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CARI ANNUAL REPORT 2008-2009

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प्राक्कथन

द्वीपीय पारिस्थितिकी तन्त्र भंगुर है तथा इसके स्रोतों का बहुत ही सावधानीपूर्वक विदोहन किया जाना चाहिए, मगर पारिस्थितिकी संरक्षण तथा जीविकोपार्जन में मतभेद उत्पन्न हो गया है। सतत जीविकोपार्जन हेतु यह आवश्यक है कि प्राकृतिक स्रोतों का उचित विदोहन करने हेतु उपयुक्त प्रौद्योगिकीय हस्तक्षेपों का निर्धारण किया जाए। यद्यपि अंडमान निकोबार द्वीप समूह में 3100 मि. मी. वार्षिक वर्षा होती है, मगर इसमें से लगभग 75 % वर्षा जल बह जाता है तथा शुष्क मौसम में सिंचाई तथा घरेलु उपयोग हेतु पानी की भारी कमी हो जाती है। पारम्परिक प्रौद्योगिकियों का उपयोग करके मात्र 3% जोत क्षेत्र हेतु सिंचाई क्षमता विकसित की जा सकी है। इसी तथ्य को ध्यान में रखते हुए केन्द्रीय कृषि अनुसंधान संस्थान ने सिंचाई तथा घरेलु उपयोग हेतु जलापूर्ति सुनिश्चित करने के लिए वर्षा जल प्रबन्धन प्रौद्योगिकियों द्वारा जल स्रोतों के विकास हेतु कार्य प्रारम्भ किया है। दो वर्षो के सतत प्रयास के परिणाम स्वरूप घाटियों, मध्यम पहाड़ियों तथा ऊपरी पहाड़ियों हेतु जल संसाधनों के विकास हेतु प्रौद्योगिकियों का विकास कर लिया गया है। इन्ही प्रौद्योगिकियों का उपयोग करते हुए संस्थान के तीनों कृषि प्रक्षेत्रों जो पहले वर्षा पर आधारित थे, को सिंचित कर दिया गया है। संस्थान के मुख्य प्रांगण में संस्थान कार्यालय, प्रयोगशालाओं, पशुधन फार्म के अतिरिक्त संस्थान के 140 परिवारों हेतु जलापूर्ति सुनिश्चित कर दी गई है। अंड़मान निकोबार प्रशासन ने इसमें रूचि दिखाई है तथा आने वाले वर्षों में कृषि विज्ञान केन्द्र, विस्तार परियोजनाओं तथा अंड़मान निकोबार प्रशासन के विभिन्न कार्यक्रमों द्वारा इन प्रौद्योगिकियों को जन साधारण तक पहुँचाया जायेगा ।

ग्यारहवीं परियोजना के लिए चिन्हित दर्शन तथा कार्यक्षेत्रों के अनुरूप सतत प्रयास करते हुए नए अनुसंधान कार्यों की पहल की गयी । इनमें से कुछ हैं:- वर्षा आधारित क्षेत्रों में फसल सघनता 300 % तक बढ़ाने हेतु धान पूर्व तथा धान उपरान्त काल में धान के साथ चारा फसलों का समन्वय, सम्पूर्ण जीविकोपार्जन हेतु रबी के मौसम में खरीफ की फसल के रूप में नारियल बगीचों में खाने हेतु मूंगफली की खेती तथा इसका बीजोत्पादन, आर्किड तथा फर्न का सूक्ष्म संवर्धन तथा ग्रूपर मछलियों की पिंजड़ा खेती। इसके अतिक्ति आगामी वर्षों में द्वीपों पर जलवायु परिवर्तन के प्रभाव का मूल्यांकन, विशेष रूप से निकोबार द्वीप समूह पर, द्वीपों की वहन क्षमता का आंकलन तथा खेती का सघनीकरण करने हेतु द्वीपीय कृषि को जैविक कृषि में बदलने की व्यवहार्यता का मूल्यांकन आदि विषयों पर भी अध्ययन किया जाएगा।

