). With the finfish species and shrimp combination tested a good production of 3 tons/ha and was much higher than earlier trials conducted in farmers ponds. The high count shrimp harvested in this system would also help gain a higher profit.

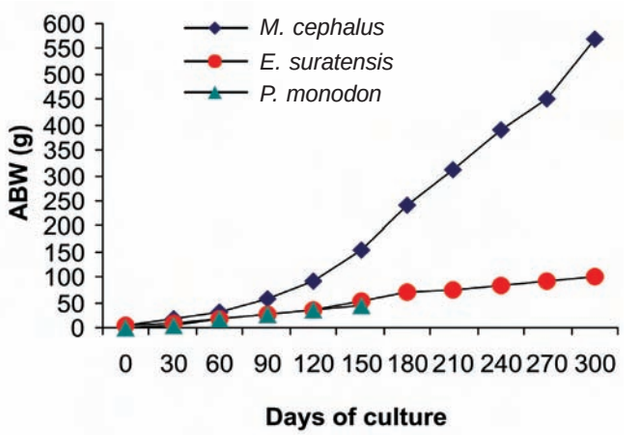


Fig. 46. Average body weight of fish and shrimp in polyculture pond

Evaluation of biofloc technology and associated microbes based intervention in sustainable shrimp and fish culture

Impact of Biofloc treatment on juveniles and adult of *P. monodon*

Forty five day yard trials were conducted with juveniles and adult of *P. monodon* in 1000 L tanks with 10 cm soil base. Water was filled from nearby brackishwater shrimp culture pond. Juveniles with average body weight of 1.48 g, and a total average biomass of 41.6 g/tank was stocked at the rate of 29 animals/tank. Adult shrimp with average body weight of 14.8 g was stocked at 9 animals/tank. The crumbled commercial feed at 10% of biomass for juveniles and pellet feed at 5% of biomass for adult was used during the experimental period. Molasses was used as supplementary carbon source to convert excreted and unused nitrogen into the microbial biomass at the fixed CN ratio of 10.

Treatment with supplementary source of molasses for biofloc development resulted in an additional body weight gain of 30% and 12.5% in juveniles and adult respectively (Fig. 47 a & b).

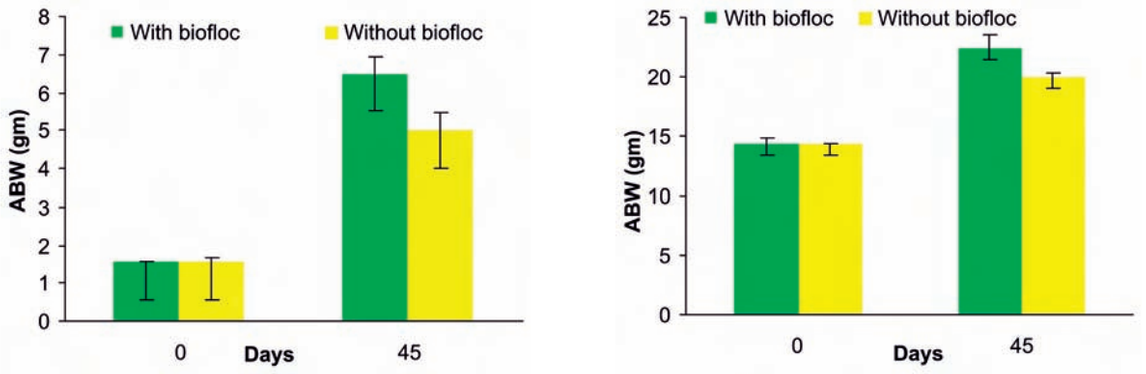
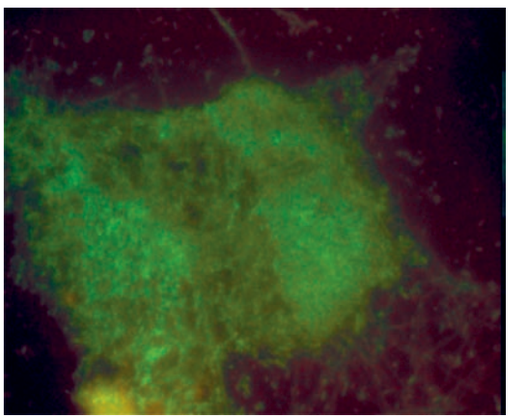


Fig. 47. Effect of biofloc treatment on the growth of *Penaeus monodon* a) juveniles b) adult

It was observed that addition of molasses had a significant impact on the recycling of toxic nitrogenous waste. Initially, 0.16 mg/L toxic ammonia-nitrogen was observed, which increased over the study period in all the experimental tanks. A maximum value of 0.73 mg/L was observed in the control adult group compared to other treatment groups. The addition of molasses was observed to have significant impact over available ammonia nitrogen in adult shrimps. However, reduction in ammonia level was not equally evident in juveniles probably due to low release of ammonia nitrogen or better feed utilization (Fig. 48). On the 45th day of experiment, ammonia reduction and simultaneous rise of nitrite and nitrate were observed in all the treatment groups (Fig. 49). This can be attributed to the effect of ammonia oxidizing bacteria.

The studies confirm that significant increase in weight can be achieved with biofloc not only with jueveniles but also with adults and that biofolc influences the build up of ammonia and nitrite in the system. Based on these yard experiments, pond based trials with *P. monodon* are under way.

Biofloc was examined by fluorescent microscopy using acridine orange stain. The green tangled mass is the biofloc around which few independent bacteria are also visible in the adjacent photo. Heterotrophic bacteria was the major constitutent of biofloc, apart from that, protozoa, algae and food particles were also associated.



Biofloc under fluorescent microscopy

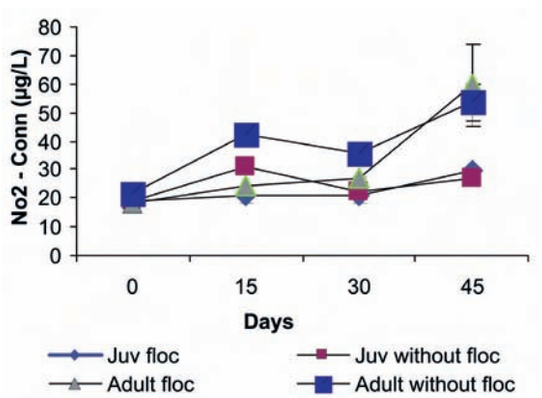


Fig. 48. Effect of biofloc treatment on ammonia concentration

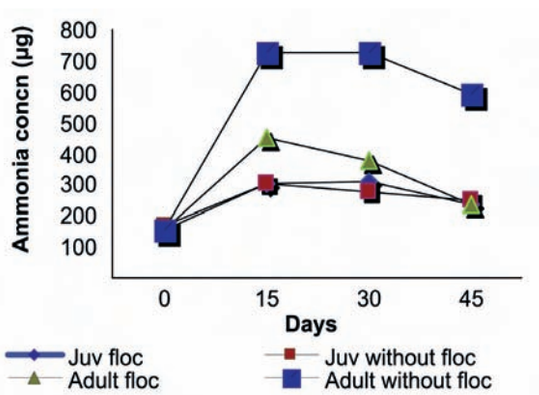


Fig. 49. Effect of biofloc treatment on nitrite concentration

Incidence of WSSV in traditional brackishwater aquaculture systems of West Bengal

In order to document the incidence of WSSV in bheris, the traditional brackishwater systems of West Bengal, monthly samples were collected from two bheris in Kakdwip and Namkhana from March to September 2010. The size of females sampled ranged from 15.14±1.73 to 38.53±3.65 g and that of males 11.89±2.78 to 39.36±4.84 g. Along with WSSV screening, hematological (Total hemocyte count (THC), granular hemocyte (GH) and nongranular hemocyte (NGH) count) and immunological (serum protein and phenoloxidase (PO) activity) parameters were recorded sex wise. THC varied between 13.88±0.45 and 20.91±0.19 x 10^6 while GH counts were between 2.85±0.25 and 3.88±0.25 x 10^6 and NGH counts between 10.96±0.35 and 17.03±0.36 x 10^6 (Fig. 50). The THC and NGH differed significantly ($P<0.01$) in both the sexes during the different months of calendar year, but no significant difference was observed between sexes. No significant difference was observed in total serum protein and serum phenoloxidase activity over the months and between sexes. PCR screening was carried out for WSD with the same collected samples (n =210). No shrimp was first step positive for WSSV and seven were PCR nested positive for WSD during September (Fig. 51) with no significant difference in hematological and immunological parameters in WSSV negative animals.

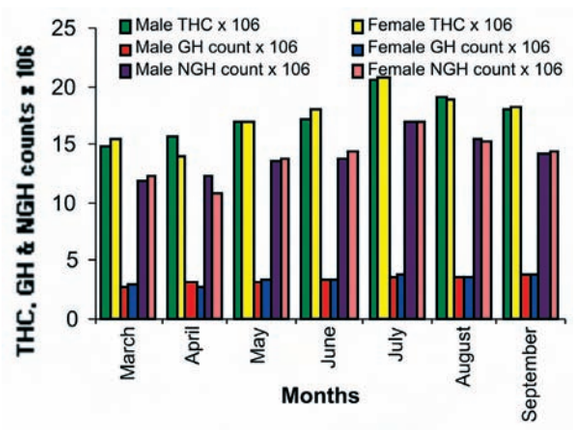


Fig. 50. Comparison of hematological parameters of wild *Penaeus monodon*

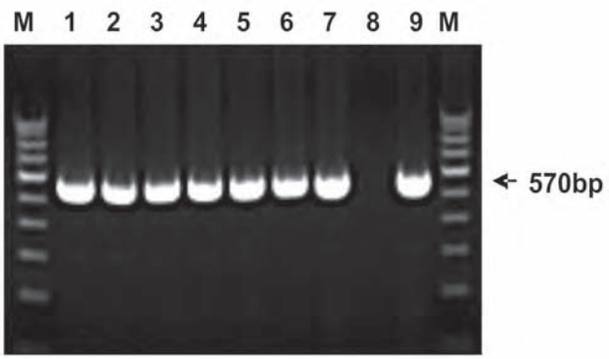


Fig. 51. Incidence of second step positive WSSV *Penaeus monodon* in bheris (Lane M-100bp Ladder; 1-7- nested positive; 8-nested negative control; 9-nested positive control)

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

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

A number of direct interventions with regard to land shaping and fish culture have been made in three identified villages. A total area of 7.638 ha has been developed under land shaping program with 36 numbers of freshwater ponds for water harvesting and fish culture. Inputs (paddy, brinjal, okra, ridge gourd, bitter gourd, snake gourd, cucumber, pumpkin and yam seed, organic fertilizer and neem pesticide) for summer and kharif crop have been distributed to the beneficiaries for cultivation in converted land. Under brackishwater aquaculture, 8.63 ha area has been developed with 48 nos. of brackishwater ponds. A total area of 7,266 ha has been developed with 33 nos. of trench and freshwater ponds for paddy-cum-fish cultivation. Nursery rearing of fish (carps) was successfully conducted in

Land shaping unit at Ganeshnagar

Nursery raising of freshwater fish

53 farmer's ponds covering 3.08 ha area with production of 1,40,000 nos. of fingerlings/ha. Farmers were able to earn a profit of ₹ 20,000-25,000 per bigha of pond.

As alternate crops for coastal degraded area, sunflower, green gram and sesame has been cultivated as potential alternate crops in 16 ha area belonging to 193 beneficiaries. Production of sesame to the tune of 1 Q/ bigha, sunflower, 2 Q/ bigha and green gram, 1.5 Q/ bigha have been achieved. Farmers sold sesame @ ₹ 1800/Q, sunflower @ ₹ 2500/Q and greem gram @ ₹ 4000/Q. Under crop nutrient management, zinc and boron was supplied to the beneficiaries for application in kharif paddy crop of 23.51 ha area. Data of the previous year paddy yield without micro-nutrient application was compared with data of this year after application of micro-nutrients. Paddy yield production increased from 2.25 t/ha to 2.70 t/ha in the kharif crop.

A number of alternate livelihoods were promoted in the three villages. Ten vermicomposting units have been constructed in 10 farmer's field. Vermicompost production of 1.5 quintal per unit per cycle has been recorded with selling price of ₹ 5.00 / kg of vermicompost. Mushroom cultivation was started with three women self-help groups (22 members) and 10 individual farmers to improve the livelihood and nutritional security of women in Sunderban. Each self-help group was provided a shed with 16 row rack system with a capacity of keeping 500 cylinders while every individual beneficiary was provided 2 almirahs of 50 cylinders capacity. The spawn for three varieties of mushroom *viz*. oyster, milky and paddy straw was provided at every 15 days interval and in the first month of cultivation,

Sunflower cultivation as alternate crop

Vermicompost unit

85 kg mushroom production was recorded. Nine units of bee boxes (each unit comprised of two bee boxes) have been distributed to 14 beneficiaries for honey production. Beneficiaries started harvesting of 250-750 g of honey per box per collection at 15 days interval and selling in the local market @ ₹ 160 per kg. Twelve units of goat (each unit consisting of 1 male and 2 females) of about 8 month age has been distributed to 12 resource poor farmers in NAIP villages. As Black Bengal is a prized goat of West Bengal with its tasty meat and multiple birth, farmers will practice breeding for its propagation and better livelihood. Low cost farm implements (thresher, paddy weeder, conoweeder, Knapsack sprayer and drum seeder) have been distributed in six villages for adoption by the beneficiaries in a co-operative manner.

Ten training programmes to upgrade the capacity of farmers was conducted in the area of land shaping, nursery rearing of fish, diversification of crops in degraded coastal lands, crop nutrient management, livestock health management, goat keeping, bee keeping, mushroom cultivation and vermicomposting. A total of 738 farmers have been trained at this centre.

