Annual Report
2013-2014

CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE

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Front Cover

Ornamental Fish
Scatophagus argus

Pacific White Shrimp
Litopenaeus vannamei

Organic Shrimp Feed

Milkfish
Chanos chanos

Back Cover

Shrimp with WSSV

Silver Jubilee Laboratory Building at KRC, Kakdwip

Hilsa Fish
Tenualosa ilisha

Harvest Mela of Milkfish in Gujarat

वार्षिक प्रतिवेदन

Annual Report

2013-14

केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान
(भाकृअनुप/ICAR)
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Preface

Shrimp production in India has shown phenomenal growth consequent to the introduction of Specific Pathogen Free *Litopenaeus vannamei*. The production had crossed more than 2.80 lakh tonnes during last fiscal and is expected to further increase this year too. This would not have been possible if not for the controlled introduction of vannamei as per the risk assessment study carried out by Central Institute of Brackishwater Aquaculture (CIBA) and National Bureau of Fish Genetic Resources (NBFGR) and the quarantine center for vannamei broodstock operated by Rajiv Gandhi Center for Aquaculture. The well-laid scientific guidelines on seed production and farming of vannamei developed with CIBA's input and effectively monitored by the Coastal Aquaculture Authority has ensured sustainable production. This growth in shrimp production can be sustained by shrimp producers following the guidelines strictly and by incorporating the latest advances and addressing the risks the sector faces. We experimented with the culture of vannamei in a biofloc system at our experimental station at Muttukadu and the results indicate that a high density nursery system based on biofloc in tanks can be adopted. The harvest of vannamei shrimp using biofloc system was witnessed by the stakeholders of the shrimp farming community and all of them have evinced keen interest in duplicating this model in their respective farms. In addition, our Research Centre at Kakdwip which gives an excellent platform for on-farm trials, has had a culture trial with vannamei under the zero water exchange system and strict adherence to biosecurity protocols and a production of 4.6 to 5.96 tonnes/ ha and 6.36 to 8.76 tonnes/ha for the stocking densities of 20 and 40 per m^2 respectively was achieved with reduced aeration. I need not emphasize the excellent output from the hard-working Scientists, Technicians and other personnel of Kakdwip Research Centre who have toiled hard under very trying circumstances to deliver amazing results. We have initiated studies on our indigenous shrimp *Fenneropenaeus indicus* and plans are on the anvil for a genetic improvement programme. This is being addressed on a priority basis as we need to have an alternate to the vannamei for the shrimp farming sector. CIBA has played a very important role in allaying fears of the presence of Early Mortality Syndrome in India. CIBA along with the partners in the surveillance project took the initiative of carrying out active surveillance and came out with a report indicating that this syndrome is not present in our country. The report was placed in our website and has been received quite well and helped in restoring the confidence of the international community that India has nothing to hide and has the capacity to address any disease risks. CIBA thanks the farmers and others who helped in the sampling and this also highlights the fact that if farmers provide adequate samples, the scientific community can come out with clear cut and definite conclusions. We feel that in the world of today, information has to be provided at a fast pace to the stakeholders so that they benefit from it.

Regarding finfishes, cobia appears to be a very promising species looking into its tremendous potential for growth. We are in the process of looking into various aspects of this species so that the farmer can culture them with confidence. The pearlspot is another fish which is being experimented upon for seed production and culture. Nutrition interventions have clearly indicated that the slow growth during the nursery phase can be addressed.

I would like to place on record the immense support from our beloved Secretary, DARE and DG, ICAR, Dr. S. Ayyappan, who has been a constant source of inspiration and encouragement, who with his sagacious advice has helped us in charting the future course of this high potential sector of fisheries. Thanks are also due to Dr. B. Meenakumari, Deputy Director General (Fisheries) and Dr. Madan Mohan, Assistant Director General and the Fisheries Division of ICAR who have rendered all necessary support to our Institute. I am also thankful to Dr. M.V. Gupta, World Food Prize Laureate and Chairman of the Research Advisory Committee alongwith other members who have critically examined the research programmes and rendered constructive advice and direction.

I joined CIBA in April 2006 and shall be laying down office by the end of April 2014. May I place on record the tremendous support that I received from Scientists, Technical Officers, Administration, Finance and Supporting Staff during my entire tenure at this Institute without which the prominence that CIBA has in aquaculture would not have been possible . The strength of this institution has been the diversity of disciplines the Scientists are experts in and I am sure nowhere can we find such an excellent combination which can address issues of this important fisheries sector so effectively. I leave a very satisfied and contented person. While passing on the baton to the next in command, I fervently hope that the zeal and enthusiasm which the employees of CIBA hold true to their heart flourishes and would take CIBA to greater heights.

A.G.Ponniah

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कार्यकारी सारांश

पर्यावरणानुकूल.लागत प्रभावी प्रौद्योगिकि

- एकल जोड़ी समागम की तुलना में (62.5 % बनाम 29.2 %)भारतीय सफेद झींगों के सामुदायिक प्रजनन में परिपक्वता और बोयाना (निषेचित अंड़ों की अधिक संख्या तथा बढ़ी हुई प्रस्फुटन संख्या)प्रवृत्त करने में बेहतर पाए गए हैं।
- सैखरोमईसिस सेरेविसिये और बैसिलस सबटिलस जेसे प्रोबयॉटिक्स ने झींगों की प्रतिरक्षा प्रतिक्रिया बढ़ाई और इसके माध्यम से सुरक्षात्मक प्रतिक्रिया प्रदान की। ऐन्टिबयॉटिक्स का प्रयोग करते हुए पाले गए झींगों की तुलना में प्रोबयॉटिक्स का प्रयोग करते हुए पाले हुए के इल्ली स्तर के पश्चात् झींगों ने बेहतरीन सुरक्षात्मक प्रतिक्रिया दर्शाई है।
- विभिन्न लवण क्षेत्रों में छोटे सिल्ला सेर्रेटा की वृद्धि ने यह दर्शाया है कि लवणता वृद्धि को प्रभावित करता है लेकिन उनकी जीवंतता नहीं।
- पुलिकैट में कुलतुमेडू में आयोजित एक संवर्द्धन निरूपण में यह पाया गया कि उप–इष्टतमीकृत संवर्द्धन व्यवस्था में मिट्टी के केंकड़ों का संवर्द्धन व्यावहारिक है तथा ग्रामीण जनता के लिए ये एक वैकल्पिक रोज़गार प्रदान कर सकता है।
- गुजरात और तमिलनाडू में स्थित झींगा संवर्द्धन तालाबों में किए गए क्षेत्र अध्ययनों से यह पता चला कि पानी में उपस्थित फॉस्फेट की सान्द्रता का फॉस्फेट विलेयशील बैक्टीरिया संख्या के साथ कोई सह–संबंध नहीं था। तथापि, फॉस्फेट और N/P के अनुपात का प्लैंक्टन संख्या और क्लोरोफिल तत्व के साथ सकारात्मकसह–संबंध था।
- पश्चिम बंगाल में स्थित नमखाना के एक किसान के तालाब में लिज़ा टाड़े के साथ सिल्लासेर्रेटा का सफलता बहु–संवर्द्धन निरूपित किया गया।
- नर्सरी में पारिस्थितिकी–आधारित जैव–उर्वरण तथा/और पेरीफईटन प्रौद्योगिकी तथा एल. वान्नमई की वर्द्धन व्यवस्था का मूल्यांकन किया गया। परंपरागत व्यवस्था के 92-93 %की तुलना में इस व्यवस्था द्व ारा 98-99 % दर्शाई गई जीवंतता उच्च पाई गई है। नर्सरी में पाले गए झींगों ने रोगजनक बैक्टीरियल विब्रियो पाराहीमोलिटिकस के साथ रखे जाने पर अधिक प्रतिरोध दर्शाया था।
- जैव–ऊर्णन से पैदा किए गए CHO के दो स्रोत, झींगों पर प्रयोग किए जाने पर उच्च स्तरीय कोशिका प्रतिरक्षी प्राचलों (PropOक्रियाकलाप, टी.एच.सी.आदि) में परिणत हुएतथा कुछ प्रतिरक्षी संबंधी जीनों का उच्च–विनियमन देखा गया, जिससे प्रतिरक्षी उतार–चढ़ाव की संभाव्यता का संकेत मिला।
- खेत स्थल में कैल्शियम, मेग्नीशियम और कुल कठोरता के आकलन के लिए क्षेत्र–किट (CIBA-CMHK) का विकास किया गया। यह संक्षिप्त है तथा इसे जलकृषि, कृषि, पेय जल आदि जैसे क्षेत्रों में प्रयोग किया जा सकता है।
- ऑक्सीजन को रिलीज़ करने में चार उत्पादों का उनकी क्षमता के लिए तथा इन उत्पादों से ऑक्सीजन

रिलीज़ की यांत्रिकी पर आधारित उत्पाद के विकास हेतु मूल्यांकित किया गया। परीक्षित इन चार उत्पादों में से सोडियम पेरबोरेट और कैल्शियम पेरॉक्सईड संयांजक युक्त दो उत्पाद जलीय व्यवस्था के साथ मृदा जलीय व्यवस्थाओं में प्रभावशाली पाए गए।

- आन्ध्र प्रदेश के प्रकाशम जिला में पाँच प्रमुख स्रोत/ प्राप्ति पानी में वान्नमई खेती में पर्यावरणीय प्राचलों का अनुवीक्षण किया गया। आस पास के जगहों में अत्यधिक फसल के कारण मई माह के दौरान ही पौष्टिकता लोड, इष्टतम स्तर से अधिक पाया गया। इसमें कुल निलंबित ठोस पदार्थ की समस्या भी रही है तथा फसल की योजना बनाने और TSS लोड कम करने के लिए निस्सारण पानी उपचार व्यवस्था (DWTS)का प्रयोग की भी संस्तुति दी गई है। फिर भी, मृदा लवणीकरण पर कोई प्रभाव नहीं रहा।

बृहत् स्वास्थ्य प्रबंधन

- एक प्राथमिक अध्ययन के परिणामों से पता चलता है कि संवर्द्धन निलंबन के साथ साथ बैसिलस, साकरोमईसिस और LAB जैसे विभिन्न प्रोबयॉटिक स्ट्रेनों के अधिप्लवी में रोगजनक विब्रियो को 30–90 मिनटों में कम करने की क्षमता है।
- छोटे वान्नमई की वृद्धि एवं जीवंतता पर अश्वगँधा के मौखिक फीडिंग के प्रभाव को निश्चित करने के लिए किए गए ट्रायलों से पता चला कि 35 दिनों के बाद वृद्धि और जीवंतता में सुधार देखा जाता है।
- नीम के पत्ते, लहसुन और हल्दी जैसे जड़ी बूटी बैक्टीरिया–प्रतिरोधी उत्पादों को सजीव फीडों (पाली. कीट और क्लेम माँस) पर लगाया गया और इसके परिणाम से सूक्ष्मजैविक लोड को कम करने में यह काफी प्रभावशाली रहा है। नीम और लहसुन सार का रोगाणुनाशन उपचार की अवधि सीधे अनुपाती पाए गए। आगे, नीम, लहसुन और हल्दी चूर्ण, रोगाणुनाशन गुणधर्म भीप्रदर्शित करते हैं और सजीव फीडों की स्वादिष्टता को प्रभावित नहीं करते।
- YHV और TSV जैसे असाधारण वाईरल रोगों के लिए चिकित्सकीय क्षमता बढ़ाने के लिए प्रयोगशाला वृद्धि परीक्षण कार्यक्रम के अंतर्गत प्राप्त धनात्मक सैम्पलों का प्रयोग करते हुए PCR नैदानिक मानकीकरण किया गया। इस कार्यक्रम के अंतर्गत प्राप्त धनात्मक कंट्रोल के स्रोत में TSV और YHV के रोगजनात्मक सामग्रियों (गैर–व्यावहारिक) के दो विकासात्मक सैम्पलों का OIE प्रोटोकॉलका प्रयोग करते हुए PCR नैदानिक तकनीकों को मानकीकृत किया गया।
- तालाब को 21 दिनों तक धूप में सुखाने तथा गैर–ड्रेनबल प्रायोगिक परिस्थितियों के अंतर्गत 40 दिनों के बाद वाईरल लोड के घटने पर नेस्टेडद्वारा पी.सी.आर.(PCR)ही अवसाद धनात्मक पाए गए और इस समय तक WSSV की व्यावहारिकता लगभग लुप्त हो गई। अतः संवर्द्धन शुरू करने से पहले झींगा खेत अवसादों केपी.सी.आर.परीक्षण करने से जैव–सुरक्षा सुनिश्चित की जा सकती है।
- ऐपिफ्लूरसेन्स माईक्रोस्कोपीद्वारा जलकृषि पारिस्थितिकी में वायरल संख्या का आकलन करने के लिए तथा झींगा तालाब अवसादों से वायरसों का निस्सारण करने के प्रोटोकॉल संबंधी पद्धतियोंका विकास किया गया। इन तकनीकों को संवर्द्धन में अपनाई गई जैव–सुरक्षा की क्षमता को समझने के लिए तथा जलीय रोगजनक वायरस की महामारी विज्ञान जाँच पड़ताल करने के लिए प्रयोग किया जा सकता है।
- तमिलनाडु और आन्ध्र प्रदेश में किए गए 49 वान्नमई झींगा खेतों के क्षेत्र जाँच पड़ताल के साथ EMS पर लक्षित आवेक्षण से पता चलता है कि किसी भी खेतों में EMS/APHND नहीं पहचाना गया, यद्यपि 33 खेत WSSV के लिए सकारात्मक पाए गए और 20 खेत IHHNV के लिए सकारात्मक पाए गए।
- छोटे ऐशियाई सीबॉस में अंतः स्नायु इंजेक्शन के माध्यम से नोडावायरस की चुनौती के साथ उसका

DNA वैक्सीन की क्षमता का मूल्यांकन किया गया। वैक्सीन किए गए तथा वैक्सीन नहीं किए गए छोटे ऐशियाई सीबॉस के बीच में आपेक्षिक प्रतिशत जीवंतता (RPS)30 दिनों की अवधि में 50%पाया गया तथा वैक्सीनेशन के बाद 34 दिनों में 34%पाया गया, इससे छोटों में वैक्सीनेशन के प्रति सकारात्मक प्रतिक्रिया का संकेत मिलता है।

- गुजरात के विभिन्न झींगा खेतों से प्राप्त किए गए WSSV पृथ्थकों पर आण्विक निदान और जीनो. टाइपिंग से किसी निर्धारित समय में एक ही तालाब में दो भिन्न प्रकार के जीनोटाइपों की उपस्थिति का पता चला है। वायरस जीनोटाइप और उसके फैलने में मृत्यु संख्या की गंभीरता के बीच में कोई सह–संबंध नहीं देखा गया है। इसके परिणामों से क्षेत्र में WSSV की उपस्थिति और एक अलग से वायरल जीनोटाइप का सुझाव मिलता है।
- कस्सावा व्यर्थ जैव–ढेर पर पैदा होने वाले जैव फिल्म इकट्ठा किया गया तथा उसका संवर्द्धन करके उससे बैक्टीरिया पृथ्थक किए गए। इनके आण्विक लक्षण–वर्णन से पाँच शेवानेला प्रजाति और चार विब्रियो प्रजातियों की उपस्थिति का पता चलता है जिसमें जैव उपचार करने तथा रोगजनक विब्रियो के खिलाफ चलने की क्षमता है।
- प्रचालित मृत्यु संख्या, कुछ महत्त्वपूर्ण प्राचलों के अत्यधिक वैल्यू से संबंधित पाए गए जिससे झींगों पर दबाव पड़ता हुआ दिखाई देता है। विशेष रूप से तालाब तैयारी के बेहतरीन प्रबंधन पद्धतियों को अपनाने से महत्त्वपूर्ण प्राचलों को इष्टतम स्तरों तक रखा जा सकता है।

तेज़ गति की वृद्धि, रोग प्रतिरोध में बढ़ोतरी तथा समय से पहले परिपक्वता

- केवल पालीकीटों को फीड करने से प्राप्त उच्च परिपक्वन और बोयाना के बावजूद भी 30% पालीकीटों से युक्त परिपक्वन फीड ने उच्चस्तरीय परिपक्वता और बोयाना प्रवृत्त करता है।
- 50 µg per प्रति g^{-1}शारीरिक वज़न पर दिए गए सेरोटोनिन से तृतीय दिवस से ही परिपक्वन शुरू हो गया। सेरोटोनिन से इंजेक्ट किए गए झींगों में बढ़े हुए प्रजननात्मक निष्पादन देखा जाता है और इसके प्रयोग से एफ. इंडिकस के प्रजननात्मक निष्पादन में सुधार करने के लिए यह एक सक्षम हॉर्मोन उम्मीद्वार है।
- 13 चयनित उम्मीद्वारों के 2 सप्ताहों की लवणता दबाव के बाद कम लवणता स्तर की परिस्थितियों के प्रति जीन अभिव्यक्ति के स्तरों ने डिफरेण्टशियली अभिव्यक्त जीनों की पहचान की गई। Na+/K+ATPase ऐल्फा सब–यूनिट के लिए गिल ऊतकों, अंतःकोशिकीय वसा अम्ल एवं माँस ऊतकों के इन्नेक्सिन 2 में क्रमशः अत्यधिक जीन अभिव्यक्ति स्तर देखे गए। जीन अभिव्यक्ति के डिफरेण्टशियल एवं उच्च स्तर से झींगा दबाव अनुकूल पद्धतियों में इन जीनों की प्रकार्यात्मक भूमिका स्पष्ट होती है।
- एक प्राइमर ने भारतीय सफेद झींगे में नहीं, केवल वान्नमई में ही DNA के फ्रागमेंट को बढ़ाया है। यह प्राइमर बाईण्डिंग स्थल के 3'–अंतमें SNP की उपस्थिति के कारण हो सकता है। 20 वानमई, 55 एफ. इंडिकस और कुछ बनाना झींगों में किए गए परीक्षणों से पता चलता है कि इस प्राइमर को एफ. इंडिकस से वान्नमई को अलग दिखाने के लिए प्रयोग किया जा सकता है।
- WSSVदूषण की प्रतिक्रिया में अलग से अभिव्यक्त जीनों को पहचानने के लिए 50 क्लोनों के अनुक्रमण से पता चला कि ऐल्फा–अमईलेज़ एवं सईटोक्रोम जीनों में प्रमुख रूप से अभिव्यक्त हुए। भिन्न समय बिन्दुओं पर दूषित झींगों के गिल से ऐल्फा–अमईलेज के रियल टाईम विश्लेषण से पता चला कि वे सभी समय बिन्दुओं पर डाऊन रेग्युलेशन प्रदर्शित किए गए।
- एक माइक्रो ऐर्रे चिप पर कुल 42,013 अनुक्रमण के साथ झींगा cDNAs मुद्रित किए गए। WSSVके

दूषण की प्रतिक्रिया में टाईगर झींगा में जीन अभिव्यक्ति का पता करने के लिएमाइक्रो ऐरे विश्लेषण किया गया। विभिन्न जीन अभिव्यक्तियों के लिए दूषण के पश्चात् विभिन्न समय बिन्दुओं पर WSSV दूषित झींगों से प्राप्त किए गए गिल ऊतकों का विश्लेषण किया गया। संकरण से WSSV दूषण पश्चात् विभिन्न समयांतरालों में 8633 अप–रेग्यूलेटेड और 11147 डाऊन–रेग्युलेटेड जीनों की अभिव्यक्ति देखी गई है।

- उलवा फैसियटा से जैव–सक्रिय सम्मिश्रों के सारों को झींगा इल्ली संवर्द्धन के दौरान वी. हार्वेई को नियंत्रित करने के लिए जैव–दमनकारी एजेन्टों के रूप में प्रयोग किया जा सकता है।

प्रजाति और व्यवस्थाओं का विविधीकरण तथा प्रोत्साहन

- हेपेटोसईट्स में बढ़े हुए मईक्रोविली सघनता एवं ग्लईकोजन जमाव के माध्यम से ऐशियाई समुद्री बॉस में फीड योजक के रूप में फ्रक्टो–ऑलिगोसैखरईड(FOS)का लाभदायक प्रभाव देखा गया जिससे यह स्पष्ट होता है कि मत्स्य के खाद्य पदार्थ में FOSको 1.0% के दर पर पूरक के रूप में प्रयोग किया जा सकता है।
- 100 ppmईथॉक्सिक्विन युक्त खाद्य पदार्थ देने पर खाद्य पदार्थ के कम खाए जाने का संकेत मिलता है जिससे किईथॉक्सिक्विन को अधिक जोड़ने से स्वादिष्टता प्रभावित होती है।
- वान्नमई और भारतीय सफेद झींगे में 30 ppt और 20 ppt में अधिक वृद्धि देखी जाती है। 10-40 ppt लवणता के बीच में पाले गए झींगों में (>80%) की उच्च जीवंतता देखी जाती है। लवणता को 60 ppt तक बढ़ाने से जीवंतता बहुत कम हो गई।
- मुगिल सिफेलस फिंगरलिंगों में फीडिंग की बारंबारता को इष्टतमीकृत करने के लिए फीडिंग को दिन में तीन बार किया जाना चाहिए।
- पर्लस्पॉट मत्स्य में खाद्य पदार्थ में 12 एवं 15% के लिपिड स्तरों से त्वरित परिपक्वन और आवृत्त बोयाना के परिणाम देखे जाते हैं।
- एल. वान्नमई में निःस्रावित तथा 35% प्रोटीन युक्त पेलेट किए हुए फीड एवं 6.0% लिपिड युक्त खाद्य पदार्थ के प्रभाव का मूल्यांकन करने के लिए एक प्रयोग किया गया और इनके परिणामों से पता चलता है कि पेलेट किए हुए फीड की तुलना में निःस्रावित फीड बेहतर है जिससे कि संवर्द्धन में फीड की लागत को कम किया जा सकता है।
- मृदा के तालाबों में ऐशियाई बॉस के संवर्द्धन में प्लैटफॉम पर या प्लैटफॉर्म के बिना फीडिंग ट्रे में खेत में बनाए गए फीड खिलाए गए। संवर्द्धन के 120 दिनों के बाद प्लैटफॉर्म पर रखे ट्रे पर फीड करने वाले मत्स्यों में हुई वज़न बढ़ोतरी (80.97g)की तुलना में प्लैटफॉर्म के बिना रखे ट्रे से मत्स्यों ने वज़न बढ़ोतरी में अधिकता (106.34g) देखी जाती है।
- मरक्काणम मेंवान्नमई संवर्द्धन करनेवाले एक किसान के तालाब में एक स्वचालित फीड डिसपेन्सर संस्थापित किया गया। इसके परिणाम, हाथ से फीड किए गए झींगों के तालाब से हुए उत्पादन की तुलना में स्वचालित फीड डिसपेन्सर युक्त तालाब से हुए उत्पादन काफी उत्साहवर्द्धक थे तथा इन तालाबों में पानी के प्राचलों कोई अंतर नहीं किया गया।
- पश्चिम बंगाल में स्थित मईतिपरा के किसान के तालाबों में किए गए पेरीफईटन आधारित वृद्धि निरूपण ट्रायलों में से टाइगर झींगा युक्त चार तालाबों ने नियंत्रित तालाबों की तुलना में FCR में 9.5 % सुधार दिखाया है तथा उपचार तालाबों में 27.3 % पाया गया।

- नियंत्रित स्थितियों की तुलना में जैव–ऊर्णन और मैट्स के संयोजन के साथ उपचारों में पाले हुए झींगों ने बेहतरीन प्रतिरक्षा प्रतिक्रिया दर्शायी है। केवल नियंत्रित स्थितियों की तुलना में खस आधारित व्यवस्था से पहले जैव–ऊर्णऩमैटठ में काफी अधिक कुल हीमोसईट की संख्या पाई गई। इसी तरह, ऊर्णन एवं मैट संयोजनों में काफी अधिक ग्रेन्युलोसईट एवं हयलीन कोशिकाए रिकार्ड की गईं।
- वान्नमई के साथ KRC में किए गए संवर्द्धन ट्रायल में 1.36 का औसत FCR प्राप्त हुआ है तथा झींगों के 5.81 टनों का उत्पादन किया गया जिनके विक्रय से 26.3 लाख रुपयों का राजस्व तैयार किया गया।
- केरल में स्थित एक किसान के सहयोग में पर्लस्पाट मत्स्य को आठ हापा में पाले गए जहां बहुत प्रकार का प्रजनन देखा गया। औसत फ्राई उत्पादन की श्रेणी 60–200 संख्याओं/ हापा/प्रजनन के बीच में होते हुए देखा गया है। तीन माहों में फ्राई उत्पादन की कुल संख्या लगभग 1000 देखी गई है।
- केरल में स्थित कोल्लम के अष्टमूडी झील में परंपरागत मछुआरों के साथ सीबॉस के संवर्द्धन हेतु छोटे स्तर के कटघरे संवर्द्धन पर पायलट अध्ययन किए गए। सीबॉस के फ्राई को नेट कटघरों में तथा उन्हें ट्राश मत्स्यस्टॉक किए गए। संवर्द्धन के 9 महीनों के बाद 50% की जीवंतता तथा 1.3 किलो का अधिकतम शारीरिक वज़न रिकार्ड किए गए।
- दुधिया मत्स्य फ्राई का नर्सरी पालन तीन भिन्न मृदा तालाबों में तीन फीडिंग क्षेत्रों में किए गए। संविरचित फीड खिलाए गए दल में अधिकतम वृद्धि देखीगईउसके साथसाथचावल का भूसा और ऑयल केक मिश्र खिलाए गए दल तथा अंत में कार्बनिक खाद खिलाए गए दल की वृद्धि होते हुएभी दिखाई दीगइ। जीवंतता के मूल्य में भी इसी प्रकार की प्रवृत्ति दिखाई देती है जिससे यह स्पष्ट है कि दुधिया मत्स्य को संविरचित फीड और कार्बनिक फीड खिलाकर भी पाला जा सकता है।
- कोबिया फिंगरलिंगों को KRCके एक तालाब में पाला गया तथा उन्हें 11 महीनों तक टुकड़े किए गए ट्रैश–मत्स्य खिलाए गए। इसमें 2.43 किलो के औसत शारीरिक वज़न तथा 86% की जीवंतता रिकार्ड किए गए। 10ppt से अधिक स्तर पर वृद्धि अधिक पाई गई तथा मत्स्य ने 4 ppt से कम स्तर पर लवणता दबाव दर्शाए। कम लवणता ने मत्स्यों में रंग के क्षीण होने की स्थिति देखी जाती है, फीड उद्ग्रहण में कमी तथा चर्म पर फोड़े दिखाई देते हैं।कोबिया को काक्द्वीप के आसपास के जगहों में कम लवण क्षेत्रों में अक्तूबर से अगस्त तक की अवधि में भी पाला जा सकता है तथा पूरे वर्ष के लिए पालने के लिए सुन्दरबन के क्षेत्रों में जहां अत्यधिक लवणता है, वहां भी पाला जा सकता है।

नीति और योजना के समर्थन हेतु सामाजिक–आर्थिकी एवं पर्यावरणीय विश्लेषण

- आन्ध्र प्रदेश, तमिलनाडु, कर्नाटक और गुजरात में 333 वान्नमई झींगा खेतों में किए गए सर्वेक्षणों से जैव–सुरक्षा के साथ बेहतर खेत अवर–संरचना, सक्षम फीड प्रबंधन, वान्नमई खेती में प्रशिक्षण, रोगाणुनाशन अपनाना, फसल की अवधि तथा शून्य पानी विनिमय जैसे पद्धतियों को अपनाने जैसे कई पहलू सामने आए तथा उक्त सभी ने खेती की तकनीकी क्षमता में बहुत बड़ा योगदान दिया है।
- पश्चिम बंगाल के घरेलू उत्पादन व्यवस्था में बागबानी और पशुपालन व्यवसाय के हस्तक्षेपों के परिणाम से जलकृषि और बागबानी उत्पादन में काफी सुधार होते हुए दिखाई देती है।
- तमिलनाडु के तिरुवल्लूर जिले में पुलिकाट के कुलतुमेडू गाँव के मरिकोलुण्डु और अन्नपरवै महिला स्वयंसेवक दल में हापा में सीबॉस नर्सरी पालन का निरूपण किया गया।
- SMS के माध्यम से अंग्रेज़ी में सीबॉस संवर्द्धन और खेत प्रबंधन संबंधी पचपन संदेश भेजे गए तथा उन्हें तमिलनाडु, आन्ध्र प्रदेश, उड़ीशा, पश्चिम बंगाल और गुजरात कवर करते हुए 289 मात्स्यिकी विभाग अधिकारियों में प्रदान किए गए। VMS के माध्यम सेसीबॉस संवर्द्धन और खेती प्रबंधन पर सैंतालीस

संदेशों को तमिलनाडु में 489 किसानों में प्रसारित किया गया।

- रफ सेट सिद्धांत पर आधारित प्रधानता पर तथा सरल ऐडिटिव वइटिंग बहु मानदण्ड निर्णय लेने (MCDM)की पद्धति पर आधारित गणितीय मॉडल से यह स्पष्ट होता है कि यह जलकृषि विकास के इष्टतमीकृत स्थान के पहचान करने के लिए अत्यंत भरोसेमंद है।
- MySQL डेटाबेस पंबंधन व्यवस्था का प्रयोग करते हुए एक ITK व्यवस्था का विकास किया गया है। PHPस्क्रिप्टिंग भाषा का प्रयोग करते हुए रिकार्ड ढूंढ़ने के लिए तथा डेटाबेस प्रबंधन के लिए डेटाबेस फ्रंटऐण्ड का विकास किया गया है। दस ITKs के साथ परीक्षित डेटाबेस अत्यंत प्रोत्साहनीय हैं।
- पईथन प्रोग्रामिंग भाषा का प्रयोग करते हुए जलकृषि अनुसंधान डाटा विश्लेषण के लिए एक सरल सांख्यकीय उपयोगकर्ता–अनुकूल पैकेज का विकास किया गया जिसमें अनुसंधाताओं और विद्यार्थियों के लिए जलकृषि डाटा के विश्लेषण हेतु विश्लेषणात्मक पद्धतिया शामिल हैं।
- आन्ध्र प्रदेश में उपयोग नहीं किए जानेवाले झींगे तालाबों के लिए उत्पादकता युक्त जलकृषि उपयोग विकल्पों को उबारने के लिए एक प्रतिभागिता ग्रामीण आगणन के विकास से झींगा किसानों के लिए खेत उत्पादकता लाने के लिए तकनीकी और नीति सलाह तैयार करने के लिए सहायता प्राप्त हुई।
- वान्नमई उत्पादन / संवर्द्धन तथा आर्थिक कार्य–नीतियों के साथ लागत और प्राप्तियों के मार्केटिंग पहलुओं पर उनका प्रभाव तथा इस क्षेत्र की आवश्यकताओं के अनुसार वान्नमई के उत्पादन की आवश्यकता पर इसके प्रभाव पर एक त्वरित रिपोर्ट तैयार किया गया। सूचनात्मक उत्पादन डाटा तथा उसकी विवरणिकाओं को कंप्यूट किया गया तथा उनके मार्केटिंग पहलुओं को उबारने के लिए उन्हें वैध ीकृत किया गया।
- राष्ट्रीय कृषि अनुसंधान व्यवस्था संस्थान – राज्य कृषि विश्वविद्यालय और आईसीएआर संस्थानों के पुस्तकालयों को समेकित करते हुए कृषि हेतु कृषिकैट का एक संयुक्त कैटलॉग का विकास करनेके लिए आईसीएआर के नैइप (NAIP) के घटक–I के एक भाग के रूप में ई–ग्रंथ परियोजना को कार्यान्वित किया गया।

Executive Summary

1. Environment-friendly and cost-effective technologies

- Community breeding in Indian White shrimp fares better in inducing maturity and spawning (higher number of fertilized eggs and increased hatching rate) compared to single pair mating (62.5 % vs. 29.2 %) .
- The probiotics Saccharomyces cerevisiae and Bacillus subtilus were found to increase the immune response (THC and ProPO) of shrimp thereby providing protective response.Post larvae reared using probiotics exhibited enhanced protective response compared to those reared using antibiotics.
- Growth of Scylla serrata juveniles in different salinity regimes indicated that salinity influences growth but not survival.
- A culture demonstration at Kulathumedu village in Pulicat revealed that mud crab culture and seabass nursery rearing in sub-optimal culture system is viable and could be an alternative livelihood for the rural people.
- Field studies in shrimp culture ponds in Gujarat and TN revealed that phosphate concentration in pond water was not correlated with phosphate solubilizing bacteria count. However, phosphate and N/P ratios are positively correlated with plankton number and chlorophyll content.
- Succesfully demonstrated polyculture of Scylla serrata with Liza tade in a farmer's pond at Namkhana, West Bengal.
- The concept of eco-based biofloc and/or periphyton technology was evaluated in nursery and grow out system of L. vannamei.This system yielded a significantly higher survival of 98-99 % compared to 92-93 % in the conventional system. The nursery-reared shrimp exhibited higher resistance when challenged with bacterial pathogen Vibrio parahaemolyticus.
- Biofloc generated from two CHO sources when used on shrimp,resulted in higher cellular immune parameters (ProPO activity, THC etc) and an up-regulation of certain immune related genes, indicating possible immunomodulation which in turn could protect the bio-floc reared shrimps.
- A field kit (CIBA-CMHK) was developed for the estimation of calcium, magnesium and total hardness at the farm site. It is precise and can be used in many sectors like aquaculture, agriculture, potable water etc.
- Four products were evaluated to test their efficiency in releasing oxygen and also to develop a product based on the mechanism of oxygen release from these products.Out of the 4 products

tested, two with the composition of sodium perborate and calcium peroxide were effective in both aqueous as well as soil aqueous systems.

- Monitoring of environmental parameters in *L.vannamei* farming was carried out on five major source/receiving waters in Prakasam District of Andhra Pradesh. The nutrient load was higher than the optimum only in May owing to the harvest in maximum area.The total suspended solid remains problematic and it is recommended to plan the harvest and use discharge water treatment system (DWTS) at least to decrease the TSS load. There was however, no impact on soil salinization.

2. Comprehensive health management

- A preliminary study indicated that the culture suspension as well as supernatant of different probiotic strains like Bacillus, Saccharomyces and LAB, harbor the potential to reduce pathogenic vibrio within 30-90 minutes.
- A trial to confirm the effect of oral feeding of W. somnifera on growth and survival in vannamei juveniles indicated improvement in growth and survival after 35 days.
- Herbal antibacterial products like neem leaf, garlic and turmeric extracts were applied to live feed (polychaete and clam meat) and were found to be very effective in reducing the microbial load. Neem and garlic extract disinfection was directly proportional to the duration of treatment. Further, neem, garlic and turmeric powder exhibit disinfectant properties and does not affect the palatability of live feeds.
- To enhance the diagnostic capability for exotic viral diseases like YHV and TSV, standardization of PCR diagnostics using positive samples received under Laboratory Proficiency Testing (LPT) Program was carried out. The PCR diagnostic techniques were standardized using OIE protocol for using two developmental samples of pathogen materials (non-viable) of TSV and YHV as a source of positive control received under this program.
- After 21 days under sun-drying of the pond and 40 days under non-drainable experimental conditions, due to reduction in viral load, sediments were positive only by nested PCR, and by this time, viability of WSSV was almost lost. Hence, PCR testing of shrimp farm sediment before initiating culture may help in ensuring biosecurity.
- Methods for estimating viral number(WSSV) in aquaculture ecosystems by epifluorescence microscopy and protocols for extraction of viruses from shrimp pond sediments were developed. These techniques could be used as important tools for comprehending the efficacy of biosecurity protocols adopted in culture and also for carrying out epidemiological investigation of aquatic viral pathogens.
- Field investigations were undertaken in 49 *Litopenaeus vannamei* shrimp farms in Tamil Nadu & Andhra Pradesh and targeted surveillance on EMS was also carried out. EMS/APHND was not detected in any of the farms,although 33 farms tested positive for WSSV and 20 tested positive for IHHNV.
- The efficacy of DNA vaccine was evaluated through intramuscular injection in Asian seabass juveniles followed by challenge with Nodavirus. The Relative Percentage Survival (RPS)

between the vaccinated and non-vaccinated was 50% in 30 days post vaccination and 33 % in 34 days post vaccination, indicating the positive response of the vaccination in juveniles.

- Molecular diagnosis and genotyping of WSSV isolates collected from different shrimp farms of Gujarat indicated the prevalence of two different genotypes infecting the same pond at a given time. No correlation could be observed between the viral genotype and the severity of the mortality in the outbreaks. The results suggest the widespread occurrence of WSSV in the region and circulation of distinct viral genotypes.
- Biofilm formed on the cassava waste biomass was collected, cultured and bacteria isolated. Molecular characterization revealed the presence of five Shewanella sp. and four Vibrio sp. which have the potential for bioremediation and also to act against pathogenic *Vibrio*.
- Running mortality has been shown to be related to the excess values of a few critical parameters in the culture ponds creating stress to the animals. Following better management practices starting from pond preparation is recommended to keep the values of critical parameters within optimum levels.

3. Faster growth, increased disease resistance and early maturation

- Maturation feed containing 30% polychaetes resulted in induced maturation and spawning although a higher maturation and spawning was achieved by feeding polychaetes only.
- Gene expression levels in response to low salinity conditions at 2 weeks post salinity stress of thirteen differentially expressed genes were identified.The highest gene expression levels were observed for Na+/K+ATPase α-subunit in gill tissues, intracellular fatty acid binding protein in gut tissues and innexin2 in muscle tissues respectively. The differential and significant levels of gene expression indicate the functional role of these genes in shrimp salinity stress adaptive mechanisms.
- A primer amplified a fragment of DNA only in *L.vannamei* but not in Indian White shrimp. This could possibly be due to a SNP in the 3'-end of the primer binding site. Testing was done with 20 *L.vannamei* samples and 55 *F. indicus* samples. A few banana shrimp samples tested also failed to amplify. This primer could possibly be used to differentiate *L.vannamei* from *F. indicus*.
- To identify differentially expressed genes in response to WSSV infection, sequencing of 50 clones revealed that alpha-amylase and cytochrome genes were predominately expressed. Real time analysis of alpha-amylase gene carried out from gills tissues of WSSV infected shrimp at different time points exhibited down regulation at all time points.
- Shrimp cDNAs were printed with a total of 42,013 sequences on a microarray chip. Microarray analysis was carried out to decipher the gene expression in tiger shrimp in response to WSSV infection.
- Bioactive compounds extracted from *Ulva fasciata* could be used as a bio-inhibitory agent for controlling *V. harveyi* during shrimp larviculture.

4. Diversification & promotion of species and systems

- The beneficial effect of Fructo-oligosaccharide (FOS) supplementation as a feed additive in Asian seabass could be observed through increased microvilli density and glycogen deposition in the hepatocytes indicating that FOS can be supplemented at 1.0% in the diet.
- A diet containing 100 ppm ethoxyquin showed significantly decreased feed intake indicating that higher supplementation of ethoxyquin affects palatability.
- In *L.vannamei*, and Indian white shrimp, higher growth was observed at 30 ppt and 20 ppt respectively. High survival (>80%) was observed in shrimp reared between 10-40 ppt salinity. With increase of salinity to 60 ppt, survival was drastically reduced.
- To optimise the feeding frequency in *Mugil cephalus* fingerlings, an experiment was carried out which revealed that the fingerlings need to be fed thrice daily.
- In pearlspot fish, lipid levels of 12 & 15% in the diet resulted in inducing quick maturation and recurring spawning
- An experiment was conducted to evaluate the effect of extruded and pelleted feed in *L. vannamei*. The feed contained 35% protein and 6.0% lipid. The results revealed that extruded feed is advantageous over pelleted feed and this could result in cost reduction of feed during culture.
- Farm-made feed provided on feeding trays with and without a platform were used for the culture of Asian seabass in earthen ponds. After 120 days of culture, the fish fed in feeding tray without platform exhibited a higher weight gain (106 g) compared to fish fed in feeding tray with platform (81 g).
- An automated feed dispenser was installed in a farmer's pond culturing *L.vannamei* at Marakkanam. The results are encouraging in that the production in the pond having automated dispenser was slightly high compared to the pond containing shrimp which were fed manually and the water parameters also did not differ among these ponds.
- Periphyton-based grow-out demonstration trial carried out in farmers' ponds at Maitypara, West Bengal, in four ponds with tiger shrimp, revealed 9.5 % improvement in FCR and 27.3 % improvement in productivity in treatment ponds compared to control.
- Shrimp reared in combination of biofloc and mats exhibited better immune response compared to control. A significantly higher total haemocyte count, higher granulocyte and hyaline was recorded in Floc+MatB followed by bamboo mat based system compared to control.
- In a culture trial at KRC with *L.vannamei*, an average FCR of 1.36 and a production of 6.81 tonnes of shrimp was achieved generating a revenue of Rs. 26.3 lakhs through sale.
- In collaboration with a farmer in Kerala, pearlspot fish reared in hapas exhibited multiple breeding, the average fry production ranging from 60-200 numbers/hapa/breeding.
- A pilot study on small scale cage culture of seabass collaborating with a traditional fisherman in Ashtamudi lake of Kollam, Kerala, revealed a survival 50 % and a maximum body weight of 1.3 kg after 9 months of culture.
- Nursery rearing of milk fish fry from wild in earthen ponds with three feeding regimes revealed that the maximum growth was observed in the group fed formulated feed followed by rice bran, oil cake mixture and organic manure.

- Cobia fingerlings reared at KRC in a pond and fed chopped trash fish for 11 months exhibited an average body weight of 2.43 kg and survival of 86%. Growth was higher at > 10 ppt and fish exhibited signs of stress at salinity < 4 ppt. Low salinity resulted in fading of colour of fishes, reduction of feed intake and signs of skin ulceration.

5. Socio-economic & environment analyses for support to policy and planning

- In the homestead production system in West Bengal, horticulture and animal husbandry interventions resulted in a significant improvement of aquaculture and horticulture production.
- Fifty five messages on seabass culture and farm management in English via SMS and 47 technical messages on seabass culture and farm management via VMS were disseminated to 289 DoF Officials and 489 farmers covering Tamil Nadu, Andhra Pradesh, Odisha,West Bengal and Gujarat.
- The correlation between ranks obtained by the rough set based Multi Criteria Decision Making (MCDM) method model and ranks obtained based on TOPSIS-AHP mathematical model was significant indicating that this model is indeed reliable for identification of optimal location for aquaculture development.
- An ITK system was developed using MySQL database management system. Database front end for searching records and database management was developed using PHP scripting language. Database tested with ten ITKs are encouraging.
- A simple statistical user-friendly package for aquaculture research data analysis was developed using Python programming language. The package includes analytical methods which would be useful for researchers and students for analysing aquaculture data.
- A Participatory Rural Appraisal to find out the productive aquaculture use options for shrimp ponds in disuse was conducted in Andhra Pradesh where the concentration of disuse of shrimp ponds is high. Technical and policy advisories were prepared which could help make the farms productive for shrimp farmers
- The informative production data and prospects were computed and validated on *L.vannamei* production/ culture for different farm categories & infrastructure development, domestic marketing requirements on size classes, price band preferences, seasonal demand patterns, sequential stocking, feed conversion ratio, harvesting, cost and returns and economic strategies followed by an analysis on marketing aspects of cost and returns and its impact on requirement of production of *L.vannamei* in the current situation as needed in this sector.
- The e-Granth project was implemented as part of the component–I of the NAIP of ICAR to develop a union catalogue of agriculture AgriCat by integrating the libraries of National Agricultural Research System institutions - State Agricultural Universities and ICAR institutions.
- Surveys carried out in 333 *L.vannamei* shrimp farms in Andhra Pradesh, Tamil Nadu, Karnataka and Gujarat revealed that better farm infrastructure with biosecurity, efficient feed management, training in *L.vannamei* farming,adoption of bio-floc and adoption of disinfection, cropping period and adoption of zero-water exchange were found to have significantly contributed to the technical efficiency.

3 Introduction

India is endowed with 1.2 million ha brackishwater area for development of aquaculture of which brackishwater aquaculture covers an approximate area of 1,25,000 ha, or 43% of the total aquaculture area equivalent to approximately 75% the area under freshwater aquaculture. A majority of the shrimp farmers (91%) in our country hold less than 2 ha whereas 6% of the farmers hold between 2 to 5 ha and only a miniscule 3% have holdings >5 ha. Brackishwater aquaculture needs to be sustained for which environment friendly and cost-effective culture technologies by all strata of farmers have to be adopted. Adoption of bio-secure farm practices, access to institutional credit, fostering linkages, development of infrastructure and favourable legislations and policies are some of the major issues that need to be addressed to promote sustainable brackishwater aquaculture. Even though brackishwater is synonymous to shrimp culture, there are a variety of finfishes that are also gaining popularity viz. pearlspot, cobia and grey mullet. Nursery rearing of Asian seabass has been found to be very useful for augmenting the income of women's self help groups and also tribals. A trial of pearlspot rearing in hapas in a farmer's pond in Kerala has shown encouraging results. The introduction of specific pathogen free Pacific White Shrimp into India in a limited way continues to change the shrimp culture scenario in India.

The introduction of *Litopenaeus vannamei* has brought out major issues regarding shrimp farming management and the environment especially with regard to stocking density, feed, water management and their role in determining the carrying capacity of the system.

It is observed that Better Management Practices (BMPs) are extremely vital for effective farm management which ultimately leads to sustained production. The Central Institute of Brackishwater Aquaculture is assiduously working on these cardinal principles for sustained shrimp farming and systematic development of this extremely vital fisheries sector.

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, 46 Scientists, 24 Technical, 23 Administrative and 34 Supporting staff as on 31.03.2014.

Mandate

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

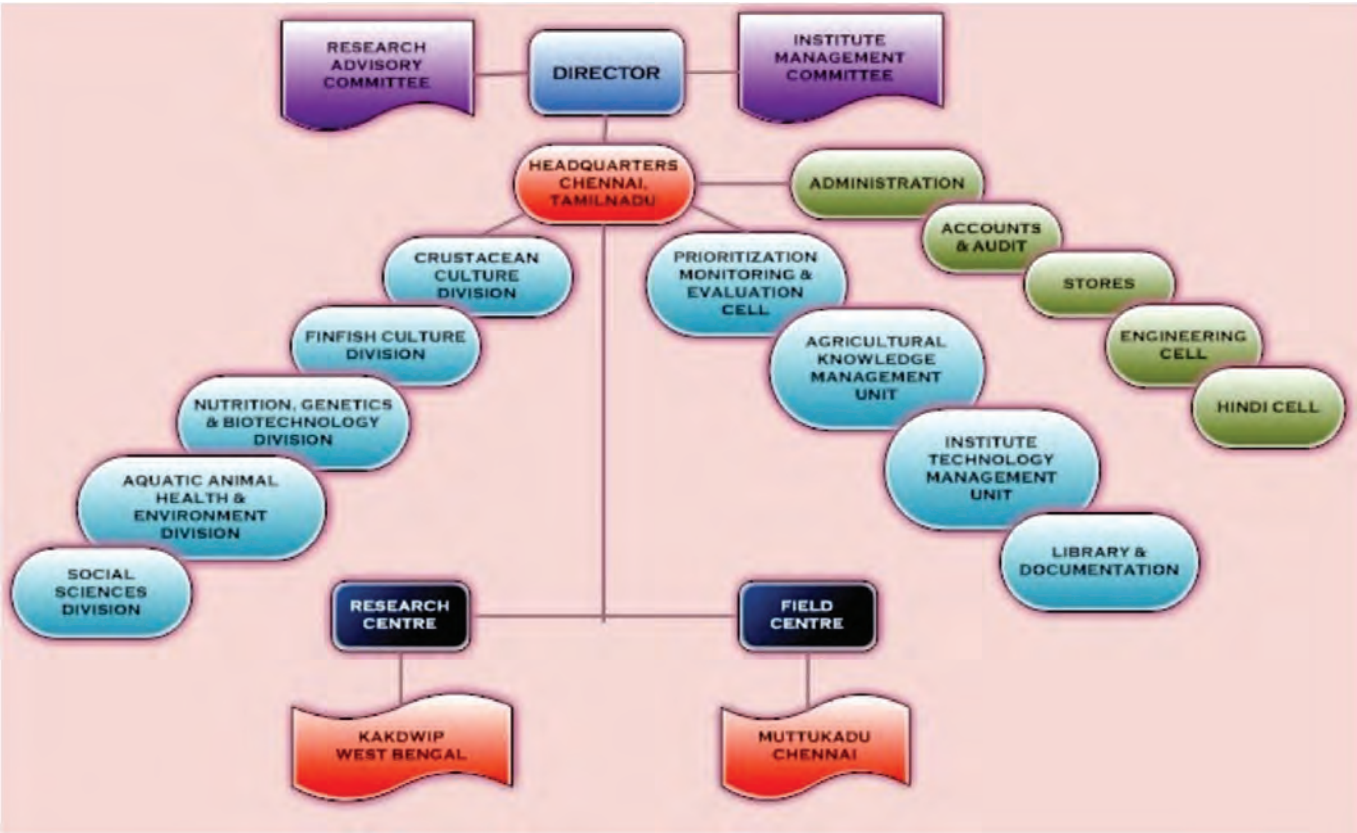
Organizational set-up

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

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

The research activities of the Institute are diverse in nature, starting from basic to applied and adoptive which was carried out under 16 in-house and 31 externally funded projects during 2013-14.

ORGANISATION CHART



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Financial Statement 2013-14 **(Rs.in Lakhs)**

Sub-Head	BE	RE	Actual Expenditure
PLAN			
Travelling Expenses	30.00	30.00	30.00
HRD	0.00	0.00	0.00
Contingency	575.00	432.50	432.46
Works	90.00	15.25	15.25
Equipments	200.00	145.82	145.81
Information Technology	50.00	35.67	35.66
Miscellaneous expenses	15.00	4.50	4.50
Library	30.00	30.00	30.00
Furniture & Fixtures	40.00	11.26	11.26
TSP	20.00	20.00	2.00
Total	**1050.00**	**725.00**	**706.94**
			NON-PLAN
Establishment	1050.00	1100.00	1021.36
O.T.A	0.00	0.15	0.00
Travelling Allowance	8.00	8.00	8.00
Research & Operational	20.00	29.99	29.97
Administrative Expenses	92.00	159.91	159.88
Miscellaneous	1.90	2.00	2.00
Sub Total	**1171.90**	**1300.05**	**1221.21**
Pension	1113.90	800.00	774.16
Loans & Advances	5.25	7.85	7.85
Total	**2291.05**	**2107.90**	**2003.22**

Revenue Generation **(Rs.in Lakhs)**

Year	Ta rget	Achievement
2013-14	32.60	58.00

Official Language Implementation Programme

Official Language Implementation Committee meetings were held once a quarter. Usage of Hindi in official correspondence, bilingual use of Hindi and English in files and publications in Hindi were reviewed during these meetings. Hindi Pakhwada was celebrated in the second fortnight of September wherein Hindi Kavita Path, Samachar, Sirf Ek Minute and Hindi noting/ drafting competitions were organized with the culmination of Hindi Day celebrations. In the valedictory function, a Hindi expert enlightened the audience on Official Language implementation and prizes were distributed. A Hindi Fortnight and a workshop on Computerization/ Unicode in the implementation of Official Language Policy were organized during which employees were awarded prizes. Hindi Week was celebrated at KRC in which Shri Prakash Chandra Thakur, Rajbhasha Department, Film Division, Ministry of Information and Broadcasting was the Chief Guest.

STAFF POSITION

The details of sanctioned, filled and vacant positions as on 31.03.2014 are as follows.

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	1	-
Head of Division	4	1	3
Principal Scientist	1	-	1
Senior Scientist	10	7	3
Scientist	52	37	15
Technical Assistant	31	24	7
Administrative Officer	1	-	1
Finance & Accounts Officer	1	1	-
DD(OL)	1	-	1
Assistant Administrative Officer	3	3	-
Junior Accounts Officer	1	1	-
Private Secretary	1	1	-
Personal Assistant	2	2	-
Stenographer Gr.III	1	2	(-)1 excess
Assistant	7	5	2
Senior Clerk(UDC)	3	3	-
Junior Clerk(LDC)	5	5	-
Skilled Support Staff	55	34	21
Total	180	127	53

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

Standardization of quality seed production technique of diversified shrimp species viz. *F. indicus, F. merguiensis and F. penicillatus*

Adult brooders (males and females) collected from Chennai (tiger and Indian white shrimp) and Adirampattinam Coast in Pattukkotai district (banana shrimp) of Tamil Nadu were transported to the hatchery of CIBA at Muttukadu. The brooders were acclimatized and spawned naturally.

A total of 40.5 lakh nauplii and 11.05 lakhs PL 15 were produced from different species of shrimp (*F. merguiensis* (5.5 lakh), *F. indicus* (3.35 lakh), *P. monodon* (2.2 lakh)) were used for demonstration trials or experiments. Banana seed produced was stocked in Danti, NAU Navsari and in farmer's ponds.