इस सभी नई चुनौतियों को पूरा करने के लिए प्रेरणास्पद मार्गदर्शन के लिए मैं माननीय डॉ0 मंगला राय, सचिव, कृषि अनुसंधान तथा शिक्षा विभाग तथा महा निदेशक, भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली के प्रति आभार प्रकट करना चाहुंगा। मैं डॉ0 एच0पी0 सिंह, उप महानिदेशक (बागानी) का भी आभारी हूँ जिन्होंने भविष्य हेतु दिशानिर्देश देने के साथ–साथ नई परियोजनाओं के प्रतिपादन हेतु मार्गदर्शन किया तथा हमारे लिए सतत् प्रेरणा स्रोत बने रहे। मैं डॉ0 यू0सी0 श्रीवास्तव, सहायक महानिदेशक (बागानी) का भी धन्यवाद करना चाहुंगा। मैं माननीय ले0 जनरल (सेवानिवृत) भूपेन्द्र सिंह, पी.वी.एस.एम., ए.वी.एस.एम. उप राज्यपाल, अंडमान व निकोबार द्वीप समूह तथा श्री विवेक रे, मुख्य सचिव, अंड़मान व निकोबार प्रशासन का भी आभारी हूँ जिन्होंने हमेशा हमें सहायता प्रदान की तथा हमारा साहस बढ़ाया। मैं अंडमान व निकोबार प्रशासन का भी आभारी हूँ जिन्होंने हमे निरन्तर समर्थन दिया तथा हमारे साथ सक्रिय सहयोग किया। अंत में मैं अपने वैज्ञानिकों तथा संस्थान के अन्य कर्मचारियों के प्रति आभारी हूँ जिनके अथक परिश्रम से ही हम इन नई चुनौतियों का सामना करने में सक्षम हुए है।

अगस्त, 2009
पोर्ट ब्लेयर

रमेश चन्द्र श्रीवास्तव
निदेशक

PREFACE

Island ecosystem is fragile and its resources have to be exploited very carefully. There is a growing conflict between ecology conservation and livelihood. For a sustainable livelihood, it is essential that suitable technology interventions are made to utilize the natural resources optimally. Although Andaman & Nicobar Islands receive an annual rainfall of about 3100 mm, about 75% of it is lost as runoff and there is huge scarcity of water during dry season both for irrigation as well as domestic use. Application of conventional technologies has been able to create irrigation potential for just 3% of cultivated area. With this in view, Central Agricultural Research Institute initiated work on rain water management technologies for water resource development both for irrigation as well as domestic use. Two years of effort has resulted in development of set of technologies for creating water resources in valleys, mid hills and hill top. Using these technologies, all the three farms hitherto rainfed have been brought under irrigation. At main campus this has been linked to water supply system for institute, labs, livestock in addition to 140 families residing in campus. A & N Administration has shown interest in it and these technologies will be replicated in field in coming year through KVK, extension projects and under programmes of A & N Administration.

In our continued effort to fulfill the vision and thrust areas identified for XI plan, new research initiatives have been taken. Few of them are; Integration of fodder in paddy areas during pre paddy and post paddy period to enhance cropping intensity to 300% in rainfed areas; Introduction of table purpose rabi groundnut alongwith seed production during kharif in coconut gardens to facilitate a total livelihood chain ; Micro propagation of orchids and ferns; and Cage culture for groupers and sea bass. In addition to it, studies will also been taken next year to assess the impact of climate change on islands with specific reference to Nicobar Islands, estimation of carrying capacity of islands and evaluating feasibility of organic farming of island agriculture in case of intensification of agriculture.

I take this opportunity to express my gratitude to Hon'ble Dr. Mangala Rai, Secretary, Department of Agricultural Research and Education and Director General, ICAR for his inspiring guidance to meet the new challenges. I am grateful to Dr. H.P. Singh, DDG (Horticulture) for his continuous encouragement and guidance in formulating new projects and advising us on future course of action. I am thankful to Dr. U.C. Srivastava, ADG (Hort.) for his help. I express my sincere thanks to Hon'ble Lt. Gen. (Retd.) Bhopinder Singh, PVSM, AVSM, Lt. Governor, A & N Islands and Shri Vivek Rae, Chief Secretary, A & N Administration for their encouragement and support. I am thankful to A & N Administration for their continued support and active collaboration. Lastly, I express my thanks to my scientists and all staff members of the institute who worked hard to meet the new challenges.