5

Ongoing Research Projects

Crustacean Culture Division

Project Title 1	**Improvement of shrimp production and productivity through quality seed production and diversification into other shrimp species**
Project Leader	**Dr.P.Ravichandran, Head, CCD**
Project Location	**Chennai**

Sub-Project Title	Sub-Project Leader
Optimization of induced maturation of domesticated tiger shrimp *P. monodon*	Dr.C.P.Balasubramanian
Environmental manipulation for improved maturation under captivity	Dr.P.Nila Rekha
Microbial monitoring in shrimp hatchery and development of probiotic based seed production techniques	Dr.A.Panigrahi
Culture of *Litopenaeus vannamei*	Dr.P.Ravichandran
To study the pattern of horizontal transmission of WSSV in shrimp farms	Dr.C.Gopal
Culture of polychaetes	Dr.C.Gopal
District level planning for brackishwater aquaculture	Dr.M.Jayanthi
Domestication of tiger shrimp	Dr.G.Gopikrishna

Project Title 2	**Development of packages for nursery and grow-out culture of mudcrabs (*Scylla* spp.)**
Project Leader	**Dr.C.P.Balasubramanian, Senior Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title	Sub-Project Leader
Optimisation of seed production of *Scylla* spp.	Dr.C.P.Balasubramanian
Refinement of nursery rearing of *Scylla* spp.	Dr.A.Panigrahi
Evaluation of potential of mudcrab nursery production and survey of mudcrab grow out practices in the country	Dr.A.Panigrahi

Project Title 3	**Development of techniques to quantify the impacts scenario between environment and aquaculture using remote sensing and GIS**
Project Leader	**Dr.M.Jayanthi, Senior Scientist**
Project Location	**Chennai**

Sub-Project Title	Sub-Project Leader
Impact of aquaculture on mangroves in West Bengal	Dr.M.Jayanthi
Impact of shrimp farming on coastal watershed	Dr. P.Nila Rekha
Development of methodologies for aquaculture development management using RS and GIS	Dr.M.Jayanthi

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

Sub-Project Title	Sub-Project Leader
To develop and demonstrate culture technologies for banana shrimp *Fenneropenaeus merguiensis / Penaeus monodon* and Asian seabass *Lates calcarifer*	Dr.S.M.Pillai
To evaluate *Penaeus monodon* farming practices in Gujarat and assess the potential for culture of brackishwater finfishes	Dr.K.Ponnusamy
To address the extension needs of brackishwater aqua farmers	Dr.V.S.Chandrasekaran
To understand the farming practices of *L.vannamei* and to generate the database	Dr.C.Gopal

Project Title 5	**Hydro geochemical impacts of shrimp farming on coastal watershed**
Project Location	**Chennai**
Funding Agency	**Ministry of Water Resources**
Principal Investigator	Dr.P.Nila Rekha, Senior Scientist
Co-Investigators	Dr.S.M.Pillai and Dr.M.Jayanthi

Finfish Culture Division

Project Title 6	**Development of technology for quality seed production of commercially important brackishwater fishes under control conditions**
Project Leader	**Dr.A.R.Thirunavukkarasu, Head, FCD**
Project Location	**Chennai & Kakdwip**

Sub-Project Title	Sub-Project Leader
Controlled breeding and quality seed production of Asian seabass *L. calcarifer*, grey mullet *Mugil cephalus* and milk fish *Chanos chanos*	Dr.A.R.Thirunavukkarasu
Technology improvement for breeding and seed production of pearlspot *Etroplus suratensis*	Dr.M.Natarajan
Development of breeding technology for ornamental fishes	Dr.M.Kailasam
Reproductive physiology of commercially important brackishwater finfishes	Dr.J.K.Sundaray

Project Title 7	**Refinement of fish culture technologies in brackishwater eco-system**
Project Leader	**Dr.M.Natarajan, Principal Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title	Sub-Project Leader
Cage culture of Asian seabass in brackishwater open system	Dr.A.R.Thirunavukkarasu
Standardisation of nursery rearing technology for grey mullet and demonstration of culture technologies for mullet and milkfish in farmer's ponds	Shri G.Biswas
Cage culture of pearlspot	Dr.M.Natarajan
Evaluation of aquatic species for cultivation in effluent treatment pond	Dr.Shiranee Pereira

Project Title 8	**An export oriented marine value chain for farmed seafood production using Cobia (*Rachycentron canadum*) through rural entrepreneurship**
Project Location	Chennai
Funding Agency	National Agricultural Innovation Project
Lead Centre	Tuticorin Fisheries College
Co-Principal Investigator	Dr.A.R.Thirunavukkarasu, Head, FCD
Co-Investigators	Dr.M.Kailasam and Dr.J.K.Sundaray

Project Title 9	**Demonstration of Asian seabass *Lates calcarifer* farming in the pond culture system**
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr.A.R.Thirunavukkarasu, Head, FCD
Co-Investigators	Dr.M.Kailasam, Dr.J.K Sundaray, Dr.Prem Kumar, Dr.S.A.Ali, Dr.K.Ambasankar and Dr.J.Syama Dayal

Project Title 10	**Development of viral vaccine against nodavirus and infectious pancreatic necrosis virus**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.A.R.Thirunavukkarasu, Head, FCD
Co-Investigators	Dr.Prem Kumar

Aquatic Animal Health and Environment Division

Project Title 11	**Diseases of finfish and shellfish in brackishwater aquaculture: Diagnostics, prophylaxis and therapeutics**
Project Leader	**Dr.T.C.Santiago, Principal Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title	Sub-Project Leader
Screening emerging viral diseases in finfish (*Etroplus suratensis* and *Mugil cephalus*) and shellfish (*L. vannamei* and mudcrab) and development of suitable diagnostic techniques	Dr.S.V.Alavandi
Epizootiology, diagnostics and prophylactics of viral diseases of cultivable finfish	Dr.K.P.Jithendran
Characterisation of finfish and shellfish viruses and virus virulence studies	Dr.M.Poornima
Prophylactics and therapeutics of diseases in responsible shrimp aquaculture	Dr.N.Kalaimani
Studies on plant based immunomodulators in shrimp for enhanced disease resistance	Dr.P.K.Patil
Search for WSSV interacting proteins in *Penaeus monodon* by yeast two-hybrid to study the virulence mechanism and treatment strategy	Dr.S.K.Otta

Project Title 12	**Technology development for environmental management in brackishwater aquaculture**
Project Leader	**Dr.M.Muralidhar, Senior Scientist**
Project Location	**Chennai**

Sub-Project Title	Sub-Project Leader
Bioremediation of chemical and microbial contaminants in coastal aquaculture	Dr.K.K.Krishnani
Impact of climate change on aquaculture and the potential role of aquaculture in mitigating climate change through carbon sequestration	Dr.M.Muralidhar
Nutrient pathway determination and nano-remediation in aquaculture	Dr.R.Saraswathi

Project Title 13	**Application of micro-organisms in agriculture and allied sectors – Agrowaste management, bioremediation and microbes in post harvest processing Sub-project: Bioremediation of effluents from shrimp farms**
Project Location	Chennai
Funding Agency	National Bureau of Agriculturally Important Microorganisms
Principal Investigator	Dr.S.V. Alavandi, Principal Scientist
Co-Investigators	Dr.T.C.Santiago and Dr.N.Kalaimani

Project Title 14	**Application of micro-organisms in agriculture and allied sectors – Microbial diversity and identification**
Project Location	Chennai
Funding Agency	National Bureau of Agriculturally Important Microorganisms
Principal Investigator	Dr.T.C.Santiago, Principal Scientist
Co-Investigators	Dr.N.Kalaimani and Dr.S.V.Alavandi

Project Title 15	**Indo-Norwegian platform on fish and shellfish vaccine development**
Sub-project	Development of bacterial vaccine (*Vibrio anguillarum*) for seabass
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.T.C.Santiago, Principal Scientist
Co-Investigators	Dr.N.Kalaimani and Dr.M.Poornima

Project Title 16	**Development of antiviral therapy using double stranded RNA (dsRNA) against shrimp viruses, WSSV, MBV and HPV**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.T.C.Santiago, Principal Scientist
Co-Investigators	Dr.N.Kalaimani and Dr.M.Poornima

Project Title 17	**Characterization and development of diagnostics for viral nervous necrosis in seabass *(Lates calcarifer)* and mullet *(Mugil cephalus)***
Project Location	Chennai
Funding Agency	Department of Biotechnology
Lead Centre	C.Abdul Hakeem College, Melvisharam
Principal Investigator	Dr.K.P.Jithendran, Principal Scientist
Co-Investigators	Dr.M.Poornima and Dr.M.S.Shekhar

Project Title 18	**Development and evaluation of green water technology for aquaticbioremediation in coastal aquaculture**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.M.Kailasam, Senior Scientist
Collaborating Centre	CMFRI

Project Title 19	**Development of in vitro system from *Fenneropenaeus indicus* and freshwater crab *Paratelphusa hydrodomous* for WSSV replication, pathogenesis and quantification**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Lead Centre	C. Abdul Hakeem College, Melvisharam
Principal Investigator	Dr.M.Poornima, Senior Scientist

Project Title 20	**Horizontal transmission and infectivity of white spot syndrome virus in brackishwater aquaculture ecosystems**
Project location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.S.V.Alavandi, Principal Scientist

Project Title 21	**Strengthening adaptive capacities to the impacts of climate change in resource- poor small scale aquaculture and aquatic resources dependent sector in the South and South-East Asian regions Sub-project: Small and poor shrimp culture farmers in low-lying coastal lands**
Project Location	Chennai
Funding Agency	Network of Aquaculture Centres in Asia-Pacific
Lead Centre	NACA
Principal Investigator	Dr.M.Muralidhar, Senior Scientist
Co-Investigators	Dr.M.Kumaran and Dr.M.Jayanthi
Collaborating Centre	NaCSA

Project Title 22	**National Initiatives on Climate Resilient Agriculture (NICRA) – Impact of climate change on aquaculture and mitigation options for minimizing green house gases from aquaculture sector**
Project Location	Chennai
Funding Agency	ICAR
Lead Centre	Central Research Institute for Dryland Agriculture
Principal Investigator	Dr.M.Muralidhar, Senior Scientist
Co-Investigators	Dr.M.Jayanthi, Dr.J.Syama Dayal, Dr.A.Panigrahi, Dr.M.Kumaran, Dr.R.Saraswathy, Shri J..Ashok Kumar, Dr.N.Lalitha and Dr.A.Nagavel
Collaborating Centre	CIFRI, CMFRI

Nutrition, Genetics and Biotechnology Division

Project Title 23	**Development of cost effective feeds for brackishwater fish and shrimp through specific dietary nutrient optimizations and alternative feed ingredients**
Project Leader	**Dr.S.A.Ali, Principal Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title	Sub-Project Leader
Optimization of nutrients and ingredients for development of cost effective feeds for pearlspot fry rearing	Dr.K.Ambasankar
Optimization of dietary nutrients for high saline shrimp culture	Dr.J.Syama Dayal
Optimization of dietary nutrients for low saline shrimp culture	Dr.T.K.Ghoshal
Optimization of nutrients and ingredients for development of cost effective feeds for grey mullet (*Mugil cephalus*) fry rearing	Dr.Debasis De

Project Title 24	**Outreach on nutrient profiling and evaluation of fish as a dietary component**
Lead Centre	**CIFRI, Barrackpore**
Project Leader	**Dr.J.Syama Dayal, Senior Scientist**
Project Location	**Chennai**

Sub-Project Title	Sub-Project Leader
Assessment and structured surveys on fish consumption profile and clinico-epidemiological studies on general health profiles of population *vis-a-vis* fish intake	Dr.J.Syama Dayal
Nutrient profiling of candidate species	Dr.J.Syama Dayal
Quality evaluation of Asian seabass	Dr.S.Kannappan

Project Title 25	**Outreach on fish feeds**
Lead Centre	**CIFA, Bhubaneswar**
Project Leader	**Dr.S.A.Ali, Principal Scientist**
Project Location	**Chennai and Kakdwip**

Sub-Project Title	Sub-Project Leader
Use of alternate protein ingredients as a replacer of fishmeal in seabass feed	Dr.J.Syama Dayal
Development of feed management strategies for grow-out culture of seabass	Dr.K.Ambasankar
Interventions to improve feed digestibility efficiency and growth performance in seabass	Dr.T.K.Ghoshal
Formulation and testing of farm-made feeds for the culture of seabass in West Bengal	Dr.Debasis De

Project Title 26	**Development of substrate specific fibrolytic enzymes for enhancing nutrient utilization in shrimp**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.K.Ambasankar, Senior Scientist
Co-Investigators	Dr.S.A.Ali and Dr.J.Syama Dayal

Project Title 27	**Enrichment of aquafeed with cellulolytic and mylolytic microbes isolated from digestive tract of brackishwater fishes**
Project Location	Kakdwip
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.Debasis De, Senior Scientist
Co-Investigators	Dr.R. Ananda Raja

Project Title 28	**Cost effective shrimp farming through adoption of indigenous innovative feed and better management practices by small scale farmers**
Project Location	Chennai
Funding Agency	National Bank for Agriculture and Rural Development (NABARD)
Principal Investigator	Dr.K.Ambasankar, Senior Scientist

Project Title 29	**Development of inhibitors for controlling quorum sensing luminescence causing *Vibrio harveyi* in shrimp larviculture system**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr..S.Kannappan, Senior Scientist
Co-Investigator	Dr.P.K.Patil

Project Title 30	**Exploring candidate genes for economically important traits in brackishwater organisms using biotechnological and bio-informatic tools**
Project Leader	**Dr.G.Gopikrishna, Principal Scientist**
Project Location	**Chennai**

Sub-Project Title	**Sub-Project Leader**
Association studies to unravel markers for growth traits	Dr.G.Gopikrishna
Larviculture, grow-out and harvest of tiger shrimp	Dr.S.Kannappan
Screening for reproduction associated genes in male *Penaeus monodon*	Dr.Sherly Tomy
Molecular studies on immune genes for disease resistance in *P. monodon*	Dr.M.S.Shekhar
Evaluating the potential for selection of economically important traits in rotifer *Brachionus plicatilis*	Dr.M.Kailasam

Project Title 31	**Outreach on fish genetic stocks**
Lead Centre	NBFGR, Lucknow
Project Leader	Dr.G.Gopikrishna, Principal Scientist
Co-PI	Dr.K.Vinaya Kumar
Project Location	Chennai

Project Title 32	**Improved disease resistance of rohu carp and tiger shrimp farmed in India : Developing and implementing advanced molecular methods and streamlining access to and use of genetic resources**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Project Co-ordinator	Dr.A.G.Ponniah, Director
Principal Investigator	Dr.G.Gopikrishna, Principal Scientist
Co-Investigators	Dr.P.Ravichandran, Dr.C.Gopal, Dr.M.S.Shekhar and Dr.K.Vinaya Kumar
Collaborating Centre	CIFA, NOFIMA (Norway)

Project Title 33	**Immunomodulation studies in freshwater prawn *Macrobrachium rosenbergii* using recombinant proteins of *Macrobrachium rosenbergii* nodavirus**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Lead Centre	CIFA, Bhubaneswar
Co-Investigator	Dr.M.S.Shekhar, Senior Scientist

Project Title 34	**Bioprospecting of genes and allele mining for abiotic stress factors**
Project Location	Chennai
Funding Agency	National Agricultural Innovation Project
Consortium	Dr. M.S.Shekhar, Senior Scientist
Co-Investigators	Dr.C.Gopal, Dr.Sherly Tomy and Dr.K.Vinaya Kumar

Social Sciences Division

Project Title 35	**Growth, marketing and extension synergies in brackishwater aquaculture**
Project Leader	**Dr.V.S.Chandrasekaran, Principal Scientist**
Project Location	**Chennai**

Sub-Project Title	Sub-Project Leader
A study on the structure, conduct and geographical direction of seafood exports from India	Dr.V.S.Chandrasekaran
Organisation and conduct of extension and outreach activities of the Institute	Dr.V.S.Chandrasekaran
Domestic marketing of aquaculture produce	Dr.T.Ravisankar
An assessment of gender participation and women entrepreneurs in aquaculture in Tamil Nadu and Orissa	Dr.B.Shanthi
Use of internet and mobile telephone technologies for rapid dissemination of aquaculture technology and farm specific information	Dr.D.Deboral Vimala
User perceptions of commercialized technologies in brackishwater aquaculture	Shri J. Ashok Kumar
Cluster farming and dynamics of its success in shrimp farming	Dr.M.Kumaran
Applications of information and communication technology for aquaculture development and planning	Smt P.Mahalakshmi

Project Title 36	**An assessment of literacy, income and health status of fishers in India**
Project Location	Chennai
Funding Agency	Department of Animal Husbandry, Dairying and Fisheries
Lead Centre	CMFRI
Principal Investigator	Dr.V.S.Chandrasekaran, Principal Scientist
Co-Investigators	Dr.K.Ponnusamy

Project Title 37	**Diversification of livelihoods among women SHGs through coastal aquaculture technologies**
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr.B.Shanthi, Senior Scientist
Co-Investigators	Dr.M.Krishnan, Dr.V.S.Chandrasekaran, Dr.C.P.Balasubramanian, Dr.S.Kannappan and Dr.K.Ambasankar

Project Title 38	**Prospective study on marketing and value chain improvement strategies for promoting Asian seabass *(Lates calcarifer)***
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr.T.Ravisankar, Senior Scientist