Evaluation of efficiency of commercial probiotic for treating shrimp farm discharge water

To reduce the nutrient load from shrimp farms discharge water (SFDW), the existing discharge water treatment system (DWTS) was efficient only for decreasing total suspended solids, but not nutrients. A commercial probiotic containing *Pseudomonas fluorescenes, Bacillus subtilis, Enterobacter aerogenes, Alcaligenes faecalis* and *Enterobacter cloacae* that is commonly used in effluent treatment of industries was used @ 1.5 (D1), 3 (D2) and 4.5 mg/l (D3) in a yard experiment that was conducted with discharge water from *L. vannamei* culture ponds of varying salinity viz. 2, 15 and 30 ppt spiked with TAN and nitrite N concentration to simulate the conditions of equivalent concentration of ammonia and nitrite.

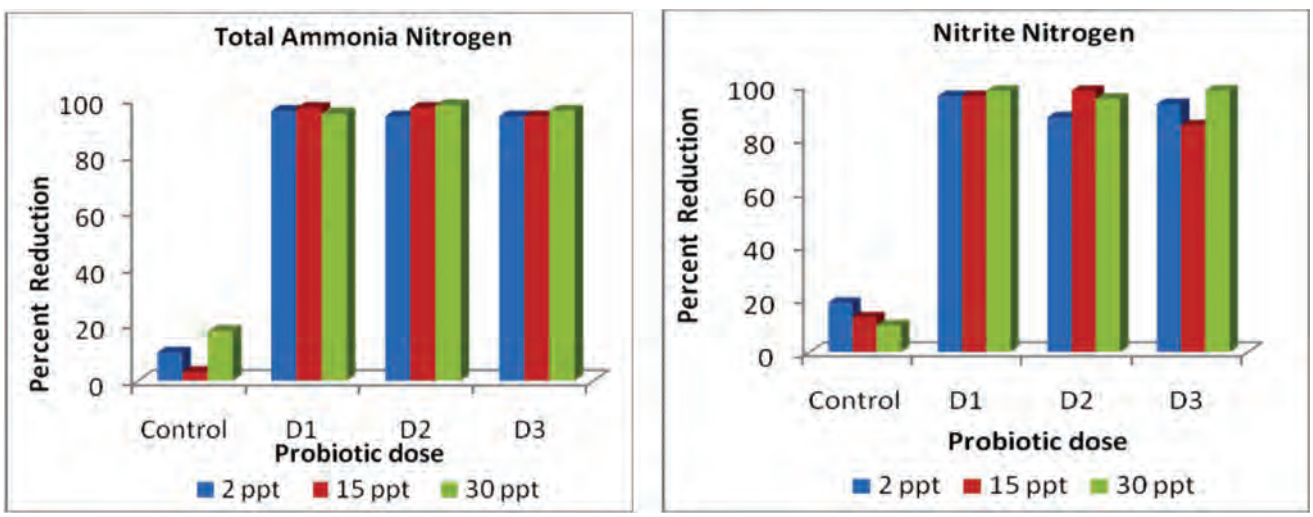


Fig.1.Effect of commercial probiotic on total ammonia N and nitrite N levels in discharge waters from shrimp farms varying in salinity

All the doses of probiotics significantly reduced TAN and nitrite N by 96, 95 and 97 per cent in 2, 15 and 30 ppt treatments, respectively (Fig. 1) within 72 and 48 hours respectively. Thus, the commercial probiotic can be used in SFDWTS for the removal of N fractions only, but not phosphate.

Project Title (Institute)	**Improvement of growth and reproductive traits in penaeid shrimp (*Fenneropenaeus indicus*) through breeding, nutritional and environmental interventions**

Evaluation of growth and reproductive traits in *Fenneropenaeus indicus*

Juveniles of Indian white shrimp *F.indicus* were tagged using blue, green, orange and red colored visible implant elastomer tags singly or in combination for identifying different families. Fortnightly samplings were carried out and at harvesting, the sex and weights were recorded. The culture was carried on till the shrimp attained maturity stage.However in the second fortnight of November 2013, all tagged shrimp were lost due to gill choke infection by diatoms which were primarily *Amphora* sp. The dead shrimp tested negative for WSSV and IHHNV.

Table 1. Family-wise harvest means of *F. indicus*

Sex	Males wt (n)	Females wt (n)
Family 1	22.433 (46)	25.732 (56)
Family 2	21.613 (54)	26.115 (46)
Family 3	23.020 (74)	27.565 (57)
Family 4	22.365 (105)	26.781 (97)
Family 5	22.591 (112)	27.565 (110)
Pooled	22.46 ± 0.10 (391)	26.87± 0.14 (366)

Reproductive performance of Indian white shrimp induced with maturation feeds, serotonin hormone, spermatophore quality and mating pattern

Live polychaetes were fed to adult Indian white shrimp to evaluate the reproductive performance in relation to either as single pair or in community tanks with/without eyestalk ablation. The results showed that community breeding (63 %) fares better in inducing maturity and spawning (higher number of fertilized eggs and increased hatching rate) compared to single pair mating system (29 %). Alternatively, the pellet feed replaced with 30% of day's feeding showed lower (55%) reproductive performance compared to when exclusively fed live polychaetes (85 %). Similarly the spermatophore quality of males was evaluated with reference to molt stage and captive conditions and the sperm quality was found to be higher in post molt animals. The effect of serotonin administered @ 50 µg per g-1 body weight significantly improved the ovarian maturation and reproduction. Also, when hormones like 17ß-estradiol was given to shrimp, there was a significant enlargement of oocyte in all the stages in the ovary.

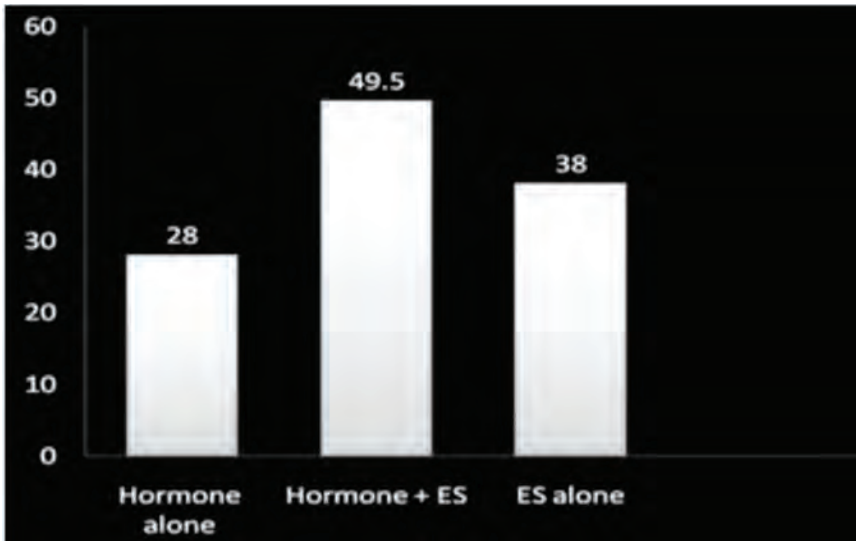


Fig. 2. Evaluation of serotonin on reproductive maturation/vitellogin

Healthy seed production in penaeid shrimp through microbial (probiotic/biofloc), environmental and nutritional interventions

The effect of application of probiotics viz. *Saccharomyces cerivisiae, Bacillus subtilis, S. boulardi, Lactobacillus rhamnosus, L. casei* and *Enterococcos sp.* on the health and performance of juvenile shrimp in *F. indicus* and *L. vannamei* showed significantly ($p<0.05$) better survival and growth (8.05, 7.65, 7.0, 6.30, 6.20 g respectively) compared to control (without probiotics) group (4.85g) with highest survival (75%) while using *Saccharomyces cerevisiae*. Amongst the probiotics, *Saccharomyces cerevisiae* and *Bacillus subtilus* were found to increase the immune response (THC and ProPO) in shrimp. Challenge tests with the virulent pathogenic strain *Vibrio anguillarum* on shrimp fed with probiotics showed significantly higher ($p< 0.005$) survival rate compared to that of the control.

Project Title (Institute)	**Scaling up of production system of mud crabs**

Mass mortality during metamorphoses from (Zoea 5) Z5 to megalopa to crab instar 1 is a major bottleneck. Using different substrata (net shelter and natural seaweed *Gracilaria edulis*) crab larvae at stage Z5 were weaned and fed with *Artemia* nauplii for 3 days and later with *Artemia* biomass for remaining four days. The highest survival was observed while using seaweed substratum (69/80nos: 86%) compared to net substratum (30/80: 38%). The results indicate the potential for the refinement of rearing procedure by weaning larvae during the last phase of culture with an appropriate substratum . The effect of salinity on growth and survival of *Scylla serrata* juveniles shows that salinity influences growth rate i.e. significantly higher ($P<0.05$) at 10 ppt than at 5 and 30 but not survival. Similar observations have been reported from researchers in Australia.

A berried crab

Mud crab culture was demonstrated in farmers' pond and also in tribal areas. Amongst successful crab culture, the nursery rearing of crab instar (2-3 day old) to juvenile crab at KRC was most prominent. The crab instars were stocked in nursery ponds (100 m^2) at 1 and 3 no per/m^2 and were fed trash fish (75%) and molluscan meat (25%) twice daily. After 75 days of nursery rearing, an average survival of 79 and 54 % with an average body weight of 39.22 and 43.98 g in 1 and 3 nos/ m^2 respectively was recorded. The technology has been adopted by one farmer. A culture period of 230 days during polyculture of mudcrabs with tiger shrimp and grey mullet at KRC resulted in crabs attaining a body weight of 250-300 g and grey mullets (initial wt-30- 40 g) weighing 200-300 g. A polyculture of *S. serrata* with *Liza tade* in farmers pond at Uttarchandanpiri village, Namkhana after 9-10 months, yielded berried crabs (yellow, orange and greyish black) females (800 g to 1 kg) numbering 7-8 and juveniles (50-60 nos.) with an average weight of 10-20 g. The farmer thereafter restocked the berried and juveniles crabs in his ponds and finally harvested 0. 700-1.2 kg crabs with an average price of Rs.1000/- per kg (both claw legs intact).

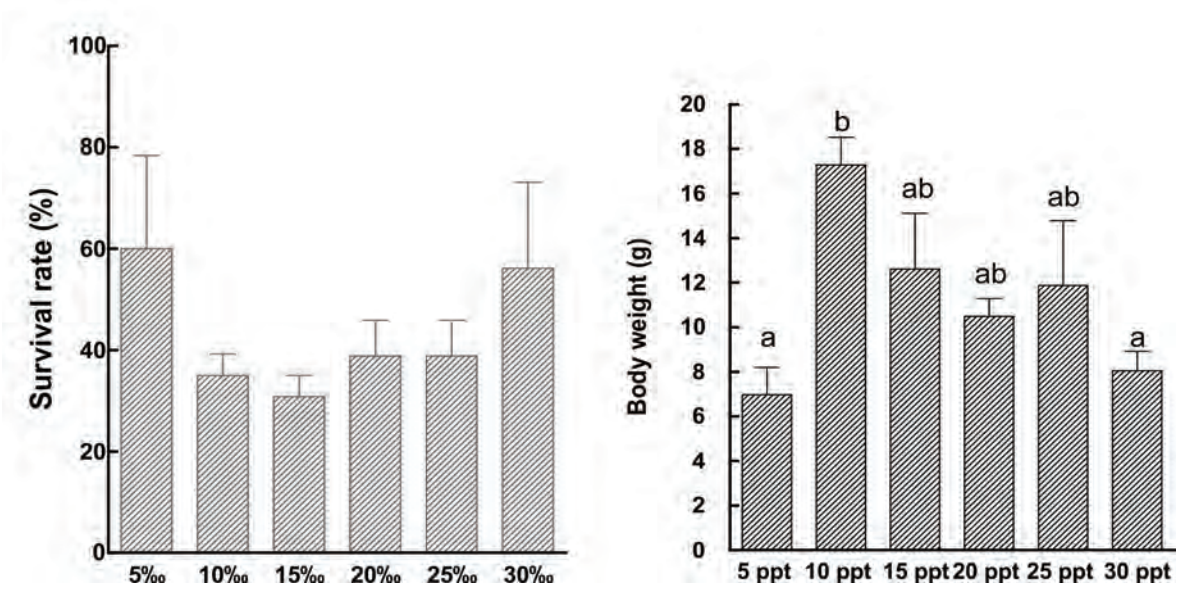


Fig.3. Effect of different levels of salinity on survival (left) and final body weight (right) of *Scylla serrata* juveniles

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

Remote sensing and GIS monitoring of the Chilika lagoon ecosystem in the changing environment was carried out to formulate appropriate measures for restoration and sustainable management of the lagoon ecosystem. The barmouth (Fig 4) was almost closed in the year 1972 and 1988, restricting the water exchange of water from the sea. In 2000, the Odisha Government opened a new barmouth. The production in Chilika lake prior to opening of the barmouth stood at 4982 MT which later increased three-fold in 2002 (11988 MT) post hydrological intervention and the present production is about 12,466 MT. Similarly, aquaculture farms increased from 167 ha to 4600 ha. However, a conflict persists between aquafarmers and fishermen and there is a need for a clear directive to solve the problems.Figure 4 shows the changes in the barmouth at different periods that indicate the distinct dynamic environment

where interplay of different energy forces from land-sea-atmosphere operate in a shallow water body which is partly enclosed by a barrier and which has restricted or ephemeral communication with the sea through one or more inlets.

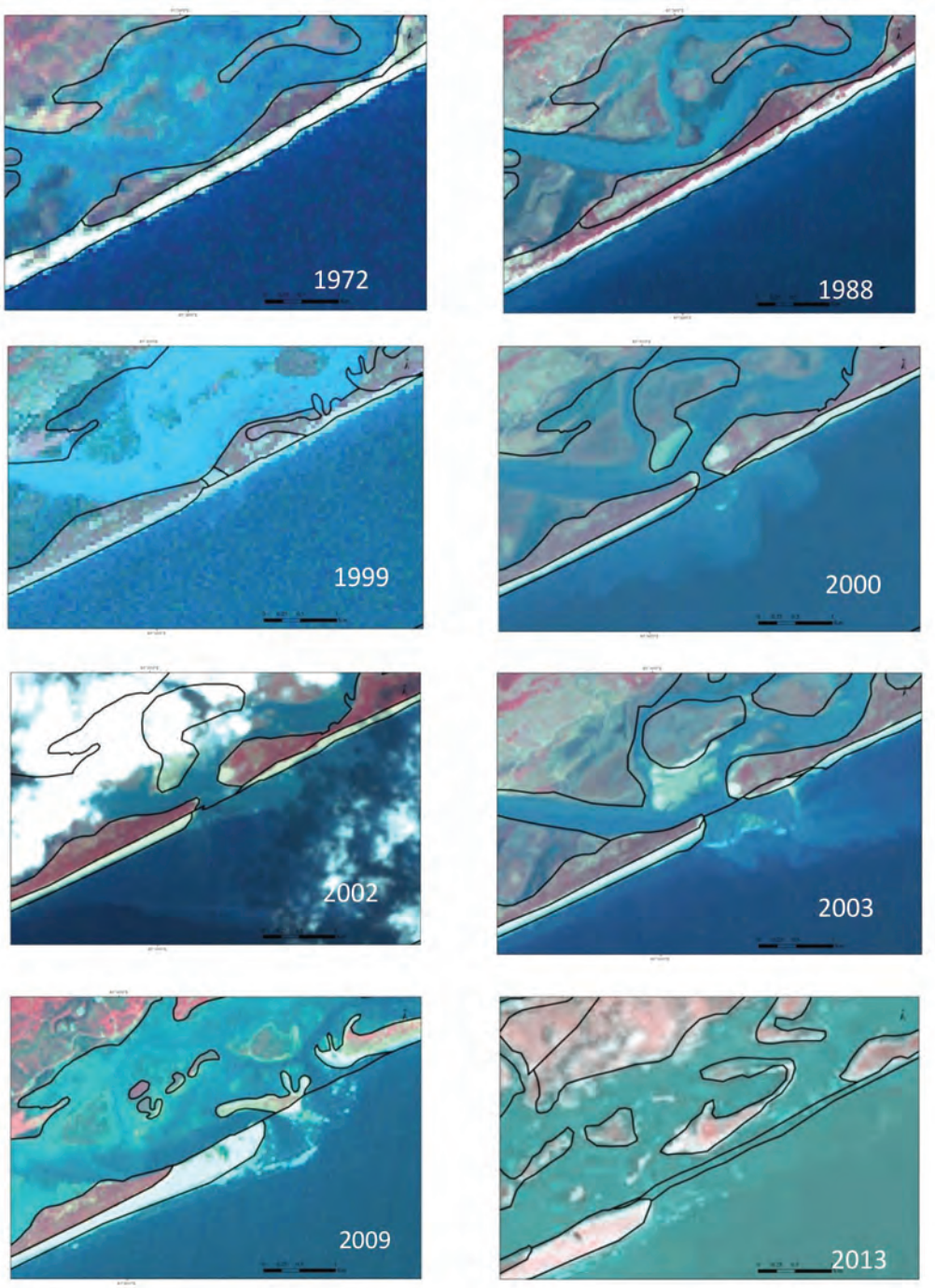


Fig.4. Changes in the Chilika lake barmouth from 1972-2013

Nursery and grow-out rearing of *Litopenaeus vannamei* in periphyton and bio-floc based systems

The concept of eco-based biofloc and/or periphyton technology is based on the retention of waste and its conversion to biofloc serving as natural food for aquatic organisms. Based on this concept, a nursery

and grow out system for *L. vannamei* was evaluated using periphyton, independent bio-floc nutrient and combination (biofloc +periphyton) of conventional autotrophic with pellet feed (34% crude protein). The biofloc and periphyton based farming showed significantly higher survival of 98-99 % compared to 92-93 % in the conventional system ($P<0.05$). A total of 2.5 to 3 kg shrimp /m^2 (25 to 30 mt/ ha) (Fig. 5) with an average body weight of 19-23 g was produced in 110 days of nursery phase. The nursery-reared shrimp technology would help in addressing the problems of EMS and RMS effectively.

Dignitaries during harvest of *L.vannamei* using biofloc

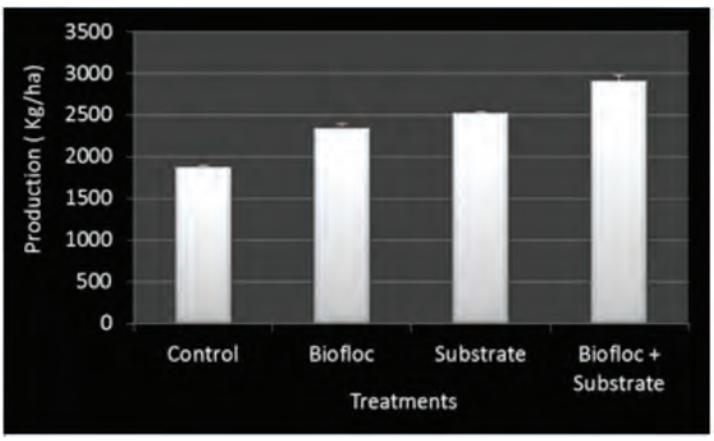


Fig.5.Productivity (kg/ha) as observed in all 4 groups

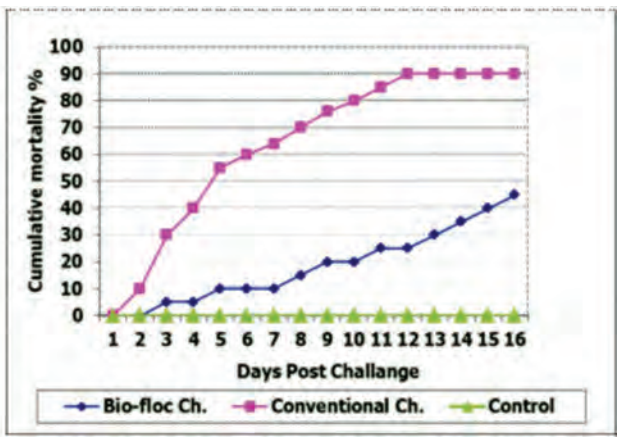


Fig. 6. Challenge experiment with pathogenic *V. parahaemolyticus*

Project Title (NFDB)	**Standardization of aerator usage in shrimp farming through improving the efficiency and operational pattern of the aeration systems use, automation and use of alternate energy source**

A study was conducted to evaluate the aeration requirements for *L.vannamei* culture during different phases of production at different stocking densities. The optimum energy use and cost of production was studied based on survival, growth and oxygen consumption rate (OCR) at different salinities (0, 10, 20, 30 and 40 ppt) for 4 months. The OCR was maximum at 40 ppt. and minimum at 20 ppt. during the early phase of shrimp growth (1st month) which later shifted to 20 ppt. (highest) and was the lowest at 0 ppt (4th month).

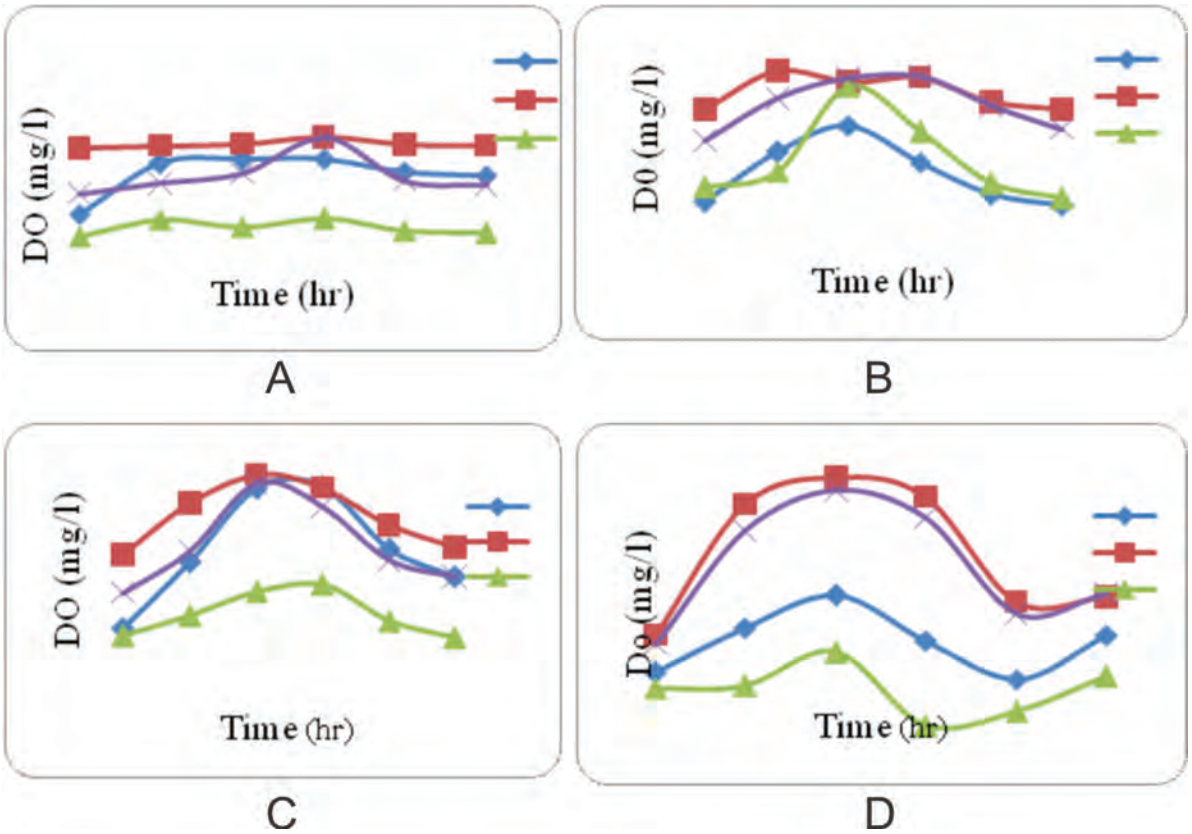


Fig. 7. Diurnal variation of DO in the ponds with different types of aeration and biomass in the (A) first month (B) second month (C) third month D. before the harvest

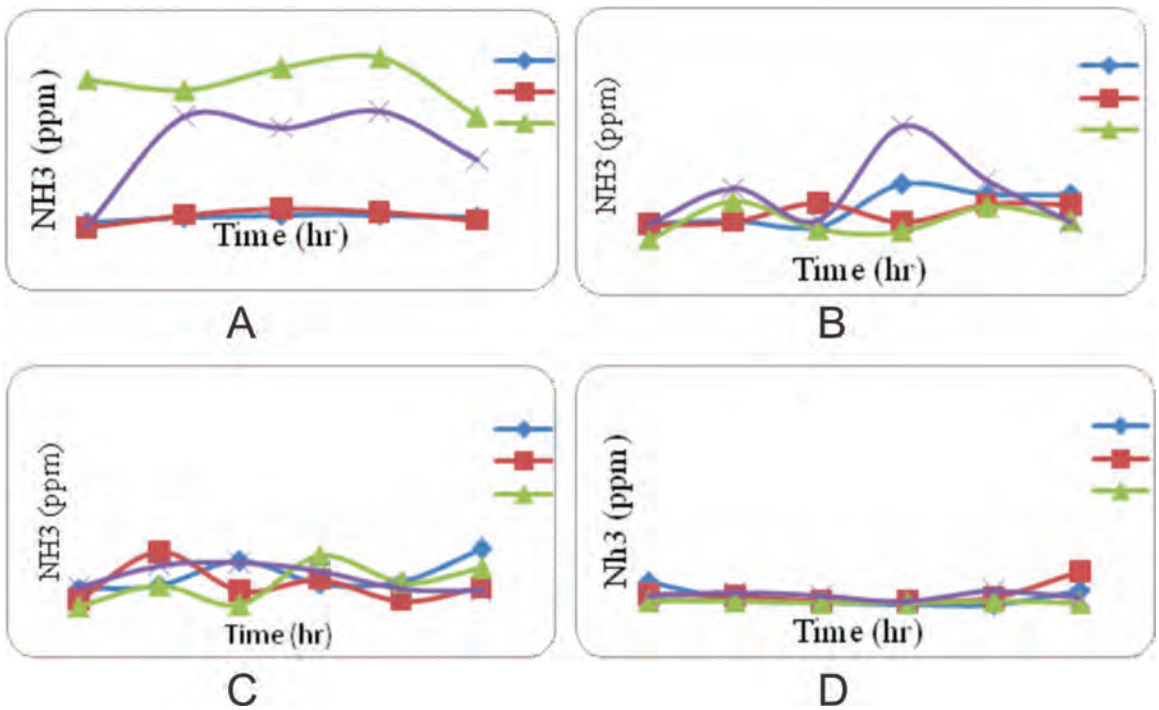


Fig. 8. Diurnal variation of ammonia in ponds with different types of aeration and biomass during culture (A.) first month (B) second month (C) third month D. prior to harvest

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

Based on the Geo-database of groundwater quality in shrimp farming area of the coastal watershed, it was observed that the hydrogen ion concentration (pH) ranged from 7.7 to 8.6, electrical conductivity (EC) 418 and 6792 µS/cm and Total Dissolved Solids (TDS) 248 -4396 mg/l respectively, indicating the alkaline nature of the groundwater samples. The heavy metal concentration, pesticide content, COD and BOD were well within permissible limits. The plot of Revelle coefficient vs. distance from shrimp farms, creek and sea reveals that most of the groundwater data falls below 1 and 1.5 (Figs.9a, b, c) clearly indicating that shrimp farming is not the main reason for ground water salinization. The spatial distribution of EC also clearly elucidates that shrimp farming does not influence groundwater quality. (Fig.10)

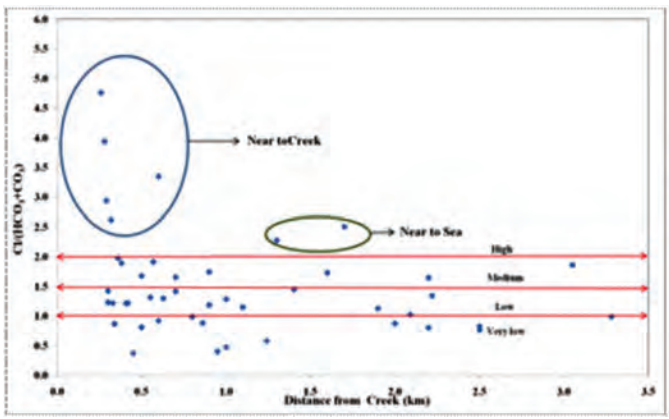


Fig.9.a: [Cl-]/ [HCO3+ CO3] versus Distance from shrimp farms (km)

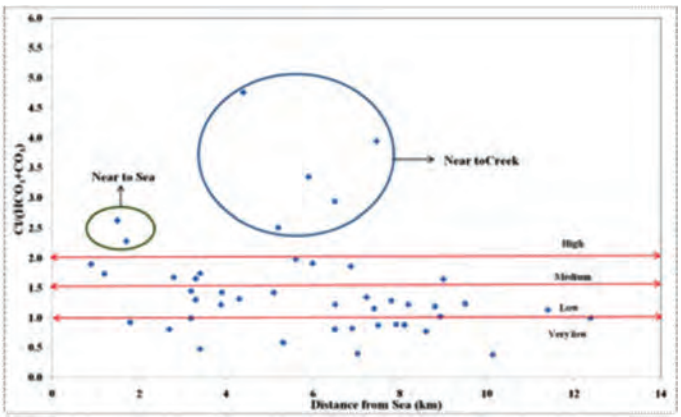


Fig.9. b: [Cl-]/ [HCO3+ CO3] versus Distance from creek (km)

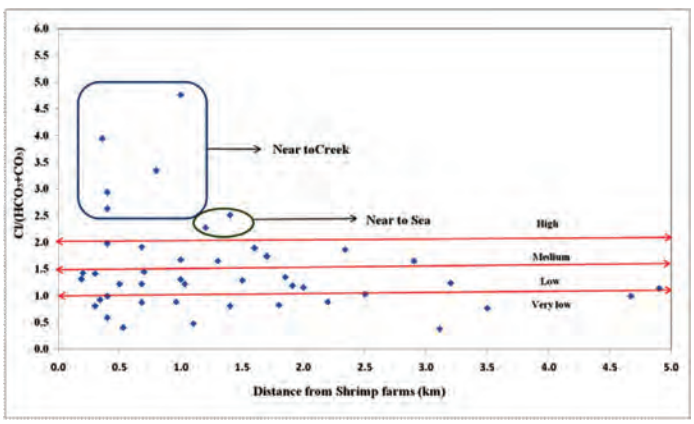


Fig.9.c .[Cl-]/ [HCO3+ CO3] versus Distance from sea (km)

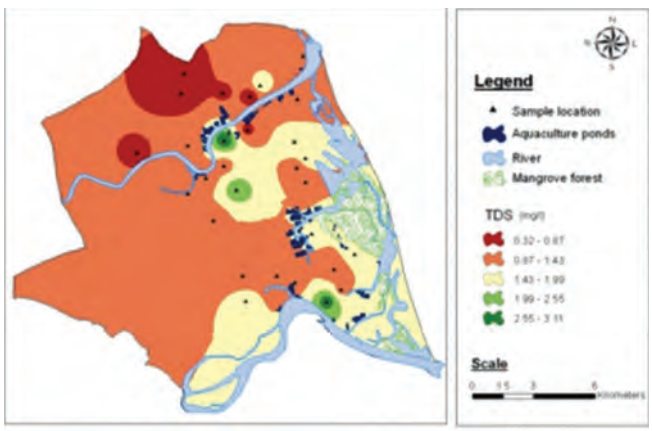


Fig.10. Spatial distribution of EC

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

Demonstration of milkfish farming in Gujarat

Milkfish larvae (50,000) in the size range of 1.0-1.2 cm were obtained from wild and maintained at MES hatchery by feeding rotifers initially followed by *Nannochloropsis oculata.* After 3 days, *Artemia* nauplii along with rotifers and algae were fed. Ten days later, they were fed a commercial formulated diet and after 21 days the fry size ranged from 2.2-2.8 cm with a weight ranging from 0.8-1.0 g. The fry were then transported to grow-out culture in Gujarat and stocked in five farmer's ponds of Olpad taluk, Surat district. At stocking, the pond area and depth varied from 0.5 to 1.5 ha and 0.75 to 1.5 m respectively the salinity ranging from 32-35 ppt. Lab-lab formed the primary feed which was supplemented with rice bran for the first two weeks @ 8-10% body weight and later with commercial pellet feed in four ponds and CIBA formulated feed in one pond.

Table 2.Details of grow-out culture of milkfish.

Location of the pond (Village)	Date of stocking	Stocking density (nos/m^2)	Days of culture	Average total length (cm)	Average weight (g)
Mor	10.5.2013	0.90*	217	34.8	350
Mor	10.5.2013	0.57**	217	38.6	381
Sarash	11.6.2013	0.61*	186	36.2	360
Mor	11.6.2013	0.53*	186	29.4	240
Mor	04.8.2013	0.52*	163	30.4	250

(* indicates floating carp feed and ** indicates CIBA feed)

Milkfish

In Gujarat, vibrio bacterin (immunostimulant) was used as a therapeutic agent in 7 tiger shrimp culture ponds with reported physical deformities. The shrimp exhibited complete recovery from deformities.

Ginger shrimp (*Metapeneaus kutchensis)* collected from wild stocked @8 nos/m^2 was harvested at 134 DOC with a production of 307 kg/ha and 90% survival.

Studies on mineral supplementation in *L.vannamei* culture ponds

A study of application of minerals on the growth and production of *L.vannamei* was conducted in a shrimp farm at Billimora District, Gujarat with a weekly application and compared with another farmer applying mineral mixture once in 10 days. The mineral application dose did not reveal any significant difference in production parameters viz., survival, average body weight, overall production and FCR (Table 3). There was no difference in growth till 12 weeks after which the treated group exhibited higher growth compared to control (Fig. 11). The results revealed that there is no need to apply excess minerals in culture ponds at higher salinities consequent to which production cost can be reduced thereby benefitting farmers.

Table 3.Comparison of treatments on production parameters

Parameter	Treatment (n=3)	Control (n=3)
Area (ha)	0.967 [a]	0.983 [a]
Mineral application (kg/ha)		
Product 1	347.82 [a]	585.18[b]
Product 2	424.97[a]	731.48[b]
Stocking (nos/m^2)	36 [a]	38 [a]
DOC (days)	133[a]	127[a]
Survival (%)	87[a]	88 [a]
ABW (g)	21.70 [a] ±2.98	20.72 [a] ±3.63
Production (kg/ha)	6796[a]	6964[a]
FCR	1.48[a]±0.13	1.46[a]±0.14

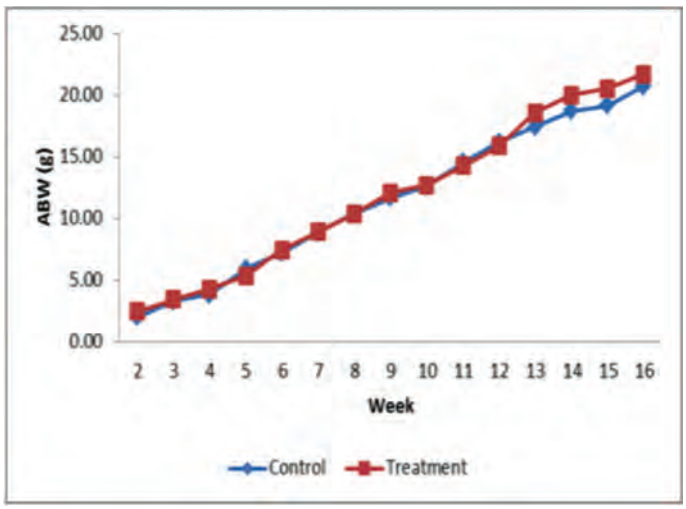


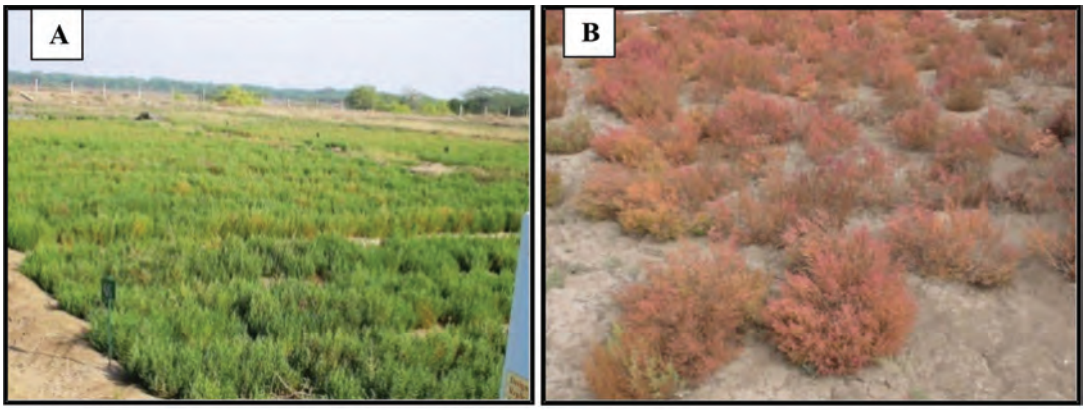
Fig. 11. Effect of mineral supplementation on growth in *L.vannamei*

Growth performance of *Salicornia* crop irrigated with aquaculture discharge water

The discharge water could be effectively used to irrigate halophyte crops such as *Salicornia brachiata*. Field studies were carried out in Danti farm, Navsari Agricultural University, by irrigating the halophyte with waste water from discharge pond. Based on the fresh biomass yield, plant height, plant canopy, number of main branches, spike number per branch, spike length, segment number per spike and seed yield, plots irrigated with SFDW gave significantly higher yield compared to seawater irrigated plots (Table 4). No significant difference in soil parameters with respect to electrical conductivity (EC) and pH of soil between the two was observed after the crop harvest. Thus, halophyte crops can be grown with treated SFDW for environmental sustainability.

Table 4. Comparison of irrigation water source on *Salicornia* crop performance

Crop parameter	Seawater	Aquaculture discharge water
Fresh biomass Yield (kg/plot)	5.66 ± 0.75	5.23 ± 0.73
Plant Height (cm)	30 ± 0.98	21 ± 0.98
Plant canopy (cm)	75 ± 4.3	64 ± 0.17
No. of main branches	22	16
No. of spikes per branch	383	286
Seed yield (kg/plot)	516 ± 36.9	437 ± 59.2



***Salicornia* crop irrigated with shrimp farm discharge water**
A) Vegetative phase B) Ripening phase

Genetic variation among White spot syndrome virus (WSSV) isolates from shrimp farms in west coast

Molecular diagnosis and genotyping of WSSV isolates collected from different shrimp farms in Gujarat showed two genotypes for ORF 75, one showing multiple repeats of two 45 bp followed by a 57 bp whereas the other showed two of the repeats that included 5 and 4 repeats of 45 bp also. Sequence analysis of the 54 bp variable sequence of ORF 94 RU type 4 revealed SNP at the 47th base. Based on this the dominance of RU types 11 or 4 were observed and one sample showed 2 bands of different sizes indicating the prevalence of two different genotypes infecting the same pond at a given time. The results suggest the widespread occurrence of WSSV in the region and circulation of distinct viral genotypes.

Pond microbial dynamics, physico-chemical and production parameters in low and high intensity grow-out culture of *Litopenaeus vannamei*

The quantity and quality of microbial products determine the cost of shrimp production. A field trial evaluated in high and low stocking densities of *L. vannamei* indicated that the application of microbial products in large quantities did not significantly benefit production among ponds with lower probiotic product usage (Fig. 12), as the environmental parameters were within the optimum range in both the groups. The study highlights the importance of regulation of quantum and schedule of biological product usage for economically sustainable shrimp culture (Table 5).

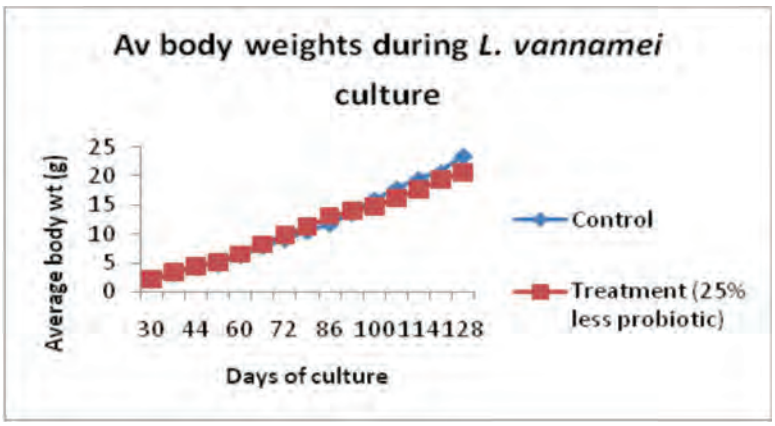


Fig.12.Growth of *L. vannamei* using probiotics

Table 5. Comparison of final harvest data of regular and reduced (25%) probiotic administered *L. vannamei* grow out culture (mean±SD).

Parameters	Treatment (n=3) (25% reduced probiotic)	Control (n=3) (regular probiotic)
Area (ha)	0.883 [a]	1.2 [a]
Probiotics application (kg/ha)	**23.44[a]**	**31.03[b]**
Stocking (nos/m^2)	39 [a]	35 [a]
DOC (days)	141 [a]	137 [a]
Survival (%)	88 [a]	90 [a]
ABW (g)	20.66 [a] ±1.24	23.47 [a] ±0.91
Production (kg/ha)	7,272 [a]	8,118 [a]
FCR	**1.67[a]**	**1.45[b]**
Cost of probiotics (Rs)	**70,320**	**93,390**

Project Title (NFDB) **Monitoring of disease occurrence and culture practices in *L. vannamei* hatcheries and farms**

For disease monitoring, a number of samples from different farms were collected as per the details given below in table

S.No	State	District	Area/Village	No of Farms	No of Samples
1	Tamil Nadu	Nagapatinam	Vettaikaranerupu,Sirkazhi	6	11
		Thiruvallur	Kattur,Pulicat	7	12
		Kanchipuram	Kalpakkam,Mahabalipuram	14	21
		Viluppuram	Marakkanam	7	10
2	Andhra Pradesh	Nellore	Podur	1	3
			Iscopalli	4	8
			Nekundapalayem	7	8
			Pottampalayam	1	1
			Puduparthy	1	1
			Nedumusili	3	3
			Kudithipalayem	1	1
			Mungamuru	1	3
			Eshwaravakkam	10	11
			Gudur	25	27
		West Godavari	Bhimavaram	3	3

However, five samples (collected twice) in Kovattur and 11 samples (collected once/thrice) were obtained from different hatcheries in Kovattur and Marakkanam. Shrimp samples collected from farms exhibited a wide number of clinical signs during disease condition.

A large number of these samples were either positive for WSSV or IHHNV. In several cases, co-infection with both these viruses was also observed. Distribution of both these viruses was observed throughout the year.

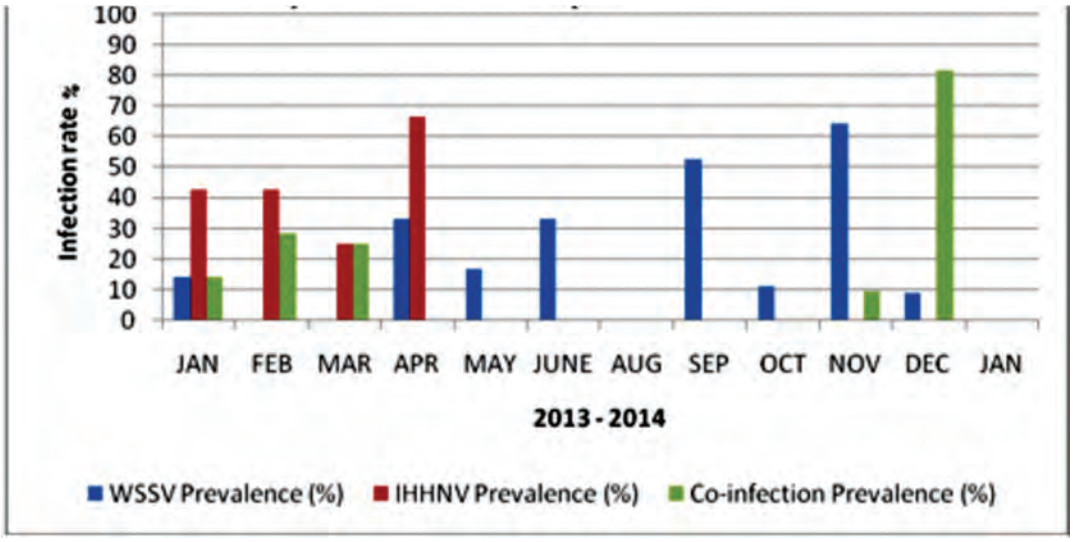
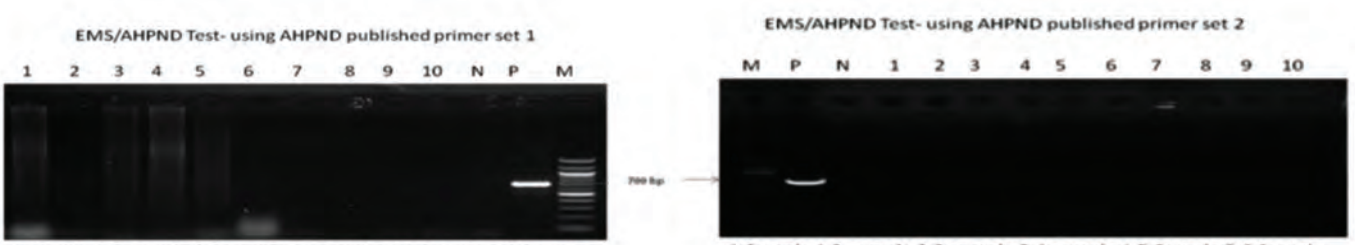


Fig. 13. Viral prevalence of *L. vannamei*

Prevalence of several *vibrio* species including *V. parahaemolyticus* was observed during different times of sampling. PCR protocol for detection of Early Mortality Syndrome (EMS)/Acute hepatopancreatic Necrosis Disease (AHPND) was standardized with two sets of primers. Pure isolates of *V. parahaemolyticus* as well as different organs of shrimp such as stomach and hepatopancreas were found negative for EMS/AHPND specific strain. The result was similar with two sets of primers designed by Dr. Flegel's group from Thailand.



1-Sample 1,2-sample 2,3-sample 3,4-sample 1,5-Sample 5,6-Sample 6,7-Sample 7,8-Sample 8,9-Sample 9,10-Sample 10,N-Negative control,P- AP 1Positive control.M-100 bp Marker

1-Sample 1,2-sample 2,3-sample 3,4-sample 1,5-Sample 5,6-Sample 6,7-Sample 7,8-Sample 8,9-Sample 9,10-Sample 10,N-Negative control,P-AP 2 Positive control.M-100 bp Marker

Targeted samples for Running Mortality Syndrome (RMS) could not detect any specific infectious agent as the causative agent either by OIE specific viral pathogen PCR or by co-habitation study. Similarly, shrimp that died in the early days of culture were invariably infected (95%) with a high load of WSSV.

Project Title (DBT)	**Molecular mechanism and steroidal control of reproductive maturation in the commercially important shrimp *Penaeus monodon***

The effect of 17 ß-estradiol (E2) a hormone that plays a vital role in the reproductive maturation of tiger shrimp and vitellogenin (Vg), a biomarker for reproduction was studied. A significant Vg mRNA up-regulation was detected in the immature(yellow) ovary explants treated with estradiol at 76 µM and 114 µM doses (Fig.14) On the contrary, no significant Vg mRNA up-regulation was detected in immature

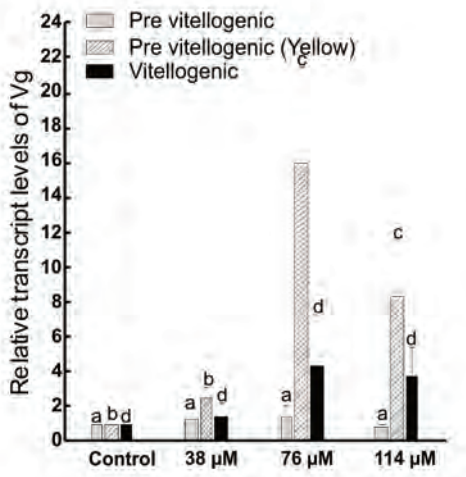


Fig. 14.Changes in the transcript levels of Vg in the ovary by quantitative RT-PCR. Bars indicate mean relative levels of Vg for 5 individuals.

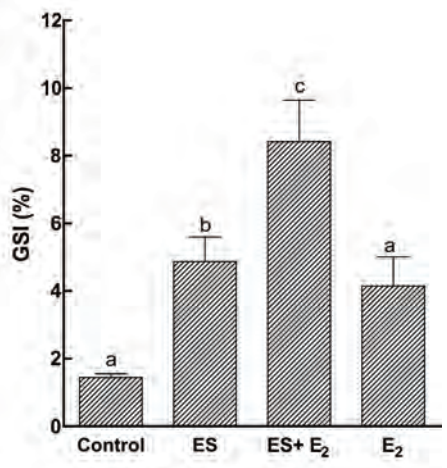


Fig. 15. *In vivo* effect of 17ß-estradiol on gonadosomatic indices in tiger shrimp (P<0.05)

(transparent) and vitellogenic ovary treated with estradiol. The results confirmed the gonadotropic role of E2 and the role of nuclear receptor in the hormonal action of sex steroid.

FINFISH CULTURE DIVISION

Project Title (Institute)	Dissemination of technology on the seed production of Asian seabass (*Lates calcarifer*) and development, standardization and refinement of seed production technology for other commercially important brackish-water fishes

Breeding and seed production of Asian seabass

A total of 120 fishes (0.5 to 8.0 kg) are being maintained in 100 t RCC tanks and also in 10 t capacity FRP tanks under RAS. Trash fishes like tilapia and sardines are fed daily @ 3-5% body weight and water exchanged daily @ 80%. Fishes were examined regularly for assessing maturation. A total of 16 breeding trials were performed out of which seven trials were with hormone (LHRHa) treatment and nine spawned spontaneously. Repeated spawning was observed four times on successive days by a single fish. The eggs in all cases got fertilized (20 to 90 %) and the number of spawned eggs varied from 0.50 to 4.0 lakhs/ spawning. Fertilized eggs were stocked for hatching in incubation tanks @ 250 eggs/l. Hatching rate varied from 35-85%. The newly hatched larvae were stocked in larval rearing tanks and maintained in zero water exchange system up to 12 days. Rotifers (*Brachionus plicatilis*) were supplied as initial feed from 2 dph (days post hatch) and *Artemia* nauplii from 9 dph. After 12th day, 30% water was exchanged and weaning diet with formulated feed initiated from 16 dph. Upto 70% survival was observed (21 dph) with an average of 45%. A total of 10.05 lakhs seabass fry were supplied to 25 farmers. An amount of Rs.7.06 lakhs was realized as revenue through sale of seed.

Transfer of Technology

A consultancy project with Surya Udyog hatchery, Gopalpur, Odisha on Hatchery technology for seabass was taken up and facilities for live feed culture established. Technical know-how was imparted for production of indoor algal culture and mass culture of marine algae and rotifers. A 10-days training was imparted to the hatchery staff on larval rearing. In Krishna district, Andhra Pradesh, consultancy was provided to a private hatchery on larval rearing and seed production of seabass.

Consultancy acitivities at Surya Udyog, Hatchery, Gopalpur, Odisha

Captive broodstock development of Grey mullet *Mugil cephalus*

To the existing stock of 45 fishes, an additional 16 fishes were added (total 61 fishes). The freshly procured fishes ranged from 400 g to 1.5 kg and were stocked in ponds and tanks. Fishes were fed

formulated pellet feed @ 5% body weight. From the second week of September 2013 to January 2014, maturing females were monitored.The oocytes in females had a diameter ranging from 330 to 440 µm and these females were administered HCG hormone @ 1000 IU/fish to accelerate the advancement of maturation. However, the size of the oocytes did not increase above 490 µ. A breeding trial with a female having an ova diameter of 490 µ by administering the hormone (HCG) was tried, but there was no response.

Induced breeding trials on *Mugil cephalus* brooders from Chilika lake

Matured fishes from Chilika were transported from Satpada to Jhonikudha by boat and from Jhonikudha to Gopalpur by road to a private hatchery. The fishes were transported in 500l FRP tanks using lake water and sufficient aeration. A total of 9 breeding trials were conducted out of which, four fishes were injected with carp pituitary extracts @ 20 mg/kg body weight as priming dose and LHRHa @ 200 µg/kg body weight. The initial oocyte diameter varied from 450 to 550 µm. Though the initial response of ovulation was good, the oocyte did not reach the final stage ovulation. However, stripping was attempted to fertilize the eggs but proved ineffective. All the trials were carried out in December 2013, the water temperature being in the range of 18-22°C. A possible reason for the oocytes not reaching the final stage of ovulation could be the low water temperature during ovulation period. However, the trials do indicate the potential of brooders from Chilika lake for breeding purposes.

Grey mullet breeding trials at Chilika lake

Chanos chanos

A total of 32 fishes in the size 3- 5 kg (7+ years) and 20 fishes (2+ years) were maintained in broodstock tanks and ponds following routine protocols. Slight oozing could be noticed in one male fish, weighing 4.0 kg. Four milk fish (7+ years) having gonadal tissues were injected with HCG hormone @ 1000 IU/ kg body weight to accelerate maturation but no further advancement in oocyte development could be noticed.