August, 2009
Port Blair

R.C. Srivastava
Director

कार्यकारी सारांश

प्राकृतिक संसाधन प्रबन्ध

- ऑनफार्म अवस्थाओं में ताजे जल पर आधारित कृषि प्रणाली में औसतन रू0 25600 की कुल प्राप्तियाँ सम्भव है जिसमें पशु तथा फसल घटक कमशः 92 % तथा 6 % योगदान करते हैं।
- काजुनाला जल ग्रहण क्षेत्र हेतु सम्भावित जल मांग तथा जल संसाधन विकास को ध्यान में रखते हुए जल संतुलन आंकलन किया गया।
- कूएं के मासिक भराव टेस्ट के आधार पर यह संस्तुति की जाती है कि जिन जगहों पर नाले का ढ़लान कम है वहाँ शुष्क मौसम के दौरान कूएं से प्रचुर मात्रा में तथा निरन्तर जल प्राप्त करने के लिए घाटी क्षेत्रों में पुनः भरण संरचनाएं–सह कूआँ प्रणाली का विकास किया जाना चाहिए।
- तालाबों की तलहटी से जल के क्षरण को रोकने के लिए सिल्पॉलीन तथा जिओ मैम्ब्रेन का लाइनिंग पदार्थ के रूप में प्रयोग उपयुक्त पाया गया।
- प्लास्टिक फिल्म तथा रिइन्फोर्स्ड प्लास्टर {1:6} को चारों ओर तथा तली में मिट्टी की 15 से.मी. मोटी पर्त बिछाकर तालाब की लाइनिंग करने की एक नई तकनीक का विकास किया गया जो लाइनिंग की आयु बढ़ाने में सक्षम होगी।
- वर्ष 2005–2009 के मध्य दक्षिणी अंडमान की चुनी हुई जगहों पर सूनामी पश्चात् मिट्टी तथा पानी के समय–समय पर एकत्रित किए गए आंकड़ों से यह ज्ञात हुआ कि चार वर्षाकालों के बाद घुलनशील लवणों की सान्द्रता में कमी आई। इसके परिणामस्वरूप अधिकतर स्थानों पर लवणता स्तर सूनामी पूर्व के स्तर तक पहुँच गया।
- उत्तरी, मध्य तथा दक्षिणी अंडमान द्वीपों के स्पाशियल मृदा उर्वरता मानचित्र तथा जल निकास प्रतिमान मानचित्र का विकास किया गया।
- मानसून के दौरान नारियल बगीचे में उगायी गई मूंगफली की बीज हेतु उपज, प्रकाश की उपलब्धता 50 % कम होने के कारण, खुले खेतों की उपज से कम प्राप्त हुई। यद्यपि यह उपज अभी भी मुख्य भूमि से रू0 111 प्रति कि.ग्रा. की दर से बीज आयात करने की अपेक्षा आर्थिक रूप से सस्ती थी। अतः नारियल बगीचे में छटाई किया के साथ मूंगफली बीज उत्पादन किया जा सकता है।
- दिसम्बर के अंतिम सप्ताह तथा जनवरी के प्रथम सप्ताह में खाने हेतु मूंगफली की SG 99 अथवा ICGS 76 किस्मों की मानवीय पंक्ति बुआई की संस्तुति की जाती है। बलुई तथा बलुई दोमट मिट्टी में धान–परती भूमि में रूपये 56000 प्रति हे0 की प्राप्ति सम्भव

है। इसके अतिरिक्त अधिक फली उपज, कुल प्राप्ति, बी.सी. अनुपात तथा जल उत्पादकता को ध्यान में रखते हुए, दो सिंचाईयों तथा बुआई के 45 दिन पश्चात् धान के पुआल से मल्चिंग की सलाह दी जाती है। दो से अधिक सिंचाई करने पर फली की उपज में कमी आई।