Project Title 39	**Agro-web digital dissemination system for Indian agricultural research**
Funding Agency	National Agricultural Innovation Project
Project Location	Chennai
Lead Centre	NBPGR, New Delhi
Principal Investigator	Dr.T.Ravisankar, Senior Scientist
Co-Investigators	Mrs.P.Mahalakshmi, Shri R.Elankovan, Shri M.Shenbagakumar, Shri S.Rajukumar and Shri S.Nagarajan

Project Title 40	**E-extension strategy for ensuring knowledge led rural growth**
Project Location	Chennai
Funding Agency	National Bank for Agriculture and Rural Development
Principal Investigator	Dr.D.Deboral Vimala, Senior Scientist
Co-Investigators	Dr.T.Ravisankar, Dr.M. Kumaran, Mrs.P.Mahalakshmi

Kakdwip Research Centre

Project Title 41	**Enhancement of brackishwater aquaculture production of shrimp and fishes through economically viable and sustainable approach**
Project Leader	**Dr.J.K. Sundaray, Principal Scientist & OIC, KRC**
Project Location	**Kakdwip**

Sub-Project Title	Sub-Project Leader
Improvement of shrimp farming by natural productivity	Ms.P.S.Shyne Anand
Polyfarming of finfish and shellfish	Shri.G.Biswas
Refinement of low cost feed for polyculture	Dr.Debasis De
Evaluation of biofloc technology and associated microbes based intervention in sustainable shrimp and fish culture	Dr.Sujeet Kumar
Epizootics of white spot disease outbreak in brackishwater aquaculture system of West Bengal	Dr.R.Ananda Raja
Documentation of evolving brackishwater aquaculture systems in West Bengal	Dr.T.K.Ghoshal

Project Title 42	**Strategies for sustainable management of degraded coastal land and water for enhancing livelihood security of farming communities**
Project Location	Kakdwip
Funding Agency	National Agricultural Innovation Project
Principal Investigator	Dr.T.K.Ghoshal, Senior Scientist
Co-Investigators	Dr.T.K.Ghoshal, Dr.Debasis De, Shri G.Biswas, Dr.R.Ananda Raja,Dr.Sujeet Kumar, Ms.P.S.Shyne Anand, Dr.A.Panigrahi and Dr.M.Kumaran

6

Technology Assessed and Transferred

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

At Headquarters

Sl. No.	Training Programme	Duration	No. of participants
1.	On farm training on brackishwater aquaculture	9-25May 2010	13
2.	Value added fish food products development (for Irrular tribal WSHG members of Kulathumedu village, Pulicat, Tiruvallur Dist.)	24 July 2010	25
3.	Aqua feed development (for Irrular tribal WSHG members of New Perugulathur, Kancheepuram Dist.) at Farm Model Fish Feed Unit' at Thonirevu, Pulicat, Tiruvallur Dist.	26 July 2010 & 3 September 2010	50
4.	Crab fattening in tide fed ponds (for Irrular tribal WSHG members of Kulathumedu village, Pulicat, Tiruvallur Dist.)	27 July - 20 August 2010	25
5.	Seabass *Lates calcarifer* seed production and culture.	23 August – 1 September 2010	
6.	Recent trends in brackishwater aquaculture (for Officers of NABARD with fisheries discipline)	18-21 October 2010	25
7.	Wastewater analysis (for the Technical staff of Coastal Aquaculture Authority)	25-29 November 2010	2
8.	Advanced technologies for the management of soil and water environment in brackishwater aquaculture	2-11 February 2011	12

At Kakdwip Research Centre

Sl. No.	Training Programme	Duration	No. of participants
1.	Nursery raising of fish	30 September 2010	42
2.	Crop nutrient management	7-8 October 2010	107
3.	Livestock health management	12-25 November 2010 & 2 March 2011	239
4.	Bee keeping	20 November 2010 & 6 January 2011	40
5.	Introduction of goat	6 January 2011	168
6.	Diversification of crops	10-11 January 2011 & 12 January 2011	168
7.	Mushroom cultivation	19 January 2011	26
8.	Vermicomposting	15 February 2011	22
9.	Land shaping	16 March 2011	34

Guidance was given to 42 final year M.Sc. / B.Tech / B.E. students from different colleges and universities for short term projects in different aspects of brackishwater aquaculture.

7

Training and Education

HUMAN RESOURCE DEVELOPMENT

International

Sl. No.	Name and designation	Training programme	Duration	Organisation
1	Dr. M.S. Shekhar Senior Scientist	Allele Mining - Identification of differentially expressed genes by microarray technology in zebra fish embryonic tissues exposed to chemical contaminants	3 May - 30 July 2010	Genome Institute of Singapore, Singapore
2	Dr.A.R.Thirunavukkarasu Head, FCD	Cobia breeding and culture	15 July-14 September 2010	Research Institute of Aquaculture, Vietnam
3	Dr.K.K.Krishnani Senior Scientist	Nano (bio-) remediation of chemical and microbial pollutants - Development of Nano (bio-) sensors	13 September -12 December 2010	Bioremediation Department of Chemical and Environmental Engineering, University of California, USA
4	Dr. Akshaya Panigrahi Senior Scientist	Biosecurity (Molecular diagnostics and immunology)	25 January-24 April 2011	Scottish Fish Immounology Research Centre, School of Biology Science, University of Scotland, UK
5	Dr.K.Ambasankar Senior Scientist	Nutraceuticals	21 March - 31 May 2011	CSIRO Marine and Atmospheric Research, Cleveland Laboratories, Cleveland, Queensland, Australia

National

Scientists

Sl. No.	Name and designation	Description of the training programme	Duration	Venue
1.	Dr.Debasis De Senior Scientist	Purchase management in Government	21-23 June 2010	Institute of Secretariat Training and Management, New Delhi
2.	Shri J.Ashok Kumar Scientist	SAS for trainers	28 June - 2 August 2010	National Academy of Agricultural Research Management, Hyderabad
3.	Dr.T.Ravisankar Senior Scientist	Advanced Ms-Excel	21 August 2010	Micro, Small & Medium Enterprises Development Institute, Govt. of India, Chennai
4.	Dr.M.Muralidhar, Dr.(Mrs)M.Jayanthi, Dr.M.Kumaran, Senior Scientists	SPSS software	7 July - 31 August 2010	Central Institute of Brackishwater Aquaculture, Chennai
5.	Ms.P.S.Shyne Anand Scientist	Communication and presentation skills for scientist sponsored by the Department of Science and Technology, New Delhi	23-28 August 2010	Xavier Institute of Management, Bhubaneswar
6.	Dr.V.S.Chandrasekaran Principal Scientist	Patent literacy campaign expert lecture series	27 August 2010	Centre for Bioresource Research and Development, Sathyabama University, Chennai
7.	Dr.J.Syama Dayal Senior Scientist	General management programme for middle level Scientist	27 September - 8 October 2010	Administrative Staff College of India, Hyderabad
8.	Smt.P.Mahalakshmi Scientist	One day Sensitization cum Training workshop for the Nodal Officers of PIMS-ICAR	25 October 2010	National Academy of Agricultural Research Management, Hyderabad

9.	Dr.C.P.Balasubramanian Senior Scientist	Recent trends in genomics, proteomics & drugs discovery	25-29 October 2010	Madras Veterinary College, Chennai
10.	Dr.P.K.Patil, Senior Scientist			
11.	Dr.Subhendu Kumar Otta, Senior Scientist			
12.	Dr.(Mrs)Sherly Tomy Senior Scientist			
13.	Shri J.Ashok Kumar Scientist (SS)			
14.	Dr.P.Ezhil Praveena Scientist			
15.	Dr.(Mrs)T.Bhuvaneswari Scientist			
16.	Dr.(Mrs)B.Shanthi Senior Scientist	Issues and challenges in sustainable agriculture and rural development in the Indian context	15-19 November 2010	M.S.Swaminathan Research Foundation, Chennai
17.	Dr.(Mrs)P.Nila Rekha Senior Scientist			
18.	Dr.Sujeet Kumar Scientist	Current trends in microbial biotechnology genomics diversity and gene mining	9-29 November 2010	Central Institute of Fisheries Technology, Cochin
19.	Dr.(Mrs) Krishna Sukumaran Scientist	Innovative and visible biotechnological techniques for ornamental aquaculture system management	10 November-3 December 2010	Tamil Nadu Veterinary and Animal Sciences University, Chennai
20.	Dr.(Mrs) P.Nila Rekha Senior Scientist	Introductory SWAT course	1-3 December 2010	Department of Civil Engineering, Indian Institute of Technology, Madras
21.	Dr.(Mrs) P.Nila Rekha Senior Scientist	Engineering and Management in Fisheries and Aquaculture	8-16 December 2010	Indian Institute of Technology, Kharagpur
22.	Shri G.Biswas Scientist	Data Analysis using SAS	19-25 January 2011	National Academy of Agricultural Research Management, Hyderabad

Technical staff

Sl. No.	Name and designation	Training programme	Duration	Venue
1	Shri N. Ramesh Technical Assistant (T-3)	Welding practices	10 March - 26 April 2010	Sri Venkateswara College of Engineering, Sriperambudur
2	Shri V.R. Senthilkumar Technical Officer (T-6)	Technical support for consortia based research in agriculture	17-23 September 2010	National Institute of Agricultural Extension Management (MANAGE), Hyderabad
3	Shri S.Rajamanickam Technical Officer (T-5)			
4	Shri D.Raja Babu Technical Officer (T-6)	Research station management	11-16 October 2010	International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh
5	Shri D.Raja Babu Technical Officer (T-6)	Employer's perspective on labour related laws	11-13 November 2010	National Academy of Agricultural Research Management, Hyderabad

Administrative staff

Sl. No.	Name and designation	Training programme	Duration	Venue
1	Shri A. Muthuraman Administrative officer	E-Governance * IT enabled services	28-30 June 2010	Anna Institute of Management, Chennai
2	Smt.E. Mary Desouza Upper Division Clerk	Decision support system using IT	26-30 July 2010	
3	Shri R.Kandamani Assistant Administrative Officer	Procurement of financial management under NAIP	21 February 2011	National Institute of Animal Nutrition & Physiology, Bangalore

A training programme was organized on 'ScienceDirect' to appraise end users regarding various features and functionalities to make information search quicker and smarter at CIBA on 30.11.2010.

8

Awards and Recognitions

- Dr.M.S.Shekhar, Senior Scientist was awarded the Yang Li memorial student abstract award (second place) for "Immunomodulatory effect of recombinant RNA-dependent –RNA polymerase (RdRp) protein of *Macrobrachium rosenbergii* nodavirus on giant freshwater prawn *Macrobrachium rosenbergii*" at Asian Pacific Aquaculture symposium held at Kochi, India held during 17-20 January 2011.

- Dr.T.Ravisankar, Senior Scientist received "ICAR Award for outstanding interdisciplinary team research in agriculture and allied sciences for the biennium 2007-2008" on 16 July 2010 for his outstanding research contribution in completion of research study on 'Exploring market opportunities for fisheries sector in India' under Social Sciences discipline.
- Dr. K. Ponnusamy, Senior Scientist received the Best Article Award for research paper entitled, "An assessment of sustainable livelihood parameters in coastal farming systems" published in Indian Journal of Dairy Science in the year 2009 during the XXXIX Dairy Industry Conference on 06.02.2011 at Kolkata.
- The following paper received best poster presentation award. "Aravindan, K., Santiago, T.C., Kalaimani, N., Alavandi, S.V., Poornima, M., Rajan, J.J.S. Identification of immune related genes from WSSV infected *Penaeus monodon* EST library". This paper was presented in National Conference on Emerging Trends in Biological Research organized by the Department of Zoology, University of Madras, Chennai, in February, 2011.
- Best paper award was adjudged for the following paper presented in Special session for students and research scholars during the Golden jubilee national seminar on "Diversification of Aquaculture through Locally Available Fish species (DALAF-2010) organised by Central Institute of Fisheries Education Kolkata Centre during 27-28 Aug. 2010. "Binesh, C.P, Jithendran, K.P. 2010. Persistent betanodavirus infection in fishes: Concerns in Indian coastal aquaculture".

RECOGNITION TO THE WOMEN CRAB FARMER

- The women crab farmer, Mrs.S.Jayabarathi of Kattur Village, Minjur, Tiruvallur District, Tamil Nadu nominated by CIBA was awarded the "Jamsetji Tata National Virtual Academy (NVA) Fellowship Award for the year 2010" by M.S.Swaminathan Research Foundation, Chennai for her expertise in the field of "Crab fattening in pens". Dr.M.Sakthivel, President, Aquaculture Foundation of India felicitated the recipient in a meeting organized by the women self help group in Kattur village panchayat on 1st December 2011.

Mrs. Jayabarathy felicitated by Dr. M. Sathivel, President, AFI at Kattur Village

Ph.D PROGRAMME

- Smt. K. Anuradha, Research scholar was awarded Ph.D. on 4 January 2011 degree for her thesis entitled "Studies on the effect of some important environmental parameters on the Asian seabass, *Lates calcarifer* (Bloch) fry" by the University of Madras under the guidance of Dr.A.R.Thirunavukkarasu, Head, Finfish Culture Division.

- Miss.M.Sanjuktha, Research Scholar was awarded Ph.D. degree on 3 November 2010 for her thesis entitled "Investigation on the RNA interference in white spot syndrome virus multiplication in *Penaeus monodon* (Fabricius, 1798)" by the University of Madras under the guidance of Dr.T.C.Santiago, Principal Scientist and Scientist-in-Charge, Aquatic Animal Health & Environment Division.

9

Linkages and Collaboration

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

National

ICAR Institutes

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

Other Institutes / SAUs / State Agriculture Depts.

- College of Fisheries, University of Agricultural Sciences, Mangalore
- College of Fisheries, Sri Venkateswara Veterinary University, Muthukuru
- Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi
- West Bengal University of Animal and Fisheries Sciences, Kolkata
- Navsari Agricultural University, Navsari, Gujarat
- Tamil Nadu Veterinary and Animal Sciences University, Chennai
- Dept. of Horticulture, Govt. of Tamil Nadu, Chennai.
- Dept. of Animal Husbandry, Govt. of Tamil Nadu, Chennai.
- Tamil Nadu Agricultural University, Coimbatore
- University of Madras, Chennai
- Center for Advanced Studies in Marine Biology, Annamalai University, Parangipettai

- National Fisheries Development Board, Hyderabad
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Coastal Aquaculture Authority, Chennai
- Ministry of Science and Technology, New Delhi
- Ministry of Water Resources, New Delhi
- Agricultural & Processed Food Products Export Development Authority, New Delhi
- Marine Products Export Development Authority, Cochin
- Department of Biotechnology, New Delhi
- National Institute of Ocean technology, Chennai

State Fisheries Departments/BFDAs

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

International

NOFIMA (Norwegian Institute of Food, Fisheries and Aquaculture Research) **Norway** A DBT-NRC project entitled "*Improved disease resistance of rohu carp and tiger shrimp farmed in India: Developing and implementing advanced molecular methods, and streamlining access to and use of genetic resources"* with Nofima, Norway.