Milkfish

Brackishwater ornamental fishes (*Scatophagus argus* and *Monodactylus argenteus*)

A total of 180 *S.argus* in the size of 65.0 to 350 g and 150 *M.argenteus* in the size range of 25.0 to 80 g were maintained in an earthen pond. New stock were also added. Commercial pellet feed @ 3-5 % body weight was fed. Regular sampling was carried out to monitor maturity. For both species, maturity was observed in the pond condition. Four sets of breeding trials were performed in *S. argus* out of which in two cases, natural spawning could be observed with fertilization being absent. About 25% attained maturity and mature females and males were observed in the ratio of 1:3. Out of 12 breeding trials using hormone, 4 were successful and larval rearing performed for 2 sets in the case of scat. Male maturity could be observed for moonfish.

Etroplus suratensis

Breeding of pearlspot in small net cages and RAS

This is being evaluated in collaboration with a pearlspot farmer using eight hapas. In the initial trials, multiple breeding was observed in all hapas. In preliminary trials, the average fry production ranged from 60-200 nos./hapa/breeding. The total number of fry produced in three months is approximately 1000 numbers.

In the experimental cage breeding trials at MES, fry were separated at an interval of 2.5 months,the production being 90-360 fry/hapa/breeding. Further simplification of the cage breeding model was attempted by suspending small earthen pots in hapas. The larvae were then harvested at wriggler stage and reared in plastic tanks. The seed production per hapa (as larvae) ranged from 1300-1800 per breeding. Larval rearing was carried out to evaluate alternate feeding strategies viz. artemia+commercial larval feed, only artemia, rotifer *(Brachionus plicatilis)*+commercial larval feed and rotifer alone. The survival rates were almost similar (94 and 96%). The specific growth rate showed significant difference (*P<0.05*) with the highest SGR being recorded in larvae fed artemia+commercial larval feed (10.97% day^{-1}), followed by rotifer + commercial larval feed (9.88 % day^{-1}), artemia (9.57 % day^{-1}) and rotifer (6.41 % day^{-1}).

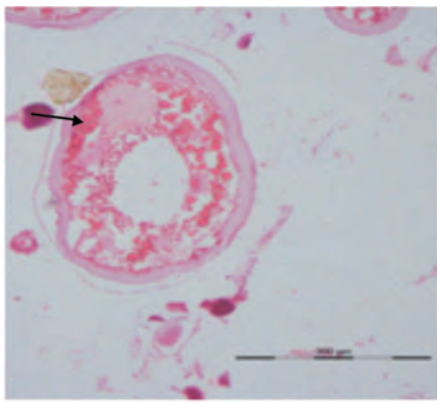
Breeding of pearlspot

Reproductive physiology of brackishwater fishes

Influence of hormone and dose on *in vitro* development of *Liza macrolepis* oocytes

The action of hormones on oocytes *in vivo* was studied using *in vitro* culture techniques by evaluating the efficacy of different sex steroids such as 17α- Methyl Testosterone, 17β- Estradiol, Maturation Inducing Steroid (1µg/ml, 0.1µg/ml, 0.01µg/ml, and 0.001µg/ml) and Human Chorionic Gonadotropin (5 IU/ml, 50 IU/ml, 100 IU/ml and 500 IU/ml) on the development of *Liza macrolepis* oocytes incubated at room temperature. A total of 0.5 g of oocytes was collected from a maturing fish (weight: 116.5 g and TL: 23 cm) having initial mean oocyte diameter of 215 µ. The growth of oocytes was evaluated by measuring the change in oocyte diameter, germinal vehicle break down (GVBD).

Improvement in oocyte diameter was observed 48 h after incubation. Among all hormones tested, HCG (500 IU/ml) appeared to be most effective in improving the size of the oocytes however GVBD was noticed only in the case of MIS.



Histology showing migration of germinal vehicle (arrow) toward animal pole

Reproductive hormone profile of Grey Mullet

Monthly hormonal fluctuation in the captive stock of female mullet was studied. Four females (1.2 Kg) and four males (400 g) were maintained in 800 l FRP tank attached to RAS. Monthly samples of blood were collected. The reproductive hormones-testosterone (T), 17β estradiol (E2) and progesterone (P) were analyzed. Maximum value of T was in September-October, maximum value for E2 was in October-November, progesterone being highest in November. Oocytes were observed only in November (180 -200 µ) after which there was no further growth.Hormone level observed in this trial may not be accurate as the oocyte diameter was never >200 µ.

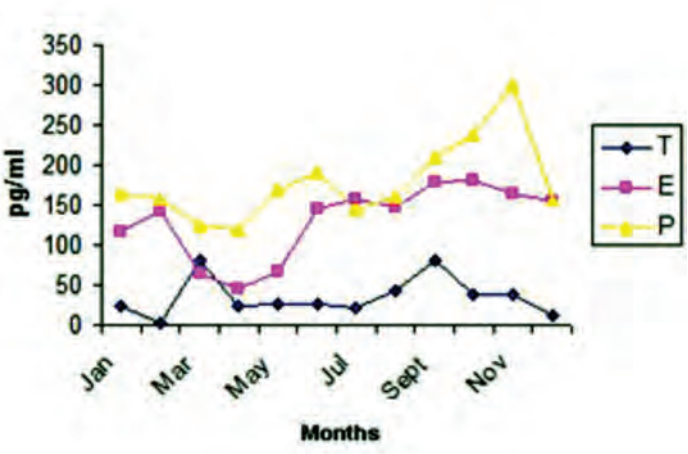
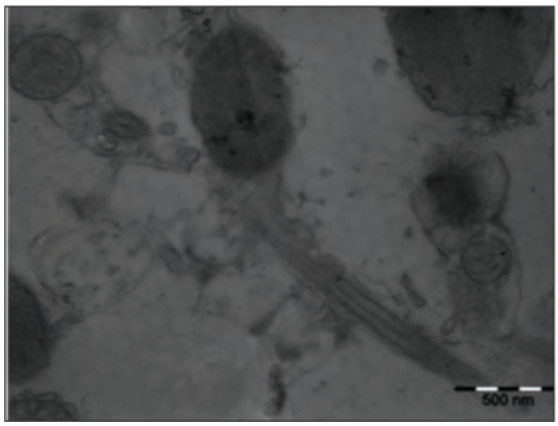


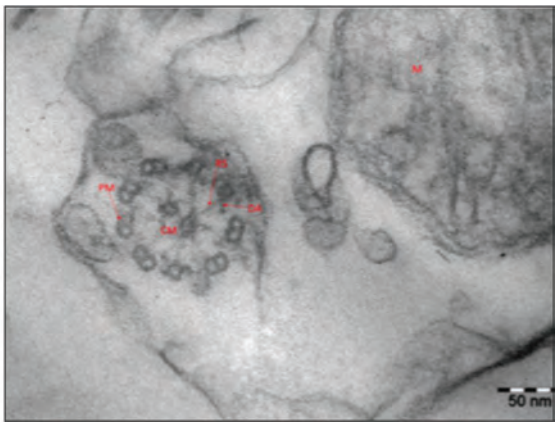
Fig. 16 Hormone Profile

Ultrastructure of grey mullet spermatozoa

The spermatozoon has a spherical shaped head measuring 803.448 nm in length and 913.79 nm in width. The nucleus is spherical and covered by a nuclear envelope that encloses a homogeneous chromatin. Microtubules in flagellum are arranged in a 9+2 fashion.



Mullet spermatozoa TEM



Mullet microtubular arrangement (9+2)

Project Title (Institute)	Improvement and validation of brackishwater fish culture technologies

Cage culture of seabass in open brackishwater system

A pilot study on small scale cage culture of seabass was initiated by collaborating with a traditional fisherman in Ashtamudi lake of Kollam, Kerala. Seabass fry (100 nos ABW: 8 g) produced at MES, were stocked in net cages (2x1.5x1.5 m). Trash fish caught using a Chinese dip net, was fed to the fishes. After 9 months of culture, a survival of 50 % and a maximum body weight of 1.3 kg were recorded. Partial harvest is being carried out and the farmer obtained an income of Rs 5000 per month for two months by selling the fish @Rs 500 kg^{-1}.

Pond culture of Asian seabass in a farmer's pond

Technical know-how was provided to a farmer in Panchanathikulam village, Vedaranyam taluk, Nagapattinam district, Tamil Nadu to take up seabass farming in earthen ponds. The farmer obtained 21,000 seabass fry of 1.0 cm size from CIBA and nursery-reared them in hapas by feeding with scrambled commercial pellet feed. After 45 days rearing, the fish reached a size of 3.5-5.0 cm with 72% survival. He then sold 12,500 nos @ Rs. 5-8 per fingerlings and stocked the remaining 2620 nos in a pre-grow out pond (0.4 ha). In the pre-grow out culture, the fishes were fed with scrambled pellet feed initially and later tilapia. After 60 DOC, the fishes reached a size of 80-100 g with 46% survival. The farmer has stocked 1200 nos of juveniles (80-100g) in a 0.8 ha pond for grow-out culture and supplied live tilapia as feed. After 75 days of culture, the fish have reached an average size of 700 g, the culture being in progress.

Secondary aquaculture in pond

Three different models for seaweed culture (*Kappaphycus alvarezii)* in pond (salinity- 27-28 ppt, pH:7.06-7.28, TAN: 0.79-0.83 mg L^{-1} , NO_2^-N: 0.053-0.06) were evaluated based on their daily growth rate (%).

Seaweed cultured for 70 days on ropes attached to PVC frames (2x1x1 m) with vertical (height: 0.5 m) and horizontal seeding recorded daily growth rate of 1.73 and 2.1% respectively. Seaweed cultured in PVC mesh cage (1x1x0.5 m) for 30 days exhibited a maximum daily growth rate of 3.19%.

Seaweed culture in cages

Rope culture on PVC frame with on horizontal seeding

Nursery rearing of milkfish

Nursery rearing of fry obtained from wild (ATL: 2.84 cm and ABW: 0.082 g) was carried out by stocking in three different earthen ponds (100 m^2 each) @ 2 no/m^2 with three feeding regimes viz. rice bran and ground nut oil cake in a ratio 1:1 (pond 1), formulated feed (pond 2) and fertilised with organic manure on a weekly basis(pond 3). The maximum growth of 7.90 cm and 3.03 g was observed in the group fed formulated feed followed by the group fed with rice bran and oil cake mixture :(7.61cm and 2.76g). In the organic manure pond it was 7.33 cm and 2.48 g. Survival values also followed a similar trend: 81% in the formulated diet, 73 % in the rice bran and oil cake diet and 73% in the organic manure pond. The results clearly indicate that milkfish fry could be reared using formulated diets and also organic manure.

Table 6.Grow-out culture of milkfish *Chanos chanos* tested with two different feeds

		Pond I	Pond II
1	Feed	CIBA feed 1 (High protein 30% and lipid 8% feed)	CIBA feed 2 (Low protein 20% and low lipid 4% feed)
2	Days of culture	215	230
3	Production (kg)	110	120

Milkfish culture was performed in two earthen ponds (600 m^2) at MES to evaluate two types of pellet feed developed by CIBA. Milkfish seed of 3 inch size were stocked @ 1000 nos each in two different ponds and fed formulated feed daily @ 3-5% body weight. High stocking density (@ 16600 nos/ha) by yielded 1917 kg/ha at 230 DOC when fed with low protein feed where as 2034 kg/ha could be obtained at 215 DOC when fed with high protein feed. The average body weight of the harvested milkfish varied from 70 to 440 g and did not show much variation between two feeds.

A haul of milkfish

Nursery rearing of Milkfish in tide-fed brackishwater ponds

Nine ponds (600 m^2) were stocked with pre-nursed fingerlings (3.08g) of milkfish @ 2.15 nos. /m^2.The fishes were cultured under three different feeding regimes: periphyton (PP), formulated feed (FF) and periphyton + feed (FP) in triplicate ponds. White velon net was used as periphyton substrate covering 10 % of pond surface area. Formulated pellet feed developed at CIBA was used for 120 days. The results are depicted below:

Parameters	PP	FF	FP
Final weight (g)	33.46 ^{c} ±4.68	61.24 ^{b} ±8.94	76.34 ^{a} ±11.38
SGR (% day^{-1})	1.22 ^{c} ±0.30	1.73 ^{a} ±0.36	1.78 ^{a} ±0.39
Survival (%)	83.6^{c}	90.8^{b}	94.3^{a}
Condition factor (K)	1.16 ^{c} ±0.14	1.26 ^{b} ±0.09	1.37 ^{a} ±0.13

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

Standardization of broodstock development, induced breeding and seed production of cobia

Wild caught and F_1 stock of cobia (26 nos, 12-30 kg) were reared in earthen pond (300 m^2) and fed daily with forage fish (sardine and tilapia) @ 5% of body weight. During the breeding season (August to May) mature females having the oocyte diameter of more than 680 and males with oozing milt were selected for induced breeding trials by injecting with human chronic gonadotropin @ 300 IU /kg to female and half the dose to male. After hormonal administration, males and females (2.1) were transferred to 100 t RCC tanks for breeding and flow-through maintained. Fishes spawned after 36 h, fertilized eggs were collected and incubated for 18 h to facilitate hatching. During the year, out of 13 trials that were

carried out, successful spawning was observed in 9 cases only. However, successful fertilization could be observed only in three breeding trials. Total hatchlings in each spawning varied from 20,000 to 300,000. Larval rearing was carried out by stocking cobia larvae in 10 t FRP tanks as well as 5 t RCC tanks. First feeding was initiated with rotifers 48 hrs after hatching and *Artemia* nauplii introduced from 6th dph. However, reduction in survival rate could be noticed on 7th dph because of changeover of feed. A total of 100,000 larvae could be produced by 7dph feeding with rotifers followed by *Artemia* nauplii. Artificial formulated feed was introduced from 10th dph and weaning by 20th dph. Cobia fingerlings attained a size of 3 inch size in 45 dph. Fingerlings are being reared in pond cages (20 nos), in RCC tanks (300 nos) with commercial feed and 500 fingerlings were supplied to farmers (M/S Maritech) for pond-based cage culture on CIBA formulated feed.

Cobia in pond

Grow-out culture of Cobia at KRC

A total of 82 fingerlings (ABW-70g) were reared in a 1100 m^2 pond and fed chopped trash fish @ 15-8% of fish biomass for 11 months after which an average body weight of 2.43 kg and survival of 86% was recorded. Overall growth rate and condition factor was 7.15 g /day and 0.86 respectively. Growth was higher at > 10 ppt and fish exhibited signs of stress at salinity < 4 ppt. Low salinity resulted in fading of colour of fishes, reduction of feed intake and signs of skin ulceration. Cobia can be grown in low saline areas around Kakdwip from October to August. Higher saline zones of Sundarbans may be selected for rearing throughout the year.

Cobia sampling

Project Title (DBT)	Indo-Norwegian platform on fish and shellfish vaccine development - development of viral vaccine against noda virus and infectious pancreatic necrosis virus

The efficacy of DNA vaccine obtained from the collaborating institute (Abdul Hakeem College, Melvisharam) was evaluated by administering the same through intramuscular injection in Asian seabass juveniles followed by challenge with Nodavirus. The Relative Percentage Survival (RPS) between the vaccinated and non-vaccinated was 50% in 30 days post vaccination and 33 % in 34 days post vaccination, indicating the positive response of the vaccination in the juveniles.

AQUATIC ANIMAL HEALTH AND ENVIRONMENT DIVISION

Project Title (Institute)	Aquatic animal diseases and intervention tools for their management

Investigation of the putative etiology of mass mortalities of farmed shrimp during early days of culture using metagenomics

Cases of mass mortalities of 11 *L.vannamei* farms during early days of culture (DOC up to 47 days) were investigated. Samples were screened for known OIE listed DNA viruses viz. WSSV, IHHNV, MBV and HPV. *Vibriyo parahaemolyticus* was isolated from two samples that were free from these viral pathogens, besides this they were also subjected to histopathological studies, wherein karyomegaly and haemocytic infiltration in the hepatopancreas were observed. Hepatopancreas tissues from these shrimp were then subjected to metagenomic analysis. The DNA was extracted, cloned in TOPO vector and *E. coli* DH 5α cells were transformed. Transformants (55 clones) were screened for inserts using M13 primers. Sequencing of 55 clones revealed presence of *Lactobacillus* and *Clostridium* like sequences, with the predominance of *Lactococcus garviae*.

Characterizing the role of WSSV during mixed pathogenic infection of shrimps

Genotyping of WSSV strains that were extracted both from the single and co-infection with IHHNV was carried out with VNTRs such as ORF 94 and ORF 125. From the samples that were only infected with WSSV,5 different genotypes were observed with ORF 94 amplification which ranged between 4-11 repeat units (RU). With ORF 125, only two different genotypes were observed. Some samples showed multiple genotypes in the same sample. WSSV isolated from co-infection with IHHNV samples were also found to have five different genotypes and with same RU range (4-11). A similar result was also found with the amplification of ORF 125 where only two different genotypes were observed. Similarly, with ORF 94 amplification, multiple genotypes were also observed in some of the samples. The genotyping revealed that similar genotypes of WSSV were present both in the single and co-infection samples. Based on the ORF 94 amplification, two strains were selected from both sample types (only WSSV infection and WSSV+IHHNV infection) and their virulence was tested with juvenile *L.vannamei*.

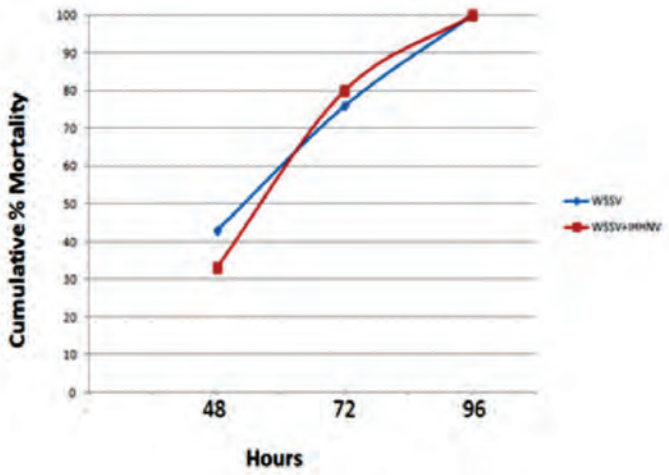


Fig. 17.Virulence of low repeat unit (4 RU) strain

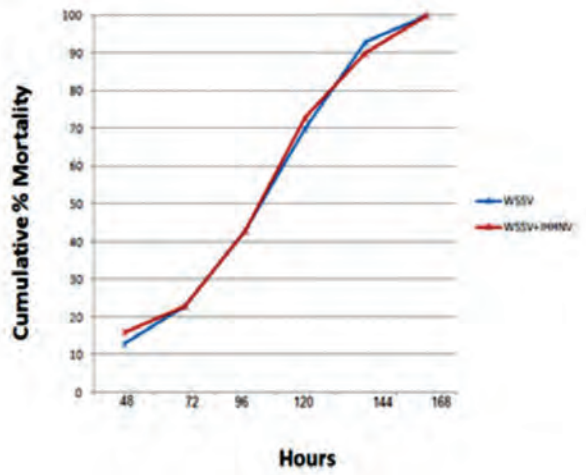
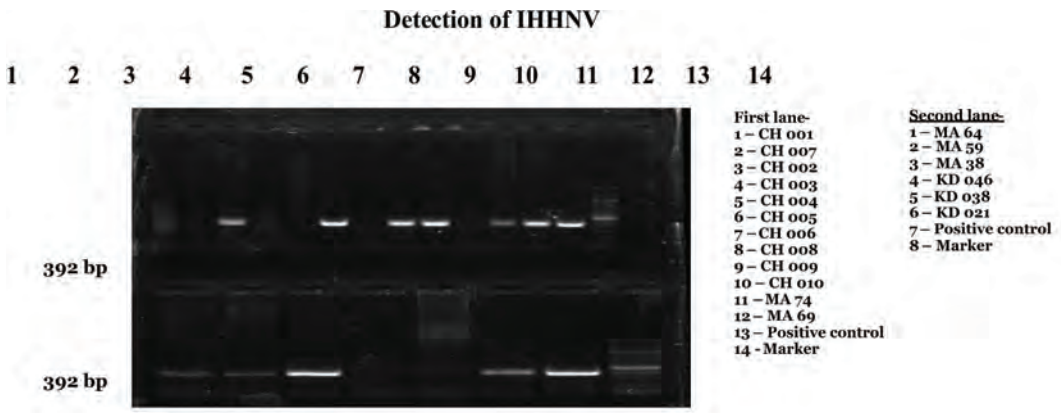


Fig. 18. Virulence of high repeat unit (11RU) strain

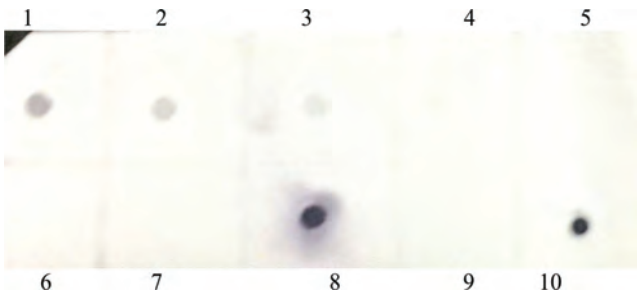
It is obvious that there was no difference in virulence of both the strains. It can therefore be concluded that WSSV strains retain their genotypes and virulence nature even when these are present with another virus such as IHHNV.

Studies on pathogenicity of IHHNV and its defensive role

Shrimp samples from 17 *L.vannamei* farms of TN and AP were screened for IHHNV using PCR to study the genetic variation in the viral strains and 14 samples were found to be positive for IHHNV. Besides this, 34 wild tiger shrimp samples from Mangalore, Kakdwip and Chennai were screened to discern whether any genotypic variation exists in IHHNV viral isolates. Fifteen samples were found to be positive for IHHNV.



In order to increase the diagnostic capability of IHHNV disease in shrimp, *in situ hybridization* technique was standardized using dot blot hybridization technique by evaluating various dilutions of the probe. It was found that a concentration of 15ng/µl gave reliable results. Therefore, a probe with a concentration of 15ng/µl was utilized for standardization in tissue sections.



A preliminary experiment was carried out in shrimp larvae to study the sequential pathology of IHHNV by collecting samples at various time points. The samples tested negative through PCR. Sequential pathology would help in ascertaining the disease progression in shrimp leading to effective disease control.

Investigating the role of *Vibrios* in shrimp during WSSV infection and mortality

Vibrios are considered to be a major problem next to WSSV infection in shrimp culture, hence importance of vibrio associated with WSSV infection was studied. Infected shrimp samples were collected from *L.vannamei* ponds of Nellore, where mass mortality was reported. The haemolymph of moribund shrimp was spread over TCBS plates for isolation of *Vibrio* spp. Bacterial colonies isolated from shrimp harbouring WSSV and belonging to eighteen ponds, were purified and subjected to biochemical identification after Alsina and Blanch (1994) and Noguerola and Blanch (2008). The identified bacteria (%) are as given below:

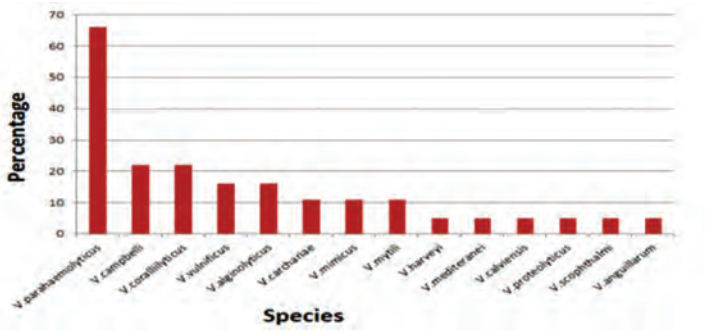


Fig. 19. Percentage abundance of different *Vibrio* sp. during disease outbreak in *L. vannamei* ponds

The dominant bacteria associated with mass mortality and WSSV infection is *V.parahaemolyticus* accounting for 66% of the total isolated bacteria, followed by both *V. campbelli* and *V. coralliilyticus (*22% each). The third majority group consisted of two species, *V. vulnificus* and *V. alginolyticus,* their percentage contribution being 16 each. The *V. parahaemolyticus* strains were tested for virulence against healthy *L.vannamei* from MES using log 10^3 dilution to log 10^5 dilutions. The mortality percentage in *V. parahaemolyticus* was 71.42 % with 10^3 dilutions of 6.0x 10^2cfu/ml.

Effect of oral feeding of *W. somnifera* on *L.vannamei*

A trial to confirm the effect of oral feeding of *W. somnifera* @ 1.0 g/kg on growth and survival in *L.vannamei* juveniles showed that improvement of 15.57% in growth and 16.67% in survival could be obtained after 35 days. The trial confirmed the efficacy and improvement in growth and survival following oral administration of the drug in juvenile shrimp.

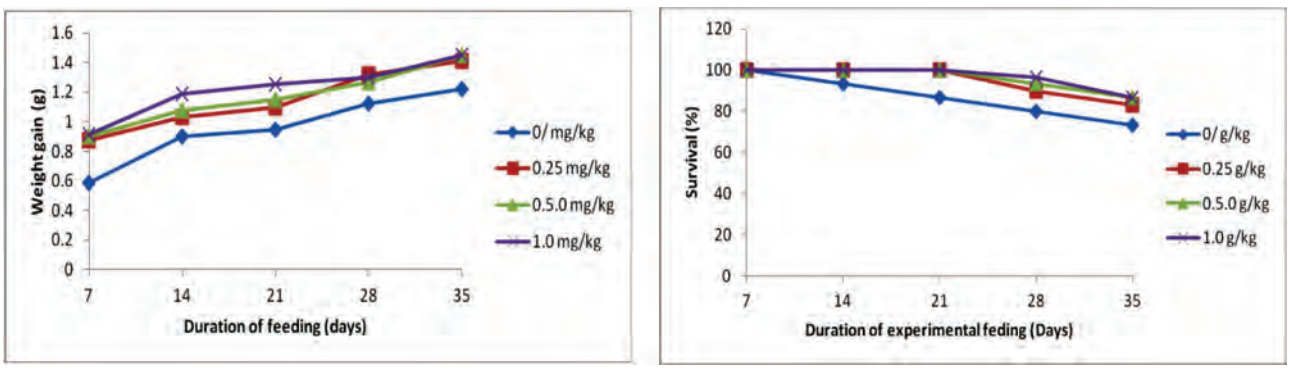
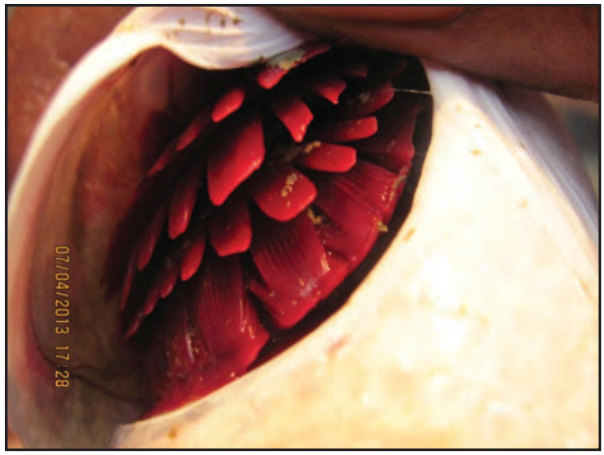


Fig. 20. Effect of *W. somnifera* oral feeding on average weight gain (g) and survival (%) in *L. vannamei* juveniles

Epidemiological investigation of brackishwater finfish diseases

No disease outbreak was reported from 13 brackishwater fish farms from Kerala and Tamil Nadu that were surveyed. However, *Liza tade* monoculture farms (12 ponds) in South 24 Parganas, West Bengal were found to be affected with copepods. The microscopic identification of the suspected parasite resembled *Lernanthropus.* The gills, pectoral fin and caudal fin were severely affected. The severity of infection was correlated with higher ammonia level, total microbial and vibrio count of pond water. The severely affected farm had fish with ABW of 70 g as compared to 106.7 g in mildly affected farm of similar DOC at the time of sampling. However, the mortality remained limited in the severely affected farm.

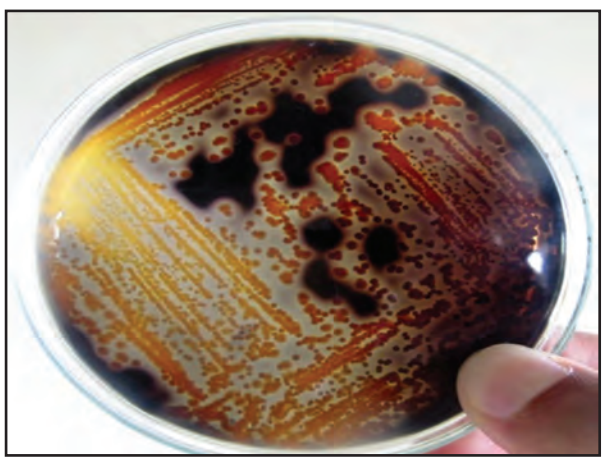


Gills of *Liza tade* affected with crustacean parasite

Bacteriological quality of brackishwater fish, water and soil samples

The bacteriological quality of fish, shrimp, water and soil samples was evaluated by total aerobic plate count, total *Vibrio* count and the presence of *Vibrio parahaemolyticus*, *V. alginolyticus* and *Aeromonas hydrophila*. Total aerobic plate count and total *Vibrio* count in fish and shrimp samples from the ponds of KRC was found to be in the range of 10^4 to 10^6 and 10^3 to 10^4 cfu/g, respectively with the exception of one diseased shrimp sample (*Metapenaeus monoceros)*, in which the total aerobic bacterial load and total *Vibrio* count was found to be 1.376 x 10^8 and > 10^6cfu/g, respectively. The presence of moderately high load of total aerobic bacteria (10^5 to 10^6 cfu/ml) was detected in water samples from brackishwater fish ponds from Purba Medinipur district. The total bacterial load of soil samples from that district ranged from 1.38 x 10^7 to 1.3 x 10^9 cfu/g. The total vibrio count in the water samples ranged from 10^3 to 10^5 cfu / ml.

Out of five water and three soil samples from brackishwater fish ponds and one *L.vannamei* seed sample (PL-10) collected from Purba Medinipur district, the presence of *Vibrio alginolyticus* was detected in 3 of the water samples, all the three soil samples and the *L.vannamei* seed sample. *Vibrio parahaemolyticus* was detected in all the five water samples and three soil samples, but not in *L.vannamei* seed sample. A total of 10 samples (four fish samples from KRC, five water samples and the vannamei seed samples from brackishwater fish farms of Purba Medinipur district) were screened for the presence of *Aeromonas hydrophila* using the selective media starch ampicillin agar (SAA). *Aeromonas* spp. was detected in all the 10 samples. The species of *Aeromonas* will be confirmed later.



Aeromonas colony on starch ampicillin agar after exposing to iodine. Aeromonas forms yellow colony on SAA. Post-exposure to iodine vapour, the media surrounding the colonies does not form black colouration due to hydrolysis of starch.

Development of *in vivo* and *in vitro* models for addressing the pathogenesis of betanodavirus infection in finfish

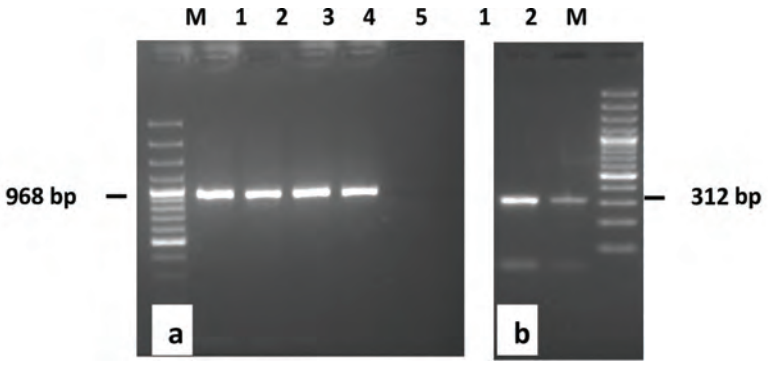


Fig. 21. a) NNV First step PCR b) NNV nested PCR

Several PCR primers have been developed and optimized for the detection of NNV in fish according to the specific geographical requirement. However, these primers failed on some occasions due to sequence variation among the different genotypes of betanodaviruses. The present attempt was to design a primer, capable of detecting all the reported betanodavirus genotypes. The NNV coat protein encoding gene was selected as the PCR target and multiple sequence alignment of the capsid protein gene of all the genotypes was carried out. Based on the analysis of these sequences, a pair of primers amplifying 3-971 nt of NNV coat protein gene for first step and a second primer pair amplifying 393-705 nt for nested PCR were designed using online software. With these primer pairs, a 968 bp product in first step and 312 bp products in nested PCR was obtained without any non-specific amplification (Figs.21 a,b).

Testing efficiency of vaccines for control of *V. anguillarum* infection in sea bass

Serotypes of O2a and O2b are the main causative *Vibrio anguillarum* species in Asian seabass. Anti-rabbit hyper immunised serum vaccinated with inactivated pathogenic *V.anguillarum* was purified by protein A sepharose column. Purified Outer Membrane Proteins (OMPs) were subjected to Immuno affinity chromatography, resolved on 2D gel electrophoresis and analysed by MALDI for identification of antigenic peptides. The challenge experiment with recombinant protein OMPK in juvenile seabass showed relative percentage survival rate of 79% against controls (34%) in a 45-day experimental period.

Maintenance of *in vitro* models for viral infections of finfish

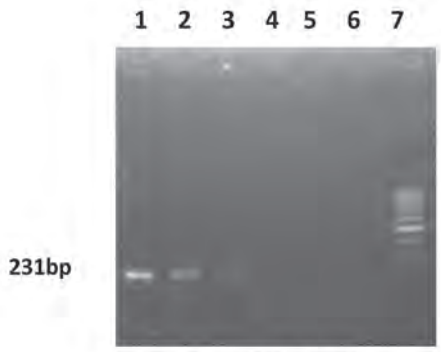
Explant tissue cultures of spleen, kidney and gills from pearlspot fish was tried with 1x L-15 basal culture medium supplemented with 10% fetal calf serum (FCS) and antibiotics. Spleen explant culture showed cell growth. The cells that emerged from spleen explants were sub cultured twice, showed 70% confluent monolayer with fibroblastic like cells. The sub-cultures could be maintained upto 10 days with FCS supplementation.

Regional proficiency testing program for aquatic animal disease diagnostic laboratories

Proficiency testing is an important mechanism for animal health laboratories to test and improve their diagnostic capabilities. The regional proficiency testing for aquatic animal disease diagnostic laboratories in Asia provides proficiency test samples for molecular testing of high priority diseases

for aquatic animals under a collaborative program between Department of Agriculture, Fisheries and Forestry (DAFF), Commonwealth Scientific and Industrial Research (CSIRO) and Australian National Quality Assurance Program (ANQAP). CIBA has been designated as the coordinating laboratory for six participating labs in India and it had participated in the testing program for three viruses viz. WSSV, IHHNV and NNV in two rounds with a satisfactory score during 2013.

In order to enhance the diagnostic capability for exotic viral diseases like YHV and TSV, standardization of PCR diagnostics using positive samples received under Laboratory Proficiency Testing (LPT) Program was carried out. The PCR diagnostic techniques were standardized using OIE protocol for using two developmental samples of pathogen materials (non-viable) of TSV and YHV as a source of positive control received under this program. The cDNA synthesized was subjected to PCR using OIE first step and nested PCR protocol. In case of YHV, an amplified product of 794 bp and 277 bp was obtained in first step and nested PCR, respectively. The TSV cDNA was subjected to one step PCR using OIE protocol amplifying 231 bp products (Figs. 22).

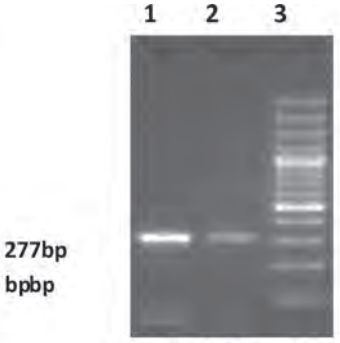


Lane 1 - TSV positive
Lane 2 - TSV positive
Lane 3 - TSV positive
Lane 4 - TSV negative
Lane 5 - TSV negative
Lane 6 - TSV negative
Lane 7 - 100 bp marker

Fig. 22 a) TSV PCR

Lane 1- YHV I[st] step positive
Lane 2 - 100bp marker
Lane 3 - YHV negative

Fig. 22 b) YHV first step PCR



Lane 1- YHV nested positive
Lane 2 - YHV nested positive
Lane 3 - 100bp marker

Fig. 22 c) YHV nested PCR

Project Title (DBT)	**Horizontal transmission and infectivity of white spot syndrome virus in brackishwater aquaculture ecosystems**

The basic objective is to comprehend the transmission of white spot syndrome virus (WSSV) in the aquatic ecosystem. Information on the viability of WSSV and its transmission in aquaculture environment,has been generated. The viability of WSSV in seawater and shrimp pond sediments under experimentally simulated drainable and non-drainable pond conditions was examined by shrimp infectivity experiments. The virus was viable and infective in shrimp in pond water for 12 days in seawater of 27 ppt salinity, pH of 7.5 at 29-33°C as revealed by its ability to infect juvenile shrimp; whereas, in shrimp pond sediment, the virus was viable and infective up to 19 days despite sun-drying. In the case of non-drainable conditions, WSSV remained infective for a period of 35 days. Although the sediment samples tested nested-PCR

positive, after 19 days of sun-drying and 40 days under water-logged conditions, shrimp did not show signs of the disease, suggesting that WSSV was not viable. After 21 days under sun-drying and 40 days under non-drainable experimental conditions, due to reduction in viral load, sediments were positive only by nested PCR, and by this time, viability of WSSV was almost lost. Hence, PCR testing of shrimp farm sediment before initiating culture may help in ensuring biosecurity.

Methodology for detection of WSSV in aquaculture ponds developed

Water represents an important component in the WSD transmission pathway in aquaculture. Detection of viruses in water is a challenge, since their count will be too low to be detected by known methods. To overcome this difficulty, viruses in water need to be concentrated from large volumes of water prior to detection by PCR. Methods have been developed for concentration of viruses by ultrafiltration using tangential flow filtration (TFF) to enable WSD detection by PCR and enumeration by Real Time PCR. Further, methods for estimating viral number in aquaculture ecosystems by epifluorescence microscopy, protocols for extraction of viruses from shrimp pond sediments and WSD detection have also been developed. These techniques could be used as important tools for comprehending the efficacy of biosecurity protocols adopted in culture and also for carrying out epidemiological investigation of aquatic viral pathogens.

WSSV can be transmitted by fauna and microalgae

Information on transmission of WSD by hard clam *Meretrix meretrix* and microalgae are scanty. Hence, the ability of molluscs to transmit WSSV was examined. Molluscs free from WSSV, maintained in aquaria spiked with 100 WSSV particles mL^{-1} were found to remove WSSV from water in 48h. However, the clam tissue was infective to shrimp, indicating its role in WSD transmission, even though for a short duration. Similarly the role of microalgae in transmission of WSD is less known. *Chlorella* culture (cells density $2.5x\ 10^5$ cells mL^{-1}), with 1000 WSSV particles mL^{-1} spiked once initially was found to transmit WSD for a period of six days in juvenile shrimp.

Project Title (NBAIM/ICAR)	**Bioremediation of effluents from shrimp farms**

Environmentally important group of bacteria viz. chemolithotrophic nitrifiers, aerobic denitrifiers, heterotrophic nitrifiers, chemolithotrophic and heterotrophic Sulfur oxidizers were isolated and evaluated for their efficiency to oxidize ammonia, nitrite and sulfide *in vitro*. These bacteria are extremely slow growing and difficult to culture. Two new methods viz., a differential filtration-micro irrigation method for rapid enrichment of chemolithotrophic ammonia oxidizing bacteria (AOB) and a simple method for qualitative confirmation of denitrifying bacteria were developed and evaluated. Large-scale AOB-NOB enrichments (80 L) were developed and concentrated to 6L by TFF. The concentrate would be useful in ponds for mitigating the effect of ammonia.

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

The objective was to identify the microbial biodiversity in aquaculture ponds using metagenomics. A metagenomic library was constructed from shrimp pond sediment. The 16S rDNA was amplified using

bacterial fD1 and rP2 universal primers and the amplified PCR products were purified and cloned into pTZ57R/T vector in *E. coli* DH5α. The clones were screened using M13F and M13R primers for inserts. Over 200 clones with 16S rDNA inserts were detected, out of which, 137 clones were sequenced and subjected to BLAST analysis to decipher the microbial diversity. About 137 clones fell into 10 major phyla of the bacterial domain and a number of hitherto unreported bacteria viz. proteobacteria (Alpha-, Beta, Gamma-, and Delta-), the bacteroides group, actinobacteria, chloroflexi, firmicutes, acidobacteria group, planctomycetes, cyanobacteria/chloroplast, chlorobi, verrucomicrobia and unclassified bacteria were identified in the pond sediment. The brackishwater aquaculture pond sediment had a higher abundance of Gamma- and delta-Proteobacteria, mainly involved with sulphate reduction in anaerobic conditions.

Project Title (DBT-NORWEGIAN Project)	**Development of bacterial vaccines (*Vibrio anguillarum*) for sea bass**

Outer membrane proteins (OMPs) extracted and purified by immune-affinity chromatography were resolved on 2D gel electrophoresis. Five major expressed outer membrane proteins *viz.* OMPW (23KDa), OMP 261a (28KDa), OMPU (35KDa), flagellin B (39KDa) and maltoporin (46KDa) were identified by MALDI analysis. Challenge experiments carried out with recombinant proteins OMPU and OMP 261a showed RPS of 75% and 73% against controls. Chitosan-based nanoparticles were prepared for antigenic vaccine delivery. Experiments with chitosan-based delivery of OMP vaccine with OMPU and OMP261a showed RPS of 78 % and 76% against controls and ELISA titres were maintained comparatively high than normal delivery protocols during the 45 days challenge period.

Project Title (DBT)	**Identification of etiology of Monodon Slow Growth Syndrome (MSGS) of black tiger shrimp in India and development of rapid diagnostic tools**

The involvement of viral pathogens in causing MSGS in shrimp was evaluated. Shrimp samples were collected from both tiger shrimp and *L.vannamei* culture farms, ranging from 35-80 DOC in AP and TN. A total of 298 shrimp samples from 24 farms, in addition to wild tiger shrimp broodstock and post larvae samples from five hatcheries were collected. The results from PCR screening are as follows:36% samples positive for PstDNV, 3% positive for MBV and negative for HPV. Wild tiger shrimp were positive for PstDNV (8%) and negative for HPV and MBV. The post larvae were positive for PstDNV (23%) followed by MBV (8.2%). About 115 shrimp and wild tiger shrimp brooders when PCR screened, tested negative for LSNV.

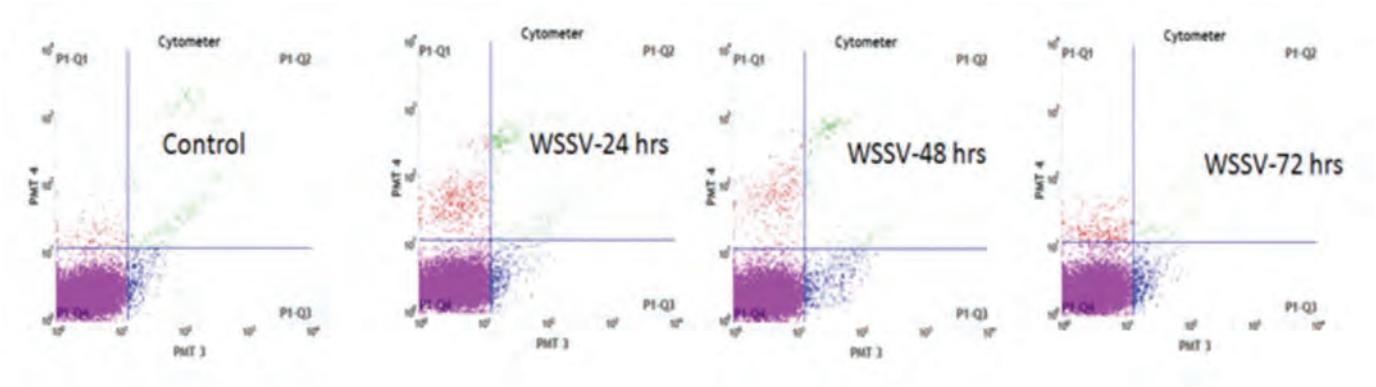
Project Title (NFBSFARA, ICAR)	**Defense genes of tiger shrimp (*Penaeus monodon*) with respect to bacteria (*Vibrio harveyi*) and white spot virus (WSSV) infection**

The host defense system was analyzed based on the biochemical and haemocyte property with respect to two different pathogens (WSSV and *Vibrio harveyi*). The shrimp were injected with pathogens, haemolymph was collected and different analyses were carried out. Biochemical analysis of shrimp haemolymph revealed that there was increase in Pro-PO and respiratory burst activity at each time point and decrease in SOD activity. However, in control also there was variation with respect to time points.

The effect on control could possibly be due to a combined effect of handling and injection stress. In order to verify this, a separate experiment was carried out where shrimps were infected by oral feeding. The control batch was supplied with pellet feed.

As was observed, the effect on control became stable. During 48 and 72 hours, the value was almost similar in all the parameters. Effect of pathogen on shrimp haemocytes was analyzed by Flow Cytrometry. Haemolymph was collected and haemocytes separated as per the standard protocol. The haemocytes were then processed and stained with propidium iodide followed by flow cytometer analysis. All the control samples showed normal peak indicating prevalence of healthy haemocytes that were stained by PI. However, haemocytes collected from WSSV, *Vibrio harveyi* or a mixture of both pathogens exhibited different cell distribution patterns where a large number of cells did not take up the stain. However, it was not possible to know if this was due to apoptosis or necrosis.

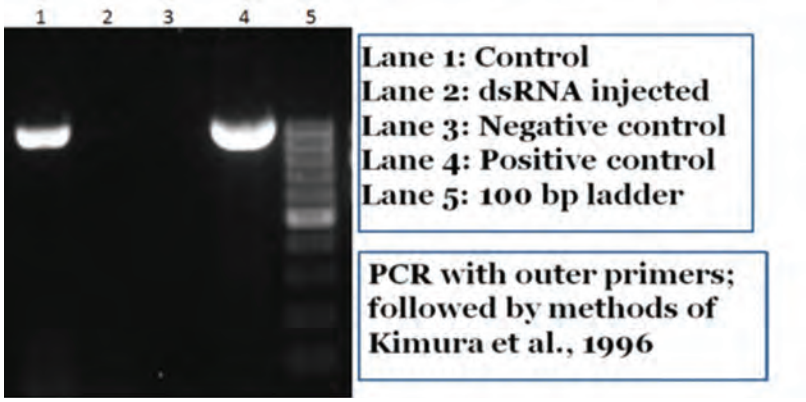
In order to determine if the effect was due to apoptosis, the haemocytes were further processed by double staining with both PI and Annexin V. To prevent stress, shrimp were infected through oral route.



Sector P1Q1 represents cell death due to necrosis, P1Q2 due to apoptosis, P1Q3 due to early apoptosis and P1Q4 represents normal cells those have taken up PI stain. Higher number of cells in early apoptotic stage was recorded at all the time points compared to control and this peaked at 48 hours post infection.

Project Title (DBT)	Development of white spot syndrome virus free shrimp brooders for seed production: using indigenous shrimp, *Penaeus indicus* as a model

When shrimp are injected with VP28 dsRNA @ 1µg/gm of shrimp either 24 or 48 hours post WSSV infection, 100% protection was provided and the shrimps survived at least for 20 days. Similar results were seen for a number of WSSV dosages such as 10^7, 10^8, 10^9 and 10^{10} copy numbers of virus/µl. The shrimp were injected with 50 µl volume of virus. Each time, the control batch (injected with PBS) shrimp showed 100% mortality



within 72 hours of infection. The experimental shrimp (VP28 ds injected) were negative for WSSV as detected by PCR.

However, when the shrimp were injected with VP28 dsRNA after WSSV infection, a slight protection was found if dsRNA was injected either 3 (6 days) or 6 (4 days) hours post WSSV infection. Beyond these time points, 100% mortality was observed within 72 hours of infection. At each stage of mortality, shrimp were found positive for WSSV by 1st step PCR.

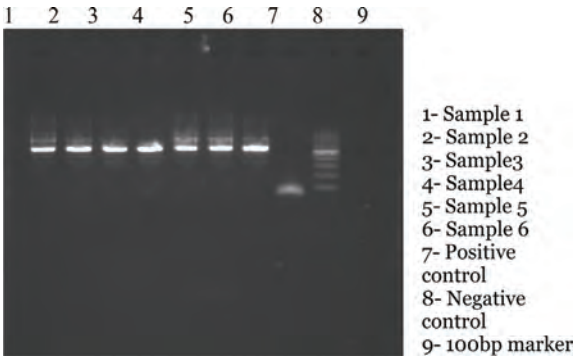
Project Title (NFDB)	**National Surveillance Programme for Aquatic Animal Diseases**

Field investigations were undertaken in 49 *L.vannamei* shrimp farms in Tamil Nadu and Andhra Pradesh and the tissues samples were collected in Davidson's fixative, 90% alcohol and *RNAlater*. Haemolymph and gut samples were collected for bacterial isolation. Targeted surveillance on EMS was also carried out. Out of the 49 farms analyzed, EMS/APHND was not detected in any of the farms and 33 farms tested positive for WSSV and 20 farms tested positive for IHHNV (Table 7). The samples were screened using OIE primers. All the samples were screened for other exotic viral diseases (IMNV, YHV and TSV) also and all tested negative. The gel pictures of the samples screened are given below separately for WSSV and IHHNV infection. The bacterial organisms isolated from the gut and haemolymph were *Vibrio parahaemolyticus, V. campbelli, V. carchariae, V. vulnificus* and *V. alginolyticus* of which *V. parahaemolyticus* was isolated from majority of the farms. Histopathological examination of the shrimp did not reveal the lesions characteristic of EMS/APHND as the hepatopancreas (HP) from all the samples appeared normal. Sloughing of tubular epithelial cells was seen in a few cases but it is not characteristic of EMS. The HPV like inclusion was seen in one sample from Nellore district. Besides this, the hepatopancreas showed a number of necrotic, rounded-up HP cells with pyknotic nuclei which are suggestive of haemocytic enteritis which is of non-infectious nature. The gills of shrimp exhibited the presence of WSSV inclusion bodies.