- विभिन्न मौसमों में क्यारी तथा नालिका पद्धति में विभिन्न फसल प्रणालियों के विश्लेषण से पता चलता है कि अधिक प्राप्ति हेतु क्यारियों में खीरा–मिर्च, चौलाई–पत्तागोभी–चौलाई–चौलाई, भिंडी–चौलाई–धनिया–भिंडी तथा नालियों में धान की लम्बी अवधि की किस्में – मूंगफली के साथ या तो मागुर या भारतीय मेजर कार्प उपलब्ध विकल्प हैं। किसान अपनी निवेश क्षमता तथा श्रम उपलब्धता के अनुसार कोई भी एक विकल्प चुन सकते हैं।
- पॉली हाऊस के अंदर तापमान नियंत्रण के लिए पॉली हाऊस क्षेत्रफल का 12 % से अधिक क्षेत्र वायु आवागमन हेतु छोड़ना चाहिए। पॉली हाऊस परिस्थितियों में शिमला मिर्च की अधिक उपज प्राप्त करने हेतु द्वीपों में 60 से.मी. X 60 से.मी. की स्पेसिंग की संस्तुति की जाती है। पॉली हाऊस में किये गए निवेश को ध्यान में रखते हुए अधिक मूल्य वाली फसलें जैसे फूलगोभी, शिमला मिर्च तथा लैटूस उगाने की संस्तुति की जाती है।

बागानी एवं वानिकी

- पॉली हाऊस परिस्थितियों में टमाटर की G - 600 अर्का विकास तथा चेरी–1, शिमला मिर्च की इंदरा, कैलीफोर्निया वंडर नामक प्रजातियों की अच्छी उपज प्राप्त की गयी।
- गाराचरमा प्रक्षेत्र स्थित ''जर्मप्लाज्म ब्लाक'' में कम उपयोग की जाने वाली सब्जियों की दस विभिन्न किस्मों के 35 एक्सेसन्स तथा कम उपयोग किए जाने वाले फलों की छः विभिन्न किस्मों का रख–रखाव किया गया।
- उत्तरी अंडमान में जनवरी के प्रथम सप्ताह में बोई गई आलू की किस्म TPS 92- PT-27 की अच्छी उपज प्राप्त की गई।
- AICRP(VC) के अन्तर्गत किये गये अनुसंधान से यह ज्ञात हुआ कि द्वीपों के लिए लोबिया की VRCP-6 तथा अर्का गरिमा, फ्रेंचबीन की DWD-FB-1, डोलीकस बीन की IIVR–Sem-8 तथा IIVR-Sem–11 बैंगन की PB-70 तथा BS-54 तथा टमाटर की अर्का विकास किस्में उपयुक्त हैं।
- AICRP(TC) के अन्तर्गत किये गए अनुसंधान से यह ज्ञात हुआ कि रतालु की DA-11 तथा CARI DA-1; कचालु की श्री पल्लवी तथा श्री किरण अच्छी किस्में हैं।

- अंडमान निकोबार द्वीप समूह के स्थानीय संकलन में से चुनी गई शकर कन्द की दो लाइनों जैसे CARI SP1 (CARI स्वर्णा) तथा CARI SP-2 (CARI अपर्णा) को प्रादेशिक किस्म रिलीज समिति के समक्ष प्रस्तुत किया गया।
- तीस दिन के अंतराल पर सूडोमोनास 0.2 % के साथ ट्राइकोडर्मा 2.5 कि.ग्रा./ हे. की दर से संयुक्त उपयोग करने पर फल प्रति वृक्ष, फलों का वजन, केविटि इंडेक्स, टी.एस.एस. तथा कुल शर्करा आदि में बेहतर प्रदर्शन प्राप्त किया गया।
- नारियल की चार बौनी लाइनों जैसे CARI–C-1 (CARI- अन्नपूर्णा), CARI–C-2 (सूर्या), CARI –C-3 (CARI–ओमकार) तथा CARI-C-4 (CARI- चंदन) को प्रादेशिक किस्म रिलीज समिति के समक्ष रिलीज हेतु प्रस्तुत किया गया।
- दक्षिणी अंडमान से प्राप्त स्थानीय सामग्री से अधिक उपज देने वाली सुपारी की किस्म (CARI-Sel-1) का चयन किया गया।
- पॉली हाऊस में झरबेरा (कल्टीवार–मनीजेल्स तथा सोनाटा) का प्रदर्शन अच्छा रहा।
- आम के उत्पादों के आर्गेनोलेप्टिक मूल्यांकन से ज्ञात हुआ कि मैंगो लेदर की अपेक्षा मैंगो टाफी की खुशबु, संरचना, स्वाद तथा सम्पूर्ण ग्राहयता उत्तम थी।
- तीस दिनों के अंतराल पर जिंदाबल्ली की पत्तियों तथा गाय के गोबर (4:1) की विघटन दर सर्वाधिक थी। इसके पश्चात् नारियल की पत्तियों, जिंदाबल्ली की पत्तियों + गाय का गोबर (4:1:1) का विघटन पाया गया तथा सबसे कम विघटन नारियल की पत्तियों + जिंदाबल्ली की पत्तियों (4:1) का पाया गया।
- नारियल आधारित सिल्वीपाश्चर पद्धति में मई में पत्तियों का प्रतिशत् सर्वाधिक पाया गया जो कि आगामी महीनों में कम होता चला गया तथा अप्रैल माह में सबसे कम पत्तियों का उत्पादन हुआ।
- पैरा घास की अपेक्षित उपज प्राप्त करने हेतु 40 कि0ग्रा0/हे0 की दर से नाइट्रोजन का उपयोग उपयुक्त पाया गया।
- प्राकृतिक वन परिस्थितियों में सिल्वीपाश्चर पद्धति के विकास हेतु चार देशी चारा वृक्षों की पहचान की गयी *(Greura glabra, Mussaenda macrophylla, Treama tomentosa* तथा *Euphorbia species)*
- ताजे तथा सूखे बायोमास का उत्पादन पैरा घास में क्रमशः 10.8 तथा 4.4 टन/हे0 पाया गया जो कि अधिकतम था। इसके पश्चात् गिनी घास से उत्पादन अच्छा पाया गया तथा नर्सरी स्तर पर देशी घासों से सबसे कम उत्पादन पाया गया।
- जिंदाबल्ली की पत्तियों के 8 टन/हे0 की दर से उपयोग करने पर भिंडी (CV. Arka Anamika) की सर्वाधिक उपज प्राप्त की गई।