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

10

List of Publications

- CIBA Annual Report (2009-2010)
- Training programme calendar (2011-2012)
- Bulletin
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- Technology Series
  - Biosecure shrimp farming technology. Panigrahi,A., A.G.Ponniah, P.Ravichandran, Shyne Anand, S.M.Pillai, C.Gopal and M.Muralidhar.No.5. pp.12.
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  - Handbook on Biosecurity measures for shrimp farming. No.47.
  - Socio-economic and gender analysis in aquaculture. No.48.
  - Refresher Training for officers of fisheries discipline, NABARD on recent trends in brackishwater aquaculture.No.49.
  - Application of HACCP principles in shrimp hatchery for disease risk mitigation.No.50.
  - Best practices in shrimp farming.No.51.
  - Training manual on Diversification of crops.No.52. (Bengali)
  - Training manual on Mushroom cultivation. No.53.(Bengali)
- Posters
  - Avenues for women in aquaculture sectors
  - Save and protect brackishwater sources
  - Impact of extreme climatic events on brackishwater aquaculture
- Video Films (Hindi, Tamil and English)
  - CIBA – Profile and Programmes (28 minutes). Chandrasekaran, V.S., S.M.Pillai, M.Krishnan and M.Kumaran.
  - Mud crab culture by women (20 minutes). Shanthi,B., C.P. Balasubramanian, V.S.Chandrasekaran, M. Krishnan, K. Ambasankar, S. Kannappan, K. Siranjothi and M.Sivasakthi.
  - Farm made aqua feed production by Women Self Help Groups (20 minutes). Shanthi,B., K. Ambasankar, V.S.Chandrasekaran, M. Krishnan, C.P. Balasubramanian, S. Kannappan, K. Siranjothi and M. Sivasakthi.

- Value added fish products development and marketing by Women Self Help Groups (20 minutes). Shanthi,B., S. Kannappan, V.S.Chandrasekaran, M. Krishnan, K. Ambasankar, C.P. Balasubramanian, K. Siranjothi and M.Sivasakthi.
- Diversification of livelihoods among coastal Women Self Help Groups in Tamil Nadu (20 minutes).Shanthi,B.,V.S.Chandrasekaran, M. Krishnan, K.Ambasankar, C.P. Balasubramanian, S. Kannappan, K. Siranjothi and M. Sivasakthi.

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GenBank Sequences Submitted

Sl. No.	Species	Year of submission	No. of gene sequences	Gene	Authors
1	*Pseudoulteromonas ruba*	2010	1	16SrDNA	Kailasam,M.
2	*Vibrio navarrensis*	2010	1	16SrDNA	Kailasam,M.
3	*Shewanella alga*	2010	1	16SrDNA	Kailasam,M.
4	*Pseudomonsa betli*	2010	1	16SrDNA	Kailasam,M.
5	*Vibrio campbelli*	2010	1	16SrDNA	Kailasam,M.
6	*Vibrio hepatarius*	2010	1	16SrDNA	Kailasam,M.
7	*Alcaligenes sp.*	2011	2	16SrRNA	Krishnani, K. and V. Kathiravan
8	*Alcaligenes faecalis*	2011	1	16SrRNA	Krishnani, K. and V. Kathiravan
9	*Pseudomonas sp.*	2011	4	16SrRNA	Krishnani, K.K and V.Kathiravan
10	*Enterococcus sp.*	2011	1	16SrRNA	Krishnani, K.K and V.Kathiravan
11	*Alcaligenes faecalis*	2011	2	16SrRNA	Krishnani,K.K., V.Kathiravan, T. Karthikaeswari and M.Kailasam
12	*Bacillus cereus*	2011	2	16SrRNA	Krishnani, K.K., V. Kathiravan, T. Karthikaeswari and M. Kailasam

13	*Bacillus sp.*	2011	1	16SrRNA	Krishnani, K.K., V.Kathiravan, T.Karthikaeswari and M.Kailasam
14	*Vibrio alginolyticus*	2011	2	16SrRNA	Patil,P.K., K.K.Krishnani and V. Kathiravan
15	*Vibrio sp.*	2011	1	16SrRNA	Patil,P.K., K.K.Krishnani and V. Kathiravan
16	*Vibrio harveyi*	2011	2	16SrRNA	Patil, P.K., K.K.Krishnani and V. Kathiravan
17	*Vibrio harveyi*	2011	2	Vibrio harveyi haemolysin gene	Krishnani, K.K.,V.Kathiravan and P.K.Patil

11

Consultancy and Commercialisation of Technology

Technologies commercialized

- pH & DO Kit - M/s Fisherman's, Near Jaistambh, Itarsi-461111, Madhya Pradesh
- Asian seabass seed production technology- Entrepreneur, Bhimavaram, Andhra Pradesh
- Extension of CIBA shrimp feed technology – M/s. Bismi Feeds, Mayiladuthurai, Tamil Nadu

Patents

- Patent filed for development of an assay and kit for molecular screening of betanodavirus by nested reverse transcription Polymerase Chain Reaction (nested rt-PCR)
- Amendment has been made in the existing patent application "Immobilizing matrix from bagasse for bacterial biomass and a process for preparation thereof" (patent application number:- 633/CHE/2006) by including additional claim on innovative way of using bagasse-biostimulator in shrimp pond to enhance the formation of indigenous biofilm for ammonia detoxification and increasing shrimp production

Copyright

Software for the estimation of carrying capacity of water body for shrimp farming version 1.0

12

RAC, IMC, IRC and IJSC Meetings

RESEARCH ADVISORY COMMITTEE (RAC)

The Research Advisory Committee of CIBA was constituted by ICAR (Council's order F.No.18-6/2007-ASR-I dated 24 November 2009) for a period of three years with effect from 25th July 2010:

Dr.S.D.Tripathi — Chairman
Former Director, CIFE
701, Ankita, SVP Nagar
Four Bungalows, Versova
Andheri (W)
Mumbai 400 053

Dr.Y.Basavaraju — Member
Dean (Fisheries)
College of Fisheries
Mangalore

Dr.S.Paul Raj — Member
Member Secretary
Coastal Aquaculture Authority
Chennai

Dr.T.Subramoniam — Member
Retd. Professor & Head
Dept. of Zoology
University of Madras
552, 3rd Cross Street
Laxmiperumal Nagar
Chennai 600 041

Dr.M.Chandramohan — Member
Retd. Deputy Director NIO
19/3 Ratnapuri Colony
J.N.Salai (100 ft. Road)
Koyambedu
Chennai 600 107

Shri M.S.Santhanakrishnan — Member
S.K.Marine Technologies
37, 1st Street
Anna colony, Besant Nagar
Chennai 600 090

Dr.Madan Mohan Assistant Director General (M.Fy.) Indian Council of Agricultural Research New Delhi	Member
Dr.A.G.Ponniah Director, CIBA, Chennai	Member
Dr.S.M.Pillai Principal Scientist & OIC, PME Unit CIBA, Chennai	Member Secretary

The 16th Meeting of the Research Advisory Committee was held on 8th February 2011 and the major recommendations are:

Finfish Culture

- Assessment is required regarding the quantity and quality of seabass broodstock. If felt essential, fresh broodstock may be added.
- Training programmes on seabass farming need to be organized in West Bengal and Orissa.
- Planned breeding be taken up in seabass paying special attention to maintenance of pedigree and related aspects.
- Importance of breeding grey mullets be given urgent attention.

Research Advisory Council meeting at Headquarters

- Feed for Pearlspot culture be given proper attention so that the growth is faster.
- *Kappaphycus* sp, *Gracilaria* sp and *Perna viridis* for use in ETPs be strengthened.
- *Polynemus indicus* and *Liza parsia* may be included in the research component at Kakdwip.

Crustacean Culture

- Attention to be focused on crab breeding,rearing and culture.
- A Centre needs to be established in Gujarat as it is an enterprising State with great potential especially for brackishwater aquaculture.
- Efficient feed delivery system may be explored for 'Low cost-Low Input Organic Farming' and 'Modified Zero-water Exchange'.

Nutrition group

- Methionine, an amino acid found to improve growth in catfish, be used to reduce fishmeal in the diet of seabass.
- *Bhetki Aahaar*" successfully tested in the field trials, should be popularized.
- During 12th Plan, projects on neutraceuticals and nutrigenomics be initiated.

Genetics and Biotechnology Group

- A greater thrust needs to be given on research in basic sciences especially in the areas related to biotechnology and molecular biology.
- Patents/commercial products to be developed from the immunomodulation studies in freshwater prawn.

Health Group

- Development of bacterial (*Vibrio anguillarum*) vaccine for seabass should be given priority
- The diagnostic kit developed for screening clinical and sub-clinical infections in fish may be tested, patented and released for commercialization.
- Practical approaches should be developed to totally eliminate antibiotics use in disease control.
- Work on plant based immune-modulators, WSSV interacting proteins and antiviral therapy development should be further intensified.

Environment Group

- Studies on 'Impact of Climate Change on Brackishwater Aquaculture' have quantified only physical losses. The extent of monetary losses also needs to be estimated and brought to the notice of the District authorities.
- Development of Greenwater Technology for biotic remediation in coastal aquaculture using mullets, milkfish or tilapia in pens in shrimp ponds without water exchange needs to be further worked on to develop a package.
- Use of nanosensors for water quality needs more clarity on field utility and the global status on this area may be reviewed before attempting to develop nanosensors.

Social Sciences

- Time series models showing trends in export (both quantity and value) have been developed and forecasts made up to March 2014. However, the model must be tested and the values verified with the actual figures in 2011 to 2013 to consider the reliability of the model before providing it to the government and traders.
- The successful model developed for women SHGs from Tiruvallur and Kancheepuram in Tamil Nadu in crab fattening and fish feed production as a measure for livelihood should be further expanded to cover other centers.

General

- When the proposed KVK is established, the feasibility of setting up a Onestop Aqua Shop (OAS) by a private entrepreneur/NGO should be explored and supported technically by CIBA so that it serves as an extension outlet of the Institute besides being a hub for providing physical inputs and guidance for preparing proposals for bank loans and arranging it.

INSTITUTE RESEARCH COUNCIL

The Institute Research Council (IRC) of CIBA has the following composition.

Dr. A.G. Ponniah Director, CIBA, Chennai	Chairman
Assistant Director General (M.Fy.) ICAR, New Delhi	Member

Dr.A.R.Thirunavukkarasu Head, Finfish Culture Division	Member
Dr.P.Ravichandran Head, Crustacean Culture Division	Member
Dr.T.C.Santiago, Principal Scientist & SIC, Aquatic Animal Health and Environment Division	Member
Dr.S.A.Ali, Principal Scientist & SIC, Nutrition, Genetics and Biotechnology Division	Member
Dr.G.Gopikrishna, Principal Scientist & SIC, Genetics and Biotechnology Group	Member
Dr.V.S.Chandrasekaran, Principal Scientist & SIC, Social Sciences Division	Member
Dr.M.Muralidhar, Senior Scientist & SIC, Environmental Group	Member
Principal Investigators of all the projects	Member
Dr.S.M.Pillai, Principal Scientist & OIC, PME Cell	Member Secretary

The half yearly IRC Meeting held on 14th December 2010 to review the progress of research work. The 24th Annual IRC meeting was held during 21-22 March 2011. The salient recommendations are:

Finfish Culture

- For both seabass and mullet, the success achieved may be benchmarked in comparison to that obtained from other countries.
- In seabass culture, the modifications made over the earlier trial and the achievements under the NFDB project to be highlighted.
- The breeding achieved in scat to be refined so as to develop a package.
- Since a series of trials on the nursery rearing of seabass in cement tanks have been completed with encouraging survival rates, this information needs to be publicised.

IRC Meeting at Muttukadu Experimental Station

- The seed production trials of pearlspot have to be worked on system based models like earthen pond, cement tanks and artificial incubation so that the farmers could choose packages as per their facilities.
- Benchmarking of pearlspot system based production trials to be completed to carry out improvements if felt necessary.

- In cobia, since the problem of breeding synchronization is acutely felt, the option of cryopreservation may be explored.
- The discharge water treatment pond is to be used to undertake experiments on rearing fishes/ mussel/seaweed or as a broodstock facility rather than developing technologies since the system at Muttukadu cannot be recommended for replication in other places.
- Cage culture of seabass is to be intensified to generate more data for recommending as a technology package.

Crustacean Culture

- A bulletin on the Best Management Practices to be prepared.
- Experiments to be designed to comprehend the maturation of normal and WSSV infected tiger shrimp.
- More trials on the male reproductive performance of tiger shrimp to be taken up to explicitly understand the problems encountered in controlled conditions in the hatchery.
- The use of markers for exploring the maturation process in WSSV infected tiger shrimp need to be explored.
- Alternate measures for drawing seawater other than the present system has to be found out to address the issue of pH problem during maturation. The role of iron in variation in the pH of seawater is to be looked into. Long term data available on pH with both FCD and CCD may be compiled and evaluated to comprehend the temporal and spatial variability.
- For polychaete culture, species other than *M. graveyli*, like *Perineries nuntia* may be cultured for mass production trials and the Ministry of Agriculture may be approached for permission to import this species.
- There should be one round of discussion with the various stakeholders of Nagapattinam district and then the studies conducted on district level planning may be brought out as a bulletin.
- For the programme on maturation of tiger shrimp, efforts are to be directed to get large sized tiger shrimp from farmers' ponds.
- For taxonomic studies of the mud crab species, the accepted prototype is to be examined and if gene sequence is available for this prototype, then it may be compared with studies undertaken for addressing the taxonomic complexities. Based on the evidence provided, it was accepted to call the larger species of mudcrab as *Scylla serrata* and a paper on this may be brought out.
- The study already carried out on the taxonomy of mud crab to be published along with the information generated by NBFGR as a joint publication.

Kakdwip Research Centre

- Fishes like *Liza parsia* and *Polynemus indicus* to be included as additional species to develop culture practices considering their local preference as food species.
- The studies on biofloc to be taken to field and planned trials be conducted to understand its positive role in enhancing the pond nutrient status.
- In culture conditions, the contribution of periphyton on the growth of tiger shrimp beyond 9g size, is to be understood. Thereafter the quantity of periphyton required to raise the crop may be quantified.

- On-station trials of tilapia culture to be taken up, for on-farm trials in farmers' ponds. Permission from Ministry of Agriculture to be obtained.

Health Group

- Disease outbreaks in bheris and pond systems in West Bengal to be monitored continuously and the pattern of disease occurrence to be studied.
- The proposed new sub project on zoea syndrome as well as white gut syndrome should first document the economic loss and its implications to the sector before taking up disease investigations.
- The transmission mode of nodavirus in seabass and other fishes is to be taken up as an activity under in-house project.

IRC Meeting at Headquarters

Environment Group

- The studies carried out on bagasse and green water technology to be replicated as on-station trials in KRC.
- Under greenwater technology, the data on plankton and vibrio are to be examined to know the presence of pathogenic bacteria and a discussion with select group of microbiologists is needed.

Nutrition Group

- As far as replacement of fish meal in shrimp diet with plant ingredients is concerned, the level of inclusion and the economic gains derived at that level to be highlighted.
- The results of work on the nutrient profiling of freshwater and seawater seabass to be presented and work on this to be completed this year.

Genetics and Biotechnology Group

- The functional differentiation of the role of genes in salinity tolerance and stress in tiger shrimp to be understood.

Social Sciences

- The annual production data and area under culture and the changes taking place in each year in brackishwater aquaculture to be documented.
- Time series data in a hub where brackishwater aquaculture is concentrated may be collected and a suitable area may be identified and included as an activity.
- The periodic updating and quality of the institute website is to be monitored by a committee.
- The extension of the NFDB project on seabass market potential is to be discussed.

General

- For all projects, benchmarking to be carried out with respect to outputs so that incremental changes are adequately represented.
- Data base on the bacterial deposits is to be maintained and a group of scientists, viz. Dr.S.V.Alavandi, Dr.P.K.Patil, and Dr.D.De are entrusted with this work.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

The Institute Management Committee has the following composition.