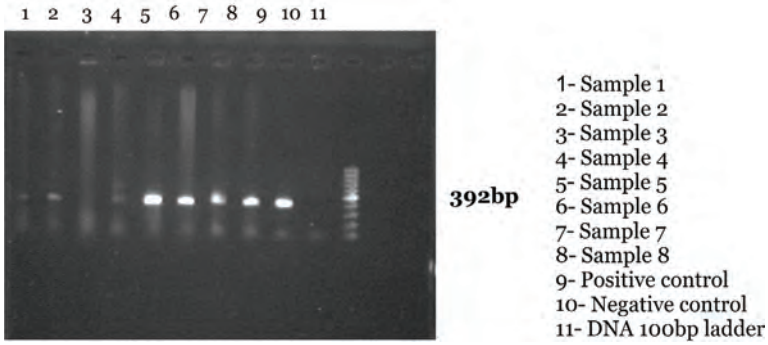
Table 7. Field investigation details

Sl. No.	Month & Year	No. of farms in-vesti-gated	Samples from other agencies	Major diseases diagnosed				Bacterial isolates isolated
				WSSV	IHHNV	EMS	IMNV, TSV, YHV	
1	Nov, 2013	19	5	16	4	0	0	*V. corallilyticum* *V. campbelli* *V. mediterranei*
2	Dec, 2013	5	12	14	13	0	0	*V. ponticus* *V. vulnificus* *V. angularum* *V. alginolyticus* *V. parahaemolyticus*
3	Jan, 2014	0	3	2	3	0	0	0

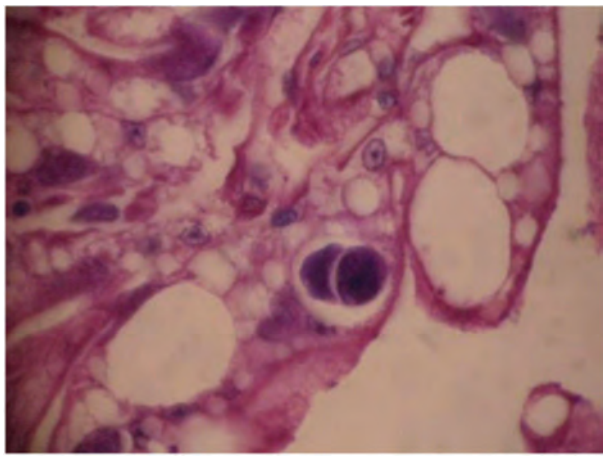
4	Feb, 2014	2	0	0	0	0	0	*V. proteolyticus* *V. coralliilyticus* *V. litoralis* *V. harveyi* *V. rotiferanus*
5	Mar, 2014	4	0	1	0	0	0	*V. mimicus* *V. scopthalmi* *V. chagasii* *V. parahaemolyticus* *V. fisheri*
Total		**24**	**25**	**33**	**20**	**0**	**0**	



Gel photo of amplified nested PCR products - WSSV



Gel photo of amplified PCR products - IHHNV



Photomicrograph of hepatopancreas showing HPV like inclusion bodies -100X H & E

Project Title (Institute)	**Develop environmental parameters monitoring tools and pond treatment technologies for brackishwater aquaculture**

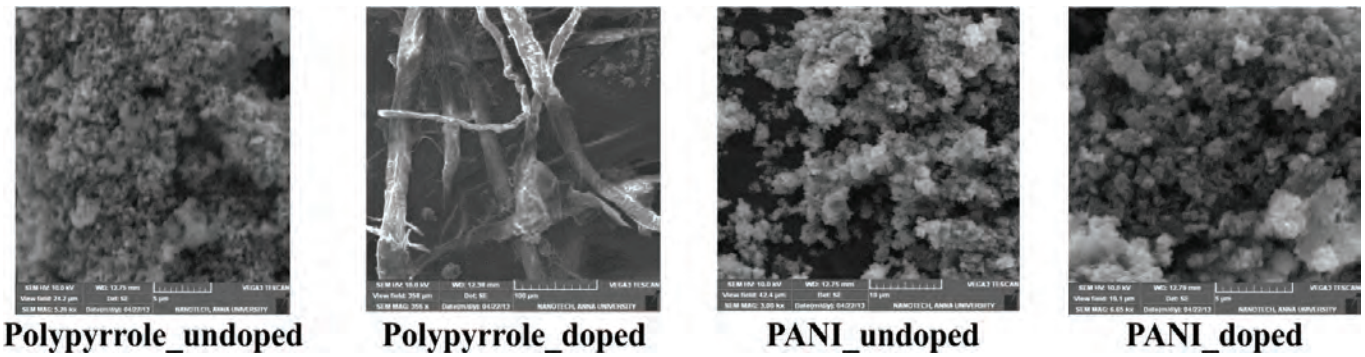
Development of calcium, magnesium and total hardness kit and refinement of DO kit

Mineral supplementation is gaining importance especially in relation to *L.vannamei* farming and farmers are evincing a keen interest in applying minerals based on the ionic concentration in pond water. A field kit (CIBA-CMHK) was developed for the estimation of calcium, magnesium and total hardness at the farm site. It is precise and can be used in many sectors like aquaculture, agriculture, drinking water etc. For aquaculture, two reagents, one for 0-15 ppt salinity and the other for 16 ppt and above

salinity are provided in the kit, which can estimate these parameters in water varying in salinity from 0 ppt to 40 ppt. Based on the feedback, the developed DO kit was tested for its accuracy and stability of the reagents. Modifications were made in DO kit for the preparation of one reagent DOD and it is recommended that the solution has to be prepared afresh every month.

Screening and characterization of polymer / CNT composites

The use of polymers as coating material was studied to increase the efficiency of nanosensor. The selected synthesized polymers, polypyrrole and polyaniline (PANI) were characterized by Scanning Electron Microscopy (SEM). Undoped Polypyrrole is in neutralized state, has spherical morphology and form clusters. Polypyrrole doped with HCl forms a fibrous structure. Polyaniline, undoped and doped with HCl had spherical morphology and the polymer formed clusters. Single walled carbon nano tube (SWCNT) composites will be prepared by coating SWCNT with polymer and will be tested for its efficiency in detecting metabolites concentration in pond water samples.



Scanning Electron Microscopy (SEM) image of polymers

Feasibility of studies on naturally occurring stable isotopes in aquaculture environment

Stable isotopes do not decay through radioactive processes over time. A desktop study showed that naturally occurring stable carbon isotopic (12C and 13C) values are used to determine potential food sources, while stable nitrogen (14N and 15N) measurements are an indicator of the consumer's trophic position. Stable isotopes have become useful in fisheries ecology and environmental studies in aquatic ecosystems. Stable isotope analysis has proved particularly effective in the study of aquatic food webs where there are often marked differences in the isotope signatures of the major primary sources. However, the availability of instrument and cost of analysis are the limitations for these studies.

Isolation, cloning and sequencing of bacteria from the biofilm formed on cassava waste biomass

Biofilm formed on the cassava waste biomass was collected, cultured and bacteria were isolated. Among the isolates eleven colonies were characterized by biochemical tests and molecular methods. Molecular characterization using 16s RNA universal primers and

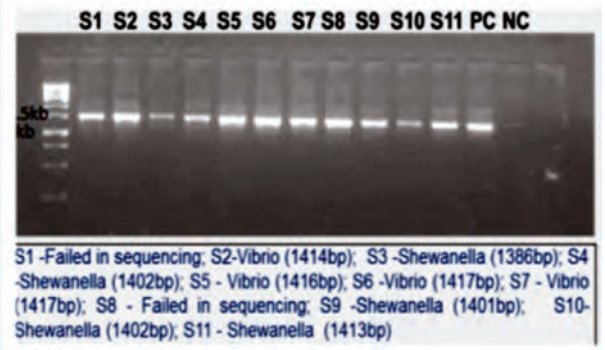


Fig.23 Gel picture of microbes developed on biofilm of cassava waste biomass

NCBI BLAST of isolates revealed the presence of five *Shewanella sp.* (1386-1413 bp) and four *Vibrio sp.* (1414-1417 bp) (Fig. 23) which have the potential for bioremediation and also to act against pathogenic *Vibrio*.

Role of phosphate solubilizing bacteria (PSB) in phosphorus cycle and phytoplankton productivity

Field studies in shrimp culture ponds in Gujarat and TN revealed that phosphate concentration in pond water was not correlated with phosphate solubilizing bacteria count (Fig.24). However phosphate and N/P ratios are positively correlated with plankton number and chlorophyll content.

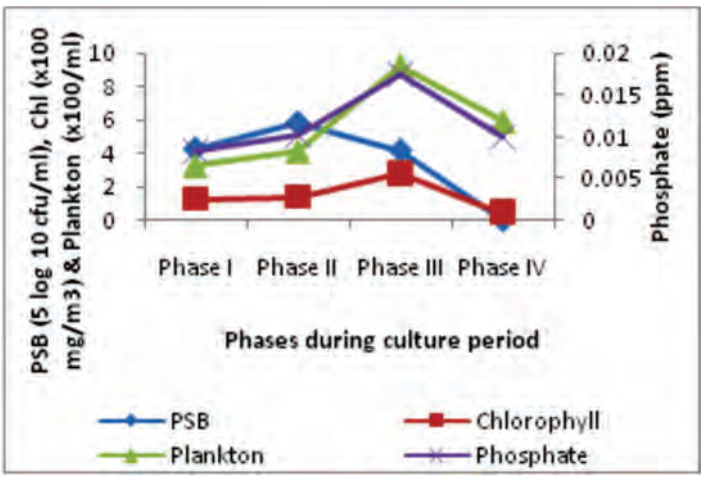


Fig.24.Concentration of phosphate, PSB, plankton and chlorophyll in *L.vannamei* culture ponds

Profile characteristics of aquaculture pond sediments

Study on profile characteristics of aquaculture pond sediment provides insight into the changes during culture. Soil samples were collected at 2.5 cm depth (each core) intervals using core sampler in four *L.vannamei* culture ponds located in Tamil Nadu. The first 2.5 cm depth soil sample was further sub divided into 0.5, 1.0 and 1.0 cm from the top in order to get more detailed picture of sediment-water interphase. Based on the texture and soil condition, the number of soil cores sampled in each pond varied, the average being 5.

Profile sampling using core sampler

The pH ranged from 7.1 to 8.7 and there was no definite trend with soil depth. Electrical conductivity was higher in surface soil compared to lower depths, the values ranging from 0.2 to 1.6 dSm^{-1} in ponds with water salinity upto 2 ppt and 3.6 dSm^{-1} in ponds with 20 ppt. Further studies are planned at additional geographical locations and the information on the changes in the pond environmental parameters at the sediment-water interphase would be useful in recommending management practices.

Evaluation of commercial DO enhancer products

A number of oxygen enhancer products are available in the market, as farmers apply these in emergency, even though aeration is provided. Four products were evaluated to test their efficiency in releasing oxygen and also to develop a product based on the mechanism of oxygen release from these products. The composition of Product 1 was unknown, Product 2 had calcium peroxide, Product 3 had calcium peroxide along with activators and stabilizers and Product 4 had tetra acetyl ethylene diamine and sodium perborate. The products were tested in aqueous system (10 l water only) and soil-water system (3 kg soil + 10 l water) at different salinities (1, 10, 20 and 30 ppt) and DO measurements were taken at intervals of 0, 1, 5, 10, 15 and 30 min. Out of the 4 products tested, two with the composition of sodium perborate and calcium peroxide were effective in both aqueous as well as soil aqueous system (Fig. 25).

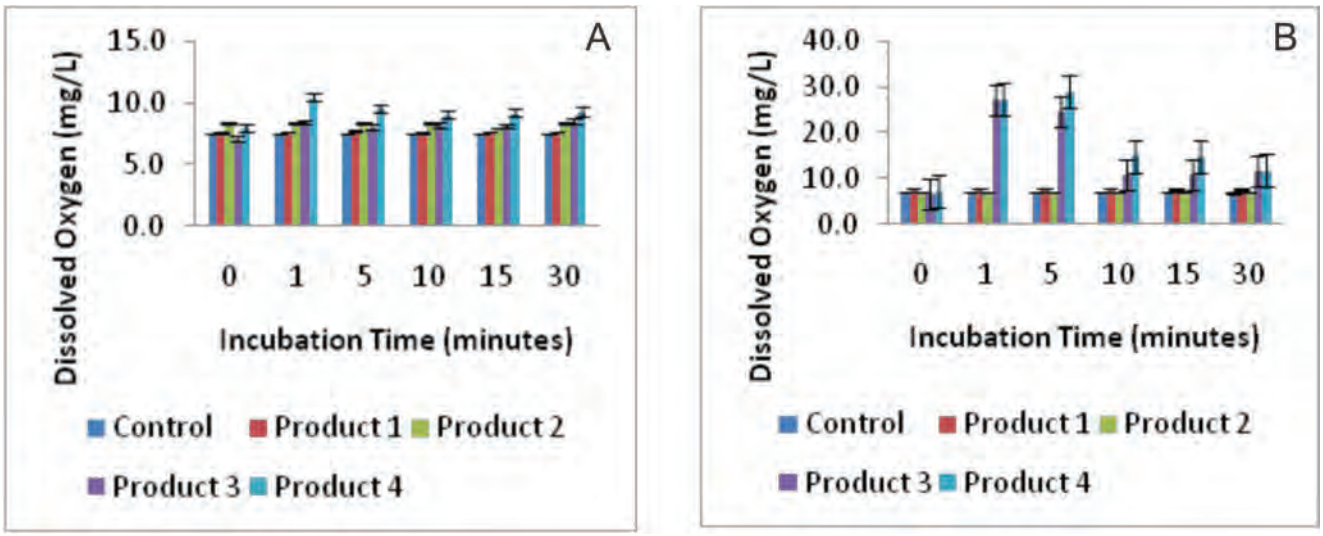


Fig. 25.Effect of commercial products on DO levels in a) Aqueous system b) Soil aqueous system

Effect of chemical treatment on oxidation of organic carbon content of pond sediments

Preliminary yard trials were conducted to comprehend the effect of chemical treatments (potassium nitrate and sodium nitrate each @ 5 and 10%) on the oxidation of post-harvest pond sediment to minimize the gap between two crops. These were applied to harvested pond bottom sediment and incubated at room temperature. Organic carbon content was measured on days 0, 3 and 6. The 10% concentration was found effective in decreasing organic carbon content (Fig. 26).

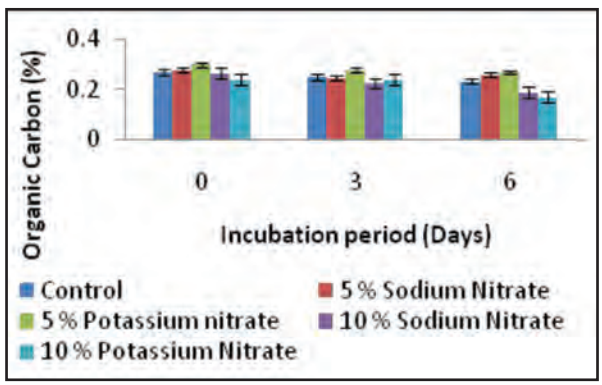


Fig. 26. Effect of chemical treatment on organic carbon content of harvested pond soil

Environmental monitoring of *L.vannamei* farming

Monitoring of environmental parameters was carried out on five major source/receiving waters: Musi River (800 ha), Kunderu Creek (1440 ha), Paleru River, Ramperu Creek (1040 ha) and Manneru Creek

(520 ha) in Prakasam District during the harvest of summer (May to July) and winter (Oct and Nov) crops (Fig.27). Only in May,was the nutrient load higher than the optimum in Musi and Kunderu owing to the harvest in maximum area. Total suspended solids (TSS) was a problem in most of the source waters. It is recommended to plan the harvest and use discharge water treatment system (DWTS) at least to decrease the TSS load. There was no impact on soil salinization.

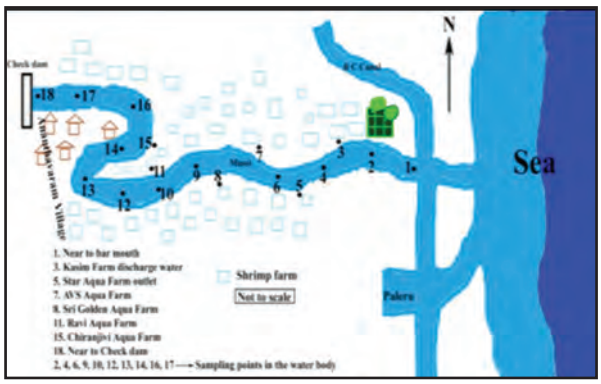


Fig.27. Sampling points on Musi River

Environmental investigations in *L. vannamei* culture ponds affected with low continuous death syndrome (LCDS)

Environmental parameters were investigated in a total of 34 ponds (Nellore District – 16 ponds, Nagapattinam District – 7 ponds and West Godavari District – 11 ponds) including both healthy and LCDS commonly known as running mortality syndrome **(**RMS). Among the 34 ponds, 9 were healthy without any mortality, 8 had medium mortality (upto 25%) and 17 had high mortality (25-50%). Based on the correlation with environmental parameters and mortality, it was observed that the values of few critical parameters viz., TAN, nitrite N and turbidity along with stocking density were associated with mortality rate and other parameters like source water, salinity variation and number of crops had no correlation with RMS. These critical parameters from 34 ponds were categorised as low, medium and high associated with low, medium and high mortality. Multiple correspondence analysis, a tool of categorical data analysis was carried out to unravel the association between categories of critical variables and mortality. The plot of MCA provides 4 quadrants and within each quadrant, the variables associated are different from other quadrants (Fig. 28).

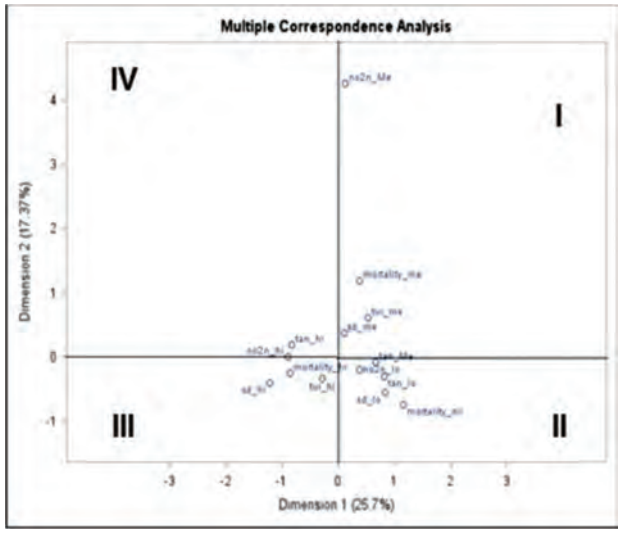


Fig.28. Variables associated with mortality categories in each quadrant

I Quadrant - Medium mortality was associated with medium stocking density, medium turbidity and medium nitrite-N.

II Quadrant – No mortality was associated with low stocking density, medium turbidity and low nitrite N and low to medium TAN values.

III Quadrant – High mortality was associated with high stocking density, high nitrite N, and high turbidity.

IV Quadrant – No direct association with mortality. High TAN in this quadrant is very close to high mortality in 3rd quadrant.

Based on the results, it is clear that running mortality is related to the excess values of a few critical parameters in the culture ponds which might have created stress to the animals. It is recommended to follow better management practices starting from pond preparation to keep the values of critical parameters within optimum levels.

Simulation of sub-optimal conditions to create stress to animals

A series of yard experiments were conducted to simulate sub-optimal conditions by varying total ammonia nitrogen (TAN) concentration, source of ammonium salts used for spiking TAN, incremental and direct spiking of TAN concentration at different water salinities on *L.vannamei* survival. Varying TAN concentrations (1, 2 and 3 ppm) with $(NH_4)_2SO_4$ spiking daily under zero water exchange system revealed that animals were healthy, even at a TAN concentration of 3.2 ppm. Varying source of ammonium salts viz., $(NH_4)_2SO_4$, NH_4Cl and NH_4OH for spiking TAN indicated that there was no difference between $(NH_4)_2SO4$ and NH_4Cl with respect to TAN concentration and pH, and the values were higher than NH_4OH treatment. Except for initial values (after half an hour), the TAN values were more in 15 ppt compared to 0 ppt water. However, there was no mortality of animals irrespective of source of ammonia. Daily incremental addition of TAN levels up to 10 ppm TAN by 6th day indicated that on 12th day 6 to 7 g animals died in NH_4Cl (17-18 ppm) and NH_4OH (16-17 ppm) treatment and on 13th day with $(NH_4)_2SO_4$ treatment. Direct spiking of 10 ppm TAN on shrimp of 2 to 3 g size for 8 days showed that after one day, animals died in $(NH_4)_2SO_4$ and NH_4Cl treatment and the animals in NH_4OH treatment were under stress. On 3rd day, fresh NH_4OH addition to make up the TAN level from 7.28 to 10 ppm resulted in mortality of animals on 4th day. The animals were active in control even after 8 days (3.145 ppm). The conditions in the experimental tanks by varying TAN concentration are unable to create sub-optimal conditions for maintaining the animals under stress. However, by decreasing DO under these conditions stress to the animals was created resulting in mortality.

Project Title (NICRA)	**National Initiative on Climate Resilient Agriculture (NICRA): Key impacts on aquaculture production systems and mitigation options through carbon sequestration and minimising GHGs emissions from aquaculture sector**

Climate change risks for aquaculture in Odisha

Monoculture of *L.vannamei* is the major farming practice during summer crop (Jan – July) and monsoon + winter crop (June – Dec) in Northern Odisha with a production of 5 – 10 t/ha. In southern Odisha, fish culture with IMC and polyculture of fish with shrimp is being practiced traditionally with a production of <1 t/ha. Based on the perceptions of farmers in Northern and Southern Odisha on climate change events and impacts, cyclone comes under disastrous, followed by heavy rains/flash floods under extremely negative risk category (Table 8).

Table 8.Risk matrix of climate change events for aquaculture in Odisha

Likelihood/ Consequences	Disastrous (5)	Extremely Negative (4)	Moderately Negative (3)	Minor Negative (2)	Little Negative (1)
Certain (5)	Cyclone		Unusual high / low Temp. and diurnal variation		
Regular (4)		Heavy Rain/ Flash flood	Seasonal variation	Unusual Fog	
Likely (3)					
Possible (2)					
Rare (1)					

CC impacts and vulnerability for aquaculture in Gujarat

Data analysis of extensive farmer's survey (n=120) in Surat District of Gujarat showed that diurnal temperature variation and high temperature came under moderate negative whereas irregular rain & low temperature came under minor negative risk categories. Vulnerability of shrimp aquaculture to climate change based on the exposure, sensitivity and adaptation indicators indicated that 64% of the shrimp farms were categorized as very low (Fig. 29). Since Gujarat developed shrimp farming systematically through proper planning

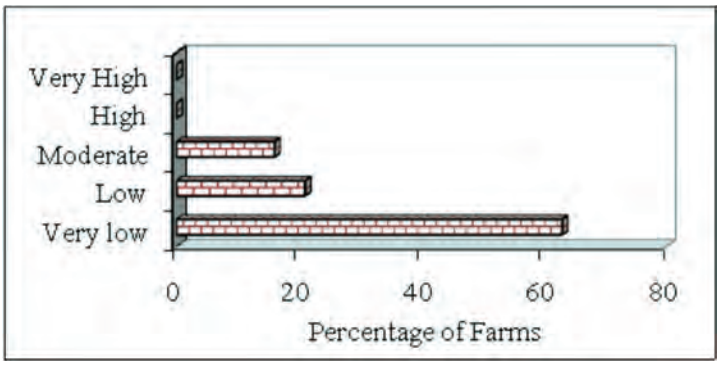


Fig. 29.Shrimp Aquaculture Vulnerability to Climate Change in Gujarat

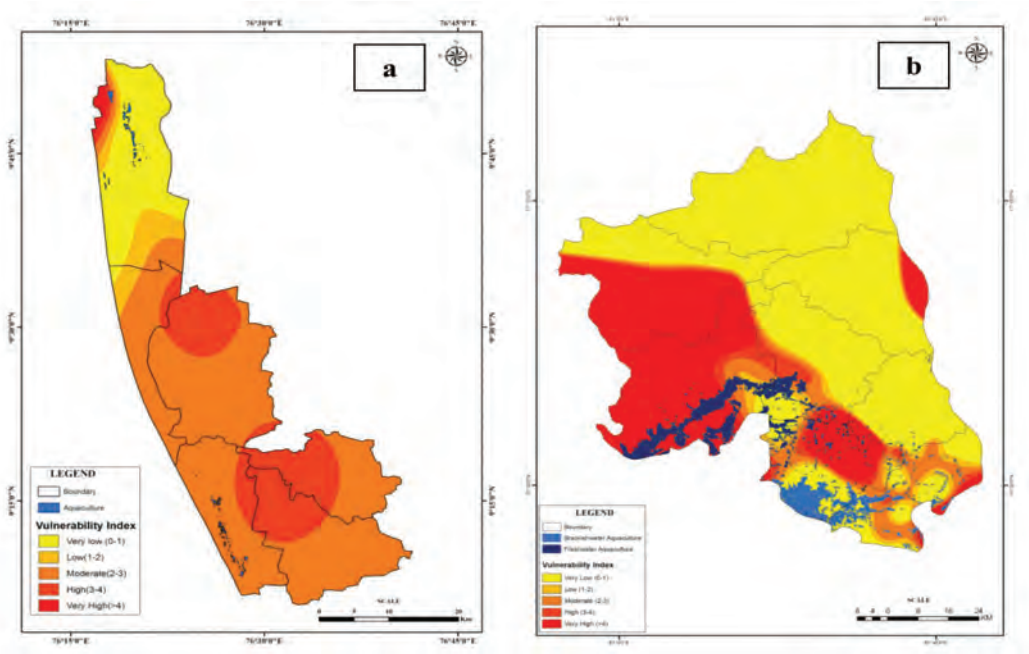


Fig.30. Maps depicting the vulnerability of aquaculture to climate change a) Alappuzha b) West Godavari

and the infrastructure availability with the farmers, it is well positioned to deal with climate change compared to other coastal states in the east coast. The adaptive measures to be taken up by farmers (autonomous), researchers and development departments (planned) for climate resilient aquaculture were documented.

Based on the vulnerability indices, vulnerability maps of aquaculture to climate change were prepared for West Godavari (AP), Alappuzha (Kerala) and South 24 Parganas (West Bengal) districts (Fig.30), which are useful for policy makers to arrive at decisions.

Assessment of impact of sea level rise (SLR) on Sunderban ecosystem

The IRS P6 LISS IV data with 5 m resolution covering Sunderban mangroves from NRSC and Department of Space were used for the quantitative estimation of the inundation of the area of different coastal resources. The total land area of 13, 98,431 ha has been classified into six categories viz. agriculture, aquaculture, mangroves, sparse mangroves, mud flat and water bodies. A total area of 5, 21,265 ha will submerge out of 13, 98,432 ha with 1 m SLR. Aquaculture area of 13,211 ha and 21,763 ha will be inundated at 0.5 m and 1m SLR, out of 55,676 ha. Agriculture area of 5,963 ha and 16,122 ha will submerge due to sea level rise of 0.5 m and 1 m respectively. However, the submerged area under agriculture can be used for brackishwater aquaculture as a livelihood for farmers, who would not be able to take up agriculture.

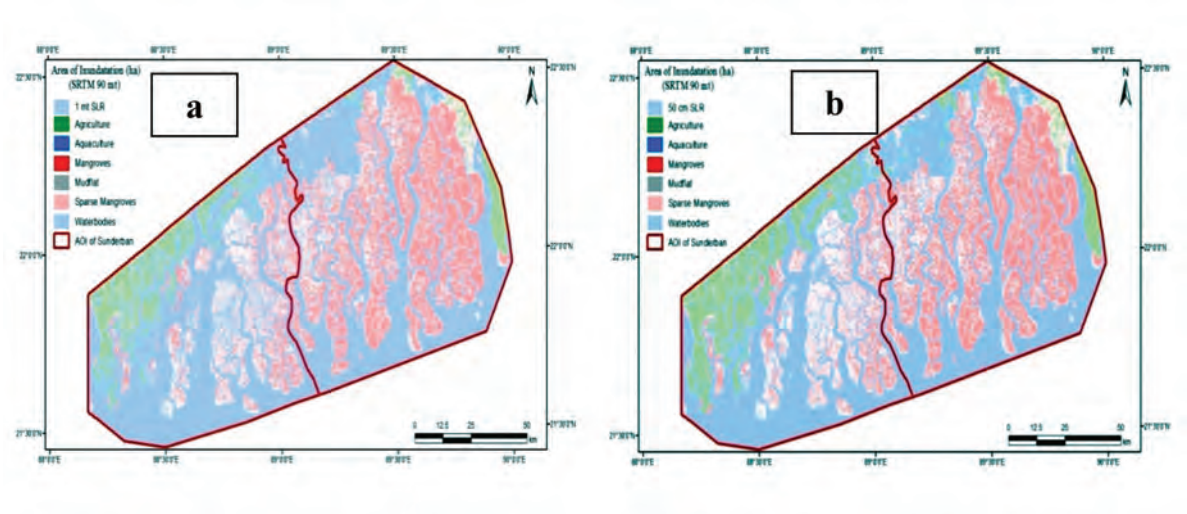


Fig.31 Inundation of Sunderbans resources at SLR of a) 1m and b) 0.5 m

Assessment of damage to aquaculture due to phailin cyclone in Odisha

Shrimp farming areas were surveyed to assess the damage due to 'Phailin'Cyclone that struck on 12th October, 2013 followed by torrential rains on 18th October in Balasore, Bhadrak, Ganjam Jagatsinghpur and Kendrapada districts of Odisha state.Fish farmers in the above districts including Jajpur were the worst affected. Torrential rains and cyclone affected 75%

Damage to shrimp hatchery due to Cyclone Phailin

of pisciculture and 85% shrimp culture in Jajpur, Bhadrak and Balasore districts. Most of the shrimp farms were completely flooded. The shrimp crop loss is around 2000 MT in Balasore, Bhadrak and Ganjam districts. The loss was 6332 ha freshwater area, 3521 ha of shrimp farming area and 10 hatcheries.

Trend analysis of weather parameters in shrimp farming areas

Forty eight years of monthly meteorological data (maximum, minimum, highest maximum (HMax), lowest minimum (LMin), mean temperatures, rainfall and number of rainy days) from 1960-2007 pertaining to Surat District, the major shrimp farming area in Gujarat, were analysed using Mann-Kendall trend test (Fig.32). Analysis of data revealed a significant trend for maximum temperature only under all the cases of experimentation. The forecasting models were built for maximum temperature in the study area, which can be used for shrimp farming crop calendar planning.

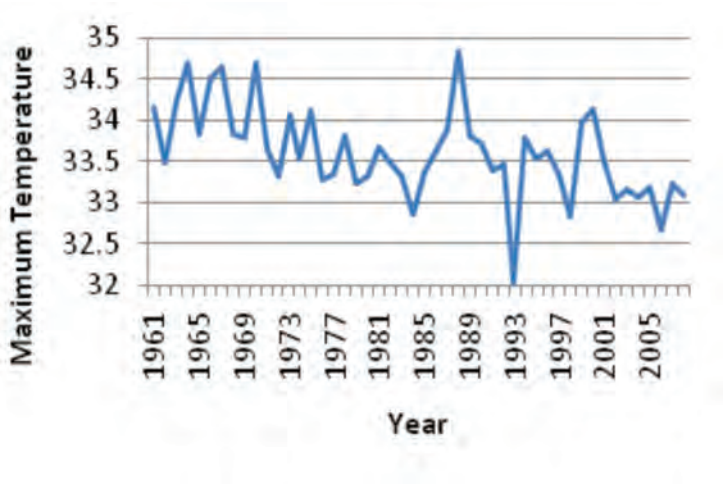


Fig. 32. Trend in maximum temperature of Surat District (48 years)

Greenhouse gases emission from aquaculture systems

Greenhouse gases viz., nitrous oxide, methane and carbon-di-oxide were monitored on different days in Milkfish culture pond stocked @ 6700 nos./ha in Nagapattinam District, Tamil Nadu. There was not much difference with respect to N_2O (0.311 to 0.324 ppb) and CO_2 (605 to 681 ppm), whereas CH_4 increased from 1.89 to 5.9 ppm with progress in culture (38 to 154 DOC). Monthly GHGs, N_2O, CH_4 and CO_2 emissions in terms of average CO_2 eq. ranged from 278-354 kg/ha in *L.vannamei* (summer and winter crops at Ongole, AP; Katur & Nagapattinam, TN) with stocking density of 42-55 nos./m^2, and 34 kg/ha in tiger shrimp (summer crop at Marakkanam) with SD of 8 nos./m^2 (Table 9). Global warming potential per kg shrimp production ranged from 0.024 to 0.031 for *L.vannamei* and 0.018 for tiger shrimp though there is a difference in per ha values due to higher stocking density and production of the former. High GHG emission profile during summer crop as compared to winter crop is due to prevailing high temperatures. The N_2O increased with an increase in dissolved inorganic N concentration in pond water. Average methane emission exhibited inverse relation with pond water salinity and hardness.

Table 9. Seasonal variation in GHGs quantification from shrimp culture ponds varying in species and intensity (GWP was calculated per season of 4 months culture/crop)

Sampling place	Stocking density (Nos./m²)	Survival (%)	Mean final body weight (g)	Final biomass (Kg)	Kg CO_2 eq./ha	Kg CO_2 eq./Kg shrimp	Species
Summer 2013							
Ongole	46	86	32	8861	336	0.027	*L.vannamei*
Kattur	55	84	27	6237	354	0.028	*L.vannamei*
Marakkanam	8	84	28	1129	34	0.018	*P.monodon*
Winter 2013							
Ongole	42	87	32	8185	278	0.024	*L.vannamei*
Nagapatti-nam	44	81	30	4277	332	0.031	*L.vannamei*

Abundance of methane producing bacteria in brackishwater aquaculture ponds

Sediment samples were collected from shrimp culture ponds at Marakkanam, Kattur and Nagapatinam to study the abundance of methanogenic bacteria by combined enrichment culture and molecular techniques. The PCR products were cloned (Fig. 33) and sequenced. Sequences were blasted and grouped into different operational taxonomic units (OTU) based on 97% similarity criteria. The aligned sequences were used to construct phylogenetic tree to known affiliation of different clones by MEGA 5.2.Out of 149 clones sequenced, 67 OTU's (phylotypes) were matched with four orders of methanogenic archaea (Methanococcales-20, Methanomicrobiales-30, Methanosarcinales-7 and Methanobacteriales -10) with a similarity of 94-99%.

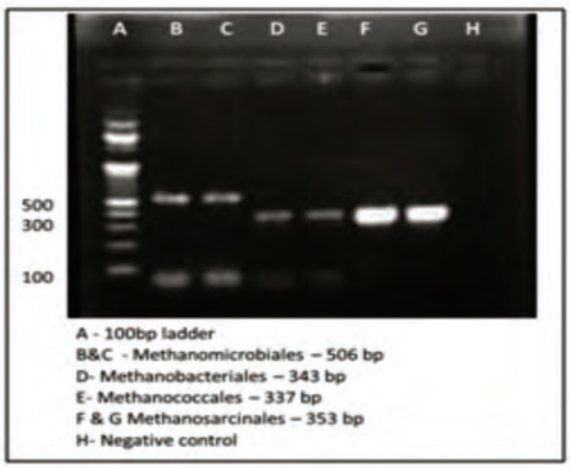


Fig. 33.Gel picture depicting PCR bands of methanogenic bacteria

Carbon sequestration through composting of harvested pond sediment

Composting of harvested shrimp pond sediment was carried out with different bulking materials (sediment + sea weed in 1:3 and sediment + wood shave in 1:2 ratios) by bed method for 2 months. The bed was kept undisturbed and optimum conditions were maintained by periodically checking temperature, pH, moisture and odour. The same procedure was followed with garden soil as control. Sampling was done at fortnightly intervals during composting from both test and control and processed to measure pH, electrical conductivity (EC), organic carbon, available nitrogen and available phosphorus. There was a reduction in EC and organic carbon content and increase in available nutrients (N and P) indicating its potential for use as manure for agricultural crops.

Composting process

Table 10. Changes in composition of materials prior to and post-composting

Parameter	Control (Garden soil + bulk material)		Test (Pond sediment + Bulk material	
	Initial	Final	Initial	Final
pH	6.46	6.23	6.49	6.58
EC	6.91	6.36	8.31	5.02
AP (mg/100g)	8.6	26.93	12.7	14.94
OC (%)	25	19	32	10.77
AN (mg/100g)	8.2	15.14	7.73	17.49

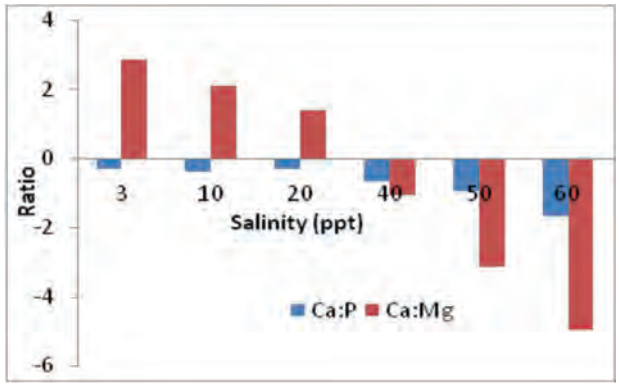


Fig. 34.Variation in mineral ratios at different salinities in comparison with 30 ppt

Refinement in minerals supplementation under abiotic salinity stress environments - effect of salinity mineral profiles of Pacific white shrimp

Yard experiments were conducted for one month at seven salinities viz., 3, 10, 20, 30, 40, 50 and 60‰ with *L. vannamei (*5.9 g size juveniles). Whole shrimp samples along with feed and water samples were analyzed for both macro and micro minerals. Salinity significantly ($P<0.05$) influenced the mineral profile of whole shrimp. Highest calcium and phosphorous contents were observed in shrimp reared at 10 ppt saline water and the lowest at 60 ppt water. Lowest sodium and potassium contents were observed in shrimp reared at 40 and 50 ppt saline waters respectively and highest contents were maintained at highest (60 ppt) and lowest (3 ppt) saline waters respectively. The Ca: P ratios decreased in all other salinities when compared to 30 ppt whereas Ca:Mg ratios increased in the salinities below 30 ppt and decreased above 30 ppt. It can be concluded that salinity has a profound effect on shrimp mineral profile and this data along with bioavailability of mineral mixtures would be useful for further mineral supplementation studies.

Water footprints of aquaculture systems

A methodology was developed for water foot print calculations (Blue, green and grey water foot prints) in aquaculture and will be tested in shrimp culture ponds using fresh/low saline water. The water foot print (blue and green water foot print only, assuming that grey water foot print is zero) for a typical 120 days *L.vannamei* culture in 1 ha pond area stocked with 60 nos./m^2 is 0.44 m^3/kg production (80% survival and 11.5 t/ha production) with initial water depth of 100 cm and assumptions of rainfall of 6 cm, evaporation loss @ 0.5 cm/day, and 20% water exchange at fortnightly intervals after one month of crop. If there is no water exchange (practicing zero water exchange farming), then the water requirement is 0.47 m^3/kg production. Under similar situations, for tiger shrimp farming (stocking density - 10 nos./m^2; survival - 80%; production - 2.72 t/ha), the water foot print is 1.9 m^3/kg production with 20% water exchange at fortnightly intervals after one month and 2.1 m^3/kg production with zero water exchange.

Productivity evaluation of different algal species with reference to temperature in shrimp hatchery

Temperature is an important parameter for better larval performance in the hatchery. The range of temperature in which the larvae showed high survival and growth is relatively narrow as compared to that of other variables like salinity or productivity. Larval performance was evaluated in *Chaetoceros, Skeletonema,* and *Tetraselmis* based live feeding at different temperatures in *Fenneropenaeus indicus*. At low temperature of 24-25°C, irrespective of the algal species, the metamorphosis from one larval stage to other is delayed by 15-36 hours or fails compared to that at higher temperature of 29-30°C. Initial observations showed that by partially replacing algal based system (*Chaetoceros* & *Skeletonema*) with heterotrophic system, the temperature effect on larval performance is less significant.

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**

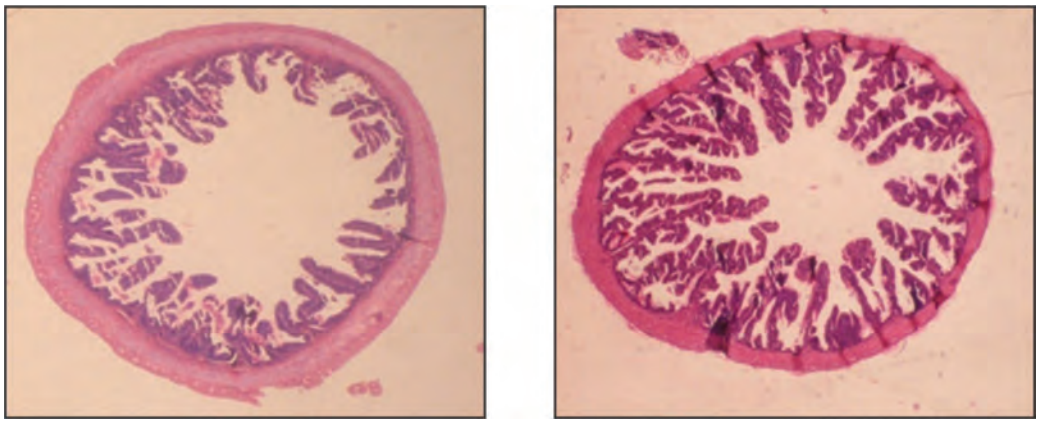
Evaluation of feed additives in shrimp and fish

a. Fructo oligosaccharide (FOS) as a health and growth promoting feed additive in Asian seabass

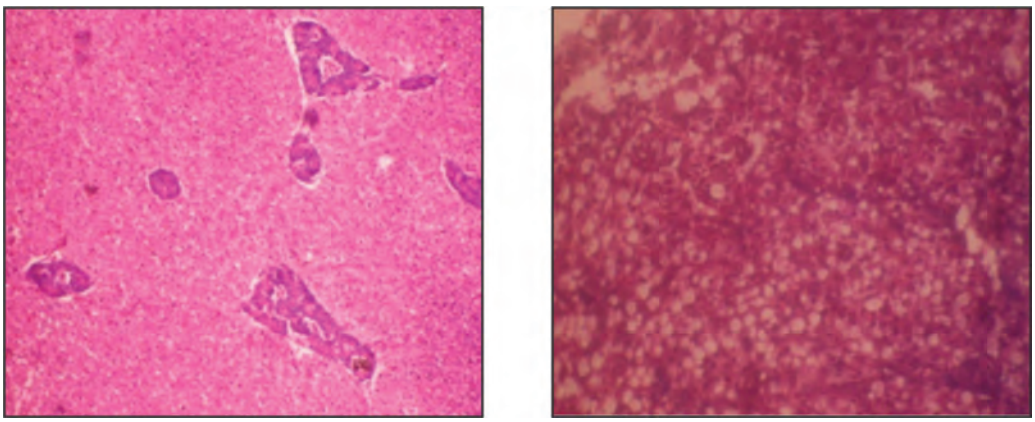
Conventional treatment of diseases using chemotherapeutics and antibiotics poses a serious problem on the safety and sustainable issues relating to aquaculture produce. As an alternative strategy to antibiotics, prebiotics have recently attracted a lot of attention. Prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the gut. An attempt was therefore made to evaluate the prebiotic effect of FOS and to ascertain the optimal level of inclusion in the diet of *L. calcarifer*.

A standard experimental diet was formulated containing 40% protein and 7% lipid. To this diet, FOS was supplemented at five different concentrations viz., 0, 0.25, 0.5, 0.75 and 1% levels and evaluated in a 45-days feeding experiment in seabass fingerlings (ABW of 11.68g) in 1000L FRP tanks.

The group fed with 1.0% FOS supplemented diet showed significant higher ($P<0.05$) survival than those fed other diets. Histological analysis (Fig. 35) revealed the anterior and posterior intestine of FOS supplemented fingerlings had higher microvilli density compared to the fish fed control diet and significant improvement in intestinal morphology was observed in 0.75% and 1% FOS supplemented group. Higher glycogen storage observed in hepatocytes of FOS supplemented diets can easily be used as an energy source during stress. The analysis of hematological parameters showed that red blood corpuscles (RBC), White blood corpuscles (WBC), haemoglobin (Hb), haematocrit value (HCT) and Mean corpuscular volume (MCV) levels increased significantly ($P<0.05$) in the fish fed with 0.5% FOS. The mean corpuscular haemoglobin (MCH) was significantly higher in 0.75 and 1.0% FOS diet while the mean corpuscular haemoglobin concentration (MCHC) showed non-significant difference among the diets. This study revealed the beneficial effect of FOS supplementation through increased microvilli density and increased glycogen deposition in the hepatocytes and it can be concluded that FOS can be supplemented at 1.0% in the diet of seabass.



a. Control (10X) b. FOS 1% (10X)



c. Control (10X) d. FOS 1% (40X)

Fig. 35.Light photomicrographs of *L. calcarifer* intestine and liver sections a) Intestine of fish fed control diet b) Fish fed 1 % FOS diet and showing positive effect through improved intestinal folding. c) Liver section of fish fed control diet showing hepatocytes d) Liver showing the glycogen deposition in fish fed 1% FOS diet.

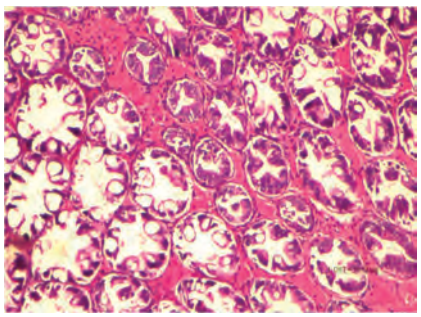
b. Effect of varying levels of supplementation of ethoxyquin as an antioxidant in tiger shrimp

On detection of ethoxyquin residues in imported shrimp during August- September 2012, Japan had rejected 19 shipments of farmed tiger shrimp that originated from Odisha and West Bengal. In this context, studies to establish the fate and depuration of ethoxyquin in shrimp are considered mandatory to ascertain depuration duration and frame guidelines.

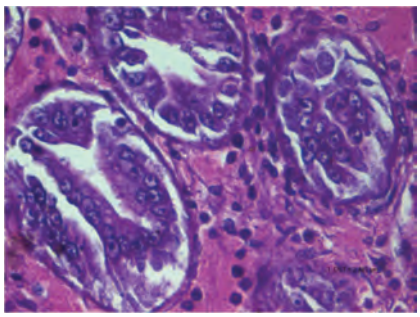
Feeds with 0, 25, 50 and 100 ppm ethoxyquin were prepared and an experiment initiated in tiger shrimp (ABW:15 g) to test the residual effects and withdrawal period of ethoxyquin. After 45 days, tissue samples were analyzed for residual ethoxyquin level. The analysis revealed that ethoxyquin could not be detected in the edible as well as inedible portion of shrimp fed with varying concentrations. The reason for ethoxyquin not being detected could possibly be due to the shorter experimental period coupled with lower weight gain attained. Even though ethoxyquin residue could not be detected, the diet containing 100 ppm ethoxyquin showed significantly decreased feed intake than the rest indicating that higher supplementation affected palatability. The hematological data revealed that the

total haemocyte count (THC) increased significantly ($p<0.01$) by 28 and 45% among 25 and 50 ppm ethoxyquin treated groups, respectively. However, the group treated with 100 ppm showed significant drastic reduction ($p<0.01$) in THC by 71%. The corresponding significant changes were also observed in granular (GH) and non-granular (NGH) haemocyte counts

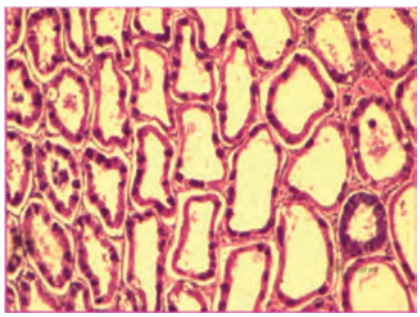
The group fed with 100 ppm ethoxyquin showed the following histopathological changes in the hepatopancreas while 0, 25 and 50 ppm ethoxyquin fed group appeared normal.



Microphotograph of hepatopancreas showing severe infiltration of intertubular tissue with hemocytes and fibroblasts. Degenerative desquamation and sloughing of hepatopancreatic cells are also observed.



Microphotograph of hepatopancreas showing absence of B, R and F cells with hemocytic and fibroblastic infiltration in the intertubular tissue.



Microphotograph of hepatopancreas showing severe atrophic changes with loss of normal architecture of all the functional cells.

Effect of salinity on growth of *Litopenaeus vannamei*.

The effect of ambient salinity on growth and nutrient utilization was studied in juveniles of Pacific white shrimp. The experiment was conducted (6 weeks) with 6.2 g size animals at seven salinities viz., 3, 10, 20, 30, 40, 50 and 60 ppt. The results (Table 11) indicate higher growth at 30 ppt (214.99 %) followed by 20 ppt (213.33%). High survival (>80%) was observed in shrimp reared between 10-40 ppt salinity. With increase in salinity to 60 ppt, survival was drastically reduced (58 %). The mineral analysis of final whole shrimp indicated that calcium content was highest (3.34% on DMB) in shrimp reared in 10 ppt compared to those reared in 60 ppt whereas phosphorous content remained constant (0.94% on DMB) in shrimp across all the salinities. Eicosapentanoic acid was higher at low (11.07%) and high salinity (10.12%) compared to shrimp reared at 30 ppt (8.81%).

Table 11. Effect of salinity on growth and survival in *L. vannamei*

Salinity (‰)	3	10	20	30	40	50	60
Weight gain (%)	$154.56^{c} \pm 3.44$	$183.03^{b} \pm 3.33$	$213.33^{a} \pm 5.74$	$214.99^{a} \pm 3.03$	$179.72^{b} \pm 4.08$	$157.22^{c} \pm 1.40$	$63.86^{d} \pm 2.79$
SGR	$2.22^{c} \pm 0.03$	$2.48^{b} \pm 0.028$	$2.72^{a} \pm 0.043$	$2.73^{a} \pm 0.023$	$2.45^{b} \pm 0.035$	$2.25^{c} \pm 0.013$	$1.18^{d} \pm 0.04$
DGC (%)	$1.59^{c} \pm 0.026$	$1.82^{b} \pm 0.02$	$2.033^{a} \pm 0.033$	$2.038^{a} \pm 0.018$	$1.79^{b} \pm 0.027$	$1.62^{c} \pm 0.011$	$0.783^{d} \pm 0.028$
Survival (%)	76^{c}	89^{ab}	98^{a}	93^{ab}	87^{b}	73^{c}	58^{d}

Effect of salinity on growth of *Fenneropenaeus indicus*

The effect of ambient salinity on growth and nutrient utilization was studied in juveniles of Indian white shrimp at seven salinities viz., 3, 10, 20, 30, 40, 50 and 60 ppt for 6 weeks.The results (Table 12) indicated higher growth at 20 ppt (211 %) and 30 ppt (207 %). High survival (>75%) was observed in shrimp reared between 10-40 ppt salinities. Increasing the salinity to 60 ppt drastically reduced survival (64 %).

Table 12.Effect of salinity on growth and survival in Indian White Shrimp

Salinity (‰)	3	10	20	30	40	50	60
Weight gain (%)	115.73 ± 6.40	192.72 ±5.09	211.35 ± 3.30	206.59 ± 5.89	188.81 ± 4.14	170.10 ± 5.03	124.45 ± 11.68
SGR	1.83 ± 0.07	2.56 ± 0.04	2.70 ± 0.03	2.67 ± 0.05	2.52 ± 0.03	2.37 ± 0.04	1.92 ± 0.12
DGC (%)	0.89 ± 0.04	1.31 ± 0.03	1.39 ± 0.01	1.37 ± 0.02	1.28 ± 0.02	1.20 ± 0.02	0.94 ± 0.06
Survival (%)	71	84	96	93	93	78	64

A 42 day's feeding experiment was conducted to optimize dietary nutrients in tiger shrimp in low saline (7-10 ppt) regime. Four iso-nitrogenous and iso-energetic practical diets were formulated with 2% lecithin and combinations of choline (900, 1200, 1500 and 1800 ppm) and pantothenic acid (100, 150, 200 and 250 ppm) as stress busters. The control group was fed diet which incorporated 2% lecithin but was devoid of choline/pantothenic acid. Results showed that 2 % lecithin, 1200 ppm choline and 150 ppm pantothenic acid were optimum (for shrimp > 15g size) as revealed by highest body weight gain and lowest FCR in low saline regime.

Table 13. Effect of combination of dietary nutrients in tiger shrimp in low saline regime

Parameters	Treatments				
	Control	T_1 (Choline -900 ppm & Pantothenic acid - 100 ppm)	T_2(Choline -1200 ppm & Pantothenic acid - 150 ppm)	T_3(Choline -1500 ppm & Pantothenic acid - 200 ppm)	T_4(Choline -1800 ppm & Pantothenic acid - 250 ppm)
Initial Body Wt. (g)	17.31±0.02	17.31±0.01	17.31±0.04	17.31±0.02	17.31±0.04
Final Body Wt. (g)	21.27^{a} ±0.02	21.58^{b} ±0.04	22.73^{e} ±0.04	22.28^{d} ±0.04	21.78^{c} ±0.08
ADG (mg/day)	94.29^{a} ±0.36	102.46^{b} ±0.78	128.89^{d} ±0.08	118.17^{c} ±0.88	106.43^{b} ±2.87
TWG (g)	3.96^{a} ±0.02	4.30^{b} ±0.03	5.41^{d} ±0.01	4.96^{c} ±0.37	4.47^{b} ±0.12
SGR	0.49^{a} ±0.01	0.53^{b} ±0.01	0.65^{d} ±0.01	0.60^{c} ±0.01	0.55^{b} ±0.01
PER	0.97^{a} ±0.01	1.11^{b} ±0.01	1.50^{e} ±0.02	1.35^{d} ±0.04	1.22^{c} ±0.05
FCR	2.71^{e} ±0.02	2.34^{d} ±0.01	1.74^{a} ±0.02	1.94^{b} ±0.05	2.16^{c} ±0.09

Optimization of feeding frequency in fingerlings of *Mugil cephalus*

An experiment with four feeding frequencies i.e. one, two, three and four was conducted for 6 weeks using fry (ABW:13.70 g). Significantly higher weight gain (Table 14) was observed when fishes were fed 3 times a day leading to the conclusion that *M. cephalus* fingerlings should be fed three times a day.

Table 14. Effect of feeding frequency on performance of *M.cephalus*

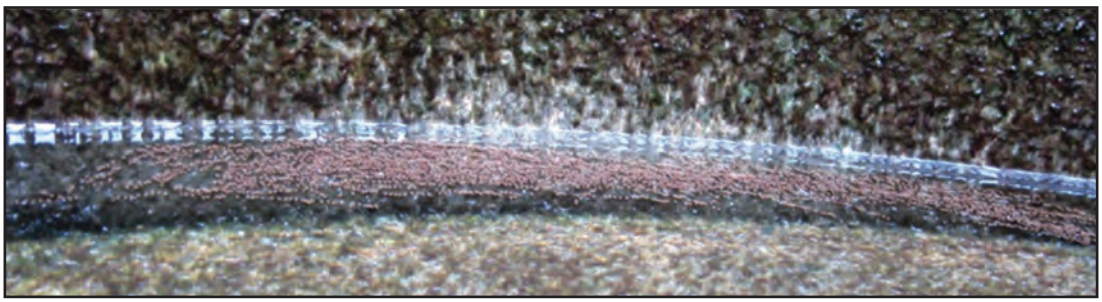
Parameters	Treatments			
	T_1	T_2	T_3	T_4
Initial Body Wt. (g)	13.70±0.01	13.71±0.01	13.70±0.01	13.71±0.01
Final Body Wt. (g)	21.60^{a} ±0.03	21.84^{b} ±0.02	22.14^{c} ±0.05	21.54^{a} ±0.06
ADG (mg/day)	188.02^{a} ±0.62	193.57^{b} ±0.49	200.95^{c} ±1.31	186.35^{a} ±1.24
TWG	7.90^{a} ±0.03	8.13^{b} ±0.02	8.44^{c} ±0.06	7.83^{a} ±0.05
TWG%	57.64^{a} ±0.16	59.30^{b} ±0.18	61.62^{c} ±0.44	57.06^{a} ±0.37
TDMI	27.35±0.48	27.78±0.88	27.21±0.52	26.34±0.82
FCR	3.46±0.05	3.42±0.12	3.22±0.07	3.37±0.11

Evaluation of broodstock diets on pearlspot from wild

As a continuation of similar work last year, maturation diets in pearlspot were evaluated on wild caught adult pearlspot maintained in large tanks. Concurrently, the fishes from previous trials, both spawned and un-spawned were monitored for confirming the dietary influences.