- अंडमान निकोबार द्वीप समूह की छानबीन की गयी तथा मोरिन्डा जैवद्रव्य का संग्रहण किया गया। मोरिन्डा सिट्रिफोलिया तथा मोरिन्डा ट्राईमेरा के चौदह-चौदह एक्सेशंस, आई.सी. नम्बर हेतु एन.बी.पी.जी.आर., नई दिल्ली के समक्ष प्रस्तुत किये गये।
- आर.ए.पी.डी. तथा आई.एस.एस.आर. मार्कर द्वारा किये गये विविधता आंकलन द्वारा ज्ञात हुआ कि मोरिन्डा सिट्रिफोलिया तथा मोरिन्डा ट्राईमेरा में क्रमशः 55 % तथा 61 % तक आनुवंशिक विविधता विद्यमान है।

क्षेत्रीय फसलें

- खाड़ी द्वीपों के लिए उपयुक्त निचले क्षेत्रों की मध्यम अवधि (110-120 दिन) की धान की पांच किस्में जैसे *CARI Dhan-1, CARI Dhan-2 CARI Dhan-3, CARI Dhan-4 तथा CARI Dhan-5* जिनकी औसत उपज 5.2-5.4 टन/हे0 है, रिलीज हेतु तैयार हैं।
- विभिन्न फसलों के 309 एक्सेशंस (धान-334, मूग-16, उडद-7, तिल-29 चना-1 तथा लोबिया-3) मूल्यांकन तथा सुधार के उद्देश्य से विभिन्न स्थानों से एकत्रित किये गये या खरीदे गये।
- IRRI से प्राप्त निचले क्षेत्रों हेतु उपयुक्त धान की अगेती किस्मों के 121 कल्टीवार का मूल्यांकन किया गया। जिनमें से कारजात-3 (6.88 टन/हे0) तथा IR – 69716-87-1-3-1-3 (5.9 टन/हे0) सर्वाधिक उपयुक्त पाए गए।
- IRRI से प्राप्त निचले क्षेत्रों हेतु उपयुक्त अगेती सिंचित धान के 45 कल्टीवार का मूल्यांकन किया गया। जिनमें से IR-79233-1-2-1-2 तथा IRYN 1068-7-1, जिनकी उपज क्रमशः 5. 68 टन/हे0 तथा 5.47 टन/हे0 थी, को सर्वाधिक आशाजनक पाया गया।
- उन्नत धान की 28 लाइनों का गुणवत्ता निर्धारण हेतु विश्लेषण किया गया। UPR-1201-1-201 में अधिकतम हलिंग प्रतिशत् 82.06 % तथा काराजात-3 में 81.83 % पाया गया। इन लाइनों का दाना लम्बा तथा बेलनाकार थ तथा पकाने पर दाने के आकार में 0.33 से 1.33 प्रतिशत् की वृद्धि हुई।
- मूंग की 10 आशाजनक किस्मों का उपज हेतु मूल्यांकन किया गया। जिनमें से IPM-062, पूना-9072, MH-124 तथा पूसा-0771 नामक किस्में सर्वाधिक आशाजनक पाई गई तथा इनकी उपज 0.29 से 0.18 टन/हे0 के मध्य थी।
- चने की चार उन्नत किस्मों का मूल्यांकन किया गया। जिनमे से CBG-647 तथा TU 17-14 सर्वाधिक आशाजनक पाई गई। इनकी औसत उपज क्रमशः 0.81 तथा 0.77 कु0/हे0 दर्ज की गई।