Dr.A.G.Ponniah Director CIBA, Chennai	Chairman
The Director (Fisheries) Government of Tamil Nadu Chennai	Member
The Director (Fisheries) Government of Andhra Pradesh Hyderabad	Member
Dr.M.C.Nandeesha, Dean, Fisheries College and Research Institute Tamil Nadu Veterinary & Animal Science University Thoothukudi	Member
Shri Chidipothu Murali Flat No.302, A-Block East Court Apartments East Point Colony Opp. VUDA Park, Visakhapatnam	Member
Shri Ajitsinha Bajirao Patil 103-B, Mittal Tower Nariman Point Mumbai-400 021	Member
Dr.K.V.Rajendran, Principal Scientist Central Institute of Fisheries Education Mumbai	Member
Dr.G.Gopakumar, Principal Scientist Mandapam Regional Centre of CMFRI Mandapam Camp-623 520 Tamil Nadu	Member
Dr.E.Vivekanandan, Principal Scientist Madras Centre of CMFRI, Chennai	Member
Dr.T.V.Sankar, Senior Scientist Head, Division of QAM Central Institute of Fisheries Technology Cochin-682 029	Member
Dr.Madan Mohan Assistant Director General (M.Fy.) Indian Council of Agricultural Research, New Delhi	Member

Shri Balabrahmaiah Senior Finance & Accounts Officer Central Plantation Crops Research Institute Kasargod, Kerala	Member
Shri A.Muthuraman Administrative Officer CIBA, Chennai	Member Secretary
Shri V.R.Senthilkumar, Tech. Officer & OIC, Engg. Cell CIBA, Chennai	Co-opted Member
The Finance & Accounts Officer CIBA, Chennai	Co-opted Member
Shri R.G. Ramesh Assistant Administrative Officer CIBA, Chennai	Co-opted Member

During the year, 35th and 36th meetings of IMC of CIBA were conducted on 21st June and 6th December 2010 respectively. The major recommendations of the meetings are:

- Approval for new major works amounting ₹ 65 lakh during 2010-11
- Clearance for procurement of equipments worth ₹ 75.67 lakh and ₹ 16 lakh towards purchase of computers.

Institute Management Committee Meeting held on 6th December 2010

INSTITUTE JOINT STAFF COUNCIL (IJSC)

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

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

Administrative Officer	Secretary
Staff side	
Shri R.Subburaj, Technical Assistant (T-4)	Member
Shri R.Balakumaran, Technical Assistant (T-2)	Member
Shri B.Palanivelmurugan, LDC	Member
Shri C.Saravanan, SSS	Member
Shri M.Pichandi, SSS	Member
Shri A.Manoharan, UDC	Secretary

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

IJSC meeting held in Headquarters

GRIEVANCE COMMITTEE

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

Dr. A.G. Ponniah, Director, CIBA	Chairman
Official Side	
Dr.P.Ravichandran, Head, CCD	Member
Finance & Accounts Officer	Member
Administrative Officer	Member
Shri.R.G.Ramesh, AAO	Member Secretary
Elected Members	
Dr.A.R.T.Arasu, HOD-FCD	Scientific Member
Shri K.Paranthaman, T-2	Technical Member
Shri.K.Nandhini, JAO	Administrative Member
Shri. K.Nithyanandan, SSS	Staff Member

During the year, two meetings were held, one at Headquarters on 31st August, 2010 and the other at Kakdwip Research Centre of CIBA, Kadwip on 5th October, 2010.

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Participation in Conferences, Meetings, Workshops and Symposia

Participation by Dr.A.G.Ponniah, Director

Particulars	Organizers	Duration
Meeting for short listing the suppliers of disease free stock of SPF *L. vannamei*	Coastal Aquaculture Authority (CAA), Chennai	12.4.2010
National Consultation on Access and benefit sharing, Traditional knowledge and amendments to Biological Diversity Act, 2002 & Rules, 2004	Ministry of Environment and Forests & National Biodiversity Authority at MSSwaminathan Research Foundation (MSSRF), Chennai	23.4.2010
Stakeholders Meeting	National Fisheries Development Board (NFDB), Hyderabad	28.4.2010
National Level Meeting on strategies for implementing the Action Plan 2010-11	NFDB, Hyderabad at NASC, New Delhi	7.5.2010
Meeting of the Organizing Committee of National Fish Seed Congress to discuss Plan of action and other issues related to the Congress	NFDB, Hyderabad, at NASC, New Delhi	7.5.2010
XXII Meeting of the Regional Committee No.VIII and KVK Interaction on 15.5.2010 at Indian Veterinary Research Institute Regional Station, Bangalore	Indian Council of Agricultural Research (ICAR), New Delhi	13-15May 2010
Committee to review the existing ARS disciplines and eligibility qualifications for various scientific positions in ICAR	Agricultural Scientists Recruitment Board (ASRB), New Delhi First Meeting 2nd Meeting 3rd Meeting 4th Meeting 5th Meeting 6th Meeting	 17.5.2010 29.6.2010 11.8.2010 1.10.2010 26.11.2010 15.2.2011
Indian Aqua-Invest Congress and Expo-2010	CIFE in association with Indian Fisheries Association, Mumbai, Pillay Aquaculture Foundation & Zoological Society of India, Bodh Gaya	26-27 May 2010

69th Board Meeting of TANUVAS 71st Meeting	Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai	31.5.2010 8.10.2010
State Level Consultation on community based management of Agro biodiversity	MSSRF, Chennai	7.6.2010
27th Meeting of the Coastal Aquaculture Authority	CAA, Chennai 28th Meeting 29th Meeting 30th Meeting	11.6.2010 17.9.2010 11.11.2010 7.1.2011
National Level Seminar on New avenues for fisheries & aquaculture development in Gujarat	Dept of Fisheries, Govt of Gujarat	14.6.2010
First Meeting of the State Level Committee on Animal Genetic Resources	Commissioner of Animal Husbandry and Veterinary Sciences, Chennai	21.6.2010
Interface programme with ICAR Institutes based in Chennai and State Agricultural Universities of Tamil Nadu	Planning Commission New Delhi at Madras Veterinary College, Chennai	22.6.2010
Concluding Session of the Workshop on Recasting the net : Defining a gender agenda for sustaining life and livelihood in the fisheries.	Hosted by International Collective in support of Fish workers (ICSF) at Chennai	10.7.2010
Directors' Conference	ICAR, New Delhi	15-16 July 2010
Design Workshop for CGIAR Mega Program 1.3 Harnessing the development potential of aquatic systems for the poor and vulnerable	World Fish Centre, at Penang, Malaysia	19-21July 2010
Participated in the function in connection with the harvest of seabass cultured in open sea cage	Central Marine Fisheries Research Institute at Chemmancherry Kuppam, Kovalam, Kancheepuram District, Kochi	3.8.2010
International Conference on Eliminating hunger and poverty : Priorities in global agricultural research and development agenda in an era of climate change and rising food prices	MSSRF, Chennai	7-9August 2010
Review workshop with stakeholders to assess performance of commercial introduction of SPF *L. vannamei* culture in India	CAA, Chennai	27.8.2010

Meeting to discuss the Final report on the performance of Jump-Start Programme of Moana Technologies	NFDB, Hyderabad	1.9.2010
2nd Meeting of the DBT Task Force on Aquaculture and Marine Biotechnology	Department of Biotechnology (DBT), New Delhi held at Central Institute of Freshwater Aquaculture, Bhubaneswar	7.9.2010
Innovations 4 Industry Meet in Fisheries	ZTM-BDP Unit, South Zone, CIFT, Kochi	8.9.2010
Global Conference on Aquaculture 2010 and Governing Council Meeting (GCM-21)	Network of Aquaculture Centres in Asia-Pacific, Thailand	22-26 September 2010
Visit to Hawaii, USA for an in-depth evaluation and appraisal of the Moana's Nucleus Breeding Center	DAHD&F, Ministry of Agriculture, New Delhi	25-29October 2010
Inaugural Session of the ICAR Sponsored Winter School on Current trends in microbial biotechnology: genomics diversity and gene mining	Central Institute of Fisheries Technology, Kochi	9.11.2010
185th Board Meeting of the Tamil Nadu Fisheries Development Corporation Limited (TNFDC Ltd.) 186th Board Meeting	TNFDC Ltd, Chennai	2.12.2010 31.12.2010
National Seminar on Biodiversity conservation and management of aquatic resources	Fisheries College & Research Institute, TANUVAS, Tuticorin	9-10 December 2010
Meeting of the National Organizing Committee of Asia-Pacific Aquaculture 2011 (APA 2011)	College of Fisheries, Kerala Agricultural University, Kochi	18.12.2010
Meeting of the Committee members of Centre for Aquaculture Development (CARD)	Department of Fisheries, Government of Tamil Nadu, Chennai	5.1.2011
Meeting of the Task Force to finalize comments on Draft standards for Responsible Shrimp Aquaculture (SHAD)	CAA, Chennai	11.1.2011
14th Meeting of the Expert Committee on Access and Benefit Sharing Executive	National Biodiversity Authority, Chennai	12.1.2011
Meeting on the presentation of the four firms to evaluate their suitability for the supply of SPF *L. vannamei* broodstock	CAA, Chennai	13.1.2011
Asian-Pacific Aquaculture 2011 Conference	College of Fisheries, KAU, Kochi	17-20 January 2011
Meeting organized to discuss the issues raised in the Memorandum submitted by All India Shrimp Hatcheries Association	Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt of India, New Delhi	25.1.2011

Pre-launch workshop on the project National initiative on climate resilient agriculture	ICAR, New Delhi	1-2 February 2011
10th Agricultural Science Congress on the theme Soil, plant and animal health for enhanced and sustained agricultural productivity	National Academy of Agricultural Sciences, New Delhi held at National Bureau of Fish Genetic Resources, Lucknow	10-12 February 2011
Inter-disciplinary Dialogue on Reaping the demographic dividend in agriculture & rural development	MSSRF, Chennai	19.2.2011
National Conference on Emerging trends in biological research (NCEBR'11)	Department of Zoology, University of Madras, Chennai	21.2.2011
Vice-Chancellors Interface and Directors' Meeting	ICAR, New Delhi	23-24 February 2011
Indo-US Joint Workshop on Critical global challenge : Managing water resources for food security and sustainability	MSSRF and University of Nebraska	4.3.2011
12th Plan meeting	ICAR, New Delhi	5.3.2011
Division-wise Interaction meeting with the Chairs of Research Advisory Committee and Directors of ICAR Institutes	ICAR, New Delhi	17.3.2011

Scientists

Particulars	**Organizers**	**Duration**	**Participants**
Expert Consultation Meeting	Central Institute of Fisheries Education, Mumbai	13-14 April 2010	Dr.A.R.Thirunavukkarasu
Orientation Workshop on District level contingency plans	CRIDA, Hyderabad	17 April 2010	Dr.M.Muralidhar Dr.(Mrs.) M.Jayanthi
Knowledge management in the globalized era	IASRI, New Delhi	22-23 April 2010	Dr.V.S.Chandrasekaran
Symposium on Gender & Fisheries	Shanghai, China	21-25 April 2010	Dr.(Mrs.) B.Shanthi
Stakeholders meeting	NFDB, Hyderabad	28 April 2010	Dr.A.R.Thirunavukkarasu
National seminar on Technology and trade prospects in ornamental aquaculture	TANUVAS, Chennai	29-30 April 2010	Dr.A.R.Thirunavukkarasu Dr.J.K.Sundaray
National Consultation on Agro-biodiversity	Indian Council of Agricultural Research, New Delhi at the National Agricultural Science Centre (NASC), New Delhi	26-27May 2010	Dr.G.Gopikrishna

3rd Management Committee Meeting	Fishers Institute of Training and Technology, Govt. of Tamil Nadu	1 June 2010	Dr.A.R.Thirunavukkarasu
National seminar on "New avenues for fisheries & aquaculture development in Gujarat	Department of Fisheries, Govt. of Gujarat at Ahmedabad	14 June 2010	Dr.S,M.Pillai
SAS Orientation Training cum Workshop	NAARM, Hyderabad	16-17 June 2010	Mr.J.Ashok Kumar
6th meeting of the Research & Extension Council (REEC)	West Bengal University of Animal and Fishery Sciences, Kolkata	21 June 2010	Dr.T.K.Ghoshal
Five day workshop on soft computing using matlab	Vellore Institute of Technology, Vellore	28 June – 2 July 2010	Mrs.P.Mahalakshmi
Scientific Advisory Committee meeting	Dr. Perumal Krishi Vigyan Kendra, Krishnagiri, Dharmapuri Dist.	29 June 2010	Dr.V.S.Chandrasekaran
Biotechnology research in ICAR	Director General ICAR, New Delhi	26-27 July 2010	Dr.(Mrs.)Sherly Tomy Dr.Subhendu Kumar Otta
First preliminary meeting for interaction and framing of syllabi for the courses offered for Community College of Fisheries at Fish for all	MSSRF training Poompuhar	28 July 2010	Mrs.P.Mahalakshmi
E-content 2010 –A seminar on E-resources & discovery Solution	Hotel Le Meridian, Chennai	2 August 2010	Dr.V.S.Chandrasekaran
Seminar on E-content 2010	Informatics India Limited, Chennai	2 August 2010	Shri.S.Nagarajan
Workshop-cum-Training program organized by NBFGR under the Outreach activity project on Fish Genetic Stocks	Lucknow	3-4 August 2010	Dr.G.Gopikrishna Dr.K.Vinaya Kumar
Eliminating hunger and poverty priorities in global Agricultural research and development agenda in an era of climate change and rising food prices	MSSRF at Chennai Trade Centre, Chennai	7-9 August 2010	Dr.M.Krishnan Dr.(Mrs.)D.Deboral Vimala

Review Workshop on commercial culture of SPF *L. vannamei*	Coastal Aquaculture Authority, Chennai	27 August 2010	Dr.C.P.Balasubramanian Dr.M.Muralidhar Dr.J.Syama Dayal Dr.M.Kumaran
Golden Jubilee National Seminar on (DALAF-2010) Diversification of aquaculture through locally through locally available fish species	CIFE, Kolkata	27-28 August 2010	Dr.Debasis DeDr.J.K.Sundaray Dr.K.P.Jithendran
Conference on Aquatic microbiology status, challenges and opportunities 2010	Centre of Advanced Study in Marine Biology, Annamalai University at Parangipettai	2-4 September 2010	Dr.R.Ananda Raja
Asian aquaculture network exhibition & workshops	Asian Aquaculture Network at Vijayawada	3-5 September 2010	Dr.K.Ponnusamy Shri D.Raja Babu
Workshop on Introduction to Nanoscience, nano technology and applications	Centre for Nano Science & Technology, JNTUCEH, Hyderabad	3-4 September2010	Dr.(Mrs.)R.Saraswathy
Workshop on PME support for research and development projects in Agriculture	NAARM, Hyderabad	6-10 September 2010	Dr.N.Kalaimani Dr.J.Syama Dayal
National workshop on livelihood opportunities for small holders; Challenges and prospects	National Academy of Agricultural Research Management, Rajendranagar, Hyderabad	7-8 September 2010	Dr.M.Kailasam Dr.M.Krishnan
XXth Meeting of the ICAR Regional Committee-II and Interactive Meeting with KVKs at Port Blair, A & N Islands	Central Inland Fisheries Research Institute, Barrackpore	14-16 September 2010	Dr.T.K.Ghoshal
National conference on marine biodiversity-present status and prospects-2010	Department of Marine Science, Bharathidasan University, Tiruchirapalli	16-18 September 2010	Dr.A.R.Thirunavukkarasu Dr.M.Natarajan Dr.Prem Kumar Dr.J.K.Sundaray
Interaction meeting with the shrimp farmers of Gujarat to ascertain the present status of shrimp culture and diversification of brackishwater aquaculture in Gujarat state	NFDB at Surat, Gujarat	16 September 2010	Dr.M.Kumaran