A pre-tested diet having 40% protein and lipids @ 12 and 15% was used. Spawned pairs from diet 12 and 15% DL were continued on their respective diets, and spawning events monitored for further 8 months. Four fishes from dietary treatments that failed to spawn in diet 6 and 9 % DL, were placed in two separate tanks and switched to diet DL15%. Sex ratio was kept 1:1. With fishes switched to DL15%, observations were recorded on pair formation and spawning, the experiment lasting for 70 days. Another trial for a similar period aimed to replicate the spawning events by feeding one of the pre-tested diet (D12%) to a new set of pre-adult wild fishes (69 g). The gonads of all the fishes were visually examined after forced termination of the trial due to unexplained mass mortality.

Oviposited eggs in a few spawnings



Egg deposition on substrate

On termination of the trial, the conditions of the gonads showed a marked difference in appearance. The ovary of the fishes fed diet which had 12 and 15% lipid level were fully ripe, tightly packed with eggs and brown in colour. Dietary shift induced spawning. There were 23 spawning events (overall from 9 single pairs) during this year with a fry yield of > 2000/ spawning. Dietary levels such as 12 and 15 % resulted in inducing quick maturation and recurrent spawning.

Project Title (Institute)	Outreach activity on fish feed

Optimization of protein level in diet of milkfish fry

An experiment was conducted with varying levels (40,45 and 50 %) of protein at a constant lipid level(10%). About 900 milkfish fry (initial mean weight 0.221g) were used.

Table 15. Effect of different levels of protein on growth and survival of milkfish fry

Parameter/ protein level (%)	Final body weight (g ± SD)	FCR	Survival (%)
40	1.11 ±0.06	1.11 ±0.01	82
45	1.22 ±0.08	1.12±0.02	81
50	0.98 ±0.09	1.30 ±0.02	79

The 2-month feeding trial revealed significantly higher body weight in fish fed 45 % protein. The diet containing 50 % protein resulted in a significantly lower final body weight than the other diets. Similarly the diet containing higher protein (50 %) showed higher FCR than the other diets. There was no significant difference in survival among different treatments. It could therefore be inferred that 45 % is optimal for growth of milkfish fry.

Optimizing the lipid level in diet of milkfish fry

An experiment using four levels of lipid viz., low (5%),medium (10%), high (15%) and very high (20.0%) at a constant protein level (40%) was conducted on milkfish fry (n=360, ABW: 1.92g).

Table 16. Effect of different levels of lipid on growth and survival of milkfish fry

Parameter/ Lipid level	Final body weight (g ± SD)	FCR	Survival (%)
Low (5%)	8.15±0.41	1.32±0.01	96
Medium (10%)	9.87±0.47	1.24±0.02	95
High (15%)	8.64±0.31	1.25±0.03	96
Very high (20%)	7.72±0.38	1.33±0.04	97

Results indicated that significantly higher body weight was observed in fish fed with medium diet indicating that lipid level of 10% is optimal. There was no significant difference in FCR and survival of fish fed with varying levels of lipid.

Evaluation of extruded feeds in the diet of *L. vannamei*

To evaluate the extruded and pelleted feed in *L. vannamei,* a feed with 35.0% protein and 6.0% lipid was formulated. The diets were prepared using pelletizer and twin screw extruder. The feeds had similar nutrient composition-the only difference being the preparation process viz. pelletising or extruding.

After a month, digestibility studies were carried out on the faecal matter. The group fed with extruded diet had significantly higher weight gain compared to those fed pellets and the increase in weight was >17.0% in the extruded diet group. The higher weight gain is corroborated by significantly improved digestibility of extruded feed. The higher digestibility reflected in better FCR (1.23 vs 1.49) in group fed with extruded diet. It could be inferred that extruded feed is advantageous over pelleted feed in *L. vannamei* consequent to which feed cost during culture could be reduced.

Fatty acid binding protein expression in hyperosmotic stressed tiger shrimp fed with varying lipid levels

Fatty acid binding proteins (FABP) are intracellular proteins that bind long-chain fatty acids, aiding transport and compartmentalization of fatty acids. They are small cytosolic proteins involved in cellular fatty acid transport and utilization and intercellular compartmentalization of stored fatty acids. A feeding trial was conducted using shrimp (5.6 g) at 45 ppt salinity with four dietary lipid levels viz., 4.98, 6.03, 7.05 and 8.12% for a period of 4 weeks after acclimatization to 45 ppt salinity. At the end of the trial, total RNA was extracted from hepatopancreas and converted to cDNA for expression studies. The relative quantification of transcripts was assessed by comparative ΔC_T method. Significantly ($P<0.05$) higher levels (%) of eicosapentanoic acid and docosahexanoic acid were observed in shrimp fed with higher lipid levels compared to those fed with lower levels. These fatty acids are mainly involved in maintaining the fluidity and integrity of cell membranes. The FABP transcripts in hepatopancreas of shrimp fed with higher lipid (8.12%) exhibited an up-regulated level (49.4 fold) compared to lower level of lipid (4.98%) fed shrimp (Fig. 36).

It can be concluded that a high lipid (8.12%) diet helps in improved osmotic competence in hyperosmotic stressed shrimp. The beneficial role of high lipid diets in hyper saline stressed shrimp could be mediated through mobilization of higher levels of lipids and FABP could be involved in this mobilization or in other aspects of osmoregulation during high salinity stress.

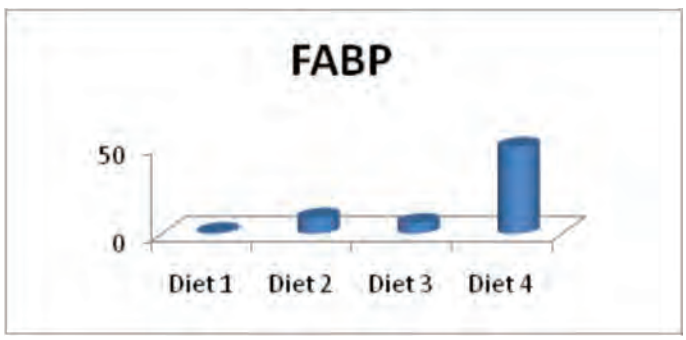


Fig.36. Effect of varying lipid levels on the expression of FABP (in folds) in hyperosmotic stressed shrimp

Evaluation of diets and feeding tactics for larval rearing of pearlspot

An experiment was carried out to evaluate the chances of rearing post hatch fry (PHF) of different ages in the absence of parental care by manipulating feeding tactics. Trials were also carried out to establish the optimum major nutrient levels in compounded larval diets. The fry of different ages like 1, 5, 10 and 20 days were obtained from same or different single pair spawnings under tank conditions. Upto day 5 the wrigglers survive on yolk sac. The larvae were maintained in 100 l well-aerated FRP tanks both indoors on clear water and outdoors in green water system which included a range of micro zooplankton, phytoplankton, pheriphyton, biofloc, etc. One day PHF (non-feeding wrigglers) were maintained on floating strainers whereas 5-day old PHF were stocked in tanks and fed *artemia* nauplii alongwith formulated feed. The 20-day old were maintained only on formulated feed.

Compared to clear water system, green water system was more successful in obtaining 100% survival in 1 day old PHF on the strainers in the absence of parents. However, 100% mortality occurred when they metamorphosed into free swimming larvae. The 5-day old and 10-day old fry fed on *Artemia* nauplii and formulated feed also resulted in partial survival (surviving for 4 to 5 days only). Twenty-day old fry alone could survive and grow successfully in the absence of parents. They were maintained up to maturation in tanks.

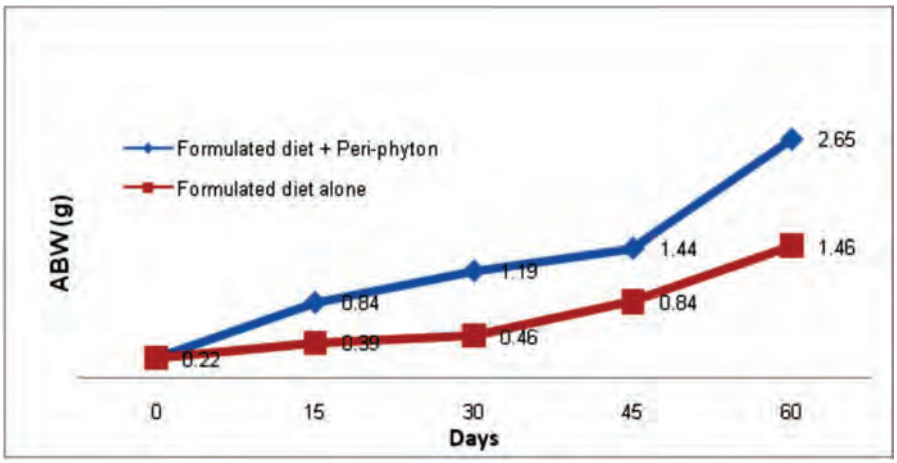


Fig.37. Larvae (30 day PHF) reared on formulated feed and green algal mat

In another 60-day trial, growth performance of 30 old PHF fed formulated diet in a clear water system was compared with the similar aged fry fed formulated feed in tanks with green water and periphyton. The growth is depicted in Fig. 37.

Larval development and ontogenic development of digestive system:

A straightforward approach to develop an apt larval diet for any fish requires information on the basic ontogenic developmental process of the digestive system and the enzyme profile. Along with larval feeding trial, an effort was made to collect and observe larval developmental stages starting from egg to day 19 PHF.

Microscopic view of developing larvae depicting yolk absorption on day 5

As a continuation, another research gap identified was optimization of major nutrient levels in larval rearing diets. A preliminary larval rearing trial using 20-day old fry was carried out for 2-months to optimize protein and lipid combination.

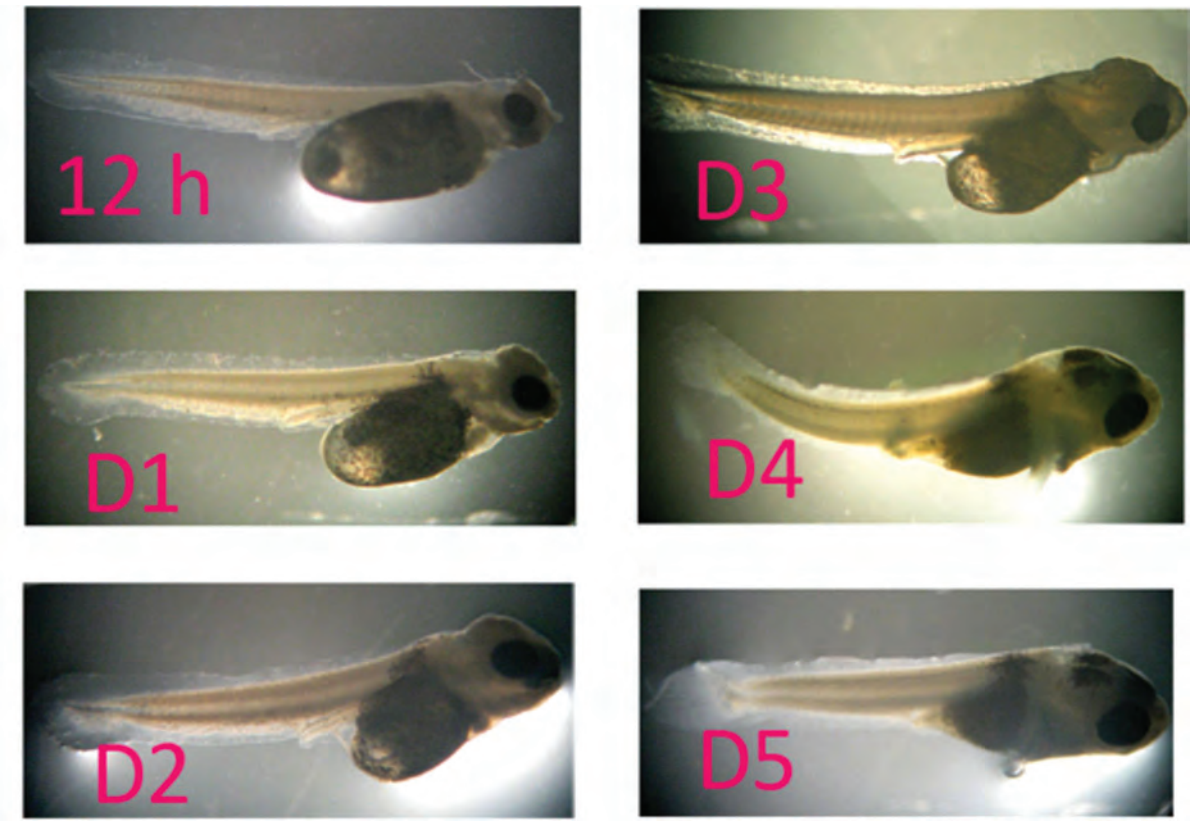


Table 17. Growth and survival of the larvae after 60 days

Diet (protein/lipid)	Initial weight (g)	Final weight (g)	Weight gain (g)	Survival (%)
40/6	0.026	0.83	0.81	74
40/9	0.026	0.64	0.62	88
40/12	0.026	0.59	0.56	86

There was a significant difference in the weight gain and survival among dietary treatments, the maximum weight gain being observed in fish fed with 40% protein and 6 % lipid diet.

Scaling up of SSF technique for field application

Five different types of containers viz. plastic bucket, jute bag, polythene bag (black and transparent), and tin containers were used for the fermentation of low cost ingredients with three levels of inoculum (i.e. 1, 2.5 and 5 %) of mixture of two bacteria (1:1), i.e., *Bacillus* sp. DDKRC1 (JN641289) and *Bacillus subtilis DDKRC5*. Observations were recorded at 24, 48, 72 & 96 h for enrichment of nutrient in the fermented ingredients. Forty eight hours of incubation with 5 % inoculum using covered plastic bucket resulted in a 9.72 % increase in crude protein, 5.41 % increase in ether extract content and 7.63 % decrease in crude fibre content in rice bran. In case of mustard cake, it was observed that 48 h of incubation with 5 % inoculum using covered tin container resulted in a 3.54 % increase in crude protein, 5.26 % increase in ether extract content and 1.77 % decrease in crude fibre content. For sunflower cake, 72 h of incubation with 2.5 % inoculum using covered plastic container resulted in a 5.57 % increase in crude protein, 5.26 % increase in ether extract content and 3.65 % decrease in crude fibre content.

Maximum enrichment of nutrient in rice bran, mustard cake and sunflower cake was observed when SSF was carried out with 2.5-5 % bacterial inoculum at 50 % moisture level at ambient temperature for 48-72 h in covered plastic bucket or tin container which can very well be adopted under field conditions.

Study on standardization of feeding platform for Asian seabass culture

An experiment for standardization of feeding platform for seabass culture in four earthen ponds of 900, 900, 450 & 450 m^2 was carried out. Wild fry (ABW-8.86g) were reared for 26 days in hapas with farm-made feed prior to start of the experiment. Iron reinforced net fabricated fibreglass hard bottom feeding trays (0.8mx0.8mx0.075m) were fabricated. Weaned fry (ABW-9.15 to 9.24 g) were stocked @0.3/m^2. Farm-made feed was fed twice daily @10-5 % of biomass at four places of each pond through broadcasting over the trays. After 2 h of each feeding, trays were checked to assess the feed intake. After 120 days it was observed that fish fed in feeding tray without platform exhibited higher weight gain (106.34 g) compared to fish fed in feeding tray with platform (80.97 g).

Table 18. Effect of platform feeding on performance of Asian seabass

	Platform	Without platform
IBW(gm)	9.23±3.09	9.15±3.13
FBW(gm)	92.19±6.93	117.27±1.42
TWG(gm)	80.97^{a} ±3.52	106.34^{b} ±2.56
ADG(gm)	0.67^{a} ±0.03	0.89^{b} ±0.02
Production(kg)	14.190	19.305
Productivity(kg/ha)	218.24	287.22
FCR	1.87±0.13	1.99±0.01
Survival (%)	81	84

Automatic Feeder demonstration in farmer's pond

Two upscaled automatic feeders were installed in a farmer's pond culturing *L. vannamei* (Silver star farm) at Marrakanam, the pond size being approximately 110m x 68 m. Based on an earlier trial, the dispenser unit of the feeder was installed in such a way that its bottom remained exactly 60 to 80 cm above water level (73 cm for feeder I and 68 cm for feeder II). Each feeder was installed 15 m from the dyke during 35 days of culture and became operative after 40 days. Feed was given 4 times a day viz. at 6.30 A.M., 10.30 A.M. , 2.00 P.M. and 5.30 P.M. and the total feeding time was 50 min for one feeding, the timer being set accordingly. The farmers evinced interest and have requested the feeders for the ensuing culture also. The water quality was monitored in all the ponds in the farm and there was no appreciable change between manual and automated feeding and shrimp production also did not differ between manual and automatic feeding.

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

Improving the product quality by re-feeding with the finisher diet in both fishmeal and fish oil replaced diets

Shrimp fed with plant ingredients by replacing marine ingredients like fish meal and fish oil resulted in a significant reduction of the most essential n-3 HUFA such as eicosapentaenoic (EPA, 20:5n-3) and docosahexaenoic acids (DHA, 22:6n-3). In addition, the proportion of palmitic (C16:0), Oleic (C18:1c n-9) and linoleic (C18:2c n-6) increased by 20, 60 and 40% units, respectively. In order to retain the original fatty acid quality, a finishing experiment was conducted with a finishing feed containing fish meal and fish oil. This restored high levels of these beneficial fatty acids to the shrimp prior to harvest. In this strategy, after 6 weeks growth trial, 'grow-out' feeds were converted to finishing feed. Tissue samples were taken at 15 and 30 days of the finishing diet phase. With the finisher diet, the percentages of 18:2n-6 and 18:1n-9 in edible portions decreased whereas the levels of ARA, EPA and DHA increased. On the 15th day, levels of most of the fatty acids recovered and were restored in all the portions of shrimp previously fed the partially replaced diet.

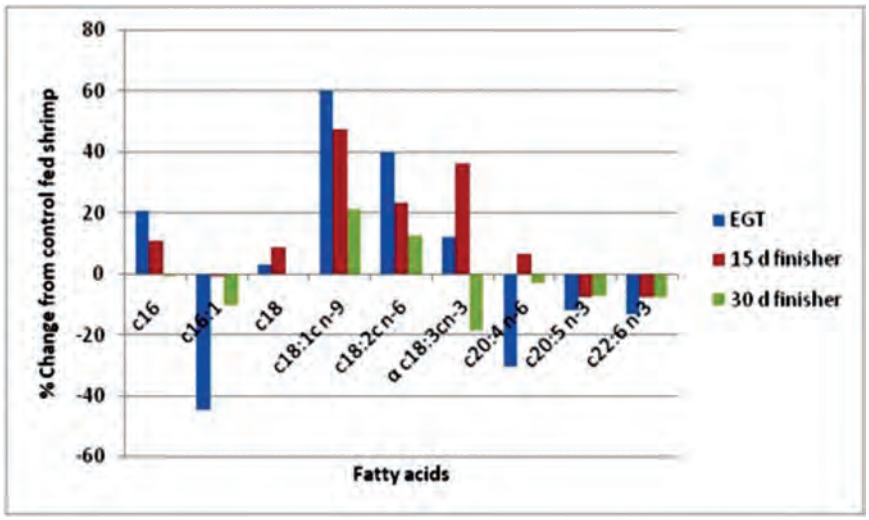


Fig.38. Percentage changes in major fatty acid profiles in edible portions of shrimp

Effect of cooking on fatty acid profile of shrimp

The effect of different forms of cooking on shrimp fatty acid profile was studied by steaming, boiling, preparing shrimp masala curry and crispy masala shrimp fry. Fresh shrimp were collected from the market, peeled and deveined. Shrimp masala curry was prepared by Indian traditional way of cooking using onion, tomato and ginger-garlic paste. After cooking, the shrimp were collected and preserved for fatty acid analysis. The crispy masala shrimp fry was prepared by using corn flour, ginger-garlic paste and deep-frying in oil. Fatty acid analysis indicated that boiling, steaming and curry making do not influence the fatty acid profiles except for a slight increase in linoleic acid (18:2n-6) and a decrease in arachidonic acid (20:4n-6). Shrimp masala curry contained increased levels of oleic acid (18:1n-9). Deep-frying shrimp influenced the fatty acid profiles. Saturated fatty acids like palmitic and stearic acids were significantly reduced and the oleic acid proportion trebled. The major changes were the increased level of linoleic acid (15 fold) and decreased levels of highly unsaturated fatty acids (HUFA).

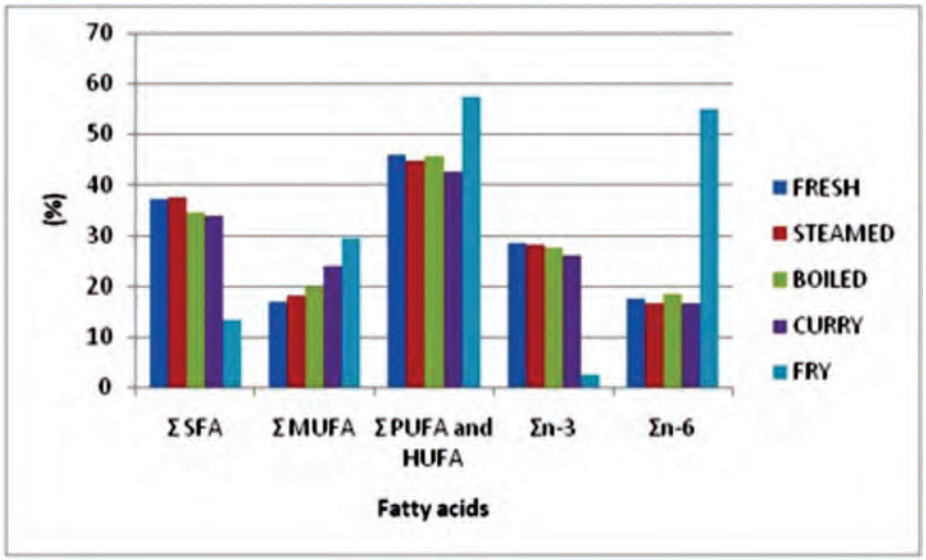


Fig. 39. Effect of cooking on shrimp fatty acid profiles

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

Till now, tiger shrimp stocks along the Indian coast spreading across Gujarat to West Bengal were studied based on truss morphometric data and mitochondrial gene sequences to comprehend the similarities among the stocks. The genetic characterization work of tiger shrimp was continued this year by genotyping of shrimp samples for microsatellite loci. Labeled primers for 19 microsatellite loci published by other researchers were short-listed and procured for genotyping which is in progress.

In an effort to check illegal hatchery and culture activities of Pacific White Shrimp, the Coastal Aquaculture Authority requested CIBA for a molecular-based tool for identification of white shrimp species. A few SNPs that discriminate *L.vannamei* from tiger shrimp were found after analyzing EST databases available in NCBI GenBank. The analysis involved 39,397 accessions for tiger shrimp and 1,61,241 accessions for *L.vannamei* . These SNPs were exploited for discrimination between Indian White Shrimp and Pacific White Shrimp. The SNPs that discriminate these species could not be directly obtained due to limited availability of database for Indian White Shrimp. Eleven SNPs were short-listed based on the number of accessions used for SNP identification. Those SNPs that were found based on maximum accessions and within known genes were the criteria set to short-list them. Thereafter, 3 more SNPs were further chosen for laboratory trials (Table 19) depending on the availability of restriction enzymes to be used for SNP genotyping by PCR-RFLP technique.

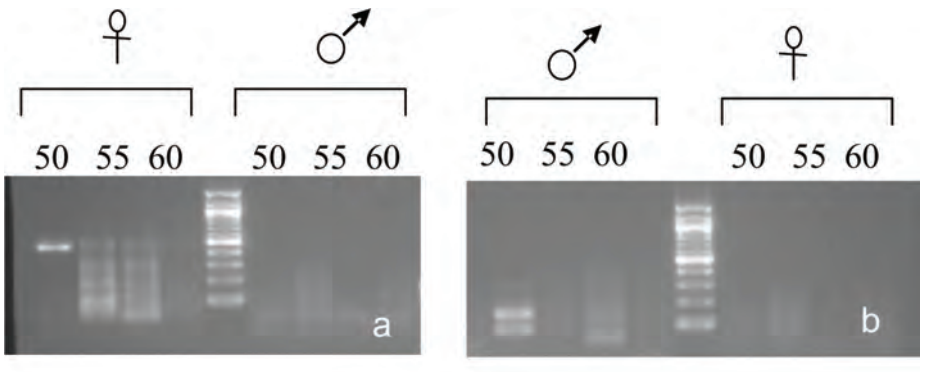
Primers were designed to amplify that stretch of DNA which would include the SNP loci for all the above 3 SNPs. Initial trial with SNP in contig 6948 led to interesting results. This particular primer amplified a fragment of DNA only in *L.vannamei* but not in Indian White shrimp. This could possibly be due to a SNP in the 3'-end of the primer binding site. Testing was done with about 20 *L.vannamei* samples and 55 *F. indicus* samples. A few banana shrimp samples that were tested also failed to amplify. This primer could possibly be useful to differentiate *L.vannamei* from *F. indicus*.

Table 19. List of SNPs used for laboratory trials to discriminate PWS and IWS

Contig	SNP allele	Restriction enzyme	SNP site
6948	G/C	EagI	166
7328	G/A	EcoRI	817
14243	T/C	NcoI	459

Sex discrimination in pearlspot

In pearlspot, it is difficult to differentiate the two sexes as there is no easily identifiable morphological character. Differential expression of genes functionally related to reproduction reported in other cichlids, namely *dmrt1, cyp11b2, Foxl2, ERalpha and ER beta, AR alpha, AR beta, FSH beta, LH beta, cyp19a* and *amh* were analyzed by semi-quantitative RT-PCR in pearlspot.Among the genes analyzed,only *cyp19a* and *Sox 9* were amplified with the expression of *cyp19a* being higher in female and *Sox9a* observed only in males. Ten RAPD primers reported to exhibit differential expression between sexes were selected for sex specific expression analysis in pearlspot. However, the primers did not show concurrent differential expression between sexes on analysis of surplus samples.



Semi-quantitative PCR analysis of the expression of (a) cyp19a and (b) Sox 9 at 50, 55, 60 and 65 ^{0}C in gonad tissues of pearlspot

Differentially expressed genes in response to WSSV infection

The SSH cDNA library was constructed from the hemocytes of the WSSV tiger shrimp to identify differentially expressed genes in response to WSSV infection. Fifty clones were sequenced which showed alpha-amylase and cytochrome genes to be predominately expressed as differential genes. Real time analysis of alpha-amylase gene carried out from gills tissues of WSSV infected shrimp at different time points (6h, 24h, 48h and moribund stage) showed down regulation at all time points of post WSSV infection.

Project Title (Institute)	**Outreach activity on fish genetic stocks**

The truss data of male and female tiger shrimp were analyzed again with an improved discriminant function analysis procedure (validation set included) for better inferences. A total of 1184 tiger shrimp

specimens collected from ten geographical locations including Kakdwip, Paradip, Visakhapatnam, Chennai, Tuticorin, Kollam, Mangalore, Ratnagiri, Harshad Miyani (Gujarat) and Port Blair were used in the analysis. For each specimen, 30 truss measurements were generated based on 14 landmarks using tpsUtil, tpsDig and PAST software. All the truss measurements were adjusted to remove the influence of size of shrimp using total length as indicator of size. Thereafter, the size-corrected variables were log transformed for normality and to make their mean independent of variance. The data was then analyzed separately for each sex by discriminant function analysis in SPSS 17.0 software to test the suitability of estimated functions for stock assignment of unknown shrimp samples. Approximately 70 % of shrimp specimens' data was used for estimation of discriminant functions and the remaining were used for validation of developed functions. The discriminant function could correctly classify about 68 and 69 % of shrimp to the respective stocks for male and female data respectively. The validation step assigned about 64 % of male shrimp and 53 % of female shrimp correctly to their stocks. Overall, discriminant function 1 clearly separates Mangalore stock from rest of the stocks. The Wilk's Lambda criterion, discriminant function coefficients and structure matrix (correlation between variable and discriminant function) were the three criteria used for identifying the variables responsible for discrimination between stocks. For both the sexes, the truss measurements spanning across first five tail segments were more important than other measurements to discriminate the stocks.

In the current plan period, it is envisaged to characterize *Fenneropenaeus indicus* and *Etroplus suratensis* along the Indian coast. During the reporting period, samples of *F. indicus* were collected from Chennai coast and *E. suratensis* were collected from Kerala coast (Vellayani Lake, Trivandrum). Samples of tissue were collected for DNA extraction and images of all animals were digitally recorded for generating truss data.

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

Identification and expression analysis of differentially expressed genes from shrimp (*Penaeus monodon*) in response to low salinity stress

Gene expression levels in response to low salinity conditions at 2 weeks post salinity stress of thirteen selected differentially expressed genes identified from SSH cDNA libraries (14-3-3 like protein, crustin, lysozyme, arginine kinase, Na+/K+-ATPase α-subunit, intracellular fatty acid binding protein, cathepsin B, anti-lipopolysaccharide factor, ferritin, ubiquitin conjugating enzyme E2, calreticulin, innexin 2 and heat shock protein 21) were analyzed by RT-PCR. The highest gene expression levels were observed for Na+/K+-ATPase α-subunit (34.28-folds) in gill tissues, intracellular fatty acid binding protein (13.30-folds) in gut tissues and innexin 2 (14.43-folds) in muscle tissues respectively (Fig. 40).The differential and significant levels of gene expression indicate the functional role of these genes in shrimp salinity stress adaptive mechanisms.

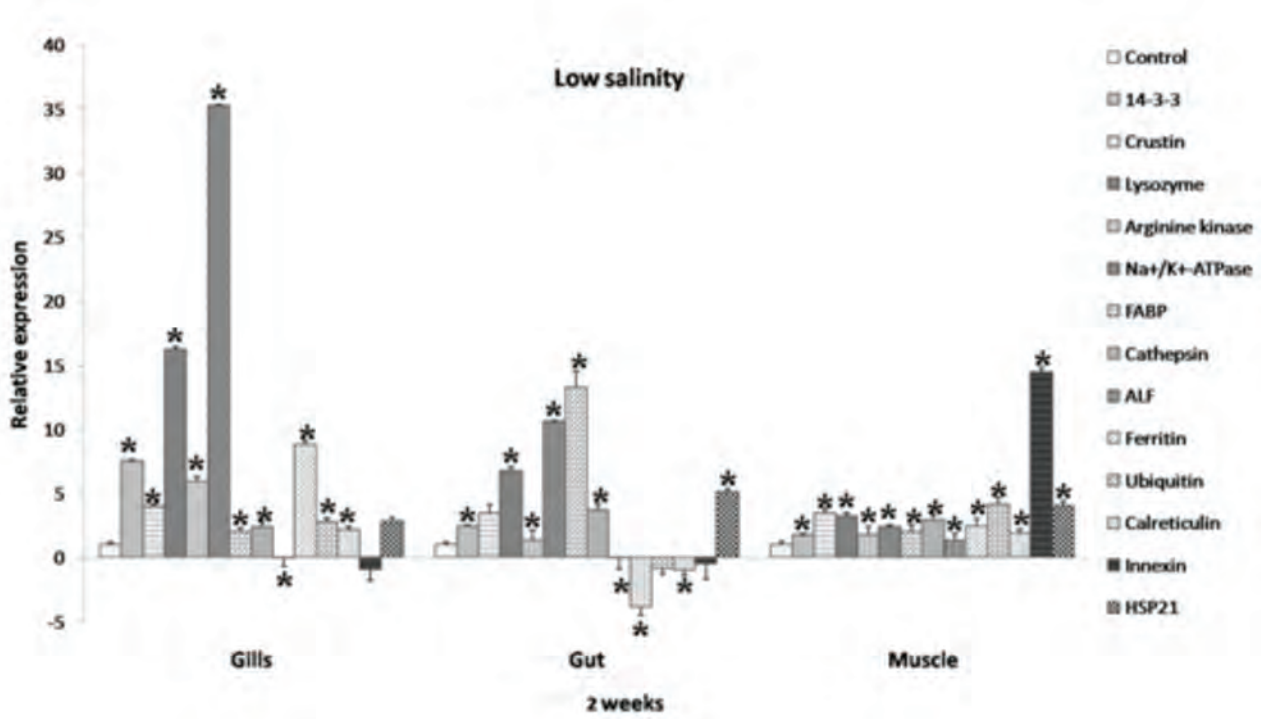


Fig. 40. Real time PCR analysis of differentially expressed genes (14-3-3 like protein, crustin, lysozyme, arginine kinase, Na+/K+-ATPase α -subunit, intracellular fatty acid binding protein (FAPB), cathepsinB, anti-lipopolysaccharide factor (ALF), ferritin, ubiquitin conjugating enzyme E2, calreticulin, innexin 2 and heat shock protein 21 (HSP 21) identified from SSH cDNA libraries in gill, gut and muscle tissues of shrimp *P. monodon* exposed to low salinity (3ppt) stress at 2 weeks time interval. The significant difference (p< 0.05) in gene expression levels are indicated with asterisks.

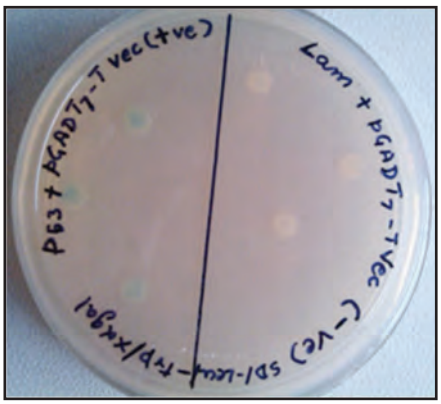
Project Title (DBT)	**Molecular studies on sequential pathogenesis of WSSV and defence mechanism in *Penaeus monodon***

Microarray analysis of shrimp immune genes in response to WSSV infection

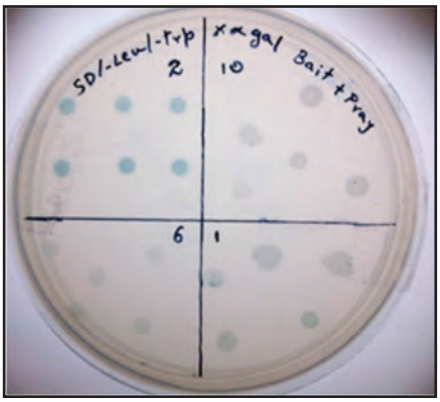
Microarray analysis was carried out as an approach to analyse the gene expression in tiger shrimp in response to WSSV infection. Gill tissues collected from WSSV infected shrimp at 6 h, 24 h, 48 h and moribund stage of post infection period were analysed for differential gene expression. Shrimp cDNAs were printed with a total of 42,013 sequences on a microarray chip. Cy3-labeled cRNA derived from healthy and WSSV-infected shrimp was subjected to hybridization with all the DNA spots in the microarray, which revealed 8633 upregulated and 11,147 down regulated genes at different time intervals post WSSV infection. The altered expression of these genes represented diverse functions such as immune response, osmoregulation, apoptosis, nucleic acid binding, energy and metabolism, signal transduction, stress response and molting.The altered gene expression observed by microarray analysis provides molecular insights and framework of genes which are up- and down regulated at different time intervals during WSSV infection in shrimp.

Project Title (DBT)	Molecular mechanisms of gonad inhibiting hormone action on the control of egg maturation in the penaeid shrimp, ***Penaeus monodon***

Proteins interacting with GIH were studied by Yeast-two hybrid to identify the receptors or partners in the GIH mediate pathway regulating vitellogenesis which can help to develop alternative captive maturation techniques to eyestalk ablation. The bait (pGBKT7-GIH) constructed was verified negative for autoactivation and was transformed to competent Y2H gold yeast strain by lithium acetate method and subjected to selection in amino acid deficient media. Libraries were constructed from ovaries of wild tiger shrimp and transformed into the Y187 yeast strain. Two hybrid library screening was conducted using yeast mating between *MATα* Y187 yeast strain (containing the library) and *MATa* reporter strain (containing the bait). The two strains were co-cultured overnight and thereafter plated on selective agar medium with X-alpha Gal. Development of blue colonies was considered as positive clones. Four positive clones were obtained which are being characterized.



Positive (p53) and Negative (Lam) controls



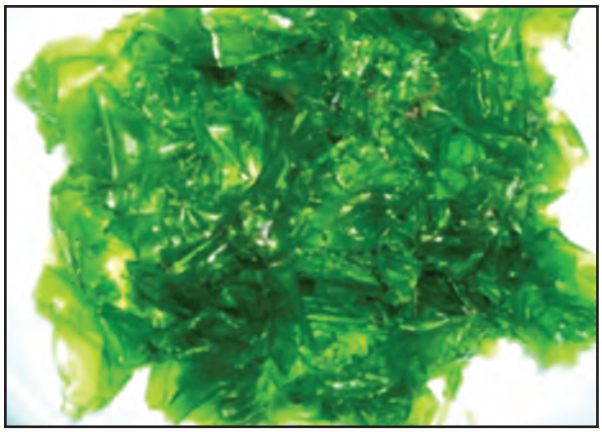
Positive clones interacting with GIH

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

Evaluation of marine macro alga, *Ulva fasciata* against Quorum sensing bio-luminescence causing *Vibrio harveyi* during *Penaeus monodon* larviculture:

From the intertidal region of Tuticorin, *Ulva fasciata* was collected from various substrates like rocks, plants, wood etc. Crude compounds were extracted from the algae. A 12.3 mm of inhibitory zone against *V. harveyi* through agar well diffusion assay was seen when 300 µg of the extract was used. Further, 300 µg/ml of the extract was treated against *V. harveyi* in LB broth which showed reduction in phospholipase and proteolysis. Production of bio-luminescence was reduced to 7.3, 7.7, 13.0, 17.0 counts per second (CPS) and growth also reduced by 25 %. About 200 µg/ml of the extract when tested against *V. harveyi* during larviculture of tiger shrimp showed 32 % reduction in the cumulative percentage mortality on postlarvae. Chemical composition of *U. fasciata* was characterized by FTIR and GCMS. FTIR spectrum showed the presence of significant functional group compounds such as alcohols, phenols, esters, ethers, alkanes, alkenes, primary amines, nitro compounds, aromatics and carboxylic acids, alkyl halides and aliphatic amines, etc. The GC-MS analysis revealed presence of organic compounds

such as Bis (2-ethylhexyl) phthalate, which was highest (88 %), followed by 1,2- benzene dicarboxylic acid- butyl (2.5%). It is possible that these bioactive compounds primarily with other organic compounds may be involved in the biological activity. It could therefore be inferred that *U. fasciata* may be a better bio-inhibitory agent for controlling *V. harveyi* during shrimp larviculture. Postlarvae of tiger shrimp when treated with crude extract of *Sesuvium portulacastrum* (mangrove plant) and *Rhizophora apiculata* (marine plant) exhibited 13 % and 10 % cumulative mortalities in 30 days respectively following challenge with *V. harveyi* as compared to 60 % cumulative mortality in control shrimp.



Marine macro alga *U. fasciata*

SOCIAL SCIENCES DIVISION

Project Title (Institute)	**Extension, Economics and Informatics in Brackishwater Aquaculture**

Assessment of present farming practices of pearlspot-*Etroplus suratensis*

The annual capture production of the species in Kerala is about 800 tonnes. In pond system with a stocking density of 5000-7000/ha, fed with supplementary diet, the production is about 2-2.5 tonnes. In intensive culture in backwater cages, they are stocked @ 20,000-25,000 fishes/ha. The culture can be promoted in brackishwater lakes viz. Ashtamudi (Kollam), Kuttanad and *Pokkali* fields to meet the domestic market demand. There are three issues: the dependence of farmers on wild seed, inadequate seed for stocking and non-availability of standard feed. Seed production technology and development of cost-effective feed for pearlspot are to be prioritised at CIBA to address these issues.

In West Bengal, pearlspot is caught in Diamond harbour and Sundarban areas and these are sold at Kolaghat and Canning markets respectively. A small scale operation of aquaculture is being carried out in and around Kakdwip. There is a contract trade system wherein arrangements are made with fishermen to get the full catch. The size of fish ranges from 80 – 250 g with a rate of Rs. 50-120/kg in primary markets and Rs. 80-180/kg in secondary markets. The average total arrival of fish is about 20 and 46 tonnes in Howrah and Sealdah markets respectively. Apart from this, pearlspot captured at Bangladesh also arrives during late August – November.

Analysis of demand and supply of selected brackishwater fishes and shrimps and price analysis of selected fish species in domestic markets

Weekly average shrimp prices from Chennai, Howrah, Vishakhapatnam, Bhimavaram and Cochin were collected along with those from New York and Tokyo markets. Thereafter, a desk top analysis was carried out on the secondary market information. Market prices had the same normal dip in March/April after which the prices increased and remained steady. The annual dip for 2014 has already commenced with a decline in international prices. The price per pound has crossed the Rs 700 mark after a gap of 13 years. International prices for Indian shrimp increased steadily due to disease attack in South East Asian countries and China. Domestic prices of shrimps remained on an average at Rs 300- 350/kg (50 count) in reference markets.

Impact analysis of CIBA technologies

Impact survey has been completed for CIBA feed technology with farmers (27), Feed Dealers (2), consultant (1) and entrepreneur (1). The impact pathway modeling is being attempted with CIBASTIM User (7) and Non user (7). The sample size would be enhanced. The direct impact of CIBA's indigenous tiger shrimp feed technology from 2007-2012 was estimated to be about Rs. 2.5 crores (1000 tonnes @ Rs.5/ less than comparable commercial brand) and about 5300 man-days of direct employment of semi-skilled/unskilled employment in factory and marketing-related jobs. An assessment was made among the involvement of coastal WSHGs of Kerala State in aquaculture and fisheries and information on 7 cases were collected, among which the details on four significant cases are presented below.

Aqua tourism by Women Self Help Groups

A case study on Aqua tourism centre monitored by Souparnika Women Self Help Group (WSHG) under the MATYSFED organisation at Njarackal, Kerala was carried out. This centre consists of 15 hectares of water body and is open to visitors for a fee. Under the ***Tsunami Emergency Assistance Project*** they have received Rs. 4,00,000/- as loan and Rs. 80,000/- as subsidy amount. These WSHGs have good management skills and have received the best WSHG award in the district.

Aqua tourism centre at Njarackal, Kerala

Pearlspot farming by women entrepreneur in Kerala

A woman entrepreneur, Ms Joyce Benny Thomas has been engaged in pearlspot farming at Njarackal, for the past eight years with technical knowledge through training and also financial support from the Fish Farmers Development Agency (FFDA), Cochin . In an acre of water spread area having 3 ponds 5000 nos. of pearlspot were stocked. The fish are fed with zooplankton and artificial feed prepared from chicken waste and rice is fed weekly once. The farmed pearlspot are sold @ Rs. 400/kg and tilapia @ Rs. 200/kg.

Pearlspot farming in Kerala

Value added fish food processing units managed by Women Self Help Groups

Four women activity groups at Munambam coastal village, are involved in managing four value added fish food processing units. All types of fish varieties are used for processing the fish food products. Items made from fish like cutlets, pickles, rolls, curry and fry are marketed. These beneficiaries were trained by Central Institute of Fisheries Technology and supported by Societies for Assistance to Fisherwomen (SAF). The products are sold in markets and fish food outlets. SAF facilitates in arranging fish food stalls in melas for these WSHGs.

Fish fertilizer unit managed by Women Self Help Groups

A fish fertilizer unit named 'Jaiyashree unit' managed by four women functions at Munambam coastal village. Fish fertilizer using fish waste was processed and marketed for plants, horticulture and vegetables. The process involves silaging the fish waste using organic acid and coir pith in tanks and buckets. Through this process, the fishy odour is lost and the final product is dried and graded according to quality and sold.

Tribal participation in integrated fish and mangrove

A study was conducted on irular tribals participating in integrated mangrove fish farming system in saline area at MGR Nagar, Killai, Chidambaram. In 6 ha area, there are 9 ponds in which crabs, seabass, mullets and milkfish were stocked. Primarily, seabass fry of 0.5 gm size are reared in hapas and when they reach 25 gms in size, are stocked in ponds. The culture period is 2 – 3 months.

Tribal participation in *neeris* and molluscan collection

In Killai, Chidambaram, irular tribals participate as families in '*Neeris'* polycheate worm collection from dried ponds and non-stocked shrimp farms. The worms are supplied to shrimp hatcheries as feed for shrimp. Sardine fish is crushed in water and sprinkled in the areas where the worms are to be collected. The smell of sardines attracts worms which are caught. Live worms fetch Rs.1000/ kg whereas dead worms fetch a lower price (Rs. 600/kg) and are marketed to Andhra Pradesh and Kerala.

Nursery rearing of seabass in hapas by women SHGs in Tamil Nadu

This was carried out among Marikolunthu and Annaparavai WSHGs of Kulathumedu village, Pulicat, Tiruvallur district, Tamil Nadu. A total of 10,000 seabass fry (average size: 2 cm) were stocked in hapas @ 500 nos/ hapa in September 2013. CIBA formulated farm-made nursery feed was fed twice daily @ 5% body weight. After 45 days of rearing, the seed attained a size ranging from 5 to 10 cm with a survival rate of 75 %. After the demonstration trial, the WSHGs earned a corpus amount of Rs.1,64,967/-which was equally distributed among the WSHG members. A few members reinvested in new business avenues viz. textile business, poultry farming, snacks preparation, vegetable sale and crab fattening in tide fed ponds.

Polyculture of mud crab & seabass farming in community pond by tribal people

A community pond located at Kulathumedu village was adopted for demonstration of polyculture trials of *Scylla serrata* and *Lates calcarifer* by *irular* tribe of the village. A total of 147 people (men: 82 and women: 65) including five WSHGs in this village came to adopt this trial utilising a pond of area 2.0 ha, water depth of 0.5 to 1.2 m and salinity of 30 - 45 ppt. A total of 2000 nos. of seabass fingerlings (6-9 cm TL and 4-6 g ABW) procured at a cost of Rs. 15/- each and 1048 crabs (249.2 kg) ranging from 100 – 450 g size procured at a cost of Rs.450/kg were stocked. Locally available low value fish were fed. Feeding was adjusted based on the standing biomass @ 8-10% of the body weight. After three months, the seabass attained a size of 19 cm and the weight ranged from 40 g to 180 g. A total of 217 juvenile fishes were collected through partial harvesting (sale amount: Rs. 13,990/). The sale of crabs yielded Rs.2,17,750/- which was deposited into the bank. This intervention proves to be a good model of supplementary revenue generation portraying the community participation in adoption of common water bodies for fish farming.

Based on this demonstration, an assessment was made in the coastal places viz. Gummidipoondi, Cuddalore, Kadapakkam and Kovalam for potential demonstration of brackishwater aquaculture technologies.

Study of the ICT models for effective ToT

The ICT model in agriculture sector was studied to compare the utility of the present model in aquaculture. The Nutrient Manager for Rice (NMR) is a decision support tool that includes both web-based and mobile applications providing personalized fertilizer guidelines for small-scale rice farmers/ extension workers. Data were collected from 77 farmers in Nagapattinam and Tiruvarur districts to study the nature of work of NMR tool. About 82% of the farmers were of the view that it helped them to manage their fertilizers judiciously.

Table 20. Feedback from DoF officials & farmers

SMS DoF Officials (N= 79)	VMS Farmers (N= 81)
Able to access the information at any time.	If calls are missed, information cannot be accessed.
Subject is comprehendible without any difficulty.	The farmers wanted to receive information between 14.00-17.00 h
Requested for Toll free number from CIBA.	Theme-based programmes through PiP and Video-conferencing.
Helpline service weekly once during a particular time about disease aspects.	Weather-based, season-based and current information about crop on a daily basis.
Publications about the thematic subject in English.	Publications in the form of FAQs about thematic subject in Tamil.
Information on reducing risk to avoid crop loss.	Timely information on reducing risk to avoid crop loss.
Information availability from authentic source was appreciated.	

Dissemination of message via SMS and VMS onseabass

Fifty five messages on seabass farm management in English via SMS were disseminated to 289 DoF Officials covering Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and Gujarat. Forty seven technical messages on seabass farm management via VMS were disseminated to the 489 farmers in Tamil Nadu. Preliminary feedback study was conducted with DoF officials and farmers, regarding information dissemination on seabass and is depicted in Table 20.

Comparative analysis of farmer groups in fisheries vis-à-vis other farming sectors

A comparative study of farmer groups operating in agriculture and allied sector vis-à-vis shrimp farming was undertaken. The criteria adopted included input access and intra-group dynamics, factors influencing farmer participation, credit and insurance support, collective marketing, social factors affecting group effectiveness, women participation in farmer associations, group effectiveness and efficiencies, converting farmer groups to a producer company and linking farm producer with the inputs and processor. The analysis indicated that effective shrimp farmer groups are at par with allied sector producer groups. However, producer groups in agriculture particularly horticulture sector have progressed far ahead in facilitating forward linkages like global marketing. Further, farmer groups like plantation and vegetable producers are moving towards producer companies and provided macro level leadership to collective marketing. Similarly, there is a need to facilitate the effective shrimp farmer group which has the potential to transform as producer companies to play an active role in the whole supply chain process.

Rural entrepreneurship development through brackishwater aquaculture

Brackishwater based entrepreneurship development of a progressive farmer in Nagapattinam district was documented. The farmer has diversified shrimp aquaculture by adding milkfish farming. He has developed his own feeding method to prevent feed wastage. As president of shrimp farmers association, he is promoting a group approach in shrimp aquaculture. He is working with research institutions for assessment and refinement of farming practices and developing the capacities of the farmers for adoption of better management practices in shrimp farming. Rural entrepreneurship through sport fishing using *Lates calcarifer* was undertaken. The entrepreneur took community ponds on lease in selected locations and reared seabass for sport fishing which is a novel idea for sustenance of business.

Roughest based optimal location model in aquaculture

A mathematical model was developed based on dominance based rough set theory and simple additive weighting Multi Criteria Decision Making (MCDM) method for identification of optimal location for aquaculture development. A list of 27 criteria classified into five categories of main-criteria *viz.*, water (9 sub-variables), soil (7 sub-variables), support (4 sub-variables), infrastructure (5 sub-variables) and risk factor (2 sub-variables) were used for constructing the model in which objective function (OF_i) was defined as $OF_i = \sum_j a_{ij} \gamma_{ij}$, where, a_{ij} is an element of the decision matrix A, showing the performance of i^{th} alternative with respect to j^{th} sub-criterion/main- criterion; γ_{ij} is relative weights of the criteria calculated using dominance roughest theory. Finally, the optimal alternative (aqua site) was identified based on the ranking according to the descending order of objective function, OF_i. A case study application of identification of optimal location in Kalla Mandal (15 aqua sites), West Godavari district, Andhra Pradesh was used to illustrate the efficiency of the proposed method. The result shows

that the correlation between ranks obtained by the rough set based MCDM model and ranks obtained based on TOPSIS-AHP based mathematical model was significant (a confidence level of 99 percent) indicating that this rough set based MCDM model is indeed reliable for identification of optimal location for aquaculture development.

Need assessment for disseminating aquaculture information through ICT tools in Gujarat

The information needs and dissemination of information through ICT tools for propagating brackishwater aquaculture for tribal aqua farmers is very important. Through a structured questionnaire to various groups, information was sought regarding polyculture of shrimp with fish and milkfish with carp from tribal, government, and farmers' group. The main requirement were video presentation of success stories or case studies of farmers, package of culture practices (seabass and milkfish) for diversified species suitable to Gujarat, alternative livelihood activities of coastal women and development of web portal for fisheries containing species wise FAQs addressed by farmers, extension materials in vernacular and establishment of knowledge centres.

Indigenous Technical knowledge and beliefs

This was documented in relation to climate,environmental changes, their impact on fisheries and aquaculture sectors, culture of ornamental fish, crab fattening and various beliefs on consuming animals in Tamil Nadu. Data were collected from 200 respondents including coastal women, men and tribals in four coastal districts *viz.*, Tiruvalur, Kancheepuram, Cuddalore and Nagapatinam districts. A well structured interview schedule, Participator Rural Appraisal, Focus Group Discussions and interactions were used to collect the data and information for this document.