- रबी के मौसम में तिल की 26 किस्मों का मूल्यांकन किया गया जिनमें PBS 9, PBS 18, PBS 17 तथा PBS 19 सर्वाधिक आशाजनक पाई गई तथा इनकी उपज क्षमता 1.09 से 1.41 टन/हे0 के मध्य थी।
- टमाटर की बीमारियों के बेहतर प्रबन्धन के लिए जैव नियन्त्रक कारक के साथ कम सान्द्रता में रासायनिक फफूंदी नाशक तथा नीम की खली के सम्मिश्रण को प्रभावी पाया गया।
- काली मिर्च के कीटों तथा व्याधियों के सर्वेक्षण के दौरान पाया गया कि बीमारियों में पौधगलन *(Phytophthora capsici)* तथा कीटों में पोलू बीटल *(Longitarsus nigripennis)* प्रमुख हैं।
- काली मिर्च उगाई गई मिट्टी से विलगित किए गए ट्राइकोडर्मा, *P. capsici* तथा *C. capsici* की कवक जाल वृद्धि को रोकने में बहुत प्रभावी हैं।
- सह सम्बन्ध विश्लेषण से पता चला कि टमाटर के मुरझाने का रोग, टमाटर की पत्तियों के मुड़ने का रोग तथा मिर्च के मुरझाने के रोग तथा मौसम मानकों (अधिकतम सापेक्षिक आर्द्रता, वर्षा दिनों की संख्या तथा वर्षा) के बीच महामारी के विकास हेतु परस्पर धनात्मक प्रभाव होता है।
- *Pleurotus florida* के लिए मूल्यांकन किये गए सब्सट्रेटों में धान के पुआल की जैविक क्षमता सर्वाधिक (77.35 %) थी। इसके पश्चात् सुपारी की फलभित्ति की 57% तथा नारियल पत्ती की जैविक क्षमता 51.25 % पाई गई। जबकि *Calocybe indica* हेतु धान के पुआल को सब्सट्रेट की तरह प्रयोग करने पर जैविक क्षमता 33 % थी।
- कुल 128 जीवाणु विलगनों का अध्ययन *Sclerotium rolfsii, Colletotrichum gloeosporioides* तथा *C. capsici* के विरूद्ध प्रतिद्वन्द्वी गतिविधि तथा पादप वृद्धि प्रोत्साहित करने वाले गुणों जैसे इंडोल एसिटिक एसिड उत्पादन, फास्फेट घुलन तथा साइडेरोफोर जानने हेतु किया गया। जिनमें से 40 की पहचान बैसीलस जाति तथा 15 सूडोमोनास के रूप में की गई।
- प्रतिद्वन्द्वी जीवाणु विलगन *BB 14, BL 5* तथा *BS1, S. rolfsii* तथा *C. capsici* को रोकते है तथा *BB 6, BR 4, BR 5, BR 6, BR 7, BR 9, BL 6* तथा *BG 6, C. capsici* की 50 % कवक जाल वृद्धि को रोकते हैं। *PfR 13* में फास्फेट तथा साइडोफोर उत्पादन की विशेषता अधिक है। *PSN 1* तथा *PfB 16* में फास्फेट घुलन की तीव्र विशेषता है तथा *BR 7, BL 5, BL 6* तथा *BS 1* में साइडोफोर उत्पादन की विशेषता है। विलगन *PfC3* तथा *BSN3* से 50 µg/ml से अधिक IAA का उत्पादन हुआ जबकि *BSD 1, BC 6, BN 16, BN 17, BSN 1,BM 18, BSP 2* द्वारा 31 – 49 µg/ml IAA उत्पादन किया गया।