Project Management Meeting	NIOT at Port Blair	20 September 2010	Dr.A.R.Thirunavukkarasu
Technical Committee Meeting	CARD, Dept. of Fisheries, Govt. of Tamil Nadu	21 September 2010 22 December 2010	Dr.A.R.Thirunavukkarasu
National Fish Festival (BENAQUA, 2010)	West Bengal State Fisheries Department, Kolkata	1-4 October 2010	Dr.T.Ravisankar Dr.T.K.Ghoshal
Seminar WAR ON WATER: Consultation meeting on NREGA - Convergence for (i) Efficient and equitable management of water resources and (ii) Augmenting saline water use: Integrated agro-aqua systems	MSSRF, Chennai	21-22 October 2010	Dr.V.S.Chandrasekaran
One day sensitization cum training workshop for Nodal officers of PIMS-ICAR	NAARM, Hyderabad	25 October 2010	Mrs.P.Mahalakshmi
9th National Symposium on Recent outlook on sustainable agriculture, livelihood security and ecology of coastal region	ISCAR, Goa	27-28October 2010	Dr.T.Ravisankar Dr.Akshaya Panigrahi
Final workshop of MPEDA/NaCSA-NACA project on Shrimp Cluster Certification	Royal Park Hotel in Kakinada, Andhra Pradesh	27-28 October 2010	Dr.M.Kumaran
International workshop on Climate change and Island vulnerability	National Institute of Science Communication and Information Resources, CSIR, New Delhi and School of Environmental Sciences and School of Social Sciences, Jawaharlal Nehru University, New Delhi held at Kadmat Island, Lakshadweep.	28-31 October 2010	Dr.S.M.Pillai Dr.M.Muralidhar

Aqua-India 2010 - Progress and profits in Indian aquaculture	Society of Aquaculture Professionals at Hotel Aloft, Chennai	29-30 October 2010	Dr.A.R.Thirunavukkarasu Dr.P.Ravichandran Dr.T.C.Santiago Dr.N.Kalaimani Dr.M.Natarajan Dr.G.Gopikrishna Dr.C.Gopal Dr.V.S.Chandrasekaran Dr.M.Muralidhar Dr.(Mrs.)M.Jayanthi Dr.(Mrs.)B.Shanthi Dr.M.Kailasam Dr.(Mrs.)D.Deboral Vimala Dr.S.Kannappan Dr.K.Ponnusamy Dr.J.K.Sundaray Dr.(Mrs.)P.Nila Rekha Dr.K.Ambasankar Dr.J.Syama Dayal Dr.M.Kumaran Dr.(Mrs.)M.Poornima Dr.(Mrs.)R.Saraswathy Dr.(Mrs.)Krishna Sukumaran Shri V.R.Senthilkumar Shri S.Rajamanickam Shri R.Subburaj Dr.Prem Kumar
IIT Task Force Meeting	Secretariat, Chennai	2 & 26 November 2010	Dr.A.R.Thirunavukkarasu
Aqua climate project workshop	NACA, Bangkok, Thailand	1-3 November 2010	Dr. M. Muralidhar, Dr.M.Kumaran
Interactive meet on Information and Communication Technology	ICAR, New Delhi	3-4 November 2010	Dr.T.Ravisankar Mrs.P.Mahalakshmi
International consultation on DNA Barcoding	National Bureaus at and ICAR at National Agricultural Science Complex, Pusa, New Delhi	6-7 November 2010	Dr.G.Gopikrishna
Challenges and way forward for agricultural products exports	Tamil Nadu Technology Development and Promotion Centre, Confederation of Indian Industry, Chennai	10 November 2010	Dr.T.Ravisankar

18th AERA Annual Conference: Value chains of agricultural commodities and their role in food security and poverty alleviation	NAARM, Hyderabad 2010	18-20 November	Mrs.P.Mahalakshmi
1st Edition of the women leadership 2010 Rising over the challenges of the 21st century	Hotel Taj Coromandel, Chennai	25 November 2010	Dr.(Mrs.) B.Shanthi Dr.(Mrs.) D.Deboral Vimala Dr.(Mrs.) P.Nila Rekha Dr.(Mrs.) R.Saraswathy Dr.(Mrs.) Sherly Tomy Dr.(Mrs.) P.Ezhil Praveena Dr.(Mrs.) T.Bhuvaneswari
Workshop on Software package for Nutrient profile data compilation and clinico-epidemiological survey	CIFRI, Barrackpore	29-30 November 2010	Dr.J. Syama Dayal
SWAT Workshop on Hydrological modeling	Department of Civil Engineering, IIT, Chennai	1-3 December 2010	Shri Ashok Kumar Jangam Dr.M.Muralidhar Dr.(Mrs.)P.Nila Rekha
National seminar on Extension management reforms initiatives and impact	Tamil Nadu, Agricultural University	11-12 December 2010	Dr.K.Ponnusamy
Review Meeting	NFDB, Hyderabad	16 December 2010	Dr.A.R.Thirunavukkarasu
Biodiversity conservation with special reference to fisheries and in management for food, livelihood and environmental security	21st All India Congress of Zoology	21-23 December 2010	Dr.V.S.Chandrasekaran
98th Indian Science Congress Association	Chennai	3-11 January 2011	Dr.(Mrs.)Krishna Sukumaran
Sensitization meeting on Exposure to women Scientists in career and funding opportunities	Department of science Technology, University of Madras, Chennai	5 January 2011	Dr.(Mrs.)M.Jayanthi Dr.(Mrs.)P.Nila Rekha Dr.(Mrs.)B.Shanthi
National workshop on Marine finfish farming with focus on Cobia to improve the livelihood of fishers	Fisheries College and Research Institute, Thoothukudi	11-12 January 2011	Dr.M.Natarajan

Drafting committee meeting of the workshop on the alternative livelihoods for fishing communities along the Chennai coast	Chennai by CDO NGO	14 January 2011	Dr.(Mrs.)B.Shanthi
Asian Pacific Aquaculture 2011	World Aquaculture Society, Department of Fisheries, Govt. of India, Kochi	17-20 January 2011	Dr.P.Ravichandran Dr.S.M.Pillai Dr.K.P.Jithendran Dr.C.Gopal Dr.V.S.Chandrasekaran Dr.M.Muralidhar Dr.(Mrs.)B.Shanthi Dr.C.P.Balasubramanian Dr.(Mrs)P.Nila Rekha Dr. K.Ambasankar Dr.J.Syama Dayal Dr.Akshaya Panigrahi Dr. Prasanna Kumar Patil Dr.R.Ananda Raja
Farmers Meet organised by the Veilankanni Aqua Farmers Society	Veilankanni, Nagapattinam, Tamil Nadu	25 January 2011	Dr.M.Kumaran
Application of bioinformatics in fisheries Domain	NBFGR, National Agricultural Bioinformatics grid in ICAR, Lucknow	29 January 2011	Shri Ashok Kumar Jangam
Pre-launch workshop of the ICAR project on National initiative on climate resilient agriculture	ICAR, New Delhi	1-2 February 2011	Dr.M.Muralidhar Dr.(Mrs.)M.Jayanthi Dr.M.Kumaran
One day symposium on 25 years of bioinformatics in India	Pondicherry University	2 February 2011	Shri J.Ashok Kumar
Workshop on Survival data analysis of rohu	CIFA, Bhubaneswar	7-11 February 2011	Dr.G.Gopikrishna Dr.K.Vinaya Kumar
Board of Research Studies Meeting	University of Madras, Chennai	9 February 2011	Dr.A.R.Thirunavukkarasu
The Agricultural Science Congress-AGRIVISION 2011	National Academy of Agricultural Sciences, NBFGR, Lucknow	10-12 February 2011	Shri D.Raja Babu
NAIP Workshop Status and innovations of farm to market linkages A-special reference to coastal agriculture	Chandkhali village of Taldi (Canning I Block)	15 February 2011	Dr.T.K.Ghoshal

Inter-disciplinary dialogue on Reaping the demographic dividend in agriculture and rural development	MSSRF, Chennai	19-21 February 2011	Dr.V.S.Chandrasekaran
Emerging trends in biological research	Department of Zoology, University of Madras, Guindy campus, Chennai	21-22 February 2011	Dr.M.S.Shekhar Dr.S.Sivagnanam
Isotope tracer for water resources management	Centre for Water Resources, Anna University, Chennai	25 February 2011	Dr. (Mrs.)P. Nila Rekha
Workshop on Development of technology commercialisation and transfer specialists	Consultancy Development Centre, Chennai	24-26 February 2011	Dr.N.Kalaimani
Sensitization meeting on exposure to women Scientists in career and funding opportunities	Madras University, Chennai	5 January 2011	Dr.(Mrs.)B.Shanthi
National Conference on Soft Computing	Dr. Sivanthi Aditanar College of Engineering, Tiruchendur	8-9 March, 2011	Smt. P. Mahalakshmi
RFD Nodal officers	Delhi	11-14 March 2011	Dr.T.Ravisankar
Second Annual Meeting of the Climate change project (Aqua climate)	NACA at Kalawewa, Sri Lanka	6-10 March 2011	Dr. M. Muralidhar Dr.M.Kumaran
International conference on water management –Watman 2011	Chennai	16-18 March 2011	Dr.(Mrs)P.Nila Rekha
Second meeting of expert group on Formulation of guidelines for *L. vannamei* farming in freshwater / inland farms	NFDB, Hyderabad	25 March 2011	Dr.M.Muralidhar
NAIP Workshop	CMFRI, Mandapam	28 March 2011	Dr.A.R.Thirunavukkarasu
Successful women entrepreneurs in brackishwater aquaculture sector-case studies in Tamil Nadu, India	9th Asian Fisheries and Aquaculture Forum, Shanghai, China	21-25 April 2011	Dr.(Mrs)B.Shanthi

Lectures delivered

Participants	Organizers	Duration	Particulars
Dr.A.G.Ponniah	Orientation Training Programme for the newly recruited Assistant Professors of Animal Sciences / Fisheries Science faculty. Delivered lecture on the topic 'Significance and responsibility of working in academic Institutions'	5.5.2010	Tamil Nadu Veterinary and Animal Sciences University, Chennai
Dr.V.S.Chandrasekaran	Talk delivered on Coastal and brackishwater aquaculture to the B.Tech (Biotechnology) and B.Sc (Biotechnology) students	15.7.2010	Department of Biotechnology, Sathyabama University, Chennai
Mrs. P. Mahalakshmi	Invited Speaker during the workshop on Soft computing using Matlab	28.6.2010 to 2.7.2010	VIT University
Dr. Debasis De	Delivered lecture to the group of students of professional development programme from CIFE, Kolkata centre on Entrepreneurship in fish feed development and commercialization	18.12.2010	KRC of CIBA, Kakdwip
Dr.Debasis De	Delivered lecture on Feed preparation and feed management for brackishwater shrimp farming to Aquafarmers in a NFDB sponsored training programme on Brackishwater Aquaculture	19.1.2011	Sunderban Development Board, Department of Sunderban Affairs, Govt. of West Bengal at Camp office, SHIS, Kakdwip

Dr.G.Gopikrishna	National Symposium-cum-Workshop on Marine microbial metagenomics for drug discovery. As Chief Guest, Inaugural lecture delivered on '*Microbial Metagenomics*'	2.2.2011	Department of Biotechnology, Hindustan College of Arts and Science, Chennai
Dr. M.S.Shekhar	Faculty Development Program on Challenges before emerging environmental biotechnology, presented a paper '*Application of Molecular Diagnostic Tools in Shrimp Culture'*	2.3.2011	School of Biosciences and Technology, Vellore Institute of Technology, Vellore
Mrs. P. Mahalakshmi	Chaired a session as an expert member in the National Conference on Soft Computing	9.3.2011	Department of Computer Science, Dr. Sivanthi Aditanar College of Engineering., Tirchendur

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Services in Committees

Dr. A.G. Ponniah, Director

- Member, Executive Committee and Governing Body, Rajiv Gandhi Centre for Aquaculture (MPEDA), Mayiladuthurai
- Member, National Committee to Oversee and Regulate Introduction of Exotic Aquatic Species, Min. of Agriculture, Govt. of India
- Member, Coastal Aquaculture Authority, Ministry of Agriculture, Govt. of India
- Member, General Body of Orissa Shrimp Seed Production Supply and Research Centre (OSSPARC), Orissa
- Member, ICAR Regional Committee No.VIII
- Member, Task Force Committee on Fisheries Development Mission – Tamil Nadu. State Fisheries Department
- Member, Scientific Advisory Committee for Dr.Perumal Krishi Vigyan Kendra
- Director - Board of Directors of Tamil Nadu Fisheries Development Corporation Limited, Chennai
- Expert Member – Tamil Nadu Fisheries Research Council
- Member, Task Force Committee on Aquaculture and Marine Biotechnology of Department of Biotechnology
- Member, Working group on Fisheries for the Eleventh Five Year Plan (2007-2012)
- Member, National Centre for Sustainable Aquaculture (NaCSA)
- Member, Committee for protection of fish germplasm through registration and documentation, constituted by ICAR
- Member, Sub-Committee for studying the potential and viability of culturing endemic and exotic species, constituted by DAHD&F,, Ministry of Agriculture
- Member, Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur
- Member, Committee to study various aquaculture standards for inclusion in National Programme for Organic Production (NPOP), constituted by National Steering Committee for Organic Products, MPEDA
- Member, Sub-Committee to formulate guidelines for farming of *L.vannamei* and norms for setting up of multiplication centres for production and supply of *L.vannamei*
- Member, Fisheries Institute of Technology and Training (FITT), Chennai
- Member, Sub-committee to finalize the guidelines for import of Ornamental fishes, constituted by Ministry of Agriculture, Department of Animal Husbandry, Dairying & Fisheries

- Member, Board of Management of Tamil Nadu Veterinary and Animal Sciences University, Chennai
- Member, Expert Committee to prepare Rules for Management and Conservation of Biodiversity Heritage sites, constituted by National Biodiversity Authority, Chennai
- Member, Expert Committee to evaluate the access, patent, transfer of research results and material transfer applications, constituted by National Biodiversity Authority, Chennai
- Member, Expert Committee on preparing guidelines on ameliorative measures for Biodiversity rich areas threatened by overuse, abuse or neglect, constituted by NBA, Chennai
- Member, Expert Committee on Access and Benefit sharing for processing the applications received by NBA, constituted by National Biodiversity Authority, Chennai
- Member, Selection Committee for selection of Deans and Directors of various faculties of TANUVAS (As ICAR representative)
- Member, Selection Committee constituted for the selection of an Awardee in the discipline of Biological Sciences, constituted by Tamil Nadu State Council for Science & Technology
- Member, State Level Committee on Animal Genetic Resources (SLCAnGR), constituted by Animal Husbandry & Veterinary Services, Chennai
- Committee to review ARS disciplines and eligibility qualifications for various scientific positions in ICAR, under the Chairmanship of Dr.R.S.Paroda, Former Director-General, ICAR.
- Task Force to finalize comments on Draft standards for Responsible Shrimp Aquaculture (SHAD), constituted by the Department of Animal Husbandry, Dairying and Fisheries, New Delhi.
- Finance Committee of TANUVAS
- Selection Committee constituted for the selection of an Awardees in the discipline of Biological Sciences, constituted by Tamil Nadu State Council for Science & Technology, Chennai.
- Academic Committee of MSSRF-IGNOU Community College in Fisheries, at Poompuhar.
- Scientific Advisory Committee of the National Seminar on 'Diversification of Aquaculture through locally available indigenous Fish Species' organized by CIFE, Kolkata Centre, during 27-28 August 2010, on the occasion of Golden Jubilee Year.
- Advisory Council of Indian Aqua-Invest Congress and Expo-2010 organized by Pillay Aquaculture Foundation, at Central Institute of Fisheries Education, Mumbai during 22-24 April 2010.
- Advisory Council of 8th Symposium on 'Diseases in Asian Aquaculture' (8th DAA) of the Fish Health Section (FHS), Asian Fishery Society in Mangalore, organized by Karnataka Veterinary, Animal and Fisheries Sciences University College of Fisheries, Mangalore, during 21-25 November 2011.
- National Organizing Committee of the Asian Pacific Aquaculture (APA 2011) Conference and Giant Prawn 2011 (GP 2011), held during 17-20 January 2011 at Kochi.
- National Advisory Committee of 21st All India Congress of Zoology, National Seminar on 'Biodiversity Conservation with Special Reference to Fisheries and its Management for Food, Livelihood and Environmental Security' and National Helminthological Congress, organized by Inland Fisheries Society of India, Barrackpore, Zoological Society of India, Bodh Gaya and

Central Inland Fisheries Research Institute, Barrackpore at CIFRI, Barrackpore, held during 21-23 December 2010.