ITK database home page

Scenario analysis for shrimp farming in India

Scenarios were built based on the shrimp production data collected from MPEDA, Cochin. Scenarios like 'business as usual' were built which is based on average annual growth rate of shrimp production for a period of 18 years starting from 1996 to 2013 (Table 21) It could be inferred from the data that the average annual growth rate (AAGR) of shrimp production is 10.36% and for the 'business as usual' scenario, the shrimp production would be 4.67 lakh tonnes by year the 2020 and 6.08 lakh tonnes by the year 2025. 'Positive scenarios' and 'negative scenarios' were built in with a hypothetical condition. The negative and positive scenarios ranged from 1.54 – 5.62 and 4.45 – 7.69 lakh tonnes for the years 2020 and 2025 respectively. State wise scenarios were also built based on time series ARIMA models. The prediction for shrimp production for the year 2020 are 2.05, 3.65 and 0.45 lakh tonnes for 'business as usual', 'positive' and 'negative' scenarios respectively. The variations in the predictions among the methods implemented are due to seasonal fluctuations.

Table 21. Scenarios of state-wise shrimp production

State/ year	2012-13		2020			2025		
	AAGR (%)	Actual*	Negative*	BAU*	Positive*	Negative*	BAU*	Positive*
Andhra Pradesh	15.30	1.59	2.74	3.29	3.85	3.56	4.51	5.47
Tamil Nadu	31.20	0.25	0.73	0.82	0.91	1.07	1.22	1.38
West Bengal	6.30	0.52	0.57	0.76	0.94	0.61	0.92	1.24
Odisha	13.10	0.14	0.23	0.28	0.33	0.29	0.37	0.46
Maharashtra	15.40	0.03	0.06	0.07	0.09	0.08	0.10	0.12
Gujarat	25.20	0.09	0.23	0.26	0.29	0.32	0.38	0.43
Kerala	-0.40	0.05	0.03	0.05	0.07	0.02	0.05	0.08
Karnataka	-2.10	0.007	0.003	0.006	0.008	0.001	0.002	0.01
Goa	-0.47	0.0006	0.0002	0.0004	0.0006	-	0.0001	0.0006
Overall for India	10.36	2.7	3.72	4.67	5.62	4.45	6.08	7.70

* Values in lakh tonnes

Developing statistical package for aquaculture research data analysis

Statistical package for aquaculture research data analysis was developed using Python programming language. WxPython was used for graphical programming. The package is user-friendly with a menu driven format. All the operations such as input of data, selection of analytical tools/parameters and output of report are in a single page. The package has been designed with the analytical methods like descriptive statistics analysis, t-tests, chi-square test, correlation, regression, completely randomised design, randomised block design, Latin square design and factorial design which would be useful for researchers and students for analysing aquaculture data. The outputs can be transferred to word format and is amenable for documentation and reporting.

Project Title (NABARD)	**Economics of shrimp ponds in disuse and participatory appraisal of productive use options and policy needs**

This project traces the history, current status, reasons for the disuse of shrimp ponds, constraints in culturing of shrimp and socio-economic status of shrimp farmers who keep their shrimp ponds in disuse. The project attempted to solve the existing issue of shrimp ponds under disuse with a participatory approach combining domain knowledge of aquaculture technologies, socio-economic evaluation, Geo-spatial and environmental appraisal techniques. A well-structured questionnaire was framed for the interaction with farmers whose ponds were in disuse. Field survey was carried out in Andhra Pradesh (200), Odisha (162), Tamil Nadu (100) and Kerala (100) and the data were digitized, validated and resurveys were approved wherever needed. Ecological Case Analysis was carried out by analyzing the soil and water samples collected from the surveyed sites to evaluate the present condition and suitability of the shrimp ponds in disuse for revival. Geo-Spatial Analysis of shrimp ponds in disuse was carried out using Geographic Information Systems tools. Participatory Rural Appraisal was conducted in Pedapatnam Village, Machilipatnam Mandal, Krishna District, (AP) where the concentration of disuse of shrimp ponds is high in order to find out the productive aquaculture use options for shrimp ponds in disuse. After analyses, technical and policy advisories were prepared which could help make the farms productive for shrimp farmers.

Project Title (NFDB)	Study on Marketing and Value Chain Improvement Strategies for Promoting White Leg Shrimp (*Litopenaeus vannamei*) Farming in India

This project identified the marketing and value chain improvement strategies for promoting *L.vannamei* farming in India. The strategy was to solve the exploratory and prospective analyses of production economics and marketing prospect for *L.vannamei* shrimp in domestic markets with a rapid survey and 'first benchmark farm dataset' on *L.vannamei* farming in Andhra Pradesh, Tamil Nadu, Maharashtra, Karnataka, Gujarat and Odisha. A rapid report was prepared on *L.vannamei* production/ culture for different farm categories & infrastructure development, domestic marketing requirements on size classes, price band preferences, seasonal demand patterns, sequential stocking, feed conversion ratio, harvesting, cost and returns and economic strategies. An analysis was carried out on marketing aspects of cost and returns and its impact on requirement of production of *L.vannamei* in the current situation as needed in this sector. The informative production data and prospects were computed and validated to find out the marketing aspects for this study.

Project Title (ICSSR)	Assessment on the impact of Environmental Changes on the livelihoods of coastal Women in Tamil Nadu

Challenges faced by coastal women due to the impact of environmental changes

One hundred coastal beneficiaries (25 women from each district) belonging to all communities were selected from Tiruvallur, Kancheepuram, Cuddalore and Nagapatinam . Data related to socio-economic profile, livelihoods adopted before and after tsunami, stress and drudgery details, risk faced etc. were collected from the respondents using pre-tested interview schedules. A SWOT analysis was carried out to study the impact of environmental changes. Strength, Weakness, Opportunities and Threats of coastal women due to impact of environmental changes was analyzed.

Livelihood of the coastal women before tsunami and post tsunami

Prior to tsunami, maximum number of women participated in fish sales, dry fish sales and wild shrimp collection. This was followed by fish vending, jelly fish processing, clam collection, goat rearing, crab fattening (in concrete tanks) and as labour force in shrimp farm and agricultural farms. Post-tsunami, the maximum number of coastal women participated in NREGA (National Rural Employment Guarantee Act) 100 days' rural employment in all the districts, followed by crab fattening (in pens and in tide fed ponds), seabass nursery rearing in hapas and fish feed development. Women being members in the Women Self Help Groups (WSHG) have also facilitated in the adoption of these technologies.

Stress and drudgery faced by coastal women due to impact of environmental changes

Different kinds of stress and drudgery were faced by women due to the impact of environmental changes. Adoption of diversified livelihoods, interrupted power supply, irregular employment and difficulty in drying fish due to lack of space were the maximum scores in all the districts. Death of family members in natural calamities was the factor that scored maximum only in Nagapatinam district. The respondents also attributed maximum death to tsunami.

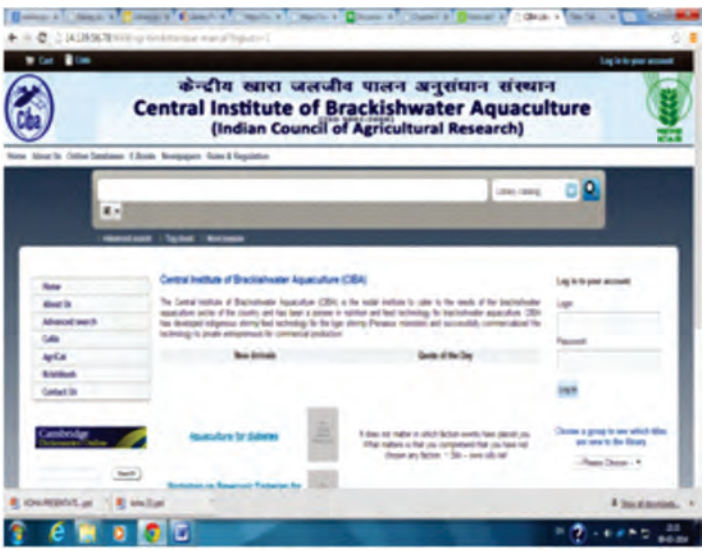
Risk faced in the selected coastal districts due to environmental changes

Change in regular monsoon, non- availability of seasonal fishes, high rate of fish, land pollution, increasing fishing fleets and fish catch, unusual rains, high salinity in ground water and water pollution were given maximum scores by the coastal women of Tiruvallur, Kanchipuram, Cuddalore and Nagapattinam districts. Incidents like seawater intrusion into dwelling areas, sea erosion and sea level rise were reported only in Kanchipuram district whereas incidents like fishing ban in Pulicat Lake, evacuation of village due to rocket launching at Sriharikota and use of very small mesh size fishing nets by trawlers were reported by the respondents of Tiruvallur district.

Project Title (NABARD)	**e-Extension Strategy for ensuring rural led knowledge growth**

A Workshop was conducted on e – Extension Strategies for shrimp farming in April at Avarikadu village, Nagapattinam district of Tamil Nadu. About 219 farmers, 8 Scientists from CIBA, a Senior Research Fellow, Officers from Indian Overseas Bank, Nagapattinam, MSSRF, National Centre for Sustainable Aquaculture, 7 technicians from nearby villages and 5 farmers from Velankanni attended. During the farmers' interactive session the farmers discussed issues on pending license aqua insurance, installation of a laboratory in the village for testing water quality parameters and mobile laboratory for that district. They requested information on *L.vannamei* via VMS through mobile phones.

Project Title (NAIP)	**Strengthening of Library and Information Management under NARS (e-GRANTH)**



The e-Granth project was implemented as part of the component –I of the NAIP of ICAR to develop a union catalogue of agriculture *AgriCat* by integrating the libraries of National Agricultural Research System institutions - State Agricultural Universities and ICAR institutions. Accordingly, about 16,000 library holdings were placed into a MRARC 21 compatible format and the whole library operations were migrated into KOHA Integrated Library Management System.

In order to sensitize the end users of the library about the utility features of the Koha for the effective utilization of the system developed a workshop on Strengthening of Digital Library and Information Management Using KOHA (ILS) was organized in March 2014 at CIBA. A user manual and a CD with user-friendly screen shorts were prepared to facilitate the library users to access the Koha enabled cataloguing system for their information search requirement.

Project Title (NFBD)	Appraisal of *Litopenaus vannamei* culture systems and associated production risks for the development of Better Management Practices (BMPs)

The objective of the project is to assess the technical efficiency of *L.vannamei* culture systems, production related risks and their impact to develop better management practices for *L.vannamei* farming.

Farm surveys were carried out in 333 *L.vannamei* shrimp farms in Andhra Pradesh, Tamil Nadu, Karnataka and Gujarat. Brackishwater culture constituted 62% of the surveyed farms whereas 38% belonged to freshwater and low saline culture systems. The technical efficiency (TE) of *L.vannamei* farming was computed using Frontier 4.1 programme and the results are depicted in (Fig. 41). Stocking of SPF quality seed, judicious use of fuel and electricity make the farm more efficient. Better farm infrastructure with biosecurity, efficient feed management, training in *L.vannamei* farming, adoption of bio-floc, disinfection, cropping period and zero-water exchange significantly contributed to technical efficiency. Further, there is a significant difference in the TE of *L.vannamei* farms with different salinities, HDPL vis-à-vis earthen ponds cultures, different stocking densities and different FCRs realized by the farms (P<0.01).

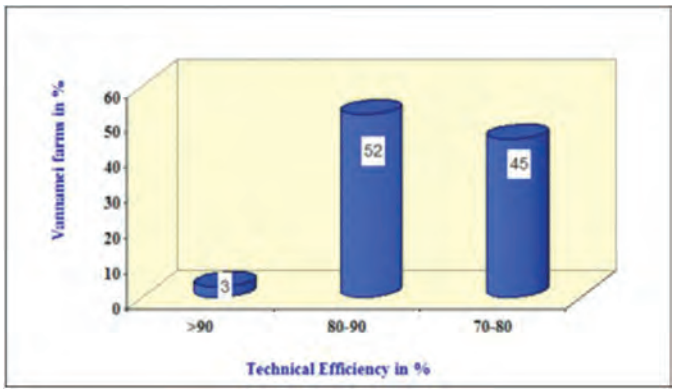


Fig. 41.Evolving culture systems and their technical efficiency

Important observations and concerns regarding *L.vannamei* farming

- Ploughing the bottom soil with cultivator followed by rotavator enhanced soil oxidation thereby increasing the availability of nutrients, release of obnoxious gases and better decomposition. Rotavator made smaller lumps of soil which provided better oxidation and minimized seepage
- Extension of water culture for few more days (12-15 days) enhanced seed survival
- Hatcheries forbid seed screening. Nursery rearing for one month helps in better survival and growth
- High-protein feed was used initially followed by low-protein feed. Automatic feeders facilitate better FCR (up to 2 points), uniform growth and pond bottom management
- Combining paddle wheel and spiral aerators provided efficient circulation and dissolved oxygen levels. Air blowers/air injectors along with minimum aerators provided better performance as they minimise the number of aerators and power thereof
- WSSV and RMS were the major disease risks
- Partial harvesting up to 3-4 times helps in minimising risks
- Use of pond-reared brood stock for seed production
- Very high stocking densities without adequate infrastructure and biosecurity
- Inadequate acclimatization, poor survival and uneven growth

- Shallow ponds and inadequate pond management- low pH and DO levels
- Emerging diseases like RMS and lack of screening protocols for them
- Inadequate regulation in low saline areas

Identification and assessment of production oriented risks in the *L. vannamei* culture systems and their impact on production

The overall risk assessment indicated that diseases were a major risk having high probability of occurrence during culture, the impact being disastrous with 75 to 100 % loss of crop. Poor seed quality, lack of biosecurity, poor water quality and climate change extremes, torrential rain, flood and unusual temperature were the other major risks likely to occur with moderately negative impact (25-50% loss). About 100 FAQs on *L.vannamei* farming were collected and compiled for the benefit of the farmers.

LIKELIHOOD	IMPACT				
	Little Negative (1)	Minor Negative (2)	Moderately Negative (3)	Extremely Negative (4)	Disastrous (5)
Very High (5)			Poor Seed quality		
High (4)			Lack of Biosecurity		Diseases
Likely (3)	Feed quality/ cost		Poor Water quality/ Climate	Market	
Low (2)					
Very low (1)				Food Safety / Social/ Policy	

Extremely low risk
Low risk
Moderate risk
High risk
Extremely high / Catastrophic

KAKDWIP RESEARCH CENTRE

Project Title	Enhancement of brackishwater aquaculture production of shrimp & fishes through economically viable and sustainable approach

Improvement of natural productivity in bheries & polyfarming of fish & shrimp (Tribal sub-plan)

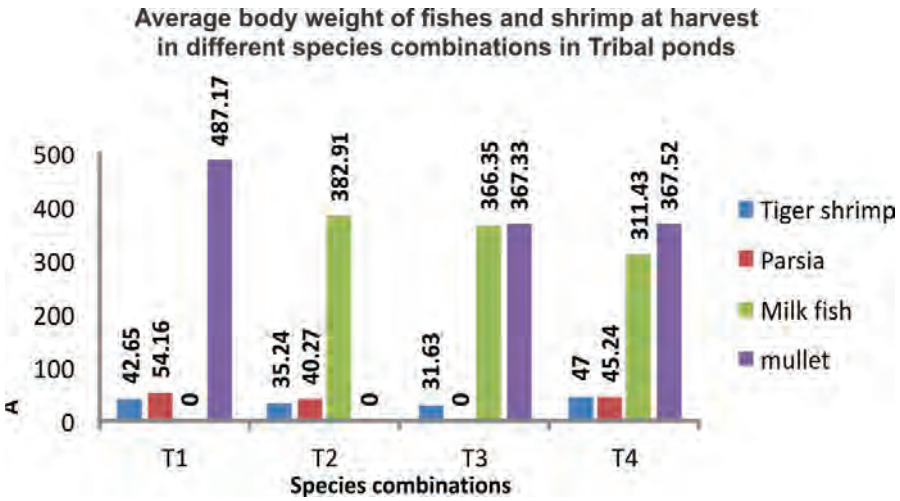
Polyculture of finfishes and shrimp was demonstrated at Manmathapur Mundapara (a tribal village), South 24 Parganas District, West Bengal, to improve the livelihood of tribal farmers by selecting thirteen small brackishwater ponds with water spread area of 3905 m^2 . Stocking density of different shrimp and fish viz. tiger shrimp, grey mullet, parsia and milk fish were 2, 0.5, 0.5, and 0.5/m^2 respectively in all the treatments and the culture was carried out for 240 days. The total biomass production was highest in mixed culture (T4). Interestingly, highest production of tiger shrimp was found in T1 where milkfish was absent and in absence of *L.parsia,* milkfish production was high along with tiger shrimp. *L. parsia* at a stocking density (0.5/m2) showed very less impact on production.

Table 22. Production (kg/ha) from polyculture trial under Tribal sub plan

Combination	*P. monodon* (2no./m²)	*L.parsia* (0.5no./ m²)	*M.cephalus* (0.5no./ m²)	*C. chanos* (0.5no./ m²)	Total
T1	352.12	151.04	1235.51	-	1738.66
T2	201.64	120.51	-	601.36	923.50
T3	174.60	-	998.08	622.20	1794.96
T4	175.20	105.53	1105.96	544.35	1931.04

Table 23. Water quality parameters (averages) in ponds

Combinations	DO (mg/l)	pH	Salinity (ppt)	Temperature (°C)	Alkalinity
T1	4.41	7.74	5.2	29.5	119.34
T2	5.2	7.47	3.4	30.7	111.34
T3	4.54	7.31	1.9	29.17	127.33
T4	5.6	7.49	3.57	29.25	147.5



Standardization of feed management practices of shrimp/fish polyfarming with low cost feed

Shrimp/fish polyfarming in ten farmers' ponds from Ganeshnagar, Namkhana was carried out using low cost polyculture feed for 120 days culture period. The species stocked were *Liza parsia* (5000/ha), *Liza tade* (5000/ha), *Mugil cephalus* (2500/ha), *Scatophagus argus* (2500/ha), *Mystus gulio* (30000/ha) and *Penaeus monodon* (2500/ha). The feeding strategies adopted were 100% broadcasting (T1), 75% broadcasting + 25 % tray feeding (T2), 50% broadcasting + 50 % tray feeding (T3), 25% broadcasting + 75 % tray feeding (T4) and 100 % tray feeding (T5 @ 4-10 % body weight in two ponds for each treatment. Significantly the growth of all the species and productivity ($P<0.01$) were higher and FCR ($P<0.05$) lowest in 100% tray feeding group.

Table 24. Production performance in polyfarming under different feeding methods

Parameter	Treatment groups				
	T_1	T_2	T_3	T_4	T_5
Pond area (m^2)	372	300	302	299.5	302
Culture duration (days)	120	120	120	120	120
Production (kg)	36.99	30.31	32.99	35.00	37.21
Productivity (kg/ha)**	994.29 ^{a}	1010.48 ^{a}	1086.08 ^{b}	1163.66 ^{c}	1232.28 ^{d}
FCR*	2.31 ^{c} ±0.03	2.25 ^{bc} ±0.01	2.03 ^{bc} ±0.02	1.92 ^{ab} ±0.08	1.64 ^{ab} ±0.20
SR%	72	71	75	73	74

*P<0.05, ** P<0.01, Values bearing different superscripts in a row differ significantly

Table 25. Growth performance of individual species in polyfarming under different feeding methods

Species	Parameter	Treatment groups				
		T_1	T_2	T_3	T_4	T_5
Liza parsia	TWG (g)**	15.82 ^{a} ±0.24	17.17 ^{b} ±0.20	18.56 ^{c} ±0.02	19.65 ^{d} ±0.14	22.02 ^{e} ±0.10
	ADG (mg)**	131.83 ^{a} ±2.01	143.08 ^{b} ±1.67	154.64 ^{c} ±0.15	163.76 ^{d} ±1.17	183.53 ^{e} ±0.85
Liza tade	TWG (g)**	50.80 ^{a} ±0.21	51.98 ^{a} ±0.51	52.27 ^{a} ±0.92	56.01 ^{b} ±0.2	58.92 ^{c} ±0.63
	ADG (mg)**	423.34 ^{a} ±1.74	433.17 ^{a} ±4.25	435.56 ^{a} ±7.69	466.74 ^{b} ±1.70	491.0 ^{c} ±5.23
Mugil cephalus	TWG (g)**	78.66^{a}±0.001	82.07^{b}±0.15	83.22^{b}±0.87	86.92^{c}±1.07	92.35^{d}±0.33
	ADG (mg)**	655.49^{a}±0.01	683.88^{b}±1.21	693.50^{b}±7.22	724.29^{c}±8.93	769.61^{d}±2.74
Scatophagus argus	TWG (g)**	19.42^{a}±0.39	20.12^{ab}±0.14	20.91^{bc}±0.17	21.50^{cd}±0.20	22.60^{d}±0.64
	ADG (mg)**	161.87^{a}±3.21	167.63^{ab}±1.21	174.23^{bc}±1.38	179.15^{cd}±1.6	188.31^{d}±5.33
Mystus gulio	TWG (g)*	18.16^{a}±0.08	18.62^{b}±0.54	19.69^{ab}±0.96	21.07^{b}±0.65	21.45^{b}±0.27
	ADG (mg)*	151.30^{a}±0.63	155.13^{b}±4.54	164.10^{ab}±8.00	175.58^{b}±5.42	178.76^{b}±2.25
Penaeus monodon	TWG (g)*	19.30^{a}±0.57	20.41^{ab}±0.04	20.57^{ab}±0.14	22.17^{bc}±0.88	22.79^{c}±0.18
	ADG (mg)*	160.80^{a}±4.71	170.08^{ab}±0.33	171.39^{ab}±1.13	184.74^{bc}±7.32	189.93^{c}±1.47

*P<0.05, ** P<0.01 Values bearing different superscripts in a row differ significantly

Improvement of shrimp farming through natural productivity

Periphyton-based grow-out demonstration trials in four ponds (average pond size 1300 m^2) was carried out in farmers' ponds at Maitypara, Ramakrishna Chowk village, Kakdwip Block. Velon nets were installed as substrates for periphyton development in treatment ponds covering 10% of pond surface area and the ponds were stocked with *P. monodon* at 12 nos./ m^2. After 124 DOC, the average body weight, FCR, total productivity in treatment (27.88 g, 1.62 FCR, 2796 kg/ha) was higher compared to control ponds (26.2 g , 1.79, 2196 kg/ha) with a 9.5 % improvement in FCR and 27 % improvement in productivity.

Table 26. Growth performance of tiger shrimp (mean ±SD) under periphyton based farming system

Parameters	Periphyton based system	Control ponds
Average body weight (ABW)	27.88±0.35	26.23±1.52
Survival (%)	82	68
FCR	1.62±0.03	1.79±0.11
Productivity (kg/ha)	2796	2196

Role of aeration in low density periphyton based shrimp culture

Tiger shrimp (3.8 g and 8 nos. /m^2) in ponds with and without aeration were cultured for 60 days. The study revealed dissolved oxygen level (DO) being the lowest at 5.00 AM (2.02 ppm) and maximum at 3.00 PM (4.08 ppm) in pond without aeration. There was no significant variation in treatment with and without substrate. (Fig. 42). However, there was highly significant difference in survival among the treatments ($p<0.01$) but no significant difference in final average body weight among the treatments (Table 27). Water quality parameters viz. nitrite-N (NO_2-N), total ammonia nitrogen (TAN) and nitrate-N (NO_3-N) differed significantly ($p<0.01$) among the treatments. However, significantly lower level of pH, water chlorophyll among the treatment was observed in treatments without aeration.

Table 27. Average final body weight (mean ± SE) and survival in substrate based treatment with and without aeration

Treatments	Average final body weight (g)	Survival (%)
S+A	6.96±0.79	81
C+A	6.48±0.32	65
S-A	6.74±0.07	60
C-A	6.13±0.32	65
Significance level	NS	**

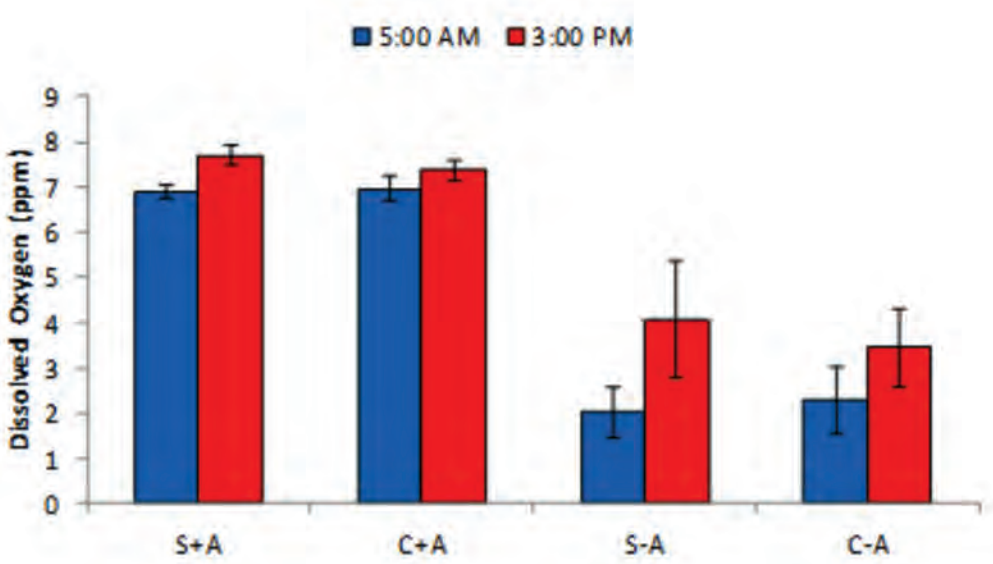


Fig.42. Average DO (mean ± SE) in substrate based with and without aeration treatment

Table 28. Water quality parameters (mean ± SE) and chlorophyll a level in substrate based with and without aeration

Parameters	S+A	C+A	S-A	C-A
pH*	7.79	7.82	7.38	7.41
Temperature (^{O}C)	29.18	29.05	29.01	29.13
Salinity (ppt)	18.80	18.82	18.88	18.77
Alkalinity(mg $CaCo_3$)	92.92±4.15	85.54±4.95	83.69±3.77	89.23±3.69
Nitrite-N (µg/L)**	23.74±3.58	48.88±8.02	28.87±4.18	53.47±7.78
Total ammonia Nitrogen (TAN) (µg/L)**	194±35	313±36	179±15	334±53
Phosphate-P (µg/L)	180.52±30.60	188.35±24.57	126.57±18.09	185.24±24.39
Nitrate-N (µg/L)**	157.55±11.30	237.91±20.41	178.56±12.39	241.77±26.97
Chl a (µg/L)	39.43±5.93	40.78±6.29	27.54±3.53	30.78±5.32

A haul of harvested shrimp in periphyton system

Improved *Litopenaeus vannamei* culture

Experimental culture trials with *L. vannamei* in zero water exchange system for 134 DOC at low (20 per m^2) and medium (40 per m^2) stocking density was carried out using pelleted diet containing 35% protein, no commercial probiotics or minerals supplements and strictly following the biosecurity protocols. Only, dolomite and LSP along with fermented organic principles were applied periodically. At harvest, the low stocking density showed higher ABW than medium stocking density.(Table. 29). An average FCR of 1.36 and a production of 4.6 to 5.96 tonnes/ ha and 6.36 to 8.76 tonnes/ha for the stocking densities of 20 and 40 per m^2 respectively was achieved. A total of 6.81 tonnes of shrimp were produced generating a revenue of Rs. 26.3 lakhs through sale. Thus, in West Bengal where *L. vannamei* has not been extensively taken up, the present low-input low-cost system can be encouraged for small-scale and resource poor farmers.

Table 29. Culture trial of *L.vannamei* at KRC

Pond no	Area (m^2)	Stocking density (No./m2)	Nos of seed stocked	Bio mass harvested (kg)	ABW (g)	FCR	Productivity tonnes/ha
2B	1620	20	32400	962.2	29.7	1.38	5.93
3B	1840	40	73600	1361.6	18.5	1.37	7.37
4B	1000	20	20000	596.0	29.8	1.37	5.96
5B	2750	20	55000	1265.0	23.0	1.33	4.60
6B	1000	40	40000	876.0	21.9	1.36	8.76
7B	2750	40	110000	1749.0	15.9	1.35	6.36

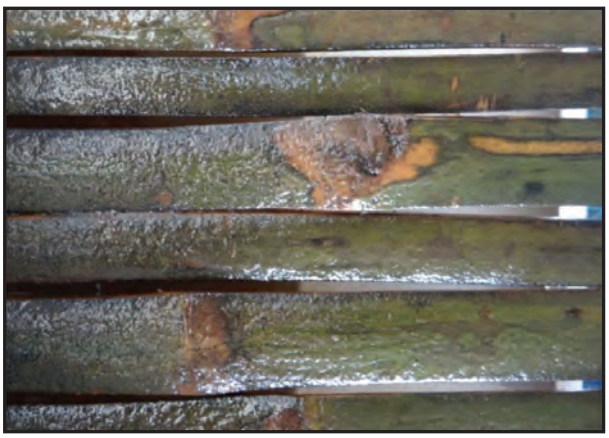
Partial haul of *L.vannamei* harvest at KRC

Evaluation of bio-floc technology and associated microbes based intervention in sustainable shrimp and fish culture

A yard trial to study the combined effect of biofloc, bamboo mat and nylon net as substrates with an area of 1307.83 cm^2 and 1312.15 cm^2 respectively on growth performance and immune response in tiger shrimp juveniles (3.3 g) was carried out for 52 days. Rice flour was used as carbon source (CN ratio 10). Two mats were provided in each 100 l tank of treatment group with Floc, floc + bamboo mat, floc + nylon mat, mat with bamboo or nylon and a control. Results indicated that significantly higher ($p<0.01$) body weights in floc and mat combinations : Floc+ bamboo (7.97 g) and Floc+Mat N (7.51 g) [Fig. 43]. Contrastingly, bamboo mat (93 %) and nylon mat (82 %) showed higher survival ($p<0.01$) than with floc with and without mat and control (64 %). Shrimp reared in treatments with combination of biofloc and mats exhibited better immune response compared to control. (Fig. 44).

Survey work at brackishwater fish farms at Purba Medinipur district of West Bengal:

Disease surveillance was conducted in different brackishwater farms of Kalyanpur, Daulatpur, Norghat, Basudevberia, Gholbagda, Kanaichatta, Narkeldaha and Amtolia village areas of Purba Medinipur district of West Bengal mainly culturing tiger shrimp and very few farms culturing *Litopenaeus vannamei* as 2^{nd} crop. Based on the questionnaire relating to the details of the farm, aquaculture system, disease



Bamboo mat

Penaeus monodon **grazing over nylon mat**

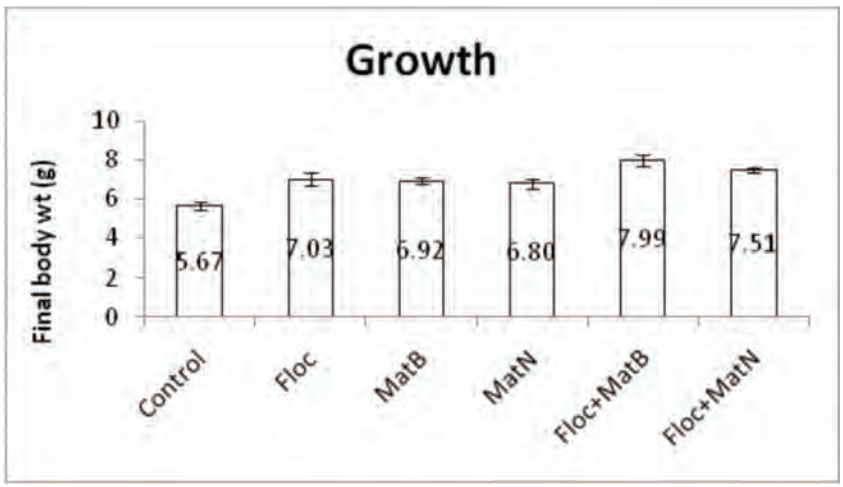


Fig. 43. Average final body weight (Mean ±SE) of tiger shrimp reared in biofloc and mat systems

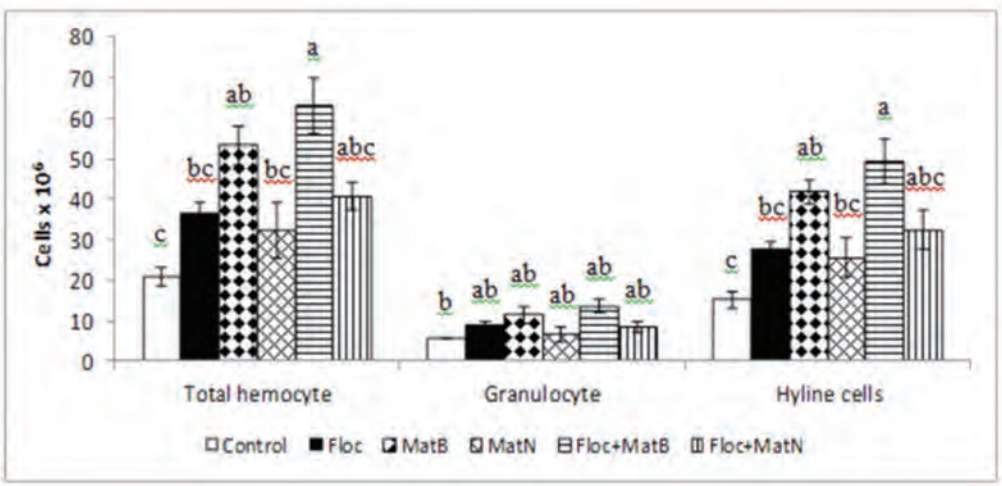


Fig. 44. Total and differential haemocyte count (Mean ±SE) in tiger shrimp reared in biofloc and mat

surveillance, feed & fertilizer use, probiotics & immunostimulant use and economics (loss or profit), there were no reports of the incidence of Early Mortality Synrome (EMS) from the district. Among diseases, farmers are aware of White spot disease (WSD) only. It was observed that certified seed is mostly sourced from hatcheries in Tamil Nadu and none of the farms were testing the seed through PCR prior to culture.

Project Title (WorldFish Center Collaboration)	**Resilient intensified and diversified agriculture & aquaculture system**

Resilient and diversified rice-based cropping systems for enhancing productivity and profitability

Three farmers from Shibkalinagar village in Kakdwip and one from Madangunj village Namkhana blocks of South 24 Parganas district were selected for rizi-pisciculture trials during wet and dry seasons. A salt tolerant paddy variety, Amalmana was cultivated in wet season and Indian Major Carps (IMC) and Scampi were stocked with fingerlings of IMC (Catla, Rohu, Mrigal : 30:35:35) @ 4000/ha and Scampi @ 1500/ha. A similar experiment was continued in the dry season with an Indian paddy variety Lalminikit and a Bangladeshi paddy variety BINA 8. Two treatments i.e. fish culture with and without selective harvest were considered. Pelleted feed (protein-24%, lipid 4%) was provided @ 5% of body weight of fish twice daily. The study shows that productivity of fish in 20% was significantly higher (161 kg) compared to 30% pond area. Apart from this, irrespective of pond size, phased harvest resulted in better productivity.

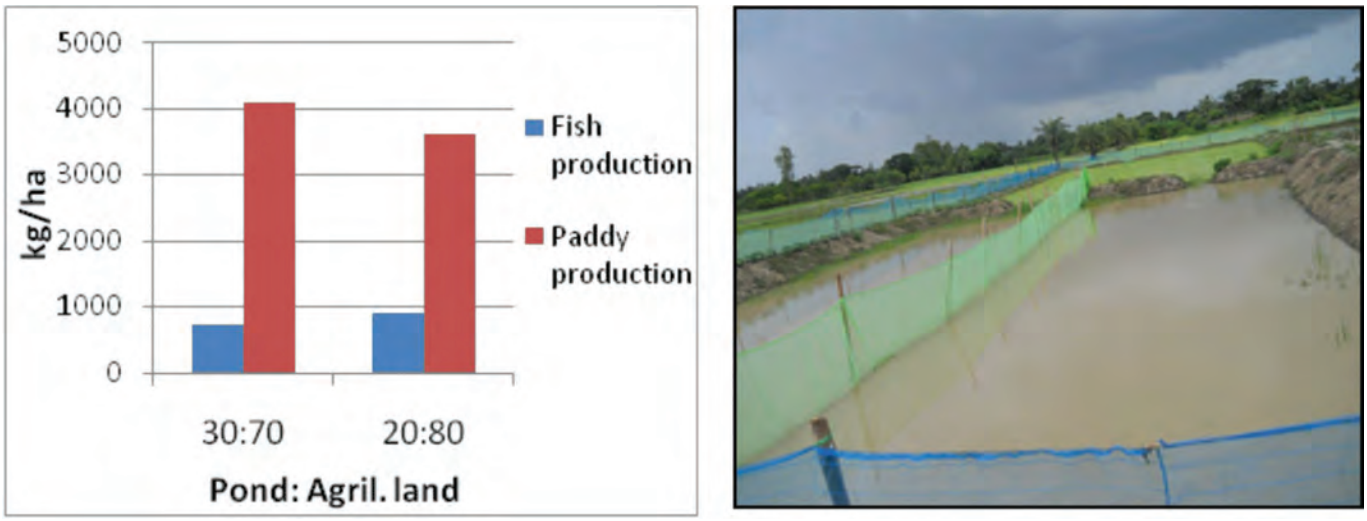


Fig 45. Production of fish and wet season paddy variety in paddy cum fish culture

Action research on homestead production system

Three farmers each from Shibkalinagar village in Kakdwip and Durganagar village of Namkhana block of South 24 Parganas district respectively with 0.04-0.1 ha pond area were selected for research in homestead production system. Aquaculture intervention included stocking of advanced fingerlings of Catla, Rohu, Mrigal:30:35:35 @ 3000/ha and Scampi @ 750/ha. Pelleted feed (protein-24%, lipid 4%) was provided @ 5% of body weight twice daily in fish culture pond. Horticulture intervention included provision of high yielding varieties of tomato, beans, cauliflower etc. whereas animal husbandry

interventions included supply of two varieties of chickens, two goats (does) and medicines. Action research in homestead production system revealed a significant improvement of aquaculture and horticulture production.

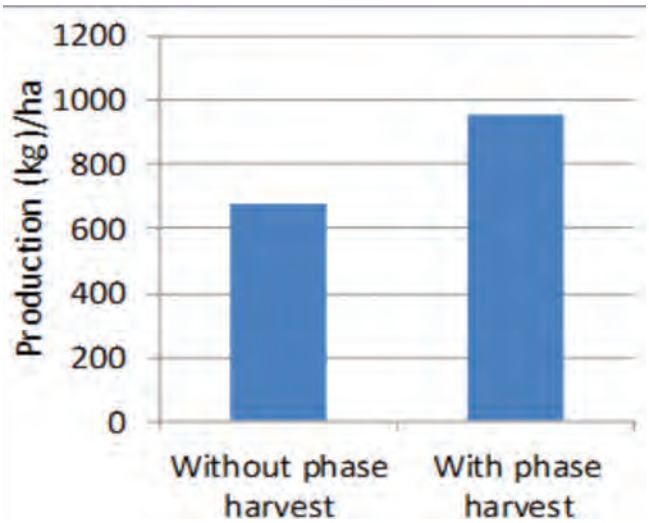


Fig 46. Production of fish

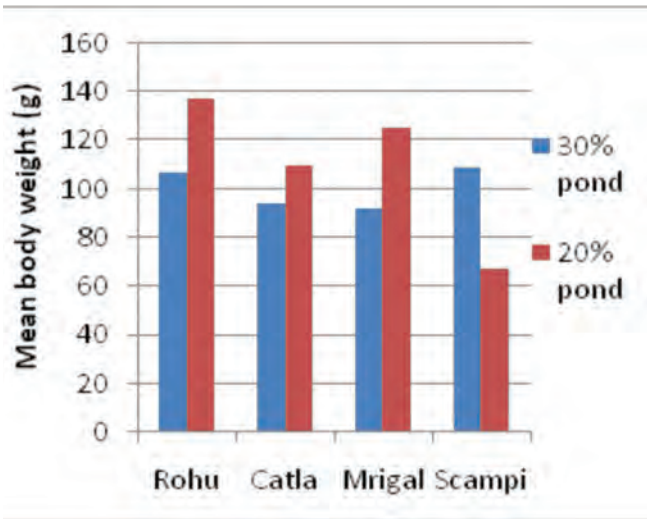


Fig 47. Performance of individual species

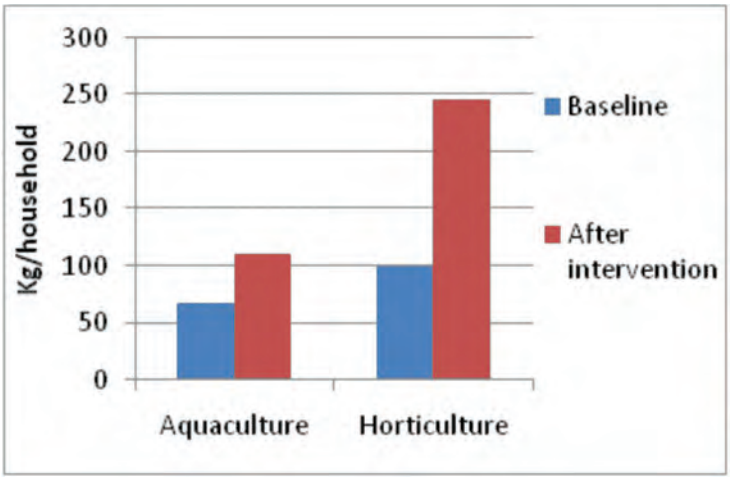


Fig 48. Production in homestead action research

Action research in homestead pond

Project Title (NFBSFARA)	Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)

Preferred food of hilsa through gut content analysis

The frequency of Hilsa seed during different periods in brackishwater zone collected from June 2013 to March 2014 revealed maximum seed availability during December to March indicating that the major breeding season could be during July-August and September-October. Specimens of different size groups ranging from 5 g to 900 g were collected from three different habitats / sampling sites viz., marine (Namkhana and Frasergunj), brackishwater (Kakdwip, Nischintapur, Sultanpur) and freshwater

(Godakhali) in West Bengal. The specimens (n=180) were dissected and gut contents analyzed for frequency of occurrence of food items and index of preponderance method. Fishes were divided into 10 different size groups as per their body weight (Figs. 49 & 50) Diatoms appeared as the major items in fishes below 5 g size, *Coscinodiscus sp.* being the most prevalent. Hilsa prefer diatoms and copepods in all stages of growth. In their early stages, they mostly prefer copepods and thereafter shift towards diatoms when they grow beyond 50 g.

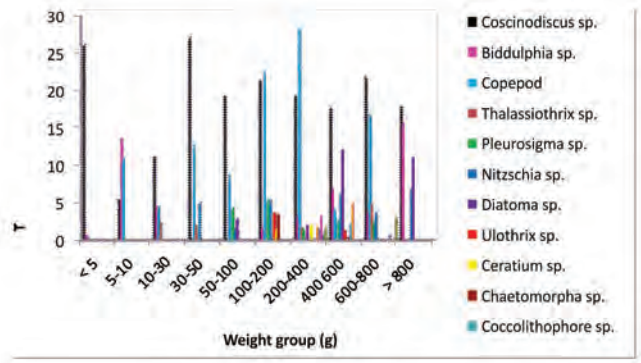


Fig 49. Frequency of different food items in different size groups of hilsa (< 5 g to >800 g)

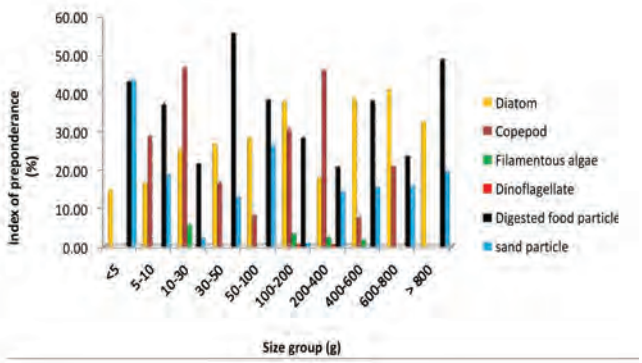


Fig 50. Frequency of different food items in different size groups of hilsa (< 5 g to >800 g)

Nutrient composition of muscle of *Tenualosa ilisha*

For development of feed for Hilsa, the body composition of different size groups was analyzed. It was observed that moisture and protein content decreased gradually from 75 and 62% (>5g) to 41 and 50% (>800g), respectively as the animal grew. In contrast, the total lipid (%) and mineral content were significantly ($P<0.05$) lower in smaller size groups (<5 g) increasing gradually in bigger size group (27/ 21% respectively >800 g group). It was observed that Ca, P, Mg, Zn, Mn and Fe content was more in fish of < 5 g compared to the bigger size group. Amino acid analysis revealed that total essential amino acids (arginine, methionine and threonine) were higher than total non-essential amino acid (glycine) in all size groups except in 400-600 g and 600-800 g size groups. Leucine and isoleucine content were significantly higher in > 800 g size group compared to smaller size group.

Fatty acid analysis revealed that mono-unsaturated and poly-unsaturated fatty acids were higher in smaller size group (<5 g) whereas saturated fatty acids were higher in bigger size groups (>100 g). Hilsa collected from Hooghly contained higher moisture, crude protein, essential amino acid, total lipid, saturated and total mineral (both micro and macro) content as compared to that from Padma. However, iron (Fe), non- essential amino acid and monounsaturated fatty acid content were higher in fish from Padma. Using Nine Point Hedonic scale (Jones *et al.*, 1955) on a panel of 50 persons, the sensory evaluation revealed that aroma, taste and muscle texture of Padma hilsa were superior to those from hilsa of Hooghly.

Table 30. Sensory evaluation of hilsa muscle

Parameter	Hooghly Hilsa	Padma Hilsa
Smell*	6.46 [a]	6.84 [b]
Taste*	6.53 [a]	6.84 [b]
Texture of muscle*	6.21 [a]	6.55 [b]
Overall grading*	6.66 [a]	7.00 [b]

*P<0.05; Values bearing different superscript in a row differ significantly

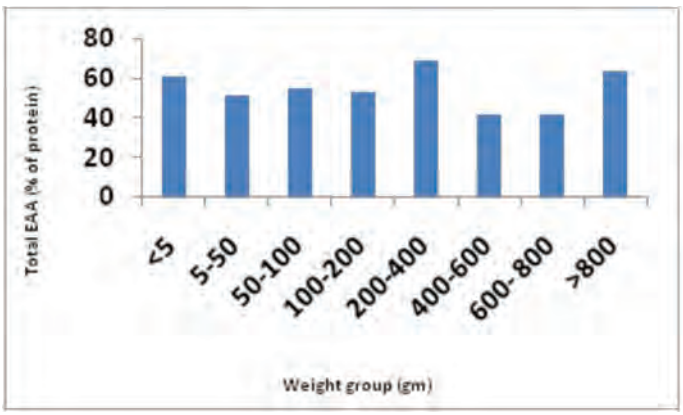


Fig 51. Total essential amino acid of different size groups

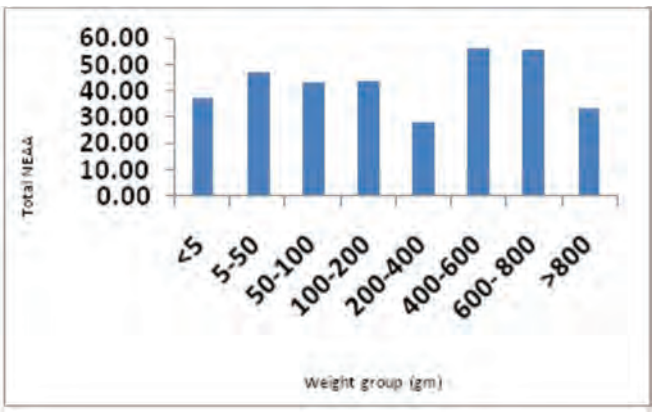


Fig 52. Total non-essential amino acid in different size groups

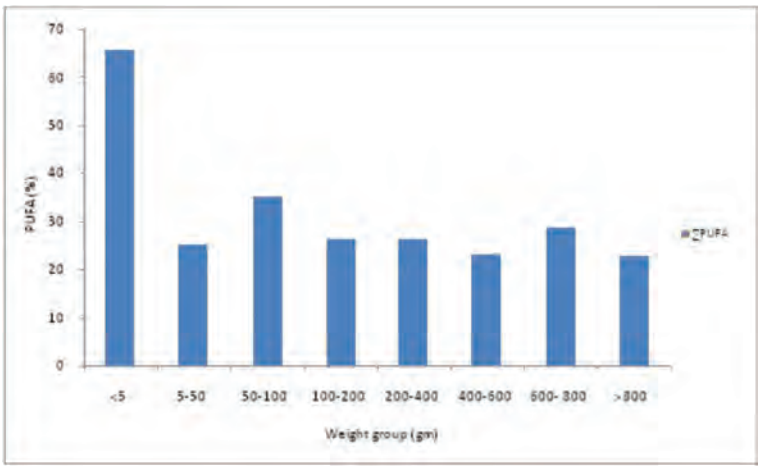


Fig 53. Total poly-unsaturated fatty acids in different size groups

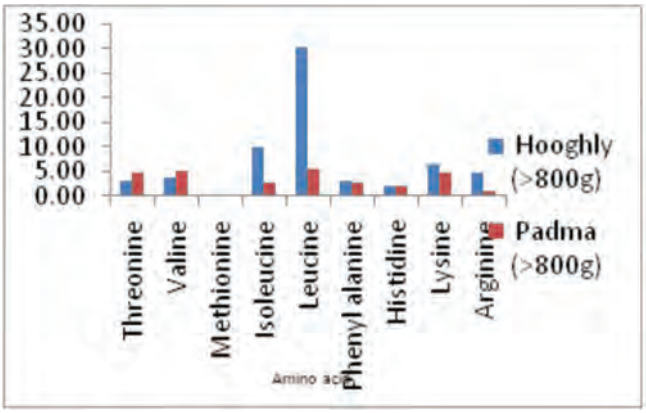


Fig 54. Essential amino acid of hilsa from Hooghly and Padma

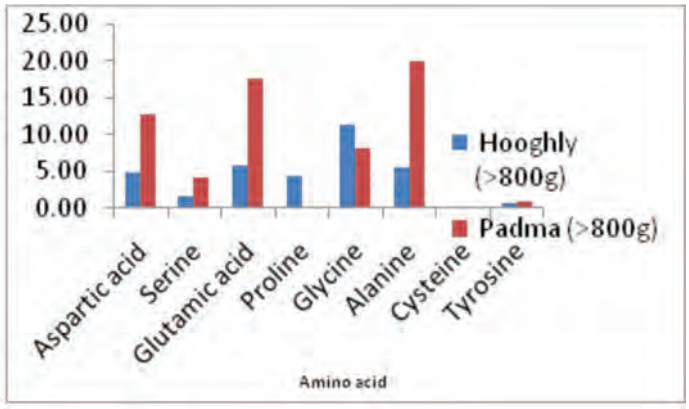


Fig 55. Non-essential amino acid of hilsa from Hooghly and Padma

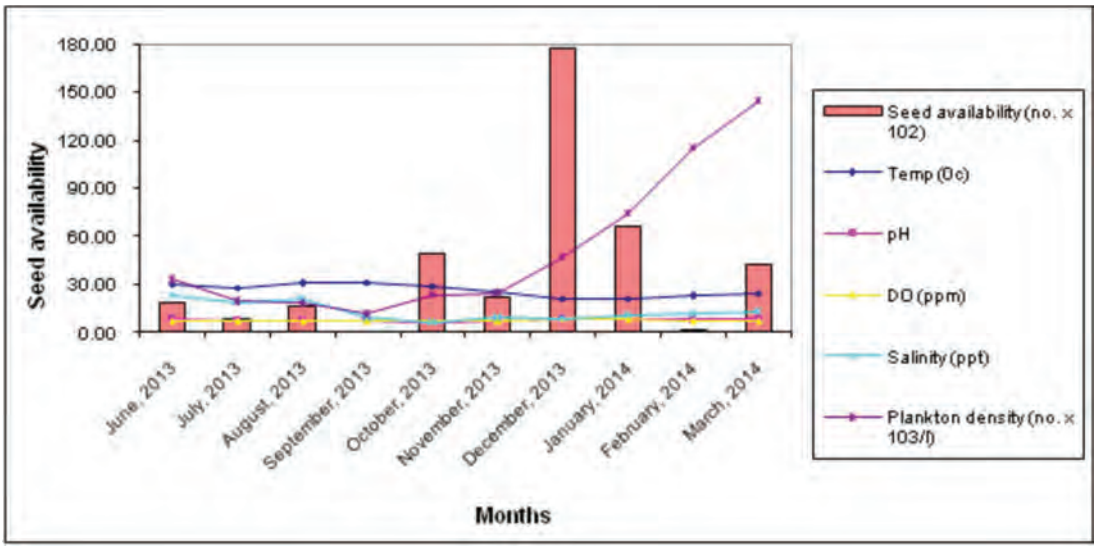


Fig 56. Seed availability, water quality parameters and plankton density

Grow out rearing of hilsa in brackish water Pond

A culture trial was initiated by collecting Hilsa fry from brackishwater estuary and after acclimatization, were stocked in two ponds of 0.1 ha area with a stocking density of 8800 nos./ha. Pond I (with aerator) and pond II (without aerator) were utilised to study the effect of flow and aeration. The initial body weight and body length of fish in pond I and pond II were 1.37 g, 1.28 g and 52.97 and 56.36 mm respectively. After 118 DOC, the average body weight was 24.96 g, 31.61 g and body length was 133.70 mm, 145.82 mm in pond I and pond II, respectively. The pond water analysed for plankton contained *Anabaena sp, Brachionus plicatilis, Calanus sp, Bosmina sp, Spiriluna sp, Diatoma sp, Microcystis sp, Navicula sp, Nitzschia sp, Chlorella sp, Gyrosigma sp, Pleurosigma sp, Synedra sp, Melosira sp.* The culture is in progress.