- National Advisory Committee of the National Seminar on Conservation and Management of Biodiversity in 21st Century, organized by Government Motilal Vigyan Mahavidyalaya, Bhopal during 26-27 February 2011 in commemoration of the 'Golden Jubilee Year'.
- Expert Committee constituted by the Secretary to Govt., AHD&F Department, Chennai, for inspection of CARD Marine Finfish Hatchery of TNFDC Ltd. at Neelankarai and to evaluate the risks of CARD hatchery to the Aquatic Quarantine facility of RGCA and the RGCA establishment to CARD.
- Expert Group to work out possible arrangements and to formulate guidelines for *Litopenaeus vannamei* farming in freshwater aquaculture, constituted by the DAHD&F, Ministry of Agriculture, New Delhi.
- Expert Group to suggest both short-term and long-term measures for creating an appropriate and effective legal and institutional frame-work for management and control of aquatic animal diseases, under the chairmanship of Deputy Director General (Fy.), ICAR, constituted by DAHD&F, Ministry of Agriculture, New Delhi.

Dr.V.S.Chandrasekaran, Principal Scientist

- Member of the Scientific Advisory Committee meeting of Dr. Perumal Krishi Vigyan Kendra, Elumichangiri Village, Mallinayanpalli Post, Krishnagiri Taluk, Dharmapuri held on 6 July 2010.
- Member of the Scientific Advisory Committee Meeting of the Krishi Vigyan Kendra, Tiruvallur of the Tamil Nadu Agricultural University held on 11 February 2011.

Dr. T.Ravisankar, Senior Scientist

- Served as Resource person: ICAR winter school on Livestock business and market intelligence, Department of Animal Husbandry Economics, Madras Veterinary College, January 2011, Chennai

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Workshops, Seminars, Meetings etc. organised by the Institute

WORKSHOPS

Workshop on Database and statistical analysis

Database analysis workshop under Aqua Climate project was held at CIBA, Chennai during 18-20 August 2010. The workshop was attended by 20 persons representing the International project partners from NACA, Bangkok, Kasetsart University, Bangkok, BIOFORSK, Norway and national partners from CIBA and National Centre for Sustainable Aquaculture (NaCSA), Kakinada. The workshop discussed the entry of expansive farmer's survey data into database and statistical analysis of the data.

Workshop on Sustainable development of inland capture and culture fisheries in Tamil Nadu

A 2-day workshop on "Sustainable development of inland capture and culture fisheries in Tamil Nadu" was jointly organized by CIBA, Coastal Aquaculture Society and Fisheries Technocrats Forum at CIBA, Chennai during 29-30 September 2010. The Workshop was conducted with the aim to bring out ways and means to overcome the production problems in inland capture and culture fisheries, including the brackishwater sector, in the state of Tamil Nadu. About 200 participants including the aqua-farmers, scientists from the ICAR fisheries Institutes, officials from fisheries departments, KVKs, NGOs, academicians, students and retired fisheries technocrats participated in the workshop.

State level sensitization workshops on Introduction and farming of *Litopenaeus vannamei* in India

State level sensitization workshops for the Fishery Extension Officers of the Department of Fisheries, Govt. of Gujarat, Andhra Pradesh and Tamil Nadu were organised respectively on, 6th 20th and 28th July, 2010 on "Introduction and farming of *Litopenaeus vannamei* in India" at Baruch, Gujarat, Kakinada, Andhra Pradesh and CIBA Chennai. A 'Handbook on seed production and farming of

Litopenaeus vannamei' was prepared incorporating the risk analysis for introduction of *L. vannamei* in India, guidelines for import of brood stock, seed production and farming of SPF *L. vannamei*, reproductive biology, induced maturation and seed production of penaeid shrimp *L. vannamei* and *c*ulture of *L. vannamei* vis-à-vis *Penaeus monodon, r*esponsible use of drugs in aquaculture and extension strategy for the sustainable development of *Litopenaeus vannamei* farming in India.

Workshop on Cost effective shrimp farming through CIBA aquafeed and BMP adoption

A workshop on "Cost Effective Shrimp Farming through CIBA Aquafeed and BMP adoption" was by CIBA, Chennai on 23.02.2011 at Ramanathapuram. About 100 stakeholders in shrimp farming sector, *viz.*, the shrimp famers, input dealers, feed manufacturers, Tamil Nadu State Fisheries officials, bankers, exporters, representatives from NGOs, KVK and fisheries research organizations participated in the workshop. In the Technical Session of the workshop the various aspects of the Best Management Practices in shrimp farming, mainly involving feed management, health management, soil and water quality management, were discussed in detail among the CIBA scientists and the participants. The shrimp farmers who are associated with the demonstration trial of the shrimp culture using CIBA feed shared their experience and the success stories with the participants.

SEMINAR

National Seminar on Organic aquaculture with special reference to diversification in brackishwater

A National Seminar on 'Organic Aquaculture' with special reference to diversification in brackishwater' was organized by CIBA and Department of Fisheries, Government of West Bengal on the occasion of BENAQUA 2010 – National Fish Festival, on 4.10.2010 at Nalban Fisheries Food Park Complex, Salt Lake City, Kolkata. Dr S.N. Dwivedi, former Director of the CIFE (ICAR), in his presidential address of the inaugural session, stressed on the need and approach for organic aquafarming and its sustainability. A compendium on "Organic Aquaculture" compiled by the institue was released during the workshop.

STAKEHOLDER MEETINGS

Interaction meeting among Women Self Help Groups

An interaction meeting was organized by *Marikkolunthu* and *Annaparavai* Women Self Help Groups, (Value-added fish products development groups) at Kulathumedu village on 22.1.2011. These

groups received the market orders for their fish food products from a Norwegian fish food processing company through their NGO.

Brackishwater aquaculture farm innovators meet

A Brackishwater Aquaculture Farm Innovators Meet was organized at CIBA, Chennai on 1.3.2011 on the occasion of National Science Day. Eight farm innovators from the states of West Bengal, Andhra Pradesh, Tamil Nadu and Gujarat were invited to share their innovative practices in brackishwater aquaculture. An interactive session was held with all the farm innovators and it was discussed that the farm innovations need to be tested in other locations and the partnerships are to be built with such farm innovators to validate and disseminate the innovations and draw feedback from the field. The farm innovators expressed their willingness to provide the inputs or techniques that they have evolved themselves for scientific assessment and refinement.

Standing Row (from left to right): Dr.M.Kumaran, Senior Scientist, CIBA; Mr.R.Subramaniam, Meenakshi Aqua farm, MannarKudi, Tamil Nadu; Mr. Subhransu Jana, Uttar Chandan Piri, Namakhana, 24 Parganas (South), Wet Bengal-743357; Mr.M.K.Sethuraman, Thambikottai Muthupet, Tamil Nadu; Dr.Manoj M. Sharma, SURAT, Gujarat; Dr.V.S.Chandrasekaran, Principal Scientist & SIC, Social Sciences Divison, CIBA.

Sitting Row (from left to right): Mrs. Nasreen Susaiammal, Crab Farmer, Punnakayal, Thoothukudi District, Tamil Nadu; Dr.A.G. Ponniah, Director, CIBA; Mr.G.Appaji, Ganapavaram, Guntur District, Andhra Pradesh.

Interaction meet of Women Self Help Groups

Two crab pens were installed at Thonirevu village, Pulicat, Tiruvallur District under the CIBA - DBT Project 'Diversification of Livelihoods Among Women Self Help Groups through Coastal Aquaculture Technologies' with the initiatives for Sri Annai WSHGs for crab fattening. After the completion of the project, the crab pens were handed over to the village panchayat and to their respective liaising NGO named 'SIGA' (SIGA Community Service Guild). These pens were constructed using bamboo poles which got damaged during the recent cyclone Laila. 'SIGA' NGO approached these beneficiaries and renovated the crab pens replacing the bamboo poles with concrete poles. These renovated crab pens were inaugurated by Dr. A.G. Ponniah, Director, CIBA, on 22.1.2011. An interaction meeting was also organized among the Shri Annai WSHGs and issues relating

to crab fattening were discussed.

MEETINGS

Interaction meeting of Women SHGs with Dr. Meryl J. Williams

Dr. Meryl J. Williams, Ex- Director General, World fish Center, Malaysia, visited CIBA during 26th March 2011 – 28th March 2011. On 26th March 2011 a meeting was conducted jointly by CIBA and Society of Aquaculture Professionals at CIBA. Dr. Meryl J. Williams Lecture gave a lecture on the topic 'Gender Issues in Aquaculture'. Forty Aquaculture Professional participated in this meeting held at CIBA. In the afternoon Dr. Meryl visited the ornamental fish culture unit of women Irrular tribes at New Perungulatur, Kancheepuram District, Tamil Nadu and participated in an interaction meeting held with the tribal women self help groups beneficiaries.

On 28th March 2010 Dr. Meryl visited the tide fed crab fattening ponds of Irrular Tribal women Self Help.

Groups at Kulathumedu village, Pulicat lake, Tiruvallur District, Tamil Nadu. She visited the tide fed crab fattening ponds and interacted with the women crab farmers. This programme was organized by the Irrular Tribal women Self Help Groups of Kulathumedu village by liaising with ATSWA NGO Kulathumedu village.

In the afternoon she visited the crab fattening pens erected at Thonirevu village, Pulicat, lake, Tiruvallur District, Tamil Nadu and interacted with the women crab farmers at Thonirevu village. She also visited the farm model fish feed unit at Thonirevu village, Pulicat. She also interacted with the value added fish food products developing WSHGs beneficiaries of Kattur village at Thonirevu village, Pulicat, lake, Tiruvallur District, Tamil Nadu. All the programme at Thonirevu village, Pulicat, lake, Tiruvallur District, Tamil Nadu was organized by 'SIGA' NGO Thonirevu village, Tiruvallur District. On 28th March 2010, in the evening Dr. Meryl Williams visited CIBA and participated in an meeting and gave a guest lecture on the topic 'Gender issues in Aquaculture'. All the Scientist and Technical Officer of CIBA participated in this programme. On 28th March

2010, Dr. Meryl J Williams, participated in the 'Women Aqua farmer's Interaction Meet' held at Thonirevu village, Pulicat, lake, Tiruvallur District, Tamil Nadu. This programme was organized by the women crab farming WSHGs, fish feed developing WSHGs of Thonirevu village along with value added fish food products developing WSHGs beneficiaries of Kattur village. 'SIGA' NGO Thonirevu village, coordinated this meet at Thonirevu village. 75 Women members of the Women Self Help Groups participated in this meet held at Thonirevu village.

World Environment Day

The World Environment Day was celebrated in the CIBA headquarters premises on Dr.S.A.Ali, Scientist in-charge of the Nutrition, Genetics & Biotechnology Division of CIBA delivered a lecture on Biodiversity with special focus on aquaculture and rural livelihood generation. Dr.T.C.Santiago, Scientist in-charge of the Aquatic Animal Health and Environment Division delivered his lecture on "Biodiversity: Ecosystem management and Green economy".

CIBA - Science Forum

Science Forum of CIBA invited eminent persons from various disciplines to deliver lectures on different aspects of science and technology during the reporting period. Apart from the lectures, an intellectual debate was conducted internally with an external renowned scientist as the facilitator. Research scholars of CIBA who have registered their Ph.D. under Madras University presented their respective research topics in the forum.

Sl. No.	Date	Topic	Name	Address
1	12.04.10	Studies on the utilization of plant protein sources in the diet of black tiger shrimp *penaeus monodon* with emphasis on protein metabolism	Mr.V.Rajaram	Research Scholar, CIBA
2	11.05.10	Stem Cell and Liver	Dr. Rosy Vennila	Professor, Stanley Medical College & Hospital, Chennai
3	25.06.10	Debate on Basic or Applied. How to Strike the right balance in research?	Science Forum Members	CIBA
4	26.07.10	Journalistic Ways of Handling Climate Change	Dr. I. Arul Aram	Director, Department of Media Sciences Anna University, Chennai
5	25.08.10	Introduction to Manavalakalai Yoga	Mr.A.Vetrivelu	SKY System of world community service center, Chennai
6	30.08.10	Presentation by Research Scholars	Mr.K.Aravindan Mr.N.Chakravarthy and Mr.S.Raja	Research Scholar, CIBA

7	10.11.10	Neuro Degenerative Diseases in Human Being	Dr.M.Sabesan	Professor, Annamalai University Chennai
8	16.12.10	Risk Assessment of Agrochemicals	Dr.P.Balakrishna Murthy	Director, International Institute of Biotechnology and Toxicology, Kancheepuram, Tamil Nadu

Women's Day celebrations

'Women Day - 2011' was jointly organized by the women staff members of CIBA and CMFRI Institutes on 8th March 2011at CIBA. To mark this occasion various competitions like rangoli competition and cultural programme (like singing, oratory, debate, dumsherads and anthakshiri) was organized for the staff members of both the institutes. Fifty women participants from both the institutes participated in the above competitions and won various prizes. Prizes were distributed to the winners by Dr. A.G. Ponniah, Director, CIBA on the occassion.

FARMERS' MEET

Aquafarmers' interaction meet at Sirkazhi

An aquafarmers' interaction meet was organized by National Fisheries Development Board and CIBA on 16.4.2010 at Sirkazhi under the NFDB Project "Demonstration of Asian seabass *Lates calcarifer* farming in the pond culture system". A farm visit to Mahendrapalli, Sirkazhi was also arranged.

Aquafarmers' interaction meet at Saphale

An interaction meet was jointly organized by National Fisheries Development Board and CIBA on 5.8.2010 at Saphale, Mumbai under the NFDB Project "Demonstration of Asian seabass *Lates calcarifer* farming in pond culture system".

Interaction meet and demonstration at Adirampattinam

An interaction meet and demonstration of Banana Shrimp *Fenneropenaeus merguiensis* was organised by CIBA at Adirampattinam on 11.11.2010. The demonstration was conducted in two ponds covering a total water spread area of 1.8 ha. The shrimp seed of PL 25 stage (about 39 mg) were stocked at a density of 13 nos./m^2 (1.3 lakhs / ha). The shrimp attained an average size of 16g in 98 days of culture. The general health of the stocked material was good without any incidence of viral attack during the demonstration. The interaction Meet was attended by the aquafarmers, scientists from CIBA and officials from Tamil Nadu State Fisheries Department, NABARD, and the MPEDA.