Sampling of hilsa from culture pond

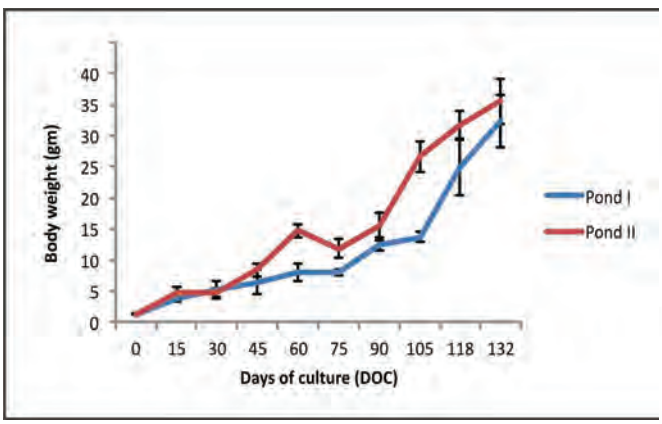


Fig 57. Growth of hilsa in ponds with and without aerator

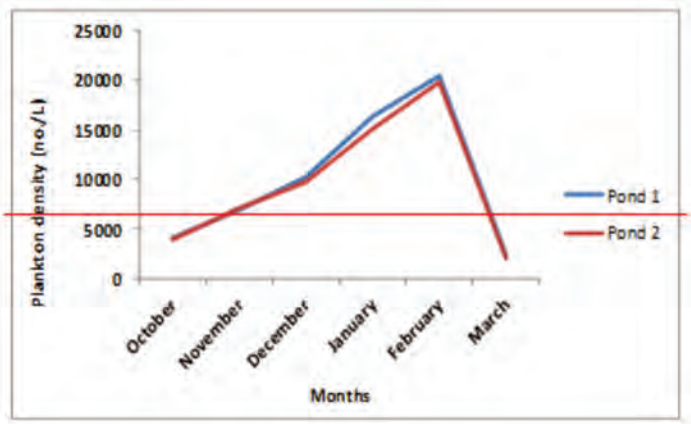


Fig 58. Month wise average plankton density (no./ L).

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
Project Location	Chennai

Sub-Project Title	Sub-Project Leader
Diversification of shrimps species	Dr.C.Gopal
White shrimp taxonomical identification	Dr.C.P.Balasubramanian
Integration of Seaweeds in RAS	Dr.P.Nila Rekha
Culture of Litopenaeus vannamei	Dr. Ashutosh D Deo
Evaluation of shrimp farm waste water treatment system	Dr.M. Muralidhar
Culture of polychaetes	Dr.C.Gopal
District level planning (DLP) for brackishwater aquaculture in Krishna district	Dr.M.Jayanthi

Project Title 2	Scaling up of production system of mud crabs
Project Leader	Dr. C.P. Balasubramanian
Project Location	Chennai
Co-Investigators	Dr.M.Jayanthi, Dr.A.Panigrahi, Dr.Ashutosh Deo, Dr.K.P.Jithendran, Dr.S.Kannappan, Mrs.Shyne Anand and Dr.Ezhil Praveena

Sub-Project Title	Sub-Project Leader
Optimization of feeding schedule for larvae of mud crab, S. serrata	Dr.C.P. Balasubramanian
Evaluation of optimum water quality requirement for nursery production of mud crab, Scylla serrata	Dr.C.P. Balasubramanian
Demonstration of nursery and grow out mud crab culture	Mrs. P.S. Shyne Anand

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
Project Location	Chennai

Sub-Project Title	Sub-Project Leader
Evaluate the impact of aquaculture on Sunderban mangroves	Dr.M.Jayanthi
Evaluate the historical changes in Coringa mangroves in AP and	Dr.M.Jayanthi

Mahanadi mangroves in Odisha

Assess the impact of developmental activities on Chilika lake — Dr.M.Jayanthi

Project Title 4	Improvement of growth and reproductive traits in penaeid shrimp (*Feneropenaeus indicus*) through breeding, nutritional and environmental interventions
Project Leader	Dr. A. Panigrahi
Project Location	Chennai
Co-Investigators	Dr.J.Syama Dayal, Dr.Saraswathy, Dr.S.K.Otta, Dr.Sherly Tomy, Dr.K.Vinaya Kumar, Dr.R.Ananda Raja, Dr.N.Lalitha and Dr.T.Bhuvaneswari

Sub-Project Title	Sub-Project Leader
Evaluation of growth and reproductive traits in Indian white shrimp *Fenneropenaeus indicus*	Dr. G. Gopikrishna
Optimization of induced maturation, endocrine and nutritional control of female maturation, immune status of broodstock shrimp and its modulation in shrimp to produce better offspring	Dr. C.P. Balasubramanian
Healthy seed production in penaeid shrimp through microbial (probiotic/biofloc), environmental and nutritional interventions	Dr. A. Panigrahi

Project Title 5	Collaborative project on brackishwater aquaculture development in Gujarat
Project Leader	Dr.C. Gopal
Project Location	Navsari Agricultural University, Navsari, Gujarat

Sub-Project Title	Sub-Project Leader
Development of technology for culturing *F.merguiensis* in different densities	Dr.C.Gopal
Assessment of culture potential of ginger shrimp M. kutchensis	Dr.C.Gopal
Monitoring of *F. merguiensis* culture ponds and potential of *Salicornia* crop using discharge water from culture ponds	Dr. M.Muralidhar
Broodstock development, seed production and culture of *M. kutchensis* and farming of pearlspot fish in different aquatic environments	Dr.M.Natarajan
To address the extension needs of brackishwater aquafarmers	Dr. V.S.Chandrasekaran
Farming of milkfish in different aquatic environments	Dr. M.Kailasam
Role of specific probiotic on microbial dynamics in farmer's shrimp culture pond	Dr. P.K.Patil
To develop ICT based dissemination system for aquaculture in tribal areas	Dr. P.Mahalakshmi
Comparatic study of nursery and grow-out culture of seabass	Dr. Prem kumar

in pond with formulated feed and low cost fish

Demonstration of cage farming of finfishes and establishment of knowledge centre under tribal sub plan (TSP) — Dr.C.Gopal

Project Title 6	Hydro geo chemical impacts of shrimp farming on coastal watershed
Project Location	Chennai
Funding Agency	Ministry of Water Resources
Principal Investigator	Dr.P.Nila Rekha
Co-Investigators	Dr. P. Ravichandran

Project Title 7	Monitoring of culture and disease occurrence in *L. vannamei* in hatcheries and farms
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr. P.Ravichandran
Co-Investigators	Dr. C.Gopal, Dr. A. Panigrahi, Dr. M. Kumaran, Dr. S.K. Otta, Dr. Ezhil Praveena, Dr. T. Bhuvaneswari and Shri D.Rajababu

Project Title 8	Up-scaling of production technology and large scale field demonstration of indigenously developed immunostimulant CIBASTIM for penaeid shrimps
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr C. Gopal
Co-Investigators	Dr. T. Ravisankar and Dr. P.K. Patil

Project Title 9	Molecular mechanism and steroidal control of reproductive maturation in commercially important shrimp *Penaeus monodon*
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr C.P. Balasubramanian
Co-Investigators	Dr. P. Ravichandran, Dr. J. Syama Dayal and Dr. Sherly Tomy

Project Title 10	Standardization of aerator usage in shrimp farming through improving the efficiency and operational pattern of the aeration systems use, automation and use of alternate energy source
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr. M. Jayanthi
Co-Investigators	Dr. P. Ravichandran, Dr. M. Muralidhar, Dr. A. Panigrahi and Dr. Ashutosh Deo

Project Title 11	Technology refinement of nutrient dense nursery rearing of grow-out of *L. vannamei* in periphyton and biofloc based systems
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr. A. Panigrahi
Co-Investigators	Dr J. Syama Dayal, Dr R.Saraswathy, Dr Shyne Anand

Project Title 12	Upgradation of breeding and culture technology of Indian white shrimp *Fenneropenaeus indicus* through stock evaluation and culture demonstration
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr. A. Panigrahi
Co-Investigators	Dr. G. Gopikrishna, Dr.C.Gopal, Dr. S. Kannappan, Dr. Kumaraguru Vasagam, Dr. P. Mahalakshmi and Dr. K.Vinaya Kumar

Finfish Culture Division

Project Title 13	Dissemination of technology on the seed production of Asian Seabass (*Lates calcarifer*) and development, standardization and refinement of seed production technology for other commercially important brackishwater
Project Leader	Dr.A.R.Thirunavukkarasu
Project Location	Chennai & Kakdwip

Sub-Project Title	Sub-Project Leader
Transfer of Seabass seed production technology	Dr.A.R.Thirunavukkarasu
Technology development for controlled breeding of pearlspot	Dr M. Natarajan
Initiation of selective breeding on pearlspot *Etroplus suratensis*	Dr. G. Gopikrishna
Refinement of captive breeding technology for important brackishwater ornamental fishes and sand whiting *Sillago sp*.	Dr. M. Kailasam
Establishing a captive broodstock development of technology for controlled breeding of threadfin bream (*Polynemus sparidius*) and golden spot mullet (*Liza parsia*) Nursery rearing of fry of asian seabass, grey mullet, milkfish, pearlspot	Dr. J.K.Sundararay
Providing feed for broodstock and juveniles	Dr. K. Ambasankar
Reproductive physiology of grey mullets	Dr. Prem Kumar
Breeding of pearlspot in small net cages and RAS	Dr. Krishna Sukumaran

Project Title 14	Improvement and validation of brackishwater fish culture technologies
Project Leader	Dr.M.Natarajan,
Project Location	Chennai & Kakdwip

Sub-Project Title	Sub-Project Leader
Cage culture of Asian seabass in open brackishwater open system	Dr.A.R.Thirunavukkarasu
Nursery rearing and growout culture of seabass, milkfish and mullets.	Dr J. K. Sundaray
Pond and cage culture of pearlspot	Dr.M.Natarajan
Secondary aquaculture in culture ponds	Dr.Krishna Sukumaran

Project Title 15	An export oriented marine value chain for farmed seafood production using Cobia (*Rachycentron canadum*) through rural entrepreneurship
Funding Agency	National Agricultural Innovation Project
Lead Centre	Fisheries College and Research Institute (TANUVAS), Tuticorin
Co-Principal Investigator	Dr.A.R.Thirunavukkarasu
Co-Investigators	Dr. J.K. Sundaray, Dr.M.Kailasam and Dr.Prem Kumar

Project Title 16	Indo-Norwegian platform on fish and shellfish vaccine development- 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
Co-Investigators	Dr.Prem Kumar

Aquatic Animal Health and Environment Division

Project Title 17	Aquatic animal diseases and intervention tools for their management
Project Leader	Dr. K. P. Jithendran
Project Location	Chennai and Kakdwip

Sub-Project Title	Sub-Project Leader
Identification of etiologic agent(s) of infectious disease(s) of shellfish and finfish identification of the putative etiology of mass mortalities of farmed shrimp during early days of culture (DOC) using metagenomics	Dr.S.V.Alavandi
Chartacterizing the role of WSSV during mixed pathogenic infection of shrimps	Dr.S.K.Otta
Studies on pathogenicity of IHHNV and its defensive role	Dr. P. Ezhil Praveena
Investigating the role of *vibrios* in shrimp during WSSV infection and mortality	Dr. T. Bhuvaneswari
Effect of oral feeding of *W. somnifera* on growth and survival in *P. monodon*	Dr.P.K.Patil
Epidemiological investigation of brackishwater finfish disease	Dr. R. Ananda Raja

Develop in vivo and *in vitro* models for addressing the pathogenesis of betanodavirus infection in finfish	Dr.K.P.Jithendran
Testing efficiency of vaccines for control of *V. anguillarum* infections in sea bass	Dr.M.Poornima
Maintenance of *in vitro* models for viral infections of finfish	Dr.M.Poornima
Studies on the role of transglutaminase (TGase) enzyme on growth and differentiation of shrimp haematopoietic (Hpt) stem cells	Dr.P.K.Patil
Validation of nucleic acid based diagnostic tests (PCR) for use in surveillance programme- NACA laboratory proficiency testing programme	Dr.K.P.Jithendran

Project Title 18	Develop environmental parameters monitoring tools and pond treatment technologies for brackishwater aquaculture
Project Leader	Dr. M. Muralidhar
Project Location	Chennai

Sub-Project Title	Sub-Project Leader
Refinement and development of water analysis kits, environmental monitoring programme of *L.vannamei* farming and rendering services	Dr. M. Muralidhar
Development of environmental parameters monitoring tools and feasibility of use of natural stable isotopes in aquaculture	Dr.R.Saraswathy
Development measures for colonization of bacteria on inert material and bioremediation	Dr. N. Lalitha
Role of phosphate solubilizing and chitin solubilising and bacteria in shrimp culture ponds	Dr.P.K.Patil
Pond soil profile characterisation and development of pond treatments for the improvement of soil and water quality	Dr. P. Kumararaja

Project Title 19	Bioremediation of effluents from shrimp farms
Project Location	Chennai
Funding Agency	National Bureau of Agriculturally Important Microorganisms
Principal Investigator	Dr.S.V. Alavandi

Project Title 20	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.S.V.Alavandi, Dr. T. Bhuvaneswari

Project Title 21	Development of bacterial vaccines (*Vibrio angullarum*) for seabass (Indo-Norwegian Platform)
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr. M. Poornima
Co-Investigators	Dr.A.R.Thirunavukkarasu

Project Title 22	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
Co- Investigator	Dr. M. Poornima

Project Title 23	Defense genes of tiger shrimp (*Penaeus monodon*) with respect to bacteria (*Vibrio harveyi*) and white spot syndrome virus (WSSV) infection
Project Location	Chennai
Funding Agency	National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA), ICAR
Principal Investigator	Dr. Subhendu Kumar Otta
Co-Investigators	Dr. K.P. Jithendran and Dr. T. Bhuvaneswari

Project Title 24	Identification of etiology of monodon slow growth syndrome (MSGS) of black tiger shrimp in India and development of rapid growth tools
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr. M. Poornima
Co- Investigators	Dr.S.V.Alavandi and Dr. P. Mahalakshmi

Project Title 25	Development of white spot syndrome virus free shrimp brooders for seed production: using indigeneous shrimp, *Penaeus indicus* as a model
Project Location	Chennai
Funding Agency	Department of Biotechnology
Collaborating Centre	C. Abdul Hakeem College, Vellore
Principal Investigator	Dr. Subhendu Kumar Otta
Co-Investigators	Dr. A. Panigrahi, Dr. P. Ezhil Praveena

Project Title 26	National surveillance programme for aquatic animal diseases
Project Location	Chennai
Funding Agency	NFDB through NBFGR
Principal Investigator	Dr.Ezhil Praveena
Co-Investigators	Dr. K.P. Jithendran and Dr.T.Bhuvaneswari

Project Title 27	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
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, Dr.K. Vinaya Kumar, Dr.A.Nagavel and Shri P. Kumararaja

Nutrition, Genetics and Biotechnology Division

Project Title 28	Development of cost effective feeds for brackishwater fish and shrimp through specific dietary nutrient optimizations and alternative feed ingredients
Project Leader	Dr.K. Ambasankar
Project Location	Chennai and Kakdwip

Sub-Project Title	Sub-Project Leader
Evaluate feed additives in shrimp and fish	Dr.K.Ambasankar
Optimize nutrients and ingredients for development of cost effective feeds for pearlspot brood stock	Dr. K.P. Kumaraguru Vasagam
Optimize dietary nutrients for high saline shrimp culture	Dr.J.Syama Dayal
Optimize dietary nutrients for low saline shrimp culture	Dr.T.K.Ghoshal
Optimize nutrients and ingredients for development of cost effective feeds for grey mullet (*Mugil cephalus*) fry rearing	Dr.Debasis De

Project Title 29	Outreach activity on fish feed
Project Leader	Dr. K. Ambasankar
Project Location	Chennai & Kakdwip

Sub-Project Title	Sub-Project Leader
Demonstration for shrimp and fish feed technology developed by CIBA and popularization of farm made feeds	Dr.K.Ambasankar
Updating of aqua feed raw material data base and exploring novel and unconventional ingredients for use in aqua feeds	Dr.K.Ambasankar

Documentation of feeding practices in the culture of finfish and optimizing the feed management strategies in seabass	Dr.T.K.Ghoshal
Formulation and testing of farm-made feeds in West Bengal	Dr.Debasis De
Functional genomic studies for effective replacement of fish oil and fish meal in shrimp and fish	Dr. J. Syama Dayal
Development of indigenous feeder for efficient nutrient delivery	Dr. P. Nila Rekha

Project Title 30	Outreach activity on nutrient profiling and evaluation of fish as a dietary component
Lead Centre	CIFRI, Barrackpore
Project Leader	Dr.J.Syama Dayal
Project Location	Chennai

Sub-Project Title	Sub-Project Leader
Nutrient profiling of brackishwater shrimps	Dr.J.Syama Dayal
Popularization of shrimp and fish as health food	Dr.J.Syama Dayal

Project Title 31	Exploring candidate genes for economically important traits in brackishwater organisms using biotechnological and bio-informatic tools
Project Leader	Dr.G.Gopikrishna
Project Location	Chennai
Co-Investigators	Dr.M.S.Shekhar, Dr.S.Kannappan, Dr.M.Kailasam, Dr.Sherly Tomy, Dr.K.P.Kumaraguru Vasagam, Dr.K.Vinaya Kumar, Dr.B.Sivamani

Sub-Project Title	Sub-Project Leader
Genetic characterisation of tiger shrimp along the Indian coast	Dr.G.Gopikrishna / Dr.K.Vinaya Kumar / Dr.B.Sivamani
Molecular studies on immune genes for disease resistance in *P. monodon*	Dr.M.S.Shekhar
Documentation of polymorphic DNA markers in candidate genes of salinity resistance in *Penaeus monodon*	Dr.S.Kannappan
Screening for sex specific genes in *Etroplus suratensis*	Dr.Sherly Tomy / Dr.K.P.Kumaraguru Vasagam
Evaluating the potential for selection of economically important traits in rotifers	Dr.M.Kailasam

Project Title 32	Outreach activity on fish genetic stocks
Lead Centre	NBFGR, Lucknow
Project Leader	Dr.G.Gopikrishna
Co-PI	Dr.K.Vinaya Kumar, Dr.B.Sivamani
Project Location	Chennai

Project Title 33	Bioprospecting of genes and allele mining for abiotic stress tolerance
Project Location	Chennai
Funding Agency	National Agricultural Innovation Project (NAIP)
CCPI	Dr. M.S.Shekhar
Co-Investigators	Dr.Sherly Tomy and Dr.K.Vinaya Kumar

Project Title 34	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
Co-Investigator	Dr.P.K.Patil

Project Title 35	Molecular studies on sequential pathogenesis of WSSV and defense mechanism in *P. monodon*
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr. M.S.Shekhar
Co-Investigator	Dr. S.K. Otta

Project Title 36	Molecular mechanisms of gonad inhibiting hormone action on the control of egg maturation in the penaeid shrimp
Project Location	Chennai
Funding Agency	Department of Biotechnology
Principal Investigator	Dr. Sherly Tomy
Co-Investigator	Dr. S.K. Otta, Dr. C.P. Balasubramanian and Prof. T. Subramoniam

Social Sciences Division

Project Title 37	Extension economics and informatics in brackishwater aquaculture
Project Leader	Dr.V.S.Chandrasekaran
Project Location	Chennai

Sub-Project Title	Sub-Project Leader
Assessment of present farming practices of the Indian white shrimp *Fenneropenaeus indicus* and the fish pearlspot *Etroplus suratensis*	Dr.V.S.Chandrasekaran
Development of refined impact assessment methodologies for evaluating effectiveness of selected CIBA technologies	Dr.T.Ravisankar
Gender assessment in aquaculture and allied aquaculture sectors in Tamil Nadu, Kerala and West Bengal	Dr.B.Shanthi
Assessment on tribal participation in aquaculture sectors in Tamil Nadu and demonstration of aquaculture technologies	Dr.B.Shanthi

Transfer of technology through ICT and capacity building	Dr.D.Deboral Vimala
Alternative strategies for aquaculture extension service	Dr.M.Kumaran
Strengthening of Information and Communication Technology and its applications for aquaculture development	Dr. P.Mahalakshmi
Computational approaches in brackishwater aquaculture research	Shri. J. Ashok Kumar
Organisation and conduct of extension and outreach activities of the Institute	Dr.V.S.Chandrasekaran

Project Title 38	Economics of shrimp ponds in disuse and participatory appraisal of productive use options and policy needs
Project Location	Chennai
Funding Agency	National Bank for Agriculture and Rural Development
Principal Investigator	Dr. T. Ravisankar
Co-Investigators	Dr. P. Ravichandran, Dr. D.Deboral Vimala, Dr. M. Jayanthi and Dr. R. Saraswathy

Project Title 39	Assessment on the impact of environmental changes on the livelihoods of coastal women in Tamil Nadu
Project Location	Chennai
Funding Agency	Indian Council of Social Science Research
Principal Investigator	Dr. B. Shanthi
Co-Investigators	Dr. P. Mahalakshmi, Dr. V.S. Chandrasekaran and Dr. T. Ravisankar

Project Title 40	Study on marketing and value chain improvement strategies for promoting white leg shrimp (*L. vannamei*) farming in India
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr. T. Ravisankar

Project Title 41	Appraisal of evolving *Litopenaeus vannamei* culture systems and associated production risks for development of better management practices
Project Location	Chennai
Funding Agency	National Fisheries Development Board
Principal Investigator	Dr.M. Kumaran
Co-Investigators	Dr.T.Ravisankar, Dr. D.Deboral Vimala and Shri J. Ashok Kumar

Kakdwip Research Centre

Project Title 42	Enhancement of brackishwater aquaculture production of shrimp and fishes through economically viable and sustainable approach
Project Leader	Dr.T.K. Ghoshal
Project Location	Kakdwip

Sub-Project Title	Sub-Project Leader
Improvement of natural productivity in bheries & polyfarming of finfish & shellfish	Dr. T.K. Ghoshal
Standardization of feed management practices of polyfarming with low cost feed	Dr. Debasis De
Improvement of shrimp farming by natural productivity	Mrs. P.S. Shyne Anand
Evaluation of biofloc technology & associated microbes based intervention in sustainable shrimp and fish culture	Dr. Sujeet Kumar
Study the biology of shrimp *Fenneropenaeus penicillatus* of Sunderban region	Dr. Ashutosh D. Deo

Project Title 43	Strategies for sustainable management of degraded coastal land and water for enhancing livelihood security of farming communities
Project Location	Kakdwip
Funding Agency	National Agricultural Innovation Project
Principal Investigator	Dr.T.K.Ghoshal
Co-Investigators	Dr.Debasis De, Dr. Ashutosh D. Deo, Dr.R.Ananda Raja, Dr.Sujeet Kumar, Mrs. P.S. Shyne Anand and Dr.M.Kumaran

Project Title 44	Productive, profitable and resilient agriculture and aquaculture systems
Project Location	Kakdwip
Funding Agency	WorldFish Center
Principal Investigator	Dr. Ashutosh D. Deo
Co-Investigators	Dr. T.K. Ghoshal, Dr. J.K. Sundaray (upto 25.4.2013)

Project Title 45	Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)
Project Location	Kakdwip
Funding Agency	National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA), ICAR
Principal Investigator	Dr. Debasis De
Co-Investigators	Mrs. P.S. Shyne Anand

Others

Project Title 46	Business Planning and Development (BPD) Unit at CIBA, Chennai
Project Location	Chennai
Funding Agency	National Agricultural Innovation Project
Principal Investigator	Dr. T. Ravisankar
Co-Investigators	Dr. P. Ravichandran

Library Section

Project Title 47	Strengthening of digital library and information management under NARS (e-Granth)
Project Location	Chennai
Funding Agency	National Agricultural Innovation Project
Principal Investigator	Dr. M. Kumaran
Co-Investigators	Shri R Elankovan

6

Technology Assessed and Transferred

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

At Headquarters			
Sl. No.	**Training Programme**	**Duration**	**No. of partici-pants**
1	Training-cum-Demonstration programme on Ornamental fish farming / mushroom farming	3.7.2013 3.9.2013	15 15
2	Training and Demonstration Programme on Seabass Nursery Rearing	13.9.2013	30
3	Training programme sponsored by NFDB	18.9.2013 to 27.9.2013	20
4	Training cum workshop on *L.vannamei* shrimp farming management at Nagapattinam in Tamil Nadu	10.10.2013	100
5	Training cum workshop on Strengthening of Digital Library and Information Management Using KOHA (ILS)	11.3.2014	90
At Kakdwip Research Centre			
1.	Training programme on Brackishwater Aquaculture and Paddy-cum-fish culture at Asha Welfare Society, Ganeshnagar	5.6.2013	60
2.	Training programme on Implementation of land shaping technology at Asha Welfare Society, Ganeshnagar	25.6.2013	66
3.	Training program on culture of *Litopenaeus vannamei*	22.7.2013 to 27.7.2013	8
4.	Field Training of M.F.Sc. and PDP student from CIFE, Kolkata	26.7.2013	(6M, 3F & 3 trainees of PDP Module 2)
5.	BMP in shrimp farming with special reference to West Bengal (NFDB)	18.9.2013 to 21.9.2013	8
Training to foreign student			
1	Mr. Uday Kumar, M.Sc. student in aquaculture from Artemia Reference Center, Department of Animal Production, Ghent University, Belgium completed his internship on Breeding and seed production of seabass	16.7.2013 to 15.8.2013	1

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Training and Education

HUMAN RESOURCE DEVELOPMENT

International

Participant	Particulars	Organizer	Period
Dr. J.K.Sundaray, Principal Scientist	Discussion meeting on aquaculture and homestead systems	WorldFish Center, Dhaka, Bangladesh	07.04.2013-15.04.2013
Dr. Ashutosh Dharmendra Deo Senior Scientist	Discussion meeting on aquaculture and homestead systems	WorldFish Center, Dhaka, Bangladesh	07.04.2013-15.04.2013
Dr. Ashutosh Dharmendra Deo Senior Scientist	CGIAR/CPWF Ganga Basin Challenge workshop	WorldFish Center, Dhaka, Bangladesh	09.11.2013-15.11.2013
Dr.B.Sivamani Scientist	Training on Marker Assisted Selection (Animal Science) under Component – 1 of NAIP	Aarhus University, Denmark	11.11.2013 - 08.02.2014
Dr. A.G.Ponniah Director	FAO/APFIC/NACA Regional Technical Consultation on Aquaculture planning and Management Toolkit and Strategies for its adoption in Asia and the Pacific	NACA, Bangkok, Thailand	27.11.2013 - 29.11.2013
Dr. A.G.Ponniah Director Dr.S.K.Otta Senior Scientist	Seminar on Early Mortality Syndrome in Shrimp	University of Malaysia, Kuala Lumpur	30.11.2013
Dr.T.Bhuvaneswari Scientist	Training on Molecular Breeding (Fisheries Science) under Component-1 of NAIP	Ghent University, Belgium	27.12.2013 - 26.03.2014
Dr.Sherly Tomy Senior Scientist	7th Asia and Oceania Society for Comparative Endocrinology(AOSCE) International Congress	National Taiwan Ocean University, Taiwan	18.03.2014 - 23.03.2014

National

Participant	Particulars	Organizers	Period
Shri.R.Elankovan Chief Tech. Officer Dr.S.Sivagnanam, Assistant Chief Technical Officer	Competency enhancement programme	National Academy of Agricultural Research Management, Hyderabad	13.05.2013 - 22.05.2013
Dr.M.Muralidhar, Principal Scientist Dr.J.Syama Dayal, Senior Scientist Dr.R.Saraswathy, Senior Scientist	Carbon Footprint Accounting	Confederation of Indian Industry, Chennai	05.07.2013
Shri.Kunal Kalia, FAO	Workshop on Ethics and Values in Public Governance	ISTM, New Delhi	09.09.2013 - 12.09.2013
Dr.S.V.Alavandi, Principal Scientist	AgrIP - National workshop on role of Intellectual property rights in modern era	Zonal Technology Management (BPD), Central Institute of Fisheries Technology, Cochin	15.11.2013 - 16.11.2013
Shri.Kunal Kalia, FAO	Training Course on Good Governance	ISTM, New Delhi	18.11.2013 - 22.11.2013
Shri P.Kumararaja Scientist	AusAid ecotoxicology training workshop	NBFGR, Lucknow	02.12.2013 - 06.12.2013
Shri.Kunal Kalia, FAO Shri.R.G.Ramesh, AAO	Workshop on Administrative and Financial Matters	NAARM, Hyderabad	09.12.2013 - 10.12.2013
Shri.Kunal Kalia, FAO	Training Programme on Financial Issues	NIFM, Faridabad	16.12.2013 - 20.12.2013
Dr.V.S.Chandrasekaran, Principal Scientist	Managerial effectiveness enhancement programme (MEEP)	Institute of Management Training and Research, Goa	13.01.2014 - 17.01.2014
Shri P.Kumararaja Scientist	Water resources management	Centre for Water Resources Development & Management, Calicut	12.03.2014 - 14.03.2014

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Awards and Recognition

- Best paper award for the research work -Challenging of crude marine algae extract against bio-luminescence disease causing *V.harveyi* during *Penaeus monodon* larviculture - was presented to K.Sivakumar, S.Kannappan and P.K. Patil in the National Seminar on Emerging Trends in Indian Aquaculture (ETIA-DHMOP-2013) conducted by Deparment of Aquatic Biology & Fisheries, University of Kerala, Thiruvananthapuram during 28- 30th March 2013.

- Dr.P.Mahalakshmi, Scientist (Sr. Scale) was awarded Jawaharlal Nehru Award for the Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences for the year 2012 for her research work- Decision Making Models for Identification and Classification of Optimal Location for Aquaculture Farming Development- on 16th July 2013 at NASC Complex, New Delhi.

- Dr.Krishna Sukumaran received best presentation award for her lecture on Efficacy of isoeugenol as an anaesthetic for handling and simulated live transport of pearlspot *Etroplus suratensis* (Bloch) at the International seminar on Advances in Aquaculture Technologies, Dept. of Zoology, All Saints College, Thiruvananthapuram, Kerala, 18-19th July 2013.

- Best paper award presented to R.Saraswathy, G. Krithika, M. Muralidhar, D.Thulasi, N.Lalitha, A.Nagavel and Jayavel for Antibacterial efficacy of zinc oxide (ZnO) nanoparticles on *Vibrio anguillarum* in the International conference on Advanced nanomaterials and emerging engineering technologies organized by Sathyabama University during 24-26th July, 2013.

- S. Syed Raffic Ali was awarded First prize for the presentation- Effect of fructooligosaccharide (FOS) supplementation as a dietary prebiotic on growth and survival of Asian Seabass (*Lates calcarifer*), in the National Conference on Current Nutritional Concepts for productivity Enhancement in Livestock and Poultry held on 29.08.2013 and 30.8.2013 at Madras Veterinary College, TANUVAS Chennai.

- SOFT(I) Best Scientific Paper Award 2012 was presented to P.Mahalakshmi and M.Krishnan for the research paper -Development and Evaluation of an e-Learning Module for Aquaculture Development through ICT Projects: ADDIE Model- published in Fishery Technology Journal 49 (1) on 27th August 2013 at Central Institute of Fishery Technology, Kochi

- Dr.Krishna Sukumaran received best paper award for -Pre-growout culture of Asian seabass *Lates calcarifer* (Bloch) in low volume cage in brackishwater Ashtamudi lake under participatory mode with traditional fisherman authored by Krishna Sukumaran, A. R. Thirunavukkarasu, M. Kailasam, Prem Kumar, R. Subburaj and G. Thiagarajan in the International Conference on Ecosystem Conservation, Climate Change and Sustainable Development (ECOCASD 2013) Theme- Aquaculture and Food Security at the Department of Aquatic Biology, University of Kerala, Thiruvananthapuram, 3-5th October, 2013.
- Best paper awarded to M. Poornima, Vijaya Kumar R, Santiago , T.C and Arasu , A.R.T. for Recombinant outer membrane protein, OMP26Ia of *Vibrio anguillarum* is an effective vaccine candidate in the International Conference on Ecosystem Conservation, Climate Change and Sustainable Development (ECOCASD 2013) held during 3-5 October 2013 at Thiruvananthapuram, Kerala
- Best poster award given to J. Kiruthika, S.Rajesh and M.S.Shekhar for the poster presentation on Potential role of differentially expressed glutamine synthetase gene in shrimp salinity stress tolerance and adaptation in the National seminar on Aquatic Toxicology, Biodiversity and Aquaculture during 15-17th November, 2013 at Acharya Nagarjuna University, Guntur
- Best oral presentation awarded to Dr.Sherly Tomy for her presentation- Identification of potential interactors for gonad-inhibiting hormone of *Penaeus monodon* using yeast two hybrid assay at the International Science Congress conference at Karunya University, Coimbatore during 8th – 9th December 2013
- S. Syed Raffic Ali was awarded Second prize for the oral presentation- Biopolymer (Lignin) as a potential source of binder in organic shrimp feed, in the National Conference on Innovations, Implementations and Controversies of Animal Biotechnology held on 20.03.2014 and 21.03.2014 at Bharathidasan University Tiruchirappalli.

Participation in exhibition and its awards

- Received Best Stall Display Award under the category of Government stall in Tamil Nadu Fish Festival- TANFIS 2013 on 12th May 2013 at Island Grounds, Chennai, Tamil Nadu.
- Annai and Anichamalar Women Self Help Groups (beneficiaries of CIBA) received Best Women Self Help Group Stall Display Award on 12th May 2013 at Island Grounds, Chennai, Tamil Nadu
- CIBA feed mill has been certified for production of organic feed by INDOCERT for a period of one year from 18th December 2013 to 17th December, 2014 and the certificate was received by Dr. A.G. Ponniah, Director, CIBA, Chennai

CIBA gets ISO 9001:2008 certification

A very important milestone was achieved by CIBA on 8.1.2014 when M/S Intertek India Pvt. Ltd., Mumbai (accredited from UKAS) certified the CIBA's Quality management system for three years w.e.f 27th December 2013 to 26th December 2016. Dr.A.G.Ponniah, Director, received the certificate from the representative of the firm.

Kakdwip Research Centre

- Mrs. P.S.Shyne Anand received Prof. P. Kameswara Rao Award for best oral presentation for Comparative performance of monosex and mixed sex culture of green mudcrab *Scylla serrata* in Sundarban ecosystem during the winter months in International Conference Probing Bioscience For Food Security and Enviornmental Safety at Central Rice Research Institute, Cuttack during16-18th February, 2014.

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

WorldFish Center, Malaysia

A project entitled "Productive, profitable and resilient agriculture and aquaculture systems" has been undertaken under CGIAR – CPWF at Kakdwip

TEMASEK LIFE SCIENCES LABORATORY (TLL), SINGAPORE

A Collaborative project entitled "Genetic analyses of Seabass populations in Indian peninsular waters using microsatellite markers" between CIBA, NBFGR and TLL.

10

List of Publications

e-Publications

- No Confirmed Cases of Early Mortality Syndrome (EMS) in India
- Successful women entrepreneurs in aquaculture sector in Tamil Nadu
- Methodology to trace the nitrogen pathway in shrimp culture
- Concept of using nanosensors for water quality monitoring in aquaculture
- Banana shrimp: A potential diversified species for culture in low temperature coastal areas (in Hindi) (CD) (English e Publication Series No.16)
- Technical advisory on steps for first time confirmation of an exotic disease – A case study with EMS/AHPND
- Ensuring WSSV free sediment and water for prevention of white spot disease
- Redox potential as an indicator of pond bottom sediment condition

Technology Series

- Low cost farm made feed for brackishwater polyfarming

Special Publications

- Handbook of Fisheries Institutions (Special Publications No. 31 -Revised).
- Value – Added Fish Products Development by Coastal Women Self Help Groups (Special Publication No. 41)
- Farm Made Aqua Feed Development by Women Self Help Groups (Special Publication No. 42)
- Mud Crab Fattening – Alternate livelihood for the Coastal Women Self Help Group (Special Publication No. 43)
- Seabass nursery rearing in hapas – A livelihood option for the Women Self Helps. Under CIBA-TSP (Special Publication No. 44).
- In BMP in shrimp farming with special reference to West Bengal (Special Publication No.67)
- Vannamei Iral Valarppu Melanmai (*L.vannmei* shrimp aquaculture management in Tamil- Special Publication No.68).
- NAIP - Way forward for sustainable livelihood improvement of farming communities of Sundarban, West Bengal. (Special publication No. 69)

- Vermicompost -an ecofriendly organic fertilizer (Special Publication No. 70)
- User Manual on KOHA Library System(Special Publication No.71)

Extension Series

- Scientific basis for probiotics use in shrimp culture systems(Extension Series No. 44)
- Scientific rationale for application of mineral in shrimp culture systems (Extension Series No. 45)
- Extension methodology for assessing the effectiveness of shrimp farmer groups. (Extension Series No.38)
- FAQs in Better Management Practices in Shrimp Culture (Extension Series No. 33)
- Pictorial guide on Koduva Meen Valarpom; Koodi Nanmei Peruvom (English and Tamil).

Refereed Journals

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3. Anand, P.S.S., Kohli, M.P.S., Kumar, S., Sundaray, J. K., Roy, S. D., Venkateswarlu, G., Sinha, A., Pailan, G.H., 2014. Effect of dietary supplementation of biofloc on growth performance and digestive enzyme activities in *Penaeus monodon*. Aquaculture,. 418–419, 108–115
4. Balasubramanian, C. P., Cubelio, S. S., Mohanlal, D. L., Ponniah, A. G., Kumar, R., Bineesh, K. K., Ravichandran, P., Gopalakrishnan, A., Mandal, A., Jena, J. K., 2014. DNA sequence information resolves taxonomic ambiguity of the common mud crab species (Genus *Scylla*) in Indian waters. Mitochondr. DNA, (2014): 1-6.
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10. Biswas, G., Korenaga, H., Nagamine, R., Kawahara, S., Takeda, S., Kikuchi, Y., Dashnyam, B., Yoshida, T., Kono, T., Sakai, M., 2013. Elevated cytokine responses to *Vibrio harveyi* infection in the Japanese pufferfish (*Takifugu rubripes*) treated with *Lactobacillus paracasei* spp. paracasei (06TCa22) isolated from the Mongolian dairy product. Fish Shellfish Immun., 35 (2013):756-765.

11. Biswas, G., Sakai, M., 2014. Loop-mediated isothermal amplification (LAMP) assays for detection and identification of aquaculture pathogens: current state and perspectives. Appl. Microbiol. Biotechnol., DOI 10.1007/s00253-014-5531-z

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11

Consultancy and Commercialization of Technology

The Business Planning and Development (BPD) Unit funded by NAIP, ICAR, New Delhi was inaugurated by Dr. S. D. Tripathi, Former Director & Vice Chancellor, CIFE at CIBA, Chennai, on 27th August 2013. The BPD Unit would offer new business opportunities for entrepreneurs, start-up companies and established corporates in starting aquaculture business ventures and will nurture the new ideas of innovators by providing technical support. In order to commercialize the technologies of CIBA, three workshops were conducted viz.,Launch Workshop of BPD Unit at CIBA, Chennai on 27th August 2013, Aquaculture Business Meet & Sensitization For New Business Ventures For Entrepreneurs at Navsari Agricultural University, Navsari on 29th October 2013, Aquaculture Business Meet & Interactive Workshop For Entrepreneurs at Kolkata Centre of CIFE on 28th January 2014, a ceremony for signing MoU on 4th December 2013 and Field exposure visit - India Africa Forum Summit Training Program by ICRISAT on 22nd February 2014.

MoUs signed

Sl. No.	Name of the technology	Entrepreneur Address	Earnings in total (Rs.)
1	Consultancy/ Technology transfer on Asian Sea bass hatchery	Mr.Amerendra Dash, M/s Suryo foods, Dinalipi Bhawan, A-54/1& A-55/1, Nayapalli, Baramunda, Bhubaneshwar. 751003 Odisha.	4,37,698/-
2	Collaborative research programme on seed production of mud crab, Scylla serrata	Agency for Development of Aquaculture, Kerala. (ADAK), T.C 15/1494, 'Reeja' Minchin Road, Thycaud-P.O, Thiruvananthapuram – 695014, Kerala	-Nil (Public-public partnership)
3	Seabass Feed Production	Shri.Thomas Alva Edison, M/s Ratna Agro-Vet Feeds India Pvt Ltd, Regd. Office 11-15-116/3, Plot No. 137, Street No 4, Doctors colony, Saroor nagar, Hyderabad 500 035, AP	First installment of 1,12,360/-
4	Consultancy services for Feed plant and machineries and stocks of raw materials, finished goods and other current assets.	Shri. Ram Baboo Goenka, M/s Tayo Matsya Super Feeds Pvt Ltd, 14/2, Paul mansion (first floor), No.6, Bishop Lefroy Road, Kolkata- 700020 West Bengal	28,090/-

5	Collaborative research programme on product evaluation and refinements	Shri.R.Srinivasan, M/s Poseidon Biotech, No-2&3, PKM cross street, Padasalai road, Mel Ayampakkam, Chennai- 600 095.	1,12,360/-
6	Transfer of CIBASTIM technology	Dr. K. Sudhakar, M/s Rajshree Sugars Pvt Ltd, Varadaraj Nagar, Periyakulam taluk, Theni 625 562 Tamil Nadu	4,49,440/-
7.	Cost effective shrimp and fish processing technology	Mr.Anjan kumar M/s Laxmi narayan feeds, At/po-shadha, via irda Block basta Balasore -756080 Odisha	1,12,360/-
		TOTAL	12,52,308

After the establishment of the BPD Unit, commercialization of technologies has increased from 2 to 7 and the total revenue generated from Rs. 5.62 lakhs to 12.52 lakhs. From this amount, Rs. 4.86 lakhs has been sent to ICAR as benefit sharing, Rs. 6.28 lakhs has been shared by Inventors team of CIBA and Rs. 1.37 lakhs remitted as service tax.

Entrepreneurs during signing ceremony

MoU signed with
Mr. Anjan Kumar Dandapat

MoU signed with Dr. K. Sudhakar, AGM Rajshree Sugars & Chemicals Ltd. for CIBASTIM

MoU signed with Mr. Thomas Alva Edison for Asian Seabass feed processing technology

South African Delegates in the Field Exposure visit at CIBA, Chennai

Technology for Organic Shrimp Feed to M/S Jass Venture Pvt Ltd, Kerala

- **Demonstration of organic shrimp feed cum technology transfer**

  In continuation of the MoU with M/S Jass Venture Pvt limited of Kerala, 15 tonnes of organic shrimp feed was produced and successful demonstrations were carried out in farmers ponds. The second phase of technology transfer is in progress.

- **Commercialization of CIBA seabass feed (BHETKIAHAR) technology**

  CIBA BHETKIAHAR has been commercialized to M/S Ratna Agro Vet India Feeds Pvt. Limited and the MoU has been signed.

- Cost effective shrimp and fish feed processing Technology transfer

  A MoU was signed between CIBA and Mr.Anjan Kumar Dandapat, Balasore, Odisha for transfer of cost effective shrimp and fish feed processing technology.

Consultancy services

- Samples of soil, water and microbes and testing for WSSV was carried out in the Aquacutlure Diagnostic Laboratory established under IDP/GUJ project in colloboration with Navsari Agrciultural University, Navsari, Gujarat.
- Collaborative research programme with M/S Poseidon Biotech for on-product evaluation and refinements for the control of LCMS (RMS).

Patents

- CIBA patent application No.368/CHE/2006 -Product from lignocellulosic waste for the remediation of water contaminated with heavy metals- was granted a patent on 14.06.2013 (Patent No. 256424).
- CIBA patent application No.633/CHE/2006-Immobilizing matrix from bagasse for bacterial biomass and a process for preparation thereof- was granted a patent on 03.07.2013 (Patent No. 256572).

Kakdwip Research Centre

- MOU signed with Tayo Matsya Super Feeds Pvt. Ltd, Kolkata-700020 on 16.11.2013 to provide technical/expert comment about present status and condition of feed mill machineries and raw materials/finished goods.

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 22.7.2013) for a period of three years with effect from 25 July 2013:

Chairman	**Dr.M.V.Gupta**
Members	Dr.(Mrs.) Krishna Srinath Mr.Udaya Ram Jyothy Dr.R.A.Selvakumar Dr.P.A.LokaBharati Dr.Sridhar Sivasubbu Dr.Madan Mohan Dr.A.G.Ponniah
Member Secretary	Dr.P.Ravichandran

The 19th meeting of the Research Advisory Committee (RAC) of CIBA was held on 11th April 2014 at CIBA Chennai

INSTITUTE RESEARCH COUNCIL

The Institute Research Council (IRC) of CIBA has been constituted as follows:

Chairman	**Dr. A. G. Ponniah, Director**
Members	Assistant Director General (M.Fy.), ICAR, New Delhi Dr.A.R.Thirunavukkarasu Dr.P.Ravichandran Dr.G.Gopikrishna Dr.K.P.Jithendran Dr.V.S.Chandrasekaran Dr.M.Muralidhar Dr.K.Ambasankar Principal Investigators of all the projects
Member Secretary	Dr.P.Ravichandran

The half yearly IRC Meeting was held on 6th and 7th February 2014 wherein the progress of research work was reviewed.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

The Institute Management Committee has been constituted as follows :

Chairman **Dr. A.G. Ponniah**

Members

Dr. Madan Mohan, ADG (M.Fy.)
The Dean, TANUVAS, Chennai
The Commissioner of Fisheries, Gujarat

Dr. K.K. Lal
Shri Ali Hussain
Shri Ajitsinha Bajirao Patil
Dr. T.V. Sankar
Dr. A.K. Pal
Dr. G. Maheswarudu

Co-opted Members

Shri. Kunal Kalia, FAO
Shri. R. Kandamani, AAO
Smt. V. Usharani, AAO
Dr. T. Ravisankar, Principal Scientist & Head of Office

The 42nd IMC meeting held on 1st July 2013 and 43rd meeting on 31st January 2014.

INSTITUTE JOINT STAFF COUNCIL (IJSC)

The composition of the Institute Joint Staff Council (reconstituted by CIBA for a period of three years upto 18.02.2016 (vide Office Order F.No.13-1/2012-Admn. Dated 19.02.2013) is as follows:

Official Side

Chairman	**Dr. A.G. Ponniah**
Members	Dr.A.R. Thirunavukkarasu, HoD FCD
	Dr. P. Ravichandran, P.S.
	Dr. G. Gopikrishna, P.S.
	Shri B. Sathish, A.O.
	Shri Kunal Kalia, FAO
Secretary (Official Side)	Administrative Officer

Staff Side

Secretary	Shri, N. Jagan Mohan Raj, Sr. Technical Asst.
Members	Shri D.M. Ramesh Babu, Sr. Technical Asst.
	Shri R. Kandamani, A.A.O.

Shri P. Srikanth, UDC
Shri S. Kuppan, Skilled Support Staff
Shri M. Pichandi, Skilled Support Staff

(Shri P. Srikanth, Member, IJSC is also a member of CJSC of ICAR)

GRIEVANCE COMMITTEE

The composition of the Institute Grievance Committee (reconstituted by CIBA for a period of two years with effect from 1st December 2013 vide Office Order F.No.6(2)/2007-Admn. Dated 23.11.2013) is as follows:

Chairman	**Dr. A.G. Ponniah**

Official Side

Members	Dr.A.R. Thirunavukkarasu, HoD FCD Shri. B. Sathish, A.O. Shri. Kunal Kalia, FAO
Member Secretary	Shri. R.G. Ramesh, A.A.O.

Elected Members

Scientific Member	Dr. C.P. Balasubramanian, Principal Scientist
Technical Member	Dr. A. Nagavel, Senior Technical Officer
Administrative Member	Shri. A. Manoharan, Assistant
Staff Member	Shri. M. Pichandi, Skilled Support Staff

13

Participation in Conferences, Meetings, Workshops and Symposia

International

- Dr. A. G. Ponniah participated in the FAO/APFIC/NACA Regional Technical Consultation on Aquaculture Planning and Management Toolkit and its adoption in Asia and the Pacific, held at Bangkok, Thailand organized by FAO/APFIC/NACA from 26-29th November 2013- Dr. A. G. Ponniah
- Dr. A.G.Ponniah and Dr. S. K. Otta participated in the Seminar on Early Mortality Syndrome in Shrimp, jointly organized by Malaysian Society of Marine Sciences at University of Malaysia 50603, Kuala Lumpur organized by Malaysian Society of Marine Sciences on 30th November 2013
- Dr.Ashutosh Dharmendra Deo participated in the Ganga basin development challenge held at Dhaka, Bangladesh from 9-15th November 2013 -

National

Participation by Dr. A.G. Ponniah

- Expert Committee Meeting to Develop standards for declaring SPF status for shrimp species, breeding and farming, held at Chennai organized by Coastal Aquaculture Authority, Chennai on 3rd April 2013
- Meeting on *L.vannamei* with the Joint Secretary (Fy.), DAHD & F, Ministry of Agriculture, Krishi Bhavan, New Delhi organized by DAHD & F, MoA, New Delhi on 4th April 2013
- First Meeting of the Committee for Preparing the guidelines for hiring technical manpower, organized by the DDG (Hort.), ICAR at New Delhi on 4th April 2013
- Meeting to discuss pending issues on establishment of SPF *P.monodon* Multiplication Centre in Srikakulam District, A.P. at Hyderabad organized by NFDB, Hyderabad on 12th April 2013
- Second Meeting of the Committee on framing guidelines for hiring of technical manpower at the Office of the DDG (Hort.), ICAR, at New Delhi on 15th April 2013
- Meeting for finalization of guidelines for pilot scale multiplication centre of RGCA/MPEDA at TASPARC, Visakhapatnam for SPF *L.vannamei*, at Krishi Bhavan, New Delhi organized by DAHD & F, MoA, New Delhi on 30th April 2013
- Meeting of the Committee on preparing guidelines for hiring of technical manpower, held in the Horticulture Division, ICAR, KAB-II, New Delhi on 1st May 2013

- Meeting of the Committee to evaluate the proposals received in response to invitation for EoI for setting up MC's for SPF *L. vannamei* & *P. monodon* and to finalize the guidelines for establishment and operation of MC's for these species at CIBA on 10th May 2013
- Inauguration of the Silver Jubilee Laboratory Building and Rural Technology Centre of Kakdwip Research Centre of CIBA, Kakdwip and Brackishwater Aquafarmers Meet at Kakdwip at CIBA, Chennai from 15-16th May 2013
- Meeting on Performance Indicators organized by NCAP, New Delhi on 17th July 2013
- The 42nd Board of Management meeting of Sri Venkateswara Veterinary University, Tirupathi, held at Directorate of Animal Husbandry Campus, Hyderabad on 18th May 2013
- International Symposium on Greening Fisheries – Towards Green Technologies in Fisheries held at CIFT, Kochi from 21-22nd May 2013
- Meeting of the Committee for preparing guidelines for hiring of technical manpower, in the Committee Room, Horticulture Division, ICAR, KAB-II, New Delhi on 27th May 2013
- Selection Committee Meeting held at Agricultural Scientists Recruitment Board, New Delhi on 31st May 2013
- Senior Officers Meeting held at ICAR, Krishi Bhavan, New Delhi on 3rd June 2013
- Foundation Day and 20th Annual General Body Meeting of National Academy of Agricultural Sciences, held at B.P.Pal Auditorium, IARI, Pusa, New Delhi during 4-5th June 2013
- Interactive Farmers' Meet on banana shrimp culture, jointly organized by CIBA and Navsari Agricultural University at Agricultural Research Station, Danti, Navsari on 18th June 2013
- Harvest of banana shrimp at Danti Experimental Station, Navsari, under the CIBA-NAU Collaborative Programme on 18th June 2013
- Selection Committee Meeting held at Coastal Aquaculture Authority, Chennai on 20th June 2013
- Brainstorming Session on Sanitary and Phytosanitary measures in Fisheries at National Academy of Agricultural Sciences, New Delhi on 27th June 2013
- The 42nd Meeting of the Institute Management Committee held at Chennai on 1st July 2013
- First meeting of the Scientific Panel on Fish and Fisheries Products held in the Conference Hall, Food Safety and Standard Authority of India, New Delhi on 2nd July 2013
- Meeting for formulation of guidelines for establishment and operation of the Multiplication Centre for SPF *L. vannamei* and *P. monodon*, held at Krishi Bhavan, New Delhi on 9th July 2013
- The 85th Foundation Day of ICAR held at A. P. Shinde Symposium Hall, NASC, New Delhi on 16th July 2013
- Meeting on Performance Indicators held at National Centre for Agricultural Economics & Policy Research, New Delhi on 17th July 2013

- The 25th Anniversary of the Foundation of M. S. Swaminathan Research Foundation held at Chennai on 7th August 2013
- Coordination Committee Meeting for NFBSFARA Project on Hilsa held at CIFRI, Barrackpore, Kolkata on 16th August 2013
- Meeting to review and finalize the All India Coordinated Research Projects, Network Projects & Agri-Consortia Research Platforms at A.P. Shinde Auditorium, NASC Complex, New Delhi from 29-30th August 2013
- Dr.E.G.Silas Endowment Lecture organized by Rajiv Gandhi Centre for Aquaculture, Sirkazhi, Nagapattinam District, Tamil Nadu held at RGCA, Sirkazhi on 5th September 2013
- First Meeting of the Committee to finalize the guidelines for setting up of Multiplication Centres (MCs) for SPF *L. vannamei* and *P. monodon* and to make recommendations on policies to govern setting up and operation of MCs held at Krishi Bhavan, New Delhi on 6th September 2013
- Demonstration Programme on Seabass nursery rearing in hapas among the Irular Tribal Women Self-help groups and Tribal Women Aquafarmers meet held at Kulathumedu Village, Pulicat, Tiruvallur District on 13th September 2013
- Viva-voce in connection with ARS Examination 2012 for the recruitment to the post of Scientist (Fish Health) held at ASRB, New Delhi from 24-25th September 2013
- Consultation on Agenda documents of 7th Session of the Committee on Fisheries Sub-Committee on Aquaculture, held at MoA, Krishi Bhavan, New Delhi on 27th September 2013
- Consultative Workshop on development of Action Plan for Livelihood options in Bali (Sunderban) held at Bali Islands on 2nd October 2013
- Second Meeting of the Scientific Panel on Fish and Fisheries Products at Food Safety and Standard Authority of India, New Delhi on 15th October 2013
- Third Meeting of the Sub-Committee for studying the potential and viability of culturing endemic and exotic species held at CIBA, Chennai during 7-8th November 2013
- Second Meeting of the DBT Task Force Committee on Aquaculture and Marine Biotechnology, Department of Biotechnology, New Delhi from 11-12th November 2013
- Meeting of Fisheries & Aquaculture Development in West Bengal at Kolkata Centre of CIFE, Kolkata on 23rd November 2013
- Discussion Meeting on Alleviating Poverty and Malnutrition in Agro-biodiversity Hotspots held at MSSRF, Chennai on 3rd December 2013
- Interaction Session on National Biodiversity Authority held at Hotel Green Park, Chennai on 6th December 2013
- Discussion Meeting of all the Surveillance partners covering EMS to work out further strategies of sampling and action to be taken regarding EMS at CIBA Chennai, on 7th December 2013

- Interactive Workshop on Administrative and Financial matters held at NAARM, Hyderabad on 9th December 2013
- Selection Committee Meeting for considering the assessment proposals of Senior Scientists under the Revised Career Advancement Scheme, held at ASRB, New Delhi from 10-30th December 2013
- ICAR Directors' Conference at Baramati, Maharashtra from 19-20th January 2014
- Third Meeting of the Scientific Panel on Fish & Fishery Products, at CIFT, Kochi from 23-24th January 2014
- Aquaculture Business Meet - Interactive Workshop for Entrepreneurs- at Kolkata Centre of CIFE, Kolkata on 28th January 2014
- Inception Workshop of the Technical Cooperation Programme (TSP) on Support to the Implementation of the strategy for Fisheries Management for sustainable livelihoods (FIMSUL) at Hotel GRT Grand, Chennai on 29th January 2014
- Institute Management Committee Meeting of CIBA on 31st January 2014
- Interaction Meeting with the officials of MPEDA, Ministry of Agriculture, DAHD & F and Director General, ICAR, regarding Early Mortality Syndrome (EMS) in shrimp on 4th February 2014
- Workshop on Development of Inland Fisheries in Tamil Nadu under the chairmanship of Vice Chairperson, State Planning Commission, Chennai on 10th February 2014
- National Seminar on Development of Fisheries in Water Deficient Regions at CIBA, Chennai from 25-26th February 2014
- TANSA 2013 Expert Advisory Committee Meeting for the selection of Awardee in Biological Sciences held at Directorate of Technical Education Campus, Chennai on 26th February 2014
- State Level Stakeholders Meeting on Sustainable Fishing and New Technologies, held at MSSRF, Chennai on 28th February 2014
- MSSRF Norman Borlaug Birth Centenary Dialogue – Take it to the Farmer, held at MSSRF, Chennai on 13th March 2014

Participation in Workshops/Seminar/Meeting by Scientists

- International Workshop on Mud crab Aquaculture and Fisheries Management (ISMAF-2013) held at Sirkazhi from 10-12th April 2013 - Dr.P.Ravichandran, Dr.K.P.Jithendran, Dr.V.S. Chandrasekaran, Dr.C.P.Balasubramanian, Dr.J.Syama Dayal, Dr.M.Poornima and Dr.A.Panigrahi
- The 2nd Advisory committee meeting of Hilsa project under NFBSFARA at CIFRI, Barrackpore from 12-13th April 2013 - Dr. Debasis De
- Scope for financing shrimp and fish farming in brackishwater held at NIRD, Hyderabad on 29th April 2013 - Dr.T.Ravisankar
- Workshop on e-Extension strategies in shrimp farming on 29th April 2013 at Nagapattinam- Dr.R.Saraswathy and Dr. N. Lalitha

- Workshop on e-Extension strategy ensuring knowledge-led rural growth under NABARD funded project-e-Extension strategy ensuring knowledge led rural growth on 29th April 2013 - Dr.D.Deboral Vimala
- Fishpedia Workshop at CMFRI, Kochi from 29-30th April, 2013 - Dr.M.Muralidhar.
- The second consultative meeting on setting up of one dedicated centre for hilsa and review on progress of research on hilsa conservation held at Kolkata on 17th May 2013 - Dr. Debasis De
- Summer school on Recent advances in bioinformatics for quality livestock production organized by TANVASU, Chennai from 2-22nd May 2013 - Dr.P.Ezhil Praveena
- Workshop on Right to Information for CPIOs organized by ISTM, New Delhi from 27-28th May 2013 - Dr.V.S.Chandrasekaran
- Awareness Program held at the Fishing Harbour, Kasimedu, Chennai and thereafter in the Rally at Marina Beach, Chennai, organized by NETFISH-MPEDA, NGOs GAIA International Organization and SOHES, Chennai on 8th June 2013-Dr.V.S.Chandrasekaran
- Annual Review Workshop of NICRA held at IARI, New Delhi from 17-19th June 2013 - Dr.M.Muralidhar, Dr.M.Kumaran and Dr.R.Saraswathy
- Meeting of Fisheries Experts Brainstorming on developing vision plan for Tamil Nadu Fisheries University, Tamil Nadu Fisheries University, Thoothukudi on 19th June 2013- Dr.V.S.Chandrasekaran
- Consultative Workshop on Extension Strategies for Animal Husbandry and Fisheries Sectors at MANAGE, Hyderabad - Dr.V.S.Chandrasekaran
- Expert consultation meeting of Indian Institute of Agricultural Biotechnology on 10th June 2013 held at NASC, New Delhi - Dr M.S.Shekhar
- The 42nd Institute Management Committee Meeting of NBFGR held at Lucknow 1st July 2013 - Dr. Sherly Tomy
- International Conference on Impact of climate change on food, energy and environment (ICCFEE-2013) held at Chennai organized by Sathyabama University, Chennai from 4-6th July 2013 – Shri.J.Ashok Kumar
- National workshop on Strategies for strengthening NARS Libraries under eGranth held at IARI, PUSA, New Delhi from 5-6th July, 2013 - Dr.M.Kumaran and Shri R.Elankovan
- One day workshop on the Husbandary of Pearlspot organized by Kerala State Coastal Area Development Corporation Ltd. held at Ernakulam on 10th July 2013 - Dr.Krishna Sukumaran
- International Conference on Emerging and transboundary diseases of global importance held at Chennai organized by TANVASU, Chennai from 15-16th July 2013 - Dr. S. K. Otta
- Meeting on Performance Indicators at NASC, New Delhi on 17th July 2013 - Dr.M.Muralidhar
- ICAR Industry meet held at NASC New Delhi on 18th July 2013 - Dr. K. Ambasankar
- Agri-Tech Innovators meet at NASC New Delhi on 18th July 2013 at New Delhi – Dr.M.Muralidhar

- Agri-Tech Investors Meet in ICAR, New Delhi from 18-19th July 2013- Dr.T.Ravisankar
- International Seminar on Advances in Aquaculture Technologies (ISAAT-2013) held at Thiruvananthapuram from 18-19th July 2013 - Dr. Krishna Sukumaran
- National Workshop on *Litopenaeus vannamei* culture in India: Problems and Prospects from 20- 22nd July, 2013 held at Nellore, Andhra Pradesh – Dr.M.Kumaran and Dr.M.Muralidhar
- The 3rd Annual Review Workshop under NFBSFARA held at New Delhi from 22-23rd July 2013- Dr. Debasis De
- International Conference on Advanced nanomaterials and emerging engineering technologies held at Sathyabama University Chennai from 25-27th July 2013 - Dr.R.Saraswathy
- Review meeting of Hilsa project with DG, ICAR held at CIFRI, Barrackpore on 27th July 2013 - Dr. Debasis De
- Expert consultation on Fish genomics research in India: A way forward-held at NBFGR, Lucknow on 2nd August 2013 - Dr.G.Gopikrishna and Dr.M.Shashi Shekhar
- Workshop on Monsoon vagaries and its impact on ground water status of Chennai and its neighboring districts in Tamil Nadu at Satyabhama University, Chennai on 3rd August 2013 – Dr.M.Muralidhar
- Co-ordination committee meeting of NFBSFARA project on Hilsa at CIFRI, Barrackpore on 16th August 2013 - Dr. Debasis De
- Workshop on Up-scaling of agro-technologies for enhancing livelihoods in coastal regions of India held at CSSRI, Canning on 20th August 2013 - Dr T K Ghoshal
- National Conference on Current nutritional concepts for productivity enhancement in livestock and poultry held at TANVASU Chennai from 22-23rd August 2013 - Dr.K.Ambasankar and Dr.J.Syama Dayal
- Agri Tech 2013 Meeting held at Bangalore on 23-24th August 2013 - Dr. K.P. Kumaraguru Vasagam
- Springer Roadshow on eResources from the researcher and end-user perspective & It's benefits organized by Springer, Chennai on 2nd September 2013 - Dr.T.Ravisankar, Dr.D.Deboral Vimala, Dr.P.Nila Rekha, Dr.K.P.Kumaraguru Vasagam, Dr.P.K.Patil and Dr.T.Bhuvaneswari
- Dr.E.G.Silas Endowment Lecture organized by RGCA, Sirkali on 5th September 2013 - Dr.P.Ravichandran, Dr.S.K.Otta, Dr.A.Panigrahi, Dr.M.Poornima, Dr.Sherly Tomy, Dr.T.Bhuvaneswari
- National Conference on New opportunities and challenges in microbial research held at Bharathidasan University, Tiruchirappalli from 5-6th September 2013 - Dr.R.Saraswathy
- An interaction meeting between the visiting Scientists/Aquaculture persons from NOFIMA, Norway held at CIFRI, Barrackpore on 17th September 2013 - Dr. Debasis De
- The 8th meeting of Fish, Fisheries and Aquaculture Sectional Committee, FAD 12 held at National Institute of Fisheries Post Harvest Technology and Training (NIFPHATT), Foreshore Road, (Near Fine Arts Hall), Ernakulam, Kochi on 24th September 2013 - Dr. K. Ambasankar

- National Conference on Biotechnology-present and future held at Dr.N.G.P.Arts and Science College, Coimbatore from 26-27th September 2013 - Dr.M.Poornima
- Workshop on IP Management and Technology Transfer for Life Sciences held at IIT Madras on 27th September, 2013 - Dr.T. Ravisankar
- Consultative workshop on development of Action Plan for Livelihood Options held at Bali, Sundarbans on 2nd October 2013 - Dr. T. K. Ghoshal, Dr. Ashutosh D Deo, Dr. P Shyne Anand
- Interaction meeting of Hilsa project scientists with DG, ICAR at CIFRI, Barrackpore on 3rd October 2013 - Dr. Debasis De
- The 2nd International Conference on Ecosystem conservation, climate change and sustainable development (ECOCASD 2013) organized by Department of Aquatic Biology & Fisheries, University of Kerala, Thiruvananthapuram from 3-5th October 2013 - Dr.Debasis De, Dr.M.Poornima, Dr.R.Saraswathy, Dr.P.K.Patil, Dr.K.P.Kumaraguru Vasagam, Dr.Krishna Sukumaran and Dr.P.Shyne Anand
- Seminar on Right to Information Act-2005 held at New Delhi organized by Institute of Secretariat Training and Management, New Delhi from 11-12th October 2013 - Dr.V.S.Chandrasekaran
- The 2nd NKN Annual Workshop on Enhancing research collaborations through NKN held at Bangalore organized by IISC, Bangalore from 17-19th October 2013 - Dr.P.Mahalakshmi and Shri M.Shenbagakumar
- The 2nd International Conference on Agriculture, Food Technologies and Environment-new approaches (AFTENA-2013) held at Jawaharlal Nehru University, New Delhi from 19-20th October 2013 - Dr.Debasis De
- DBT sponsored workshop on Hands on training in basic molecular techniques held at Bharathidasan University, Tiruchirappalli on 21st October 2013 - Dr.M.Kailasam
- The 3rd Advisory committee meeting of Hilsa project under NFBSFARA at CIFRI, Barrackpore from 22nd-23rd October 2013 - Dr. Debasis De
- The 8th National Conference on Krishi Vigyan Kendra 2013 held at University of Agricultural Sciences, Bangalore from 23-25th October 2013 - Dr.V.S.Chandrasekaran
- National workshop on Library Automation using KOHA under e-Granth held at APAU, Hyderabad from 25-26th October, 2013 - Shri R.Elankovan
- The 4th National Research Conference on Climate Change at IIT Madras from 26-27th October 2013 - Dr.M.Muralidhar, Dr.M.Jayanthi and Shri. J.Ashok Kumar
- GEF Review Workshop of NAIP project on river cruise held at Sundarban, Millennium Park, Kolkata from 26-28th October 2013 - Dr T K Ghoshal
- The 7th plenary meeting of ISO/TC 234 Fisheries and Aquaculture Technical Committee and associated Working Group and Advisory Group meetings held at Kochi from 28-29th October 2013 - Dr. K. Ambasankar

- Meeting on incidence of EMS in *L. vannamei* farming organized by MPEDA at Kochi on 8th November 2013 - Dr.M.Muralidhar
- National Workshop on AgrIP 2013, on intellectual property and technology management held at Cochin from 15-16th November 2013 - Dr.S.V.Alavandi
- National Seminar on Aquatic Toxicology, Biodiversity and Aquaculture organized by Acharya Nagarjuna University at Nagarjuna Nagar, Guntur. Andhra Pradesh from 15-17th November 2013 - Shri.Ashok Kumar and Dr. K. Vinaya Kumar
- First Meeting of the advisory committee on Hilsa conservation & Research held at Kolkata on 22nd November 2013 - Dr. Debasis De
- International Conference on 6th Bangalore India Nano held at Bangalore from 4-6th December 2013 - Dr.R.Saraswathy
- Eastern Region Agricultural Technology Showcasing Meet, 2013 held at ICAR Research Complex for Eastern Region, Patna from 6-7th December 2013 - Dr. Ashutosh D. Deo
- The 3rd International Science Congress (ISD-2013) held at Coimabatore organized by Karunya University, Coimbatore on 8-9th December 2013 - Dr.S.K.Otta and Dr.Sherly Tomy
- National Seminar on New technology of agricultural and allied sciences: Achievements & Challenges (in Hindi language) held at CIFE, Mumbai from 14-16th December 2013 - Dr.Prem Kumar
- Training cum workshop on Ornamental fish and live feed- Advanced Production technology held at Madhavaram Campus, Tamil-Nadu Fisheries University, Chennai on 17th December 2013 - Dr.Krishna Sukumaran
- Asia Pacific Congress of Virology (VIRCON-2013) held at Amity University, Noida, from 17-20th December 2013 - Dr.S.K.Otta and Dr.P.K.Patil
- BPD review meeting with Dr.S.Karuppanchetty, COO, Agri business Incubation (ABI Program) held at ICRISAT, Hyderabad on 19th December 2013 - Dr.T.Ravisankar
- Brackishwaters Aquafarmers Meet at Kavali on 23rd December, 2013 - Dr.M.Muralidhar.
- India Innovation Growth Programme held at Chennai on 7th January 2014 - Dr. K.P. Kumaraguru Vasagam
- NICRA methodology manuals finalisation meeting held at CRIDA, Hyderabad on 7th January 2014 - Dr.M.Muralidhar
- The 19th India International Seafood Show organized by the MPEDA and SEAI held at Chennai Trade Centre from 10-12th January, 2014 - Dr.M. Kumaran
- EMS-AHPND Info meeting in India held at Chennai from 20-21thJanuary 2014 - Dr.C.Gopal, Dr.P.Ravichandran, Dr.K.P.Jithendran, Dr.S.V.Alavandi, Dr.M.Muralidhar, Dr.P.K.Patil, Dr.S.K.Otta and Dr.P.Ezhil Praveena
- AquaIndia 2014 held at Vijayawada organized by Society of Aquaculture Professionals, Vijayawada from 24-25th January 2014 - Dr.A.R.T.Arasu, Dr.C.Gopal, Dr.P.Ravichandran, Dr.M.Muralidhar, Dr.J.Syama Dayal and Dr.S.K.Otta

- Aquaculture Business Meet - Interactive Workshop for Entrepreneurs at CIFE Kolkata Centre on 28th January 2014 - Dr. K. Ambasankar
- National Workshop on Library automation using Koha under e-Granth held at TANVASU Chennai from 31st January to 1st February 2014 - Dr.M.Kumaran and Shri R.Elankovan
- Meeting on Investment opportunities in Fisheries Sector held at Kolkata on 10th February 2014 - Dr T K Ghoshal
- AZRA Silver Jubilee International Conference on Probing biosciences for food security & environmental safety held at Central Rice Research Institute,Odisha from 16-18th February 2014 - Dr.Ashutosh D Deo and Dr.P.S.Shyne Anand
- Press release function on Launching of the Book, Climate Change and Agriculture in India: Studies from Selected River Basins held at MSSRF, Chennai on 21st February 2014 - Dr.M.Muralidhar.
- Review Meeting of Hilsa project with Empowered committee chairman, NFBSFARA at NIRJAFT, Kolkata on 22nd February 2014 - Dr. Debasis De
- National Conference on Dietary interventions and signaling cascades in health and diseases held at University of Madras, Taramani Campus, Chennai from 21-22nd February 2014 - Dr.J.Syama Dayal
- Workshop on e-Granth – Koha professional training held at NAARM, Hyderabad from 24-26th February 2014 - Shri R.Elangovan
- National Seminar on Development of fisheries in water deficient regions held at CIBA, Chennai from 25-26th February 2014 - Dr.A.R.T.Arasu, Dr.P.Ravichandran, Dr.C.Gopal, Dr.G.Gopikrishna, Dr.K.Ambasankar, Dr.K.P.Jithendran, Dr.M.Muralidhar, Dr.V.S.Chandrasekaran and Dr. D. Deboral Vimala
- Review Meeting of Hilsa project with DG, ICAR at CIFRI, Barrackpore on 1st March 2014 - Dr. Debasis De
- NAIP -BPD annual review workshop held at NASC Complex, New Delhi on 7th March 2014 -Dr.T.Ravisankar
- International Conference on Computer Science & Information Technology (ICCSIT-2013) organized by IRAJ Research Forum, Chennai on 9th March 2014 - Dr.P.Mahalakshmi
- The 2nd Advisory Committee meeting on Hilsa Conservation & Research held at the West Bengal Directorate of Fisheries, Salt Lake on 12th March 2014 - Dr T K Ghoshal
- Fisheries Thematic review meeting under NICRA Project on 18th March at Kochi - Dr.M.Muralidhar
- Integrated Simulation modeling, organized by NRM Division ICAR under NICRA project on 19th March 2014 at New Delhi - Dr.M.Muralidhar and Shri.J.Ashok Kumar
- Consortium Advisory Committee (CAC) meeting of NAIP held at Kolkata on 28th March 2014 - Dr T K Ghoshal
- Technical Seminar on Best management practices in aquaculture for sustainable increase in production and profits held at Bhimavaram and Amalapuram from 29-30th March 2014 - Dr.S.K.Otta, Dr.A.Panigrahi and Dr.P.K.Patil

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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, ICAR Regional Committee No.VIII
- Member, Task Force Committee on Fisheries Development Mission – T.N. State Fisheries Department
- 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.
- Executive Committee Member - National Centre for Sustainable Aquaculture (NaCSA)
- Committee for protection of fish germplasm through registration and documentation, constituted by ICAR
- Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur.
- Executive Committee member - Fisheries Institute of Technology and Training (FITT), Chennai.
- State Level Committee on Animal Genetic Resources (SLCAnGR) constituted by Animal Husbandry & Veterinary Services, Chennai
- Task Force to finalize comments on Draft standards for Responsible Shrimp Aquaculture (SHAD), constituted by the Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, New Delhi.
- Expert-formulating guidelines for *Litopenaeus vannamei* farming in freshwater aquaculture, constituted by the DAHD & Fy., MoA, New Delhi.
- Expert-suggesting 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., MoA, New Delhi.
- Evaluation Committee for screening proposals for setting up of Multiplication Centres for SPF shrimp broodstock (*P.monodon* and *L.vannamei*)

- Board of Management of S.V.Venkateswara University, Tirupathi, as ICAR representative (till 21.5.2013)
- Selection Committee for the selection of Registrar, Controller of Examination and Director of Research of TANVASU (as ICAR representative).
- Working Group on Fisheries and Aquaculture for the preparation of Twelfth Five Year Plan (2012-17), constituted by the State Planning Commission, Chepauk, Chennai.
- NACA Task Force Member to develop the NACA Regional Program on Impacts & Response to Climate Change in Aquaculture – 2012-16.
- Board of Management of Tamil Nadu Fisheries University
- Committee for examining the issues related to establishment of SPF *Penaeus monodon* Multiplication centre at Srikakulam, Andhra Pradesh, under the Chairmanship of Joint Secretary (Fy.), DAHD & F and DDG (Fy.), ICAR.
- Expert Committee to develop standards for the process to be adopted for claiming SPF status for shrimp species (*Penaeus monodon* and *Litopenaeus vannamei*) along with identification of viruses to be screened for the purpose, constituted by DAHD & F, MoA, New Delhi.
- Committee-Evaluation of proposals received in response to invitation of Expression of Interest for setting up of Specific Pathogen Free Multiplication Centres for *Litopenaeus vannamei* and *Penaeus monodon* and formulation of guidelines for setting up of the MCs, constituted by DAHD & F, MoA, Govt. of India.
- Chairman - Committee for drafting guidelines and better management practices in hatcheries and nurseries for quality seed production, constituted by the DAHD & F, MoA, Govt. of India.
- Committee for formulating guidelines for open access policy in ICAR, constituted by the Secretary, DARE & Director General, ICAR.
- Committee for preparing the guidelines for hiring the technical manpower, constituted by the Secretary, DARE & Director General, ICAR.
- Coordination Committee for the NFBSFARA funded project on Hilsa.
- Panel member of the Panel on Fish and Fisheries Products under the Food Safety and Standards Authority of India.

Dr.A.R.Thirunavukkarasu, Principal Scientist

- Member, Board of Studies in Zoology (PG) – Bharathidasan University
- Member, Board of Studies in Zoology & Aquaculture (UG), Bharathidasan University
- Member, Board of Studies in Marine Biology, Annamalai University
- Member, Board of Studies in Zoology, Pondicherry University
- Member, Project Review Board, NIOT, Ministry of Earth Sciences, Chennai

Dr.V.S.Chandrasekaran, Principal Scientist

- Member, Board of Studies, Faculty of Marine Sciences, CAS in Marine Biology, Annamalai University, Parangipettai (2014 – 2017).
- Panel Member, School of Management Studies Research and Development Meeting
- Member, Institutional Animal Ethics Committee of the Integrated Coastal and Marine Area Management Project directorate, NIOT Campus, Chennai

Dr G Gopikrishna, Principal Scientist

- Member, Expert Committee for evaluation of the Twinning R&D proposals of the Department of Biotechnology, New Delhi
- Visiting Faculty for teaching Quantitative Genetics to M.F.Sc. students at CIFE Mumbai

Dr. M. Natarajan, Principal Scientist

- Expert Member Selection Committee for Assistant Professor of Fisheries Science and Animal Science, University of Agricultural Sciences, GKVK, Bangalore

Dr. K.P. Jithendran

- Member of the committee constituted by Coastal Aquaculture Authority to examine and submit a report on the procedures to be followed by the inspection teams during monitoring of hatcheries in disposing animals rearing exotic species in violation to the statutory provisions.
- Provided service to Ministry of Agriculture on the import of shrimp / fish diagnostic kits and reagents from EMS affected countries.

Dr.T. Ravisankar, Principal Scientist

- Member, Institute Management Committee, ICAR Zonal Project Directorate VIII, Bangalore

Dr.S.V. Alavandi, Principal Scientist

- Served as UGC Advisory Committee Nominee for Special Assistance Programme (SAP) to the Department of Microbiology, University of Delhi South Campus, New Delhi.
- Served as a member of the Curriculum Committee of Kerala University of Fisheries and Ocean Studies (KUFOS)
- Served as DBT Biosafety Committee nominee for the Entomology Research Institute, Loyola College, Chennai.
- Served as a member of the single source purchase committee for the Department of Veterinary Microbiology, TANUVAS, Chennai.
- Provided service to Ministry of Agriculture by providing comments on the import of shrimp / fish diagnostic kits and reagents and on the possibilities of transmission of EMS through feeds.

Dr. K. Ambasankar, Principal Scientist

- Principal Member, Fish and Fisheries and Aquaculture Sectional committee FAD 12 of BUREAU OF INDIAN STANDARDS
- Principal member, Aquaculture Subcommittee under FAD 12 of BIS
- Expert member, Board of Studies of Fisheries Science Faculty for TANVASU

Dr. M.S. Shekhar, Principal Scientist

- Resource person for National training programme on "Multi-Omics Approaches to Alleviate Abiotic Stress in Post Genomic Era: Methods and Application in Microbiological Research" at National Institute of Abiotic Stress Management (NIASM), Baramati.

Dr. S. Kannappan, Principal Scientist

- Examiner - Tamilnadu Fisheries University
- Project reviewer - Kerala State Council for Science and Technology
- Examiner - Pondicherry University

Dr.M.Muralidhar, Principal Scientist

- Expert member of Technical Committee to examine the proposal to utilise the water in the effluent treatment systems (ETS) of the farms approved by Coastal Aquaculture Authority for SPF *L. vannamei* culture for taking up secondary aquaculture.
- Expert member of Technical Committee of Coastal Aquaculture Authority for developing methodology for destroying shrimp stock in unapproved hatcheries.

Dr. Debasis De, Senior Scientist

- Guest teacher of Aquaculture Management and Technology Department of Vidyasagar University, Midnapore, West Bengal
- Member of Advisory committee of NFBSFARA project.
- Member (Director's nominee) of the Advisory committee on hilsa conservation and research, Department of Fisheries, Govt. of West Bengal

Dr. Sherly Tomy, Senior Scientist

- Institute Management Committee, National Bureau of Fish Genetic Resources, Lucknow
- Doctoral Committee member, Dept. of Genetic Engineering, SRM University

Dr. R. Ananda Raja

- Technical guidance to the Directorate of Fisheries, Tamil Nadu for purchasing scientific equipments for PCR unit, Microbiology, Histopathology, Nutrition and Live feed unit at Chetpet, Chennai under National Agriculture Development Programme (NADP).

- Technical Evaluation Committee member in Fisheries department, Tamil Nadu for establishment of Mobile Aqua Laboratory at Chetpet, Chennai under National Agriculture Development Programme (NADP).

Dr. P. Ezhil Praveena

- Member, Technical Committee Meeting for purchasing scientific instruments for the Mobile Aqua Lab Department of Fisheries, Government of Tamil Nadu.
- Member of single source purchase committee for Bioinformatics and ARIS Cell, Madras Veterinary College, Chennai.
- Guest faculty for BVSc students of Veterinary College and Research Institute, Namakkal

Dr. T. Bhuvaneswari

- External member in Interview Committee for selection of Administrative Officer, National Biodiversity Authority, Chennai.
- External Examiner for Veterinary Microbiology at MVC, Chennai.

15

Workshops, Seminars, Meetings etc. Organized by the Institute

WORKSHOPS

Stakeholder Workshop on Climate change and its impact on aquaculture in Odisha: Adaptations and mitigations for resilience

Inaugural speech by Dr.P.Jayasankar, Director, CIFA

A stakeholder Workshop was organized at Bhubaneswar, Odisha on 22nd March, 2014 by CIBA under the NICRA project . About 140 people representing all stakeholders of aquaculture including aqua farmers, feed and input suppliers, aqua consultants, researchers (CIFA, Bhubaneswar; CRRI, Cuttack; College of Fisheries, Behrampur; IMD, Bhubaneswar), Govt. officials (Department of Fisheries, Department of Agriculture, MPEDA, NABARD) and non-governmental organisations attended. The Workshop participants were divided into three groups viz., farmers, researchers or technical and policy or institutional comprising mixed stakeholders in each group and after discussions each group delivered the adaptation measures to reduce the impact of CC events and the responsible departments to act on the problem and the time limit.

FARMERS INTERACTION MEET

Interaction Meet on ICT Initiatives in brackishwater aquaculture for tribal and aqua farmers

This meet was jointly organized by CIBA and NAU at Navsari on 8th May 2013. About 40 tribal and aqua farmers from Danti, Surat, Khursad, Mahuvas, Patri and Gandevi attended along with personnel from NAU, Krishi Vigyan Kendra, Marine Product Export Development Authority (MPEDA) and NGOs. Group discussion focussed on the information needs of tribal and aqua farmers, role of officials in brackishwater aquaculture, information related to shrimp/fish culture, cage farming, women development programmes, government schemes for women and tribal community, aquaculture/fisheries databases and extension materials/programmes.

Harvest Mela and Farmers' Interaction Meet on Banana Shrimp Farming

A fair relating to the harvest of banana shrimp at Danti farm at NAU was held on 18th June 2013 wherein Dr. S. Ayyappan, Honorable Secretary, DARE and Director General, ICAR, Dr. B. Meenakumari, Deputy Director General (Fisheries) ICAR, New Delhi, Dr. A. R. Pathak, Vice Chancellor, NAU, Navsari, Dr. A.G.Ponniah, Director, CIBA, Dr. R.R. Pathak, Deputy Commissioner of Fisheries, Gujarat, Dr. A. N. Sabalpara, Director of Research, NAU, Navsari, the scientists from CIBA and NAU, and officials from MPEDA and Department of Fisheries, Gujarat, graced the occasion. About 80 brackishwater farmers and stakeholders from Danti, Surat, Khursad, Mahuvas, Patri and Gandevi areas of Navsari and Surat districts of Gujarat participated. The aqua farmers expressed satisfaction at the research support being provided during the last four years under this collaborative project.

Farmers-Scientist Interaction Meet on scientific use of probiotics and minerals

This meet was organized at NAU, Navsari, Gujarat on 13th December 2013. About 50 persons including farmers, technicians and university faculty participated. The meeting emphasized the need for judicious use of such products and application of proven products based on scientific reasoning and findings of CIBA.

Milkfish Harvest Mela and Farmer's Interaction Meet

Milkfish harvest mela and farmer's interaction meet was conducted on 14th December 2013 in the farmer's pond site at Mor village, Surat district, Gujarat. A total of 170 participants including farmers, entrepreneurs, academicians, consultants, officials from state departments and central institutes participated and witnessed the harvest of milkfish. Dr. Kelawala, Dean College of Veterinary Sciences, NAU, delivered the presidential address and appreciated the collaborative research program. Shri Mukesh Bhai Z. Patel, MLA, Olpad constituency in Surat district, addressed the gathering as Chief Guest and lauded the efforts taken up by CIBA and NAU in promoting brackishwater aquaculture activities in Gujarat. Dr.A.G.Ponniah, Director, CIBA, Chennai mentioned the immense potential of brackishwater resources in Gujarat and importance of species diversification in this region. Representatives from fish farmers association were also felicitated. During the function, 40 kg of milkfish was harvested and sold to customers @ Rs 250/kg.

Harvest mela Biofloc based Shrimp Farming Technology

The institute conducted a harvest mela on 28th September 2013 for the biofloc-based shrimp produced at the MES wherein local farmers, hatchery managers and other stakeholders participated.

Dr A. G. Ponniah, Director, CIBA highlighted the potential of biofloc technology and its environmental benefits which could lead to sustainable intensification of shrimp farming.

MEETINGS

Tribal Aqua Farmers Meet and Distribution of Farm Inputs to the Tribal Beneficiaries

An on-field tribal aqua farmers meet was organized on 3rd September 2013 at New Perungulathur, Kancheepuram District, Tamil Nadu under the Tribal Sub Plan. Mrs. Vidya Santhanakrishnan, Marine Technologies (P) Ltd, Chennai was the Chief Guest and she emphasized the opportunities available in brackishwater aquaculture and allied agricultural technologies for livelihood development. This was followed by the distribution of farm inputs for mushroom farming and ornamental fish farming to the beneficiaries.

Diginitaries and participants in the programme

Inauguration of straw chaff cutter for mushroom farming by Mrs. Vidya Santhakrishnan

Operation of straw chaff cutter by tribal WSHG leader

Dignitaries and beneficiaries in the mushroom farming unit

Tribal Women Aqua Farmers' Meet

A tribal aqua farmers meet was organized on 3rd July 2013 at CIBA, Chennai for creating an awareness among the tribal aqua farmers (both men and women) for adopting brackishwater aquaculture technologies. About 75 tribal aqua farmers from Tiruvallur, Kancheepuram, Cuddalore and Nagapatinam districts of Tamil Nadu participated. Shri. Giridar, IFS, Director, Tribal Welfare Department, Government of Tamil Nadu, inaugurated the meet and detailed the opportunities and funding support available

for the tribal people for livelihood development. He appreciated the efforts of CIBA in successfully transferring the aquaculture technologies for the poor and down-trodden tribal people. A handout on Brackishwater aquaculture technologies towards the development of livelihoods among the coastal tribal people in the vernacular was released.

Dignitaries with the beneficiaries and CIBA scientists

Mr. Santhanakrishnan, Chairman, Maritech addressing the audience

Shri. Giridar, IFS, Director, Tribal Welfare Department, Govt. of Tamil Nadu releasing the handout

Focus Group Discussions

Focus Group Discussion on Disease risks and better management practices in *L.vannamei* Farming

A Focus Group Discussion was organized on 2nd September 2013 at CIBA, Chennai with a group of 50 field level aquaculture professionals and farmers. A plan of action to tackle the issues constraining *L.vannamei* farming was discussed.

Focus group discussion on perceived climate change impacts in Odisha state

Two FGD meetings were organized under the NICRA project at Gudupai, Balasore Dist, Northern Odisha on 18th March, 2014 with 70 farmers and at Haridas, Brahmagiri Block, in southern Odisha on 20th March, 2014 with 80 farmers. The meetings were organized to document the perceived climate change

events and impacts, risk assessment, mapping of crop calendar being followed in line with the seasonal variations and adaptation measures being implemented.

FGD interaction at Gudupai, Northern Odisha

FGD participants at Haidas, Southern Odisha

Business Planning and Development (BPD) Unit in CIBA

The BPD Unit at CIBA was inaugurated by Dr.S.D.Tripathi, Former Director & Vice Chancellor, CIFE on 27th August 2013. Dr.A.G.Ponniah, Director, CIBA, stressed the importance of business incubation support for start-ups and innovators to take up aquaculture based enterprises. The unit could offer new business opportunities for entrepreneurs, start-up companies and established corporates in starting initiating aquaculture business ventures and would nurture new ideas of innovators by providing technical support. He indicated that the ideal potential technology should be identified to sustain and diversify in the private sector.

Inauguration of BPD Unit at CIBA

CIBA Foundation Day

The 26th Foundation day of CIBA, Chennai was celebrated on 1st April 2013 wherein Dr. P Nammalwar, Project Leader of INCOIS (Ministry of Earth Sciences, Government of India), Anna University, presided.Dr. A.G. Ponniah, Director, CIBA, highlighted the significance of celebrating the Foundation Day and stressed the vision of this institution to address the needs of the brackishwater aquafarmers. He stressed the need for documenting the history of CIBA. An elocution competition was conducted and prizes awarded to the winners.

ICAR Industry Day

ICAR- Industry day was celebrated on 16th July 2013 at CIBA,Chennai. On this occasion a panel discussion on Intellectual Property Rights issues in Biotechnological Research was conducted. The participants including Dr.T.N.Shanmugam, Director of Centre for IPR, Anna University, Chennai., Shri. O.P. Rao and Dr. S.Gowda, Asst. Controllers of Patents and Designs, Patent Office, Chennai gave presentations to create awareness on Inventions by Indians, Innovations, IPR classification, Copyrights, Trade marks, and Trade secrets. A total of 76 persons attended.

Brackishwater Aquafarm Innovators Day

The Institute organised the Brackishwater Aquafarm Innovators Day in commemoration of the World Food Day on 18th October 2013 at CIBA, Chennai. Dr.S.Ramachandran, Vice-Chancellor, Hindustan University, Chennai presided as Chief Guest. Two farmers were honoured: Shri.Nithyanandham of Chennai, who has started a novel approach of sport fishing as a Farm Tourism venture using Asian seabass and Shri.S.S.Srinivasan of Velankanni, Nagapattinam who while farming milk fish, has developed an efficient feeding method in the pond using low cost material.

National Science Day

This was celebrated on 28th February 2014 at CIBA, Chennai. Dr. A.R.Thirunavukkarasu. the Director-in-Charge, CIBA, highlighted the importance of science in daily life and emphasised the need of scientists to deliver valuable research outputs for the betterment of society. Dr.P.Thangaraju, ex-Vice-Chancellor of TANVASU and present Pro-Chancellor, Medical Faculty of SRM University, Chennai was the chief guest. He mentioned the importance of the National Science Day and described the invention of Sir C. V. Raman. To encourage the younger generation, a competition on the Research proposals with innovative ideas was held among the research fellows at CIBA. The winners presented a brief about their proposals to the audience and prizes were awarded.

Kakdwip Research Centre

FARMERS FIELD DAY AND INTERACTION MEET

The main objective was to disseminate the information gained through *L.vannamei* farming amongst the shrimp farmers and to explore the possibility of culture in West Bengal. Dr Archana Sinha, Principal Scientist and Officer-in-charge, CIFRI - Kolkata Centre, Dr P. Ravichandran Principal Scientist, Dr M. Jayanthi, Principal Scientist and 52 progressive shrimp farmers participated. Dr T K Ghoshal, Senior Scientist and Incharge welcomed the gathering and highlighted the achievements of KRC. Dr Archana Sinha highlighted the role of CIBA in developing feasible fish and shrimp technologies for farmers especially *L.vannamei* and requested farmers to come forward and adopt such technologies. Dr P Ravichandran outlined the role of CIBA in bringing *L.vannamei* to India, praised the initiative of KRC scientists and also interacted with farmers on several issues. All the guests along with farmers witnessed the harvesting.

Field day and Harvest Mela of Brackishwater Aquafarming at tribal village Manmathapur-Mundapara, West Bengal

This was organised on 12th November 2013 under Tribal Sub-Plan (TSP) scheme at village Manmathapur-Mundapara, Dist. South 24 Parganas, West Bengal. Dr. A. R. Thirunavukkarasu, Principal Scientist CIBA, Chennai, inaugurated the harvest mela. The local Gram Panchayat Pradhan and Panchayat members graced the occasion and 60 participants belonging to the tribal community participated.

KRC organized a Brackishwater Aqua-Farmers' Meet-2013 on 15th May 2013 which was inaugurated by Dr. S.Ayyappan, Secretary DARE and DG, ICAR. About 257 farmers participated.

Handing over of mullet seed

Inauguration of Rural Technology Centre

EXHIBITIONS

The Centre participated in the Kishan Mela organized by Ramakrishna Ashram KVK at Nimpith, South 24 Parganas on 6th September 2013.

CIBA Exhibition Stall at Gramin Mela at 5 No. Hat, Kakdwip on 25-27 Feb, 2014

16 Visitors

Headquarters

Sl.No.	Details of visitors	Date of visit
1	Dr. P Nammalwar, Project Leader, INCOIS (Ministry of Earth Sciences, Government of India), Institute of Ocean Management, Anna University, Chennai	1.4.2013
2	Shri. Arun Padayar	5.4.2013
3	Prof.S.Arunachalam, Distinguished Fellow, Centre for Internet Society, Bangalore	20.4.2013
4	Dr.M.Thirunavukkarasu, Controller of Examinations, TANVASU, Chennai	12.5.2013
5	Dr.T.N.Shanmugam, Director, Centre for IPR, Anna University, Chennai	16.7.2013
6	Mr.Prasad Rao and Dr.Sharana Gowda, Asstt. Controllers of Patents and Designs, Patent Office, Chennai	16.7.2013
7	Dr.S.D.Tripathi, Former Director & Vice Chancellor, CIFE	27.8.2013
8	Dr.S.Selvaraj, Postdoctoral Researcher at Laboratory of Marine Biology, Department of Bioresource Sciences, Kyushu University, Fukuoka, Japan	17.9.2013
9	Prof. Baskaran Manimaran, Vice Chancellor of the Tamil Nadu Fisheries University	18.9.2013
10	Dr.P.Paul Pandian Executive Director, NFDB, Govt. of India	18.9.2013
11	Dr.M.Sakthivel, President, Aquaculture Foundation of India	27.9.2013
12	Dr.S.Ramachandran, Vice-Chancellor, Hindustan University, Chennai	18.10.2013
13	Dr K.Alagarswami, ex-Director, CIBA	8.1.2014
14	Dr.P.Thangaraju, ex-Vice-Chancellor of TANVASU and Pro-Chancellor, Medical Faculty of SRM University, Chennai	28.2.2014

Kakdwip Research Centre

Sl.No.	Details of visitors	Date of visit
1	Dr. S. Ayyappan, Secretary (DARE) and Director General ICAR	15.05.2013
2	Dr. A.P. Sharma, Director, CIFRI	15.05.2013
3	Prof. T. J. Abraham, W.B.Univ of Animal & Fisheries Sciences	27.07.2013
4	Mr. Manas Chowdhury, Deputy Advisor (Fisheries), Planning Commission, Delhi	27.07.2013
5	Dr. B. Meena Kumari, DDG (Fy), ICAR	17.08.2013
6	Dr Archana Sinha, OIC, CIFRI, Kolkata Centre	22.10.2013
7	Dr. S. K. Bandopadhyay, Member, ASRB	15.03.2013

17 Personnel

Managerial Personnel
Director: Dr. A.G. Ponniah

Headquarters

Scientific Personnel

Head of Division

Dr. A.R.Thirunavukkarasu,
Finfish Culture Division
(superannuation on 28-02-2014)

Dr. P.Ravichandran,
Crustacean Culture Division (upto 28.6.2013)

Dr. C.Gopal,
Crustacean Culture Division
(w.e.f from 29.6.2013)

Principal Scientist

Dr. M.Natarajan
Dr. G.Gopikrishna
Dr. K.P.Jithendran
Dr. V.S.Chandrasekaran
Dr. T.Ravisankar
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 (Promoted w.e.f.22.3.2013)
Dr. Akshaya Panigrahi (Promoted w.e.f.7.2.2013)
Dr. (Mrs.) P.Nila Rekha (Promoted w.e.f.3.12.2012)
Dr. K.Ambasankar (Promoted w.e.f.4.12.2012)
Dr. J.Syama Dayal (Promoted w.e.f.3.2.2013)
Dr. M.Kumaran (Promoted w.e.f.26.2.2013)

Senior Scientist

Dr.(Mrs.) M.Poornima
Dr.(Mrs.) R.Saraswathy
Dr. Prasanna Kumar Patil
Dr.(Mrs.) Sherly Tomy
Dr. Subhendu Kumar Otta
Dr. K.P.Kumaraguru Vasagam

Scientist (Senior Scale)

Dr.(Mrs.) P.Mahalakshmi
Shri Ashok Kumar Jangam

Scientist

Dr. R.Ananda Raja
Dr. K.Vinaya Kumar
Dr.(Mrs.) Krishna Sukumaran
Dr.(Mrs.) Ezhil Praveena
Dr. Prem Kumar
Dr.(Mrs.) T.Bhuvaneswari
Dr.(Mrs.) N.Lalitha
Dr. P.Kumararaja
Dr. B.Sivamani

Chief Technical Officer

Shri R.Elankovan

Assistant Chief Technical Officer

Dr. S.Sivagnanam
Shri D.Rajababu
Shri M.Shenbagakumar
Shri V.R.Senthil Kumar
(transferred to SBI on 9.4.2013)
Shri R.Puthiavan
Mrs.K.Jacquline

Senior Technical Officer

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

Technical Officer

Shri R.Rajashekaran (Superannuation on 30.6.13)

Senior Technical Assistant

Shri N.Ramesh
Shri S.Saminathan
Shri N.Jagan Mohan Raj
Shri R.Balakumaran(Driver)
Shri D.M.Ramesh Babu
Shri G.Thiagarajan

Technical Assistant

Shri K.Paranthaman (Driver)
Shri K.Karaian

Senior Technician

Shri K.V.Delli Rao

Administrative and Finance

Administrative Officer

Shri B.Sathish (transferred to CPCRI, Kasargod on 25.3.2014)

Finance & Accounts Officer

Shri Kunal Kalia

Assistant Administrative Officer

Shri R.G.Ramesh
Shri R.Kandamani
Mrs.V.Usharani

Junior Accounts Officer

Mrs.K.Nandhini

Personal Assistant

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

Stenographer Gr.III

Mrs.K.Hemalatha
Mrs.K.Subhashini

Assistant

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

Upper Division Clerk

Mrs.E.Mary Desouza
Shri P.Srikanth
Mrs.R.Vetrichelvi

Lower Division Clerk

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.Mariappan
Shri K.Nithyanandam
Shri V.M.Dhanapal
Shri E.Manoharan
Shri V.Kumar
Shri C.Saravanan
Shri S.Kuppan
Shri M.Pichandi
Shri S.Selvababu
Shri D.Senthilkumaran
Shri C.Ragu
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

Kakdwip Research Centre

Scientific Personnel

Principal Scientist & Officer-in-charge

Dr. J. K. Sundaray (Transferred to CIFA, Bhubaneswar on 25.04.2013)

Dr. T.K.Ghoshal (Promoted w.e.f 29.12.2012)

Senior Scientist

Dr. Debasis De
Dr. Ashutosh Dharmendra Deo
Dr. Sanjoy Das

Scientist

Shri Gouranga Biswas
Dr. Sujeet Kumar
Mrs.P.S.Shyne Anand

Senior Technical Assistant

Shri P.S.Samanta

Technical Assistant

Mrs.Chanda Mazumder

Administrative Staff

Private Secretary

Shri S.K.Halder

Assistant

Shri S.K.Bindu

Skilled Support Staff

Shri N. C. Samanta (Superannuation on 30.6.2013)
Shri Sasadhar Betal (Superannuation on 28.2.2014)
Shri Rash Behari Das
Shri Patit Paban Halder (Superannuation on 31.8.2013)
Shri R. K. Ray (Superannuation on 30.9.2013)

Shri Nayan Tara Dalui
Shri Narendra Nath Jana
Shri Amar Gharami
Shri Krishna Pada Naskar
Mrs. Lakshmi Rani Bhuiya
Shri Uttam Kumar Santra
Shri Purna Chandra Das

18

Infrastructure Development

Muttukadu Experimental Station of CIBA, Muttukadu

- Renovation of asbestos sheet roof in the CCD-Shrimp hatchery
- Construction of RCC tanks and rectification of the roofing sheet in the live feed section in western side of the Fish hatchery
- Renovation of water intake system in CCD shrimp hatchery under NAIP – BPD project
- Construction of compound wall in northern side of the main building area (1.7 acres area)

Kakdwip Research Centre of CIBA, Kakdwip

- Renovation of Type-I quarters (12 Nos), Type-II quarters (4 Nos), Type-III quarters (8 Nos) and Type-IV quarters (1 no)
- Renovation of laboratory at ground floor
- Construction of semi-permanent shed for housing the feed machinery under NAIP project
- Construction of live feed culture unit
- Renovation of pond no.5, 7 & 8

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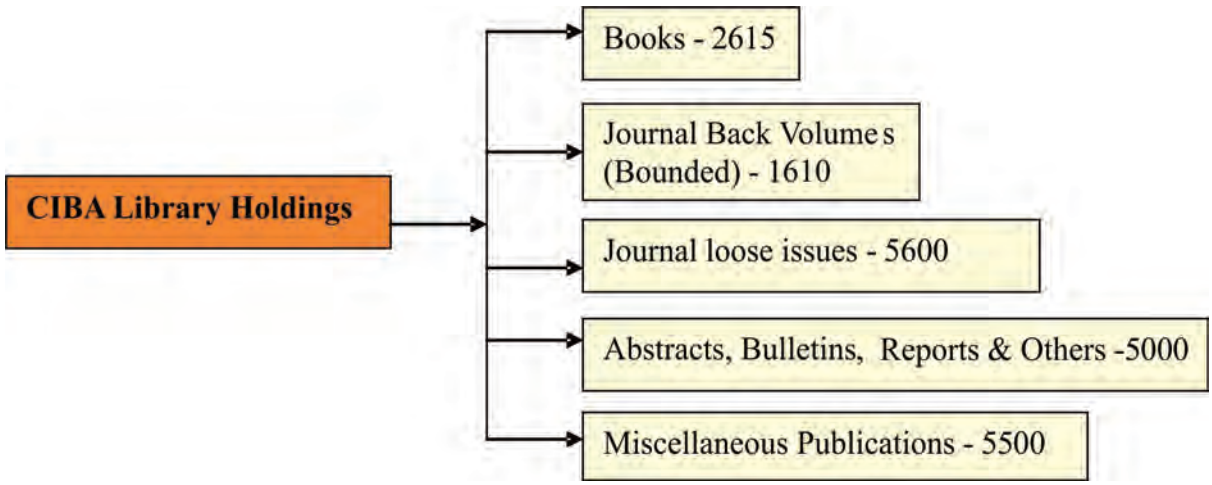
Library and Documentation

Library holdings

The library procured 52 new books including official language books during the period. Subscription to 21 international and 33 national journals including vernacular language journals for the headquarters and 30 national journals for Kakdwip Research Centre of CIBA Library were made. The library holdings as on 31.03.2014 are given below.



On line access to CeRA journals and document delivery service

Online connectivity for the Consortium for electronic Resources in Agriculture (CeRA) journals subscribed by the NAIP was established at Headquarters and KRC Kakdwip. We also supplied the photocopies of journal articles requested from various ICAR institutes, scientists and research scholars under CeRA - Document Delivery Request (DDR).

Exchange services

An exchange relationship with national and international organizations working on fisheries and aquaculture on mutual interest was maintained. Free mailing of institute's annual report and other publications to various research organizations, universities and other agencies was carried out to give greater exposure to the research and development programmes of our institute.

Information services to the stakeholders

As a reference library, we provided access to reference books and journals available in the library to scientific personnel of other research organizations, academicians, university/college students, research scholars, stakeholders and other related visitors. The library provided reprographic service to the users on a nominal payment basis.

Utilization of funds

A total of Rs.31.00 lakhs under plan funds and Institute's BPD - Project was utilized for the renewal of subscription to journals and procurement of new books for Headquarters and KRC library of CIBA.

Implementation of ICAR - NAIP (e-Granth) Project

Under the NAIP eGranth: Agri-Info-Gateway project, Rs. 14. 33 lakh was received. Two Senior Research Fellows are in place. New facilities like scanning, reference search from PCs etc. are being created. The automation of library holdings in LIBSYS software was completed and the OPAC - (Online Public Access Catalogue) operating system has been installed in all the PCs of Scientists for effective utilization of library holdings which have also been entered in the new platform KOHA- ILS Library Management System.


SILVER JUBILEE LABORATORY BUILDING
ICAR


DEMONSTRATION AND HARVEST OF MILKFISH (CHANOS CHANOS) CULTURED IN BRACKISHWATER FARMERS' POND
ખેડૂત દ્વારા ભાંભરા પાણીના તળાવમાં ઉછરેલ મીલ્કફીશ (ચાનોસ ચાનોસ) નું નિદર્શન અને હાર્વેસ્ટીંગ
jointly organised
by
Chennai, TN
&