Brackishwater aquafarmers meet at Kakdwip

A brackishwater aquafarmers meet 2010 was organized on 22.11.2010 at Kakdwip Research Centre, Kakdwip on "On-farm feed preparation and commercialization of CIBA feed technology in West Bengal". About 150 farmers participated in this meet. The representatives from MPEDA, Department of Fisheries, Govt. of West Bengal and private feed companies also attended and discussed issues related to aquaculture development in Sundarbans.

Inauguration of aquafarmers meet

Participants of aquafarmers meet

EXHIBITIONS

The institute participated in the following exhibitions.

- Chennai Science Festival - 2011 at Science City, Kotturpuram, Chennai during 29th January-2nd February, 2011.
- 10th Agricultural Science Congress at National Bureau of Fish Genetic Resources, Lucknow during 10th-12th February, 2011.
- Innovations 4 Industry Meet in Fisheries at Hotel Daspalla, Suryabagh, Visakhapatnam on 08.09.2010.

- Benaqua 2010 (National Fish Festival) held at Nalban Fisheries Food Park complex, GN-Block, Sector-V, Saltlake City, Kolkata, West Bengal during 1st-4th October, 2010
- Aqua Aquaria exhibition held at Chennai Trade Center during 6th-8th February, 2011.

CIBA exhibition etall at Innovations 4 Industry Meet

CIBA stall at Agricultural Science Congress

CIBA exhibition stall at Chennai Science Festival

CIBA exhibition stall at Chennai Trade Center

Agricultural Research (ARS) Service/NET Examination

Preliminary ARS/NET Examination of Agricultural Scientists Recruitment Board (ASRB) was conducted at Chennai Centre by the Institute on 19.9.2010.

ICAR Examinations coordinated by CIBA

- All India Entrance Examination for admission to UG Degree Programmes in CIBA exhibition stall at Agricultural Science Congress.
- Agriculture and Allied Science conducted by TANUVAS, Chennai on 17th April, 2010.
- All India Entrance Examination for admission to PG Degree Programmes in Agriculture and Allied Science conducted by TANUVAS, Chennai on 18th April, 2010.
- All India Entrance Examination for admission to UG/PG Degree Programmes in Agriculture and Allied Science – 2011 conducted by TANUVAS, Chennai in the month of April, 2010.
- ICAR-SRF Examination held in Veterinary College, Vepery on 12th December, 2010.

ARS/NET examination at Chennai exam centre

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Visitors

The following dignitaries visited the Institute

Name of the Scientists/Dignitary	Date of visit
Dr.S.D.Tripathi, Former Director, CIFE, Mumbai and a four Member Team from TIFAC	8.4.2010
Dr.Mathavan, Project Leader, Genome Institute of Singapore	9.4.2010
Mr.Ali Hussain, Managing Director, Bismi Feeds Pvt. Ltd., Mayiladuthurai	9.4.2010
Mr.Mohan Ram, Executive Director, ERNET, New Delhi	26.4.2010
Prof. (Dr) Mohan Joseph Modayil, ASRB Member	26.4.2010
Dr. A.P.Sharma, Director, CIFRI	26.4.2010
Shri.Rudhra Gangadharan, IAS, Secretary to Govt. of India, Ministry of Agriculture, Dept. of Animal Husbandry & Dairying, New Delhi	30.4.2010
Shri.Sudarsan Swamy, Moana Technologies	4.5.2010
Mr.Ashok Nanjappa, Chief Executive, Waterbase Limited, Chennai and Mr.Dries Agneessens, Director, Moana Hongkong Limited	8.6.2010
Mr.Umesh Trivedi, Madhya Pradesh	17.6.2010
Dr.George John, Advisor, DBT, New Delhi	25.6.2010
Dr.Farshad Shishehchian, President & Founder, Asian Aquaculture Network, Thailand, Dr.P.V.Subramanyam, Country Sales Manager (India), Blue Aqua International Pvt. Ltd. and Dr.M.Murali Krishna, Deputy General Manager – Marketing, Devee Biologicals Pvt. Ltd., Hyderabad	3.7.2010
Dr.M.Sakthivel, President, Aquaculture Foundation of India, Mr.Jullian Gladstone, Market Engagement Fellow, CARE , USA, Mr.Eraniappan, Periyar Integrated Farming, Mr.Mani, Graph Farmer, Kattur, Mrs.Meera Soundarajan, Manager, Tsunami Response Programme, CARE India	8.7.2010
Mr.Ashok Nanjappa, Chief Executive, The Waterbase Limited, Chennai, Mr.Ravi Palanisamy, Head, Feed Plant and Mr.P.Ravi, Vice-President, The Waterbase Limited, Nellore	26.8.2010
Mr.Arun Paddiar, Farmer, Andhra Pradesh	30.8.2010
Mr.Sudhir Bhargava, Member, Governing Body of ICAR	13.9.2010
Mr.S.Santhanakrishnan, S.K.Marine Technologies, Mr.Muthukaruppan, Poseidon Biotech, Mr.S.Chandrasekar, INVE Aquaculture	14.9.2010
Dr.M.Sakthivel, President, Aquaculture Foundation of India, Mr.Rahamah Paul, Project Officer, Tsunami Response Programme, CARE India, Ekatuthangal, Prof.V.J.Naidu, Executive Secretary, Society of Human Rights & Social Development, Tirupathi	20.9.2010

Dr.Srinivasan, Director, Texas University	10.1.2011
Mr.Mike Phillips, WorldFish Center, Malaysia	21.2.2011
Dr.Merly Williams, Former DG, World Fish Center, Malaysia	26th-28th March 2011

Prof. (Dr.) Mohan Joseph Madayil, ASRB Member at Kakdwip Research Centre

Shri. Rudhra Gangadharan, IAS, Secretary to GOI interacting at Headquarters, Chennai

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Personnel

Managerial Personnel

Director: Dr. A.G. Ponniah

Headquarters

Scientific Personnel

Head of Division

Dr.A.R.Thirunavukkarasu, Finfish Culture Division

Dr.P.Ravichandran, Crustacean Culture Division

Principal Scientist

Dr.S.Kulasekarapandian (Superannuation on 31.5.2010)

Dr.S.M.Pillai

Dr.T.C.Santiago

Dr.Syed Ahmed Ali

Dr.N.Kalaimani

Dr.M.Natarajan

Dr.M.Krishnan (Joined CIFE, Mumbai on 23.2.2011)

Dr.G.Gopikrishna

Dr.K.P.Jithendran

Dr.C.Gopal

Dr.V.S.Chandrasekaran

Senior Scientist

Dr.T.Ravisankar

Dr.(Mrs.) Shiranee Pereira

Dr.K.K.Krishnani (Joined DWSR, Jabalpur on 5.1.2011)

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.M.Shashi Shekhar

Dr.S.Kannappan

Dr.K.Ponnusamy (Joined DRWA, Bhubaneswar on 23.11.2010)

Dr.Akshaya Panigrahi

Dr.(Mrs.)P.Nila Rekha

Dr.K.Ambasankar

Dr.Syama Dayal

Dr.M.Kumaran

Dr.(Mrs.)M.Poornima

Dr.(Mrs.)R.Saraswathy

Dr.Prasanna Kumar Patil

Dr.Shubhendu Kumar Otta

Dr.Sherly Tomy

Scientist (Senior Scale)

Mrs.P.Mahalakshmi

Scientist

Dr.K.Vinaya Kumar

Dr.(Mrs.)Krishna Sukumaran

Dr.(Mrs.)Ezhil Praveena

Dr.Prem Kumar

Dr.(Mrs.)T.Bhuvaneswari

Dr.(Mrs.)N.Lalitha (joined on 10.12.2010 on transfer from IVRI, Bangalore)

Technical Officer

T (7 – 8)

Shri R.Elankovan

(T – 6)

Dr.S.Sivagnanam

Shri D.Raja Babu

Shri M.Shenbagakumar

Shri V.R.Senthil Kumar

Shri R.Puthiyavan

(T – 5)

Shri M.Gopinathan Nair (Driver)

Shri S.Rajamanickam

Shri S.Rajukumar

Shri Joseph Sahayarajan

Shri S.Nagarajan

Shri S.Stanline

Dr.A.Nagavel

Shri R.Subburaj

Shri R.Rajashekaran (w.e.f. 3.2.2010)

Technical Assistant

(T – 3)

Shri N.Ramesh

Shri S.Saminathan

Shri R.Balakumaran (Driver)

(T – II – 3)

Shri N.Jagan Mohan Raj

Shri D.M.Ramesh Babu

Shri G.Thiagarajan

(T - 2)

Shri C.Anandanarayanan (Resigned on 8.7.2010)

Shri K.Paranthaman (Driver)

Shri K.Karaian

(T – 1)

Shri K.V.Delli Rao

Administration and Finance

Administrative Officer

Shri A.Muthuraman

Assistant Administrative Officer

Shri R.G.Ramesh

Shri R.Kandamani (from 29.9.2010)

Mrs.V.Usharani (from 20.12.2010)

Junior Accounts Officer

Mrs.K.Nandhini

Assistant

Shri S.Pari (from 11.11.2010)

Mrs.E.Amudhavalli (from 29.12.2010)

Shri A.Manoharan (from 29.12.2010)

Shri A.Sekar (from 29.12.2010)

Personal Assistant

Mrs.S.Nalini

Shri K.G.Gopala Krishna Murthy

Stenographer, Grade – III

Mrs.K.Hemalatha

Mrs.K.Subhashini

Upper Division Clerk

Mrs.E.Mary Desouza

Shri P.Srikanth (from 5.1.2011)

Lower Division Clerk

Mrs.R.Vetrichelvi

Shri B.Palanivelmurugan

Mrs.M.Mathuramuthu Bala

Mrs.B.Prasanna Devi

Shri R.Kumaresan

Shri A.Paul Peter

Skilled Support Staff

Shri M.Santhosam

Shri N.Harinathan

Shri V.Jeevanantham

Shri K.Mariyappan

Shri K.Nithyanandam

Shri V.M.Dhanapal

Shri M.Subramani

Shri V.Kumar

Shri C.Saravanan

Shri S.Kuppan

Shri M.Pichandi

Shri S.Selvababu

Shri D.Senthilkumaran

Shri C.Raghu

Shri P.G.Samuvel

Shri M.Sakthivel

Shri R.Mathivanan

Shri R.Indra Kumar

Shri G.Dayalan

Shri Kanaka Prasad

Mrs.S.Premavathi

Shri M.Sampath Kumar

Shri J.Murugan

Supporting Staff

S.S.Gr.I

Shri E.Manoharan

Kakdwip Research Centre

Scientific Personnel

Principal Scientist & Officer-in-Charge

Dr.Jithendra Kumar Sundaray (from 13.10.2010)

Senior Scientist

Dr.T.K.Ghoshal

Dr.Debasis De

Scientist

Dr.R.Ananda Raja

Shri Gouranga Biswas

Dr.Sujeet Kumar

Mrs.P.S.Shyne Anand

Technical Personnel (T – 2)

Shri P.S.Samanta

Mrs.Chanda Mazumder

Administrative Staff

Personal Assistant

Shri S.K.Halder

Assistant

Shri S.K.Bindu

Shri P.K.Roy

Upper Division Clerk

Mrs.Arati Rani Panigrahi

Skilled Support Staff

Shri N.C.Samanta

Shri Rash Behari Das

Shri Gour Hari Jana (superannuation on 30.9.2010)

Shri Sasadhar Betal

Shri Kalipada Mondal (superannuation on 31.7.2010)

Shri Phani Gharami (superannuation on 30.4.2010)

Shri Patit Paban Halder

Shri Abhimanyu Naskar

Shri R.K.Roy

Shri Narendra Nath Jana

Shri Amar Gharami

Shri Krishna Pada Naskar

Mrs.Lakshmi Rani Bhuiya

Shri Uttam Kumar Santra

Shri Purna Chandra Das

Shri Nayan Tara Dalui

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Infrastructure Development

Headquarters, Chennai

- Additional facilities such as biosecurity system, FRP tanks and pipe line connections to Aquatic health testing and wet lab.

Kakdwip Research Centre, Kakdwip

- Construction of type-IV quarters – 3 Nos.

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Library, Information and Documentation

Library holdings

The CIBA Library acquired 30 new books during the period. Subscriptions to Foreign Journals (28 Nos.) and Indian Journals (33 Nos.) for Headquarters and Indian Journals (29 Nos.) for Kakdwip Research Centre were made. The Library presently holds 2,300 books, 1,563 bound Journals, 685 reprints and photocopies, 2,100 Reports / Bulletins and 4,350 miscellaneous publications.

Exchange services

The Library maintained exchange relationship with National and International Organizations of mutual interest. Publications of the institute were regularly sent to various research organizations, universities and other agencies.

Information services

The Library Section extended information service to the Scientific personnel of research organizations, universities, students, research scholars and other agencies / individuals.

On-line access to journals

The Online Connectivity for the Consortium for Electronic Resources in Agriculture (CeRA) journals was subscribed by NAIP both at headquarters and Kakdwip Research Centre.

Document delivery system

Photocopies of journal articles requested from various ICAR institutes, Scientists and Senior Research Fellows under CeRA - Document Delivery Request were provided.

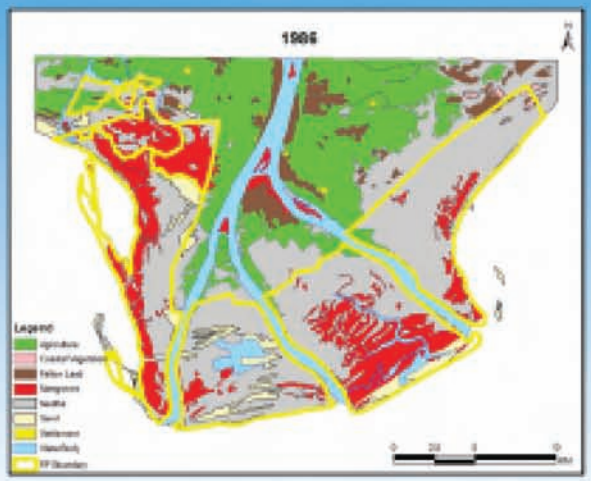
CIBA-Institutional membership in other libraries

During 2010-11, CIBA has renewed the institutional membership to access literature and other resources of libraries of various institutions like Indian Institute of Technology (IIT), Anna University, Madras University and Central Leather Research Institute (CLRI) in Chennai.

Other services

Newsletter of NACA and other important publications of FAO etc. are available individually to all the scientists of CIBA in pdf format and also through the local site of CIBA.

The library also provides 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 visit CIBA library for reference work.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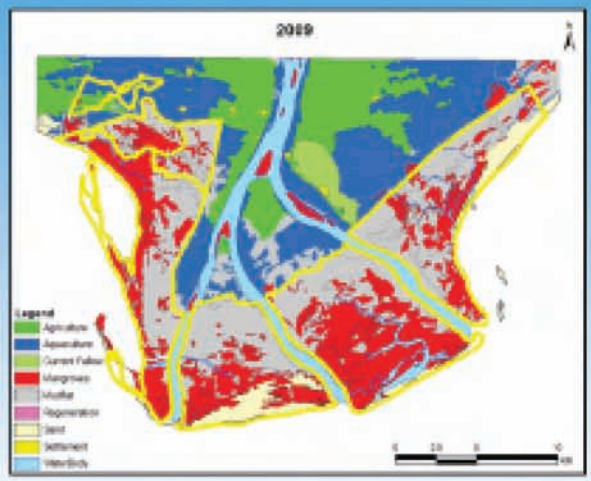
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