- ट्राइकोडर्मा के 21 विलगनों का विशिष्ट विश्लेषण किया गया। जिनमें से 17 की पहचान जाति स्तर पर की गई जैसे पांच *T. hamanum*, दो T. *longibrachiatum*, चार *T. koningii*, दो *T. harzianum* , दो *T. viride*, एक *T. strictiple* तथा एक *T. ablongiosporum*.
- *S. rolfsii, C. gloeosporioides* तथा *C. capsici* के विरूद्ध ट्राइकोडर्मा की 14 जातियों को प्रतिद्वन्द्विता अन्तःशक्ति जानने हेतु परखा गया तथा यह पाया गया कि *TSD 1* विलगन सभी रोगकारको की वृद्धि को रोक देता है। तथा *TGD 1, TND 1, TGN 1, TWN 1, TMP 1, TWC 2* तथा *TJP 1* दो रोगकारकों को विशेष रूप से प्रभावित करते हैं।
- *Colletotrichum Spp* की पांच जातियों के *PCR-ITS amplican* की सीक्वेन्शिंग की गई तथा काली मिर्च में एन्थ्रकनोस बीमारी पैदा करने वाली *Colletotrichum* की एक जाति की खोज की गई जिसका पहले कहीं उल्लेख नहीं किया गया है। इसके जीन सीक्वेन्श को NCBI के सम्मुख जमा किया गया तथा इसके कल्चर को NBAIM, मऊ में जमा किया गया ।
- *Syzygium aromaticum* की पत्तियों के पानी में बनाए गए सत्व ने *Spodoptera litura* की वृद्धि तथा विकास को प्रभावित किया तथा दर आधारित ढंग से लार्वा-प्यूवा जीविता तथा व्यस्क में बदलने की प्रकिया को भी प्रभावित किया। यह स्पष्ट देखा जा सका कि *Syzygium aromaticum* के सत्व के कारण उनका भोजन जहरीला हो गया, प्रारम्भिक अवस्था में ही 90 % लार्वा मर गये जिसके कारण व्यस्क कम विकसित हुए जो कि वास्तव में फसल हानि के लिए उत्तरदायी होते थे।
- *Annona* की चार विभिन्न जातियों में आनुवंशिक भिन्नता देखने के लिए ISSR तथा RAPD मार्कर का प्रयोग किया गया। कल्स्टर विश्लेषण द्वारा चार जातियों को तीन कल्स्टर में इकठ्ठा किया गया जिनमें 51 % तक समानता थी। यद्यपि *Annona squamosa* का एक नमूना *Annona muricata* के एक नमूने से बहुत अधिक समानता रखता था। इस जाति का संरक्षण करके फलवृक्षों के भविष्य के प्रजनन कार्यकम में उपयोग किया जा सकता है।

पशु विज्ञान

- बत्तखों के विभिन्न संकरों के मूल्यांकन से ज्ञात हुआ कि पेकिन तथा चारा चेम्बेली संकर का प्रदर्शन वृद्धि मानकों, दाना उपयोग, जीविता, परफार्मेंस इन्डैक्स तथा उत्पादन नम्बर के रूप में बेहतर रहा। इस संकर को घर आंगन में मांस उत्पादन हेतु पाला जा सकता है।
- लार्ज व्हाइट यार्कशायर के उत्पादन प्रदर्शन से ज्ञात हुआ कि आठ सप्ताह की अपेक्षा छः सप्ताह पर सुअर के बच्चों का दूध छुडा देने पर मां की उत्पादकता में वृद्धि हुई।
- मारिन्डा सिट्रिफोलिया के बीज के सत्व की जीवाणुरोधी किया शत प्रतिशत रही जबकि पत्तियों के सत्व में यह 92 % तथा फलों के सत्व में 37.33 % थी। विभिन्न जीवाणु इन्फेक्शंस में 2.0 mg/L MIC मान का उपयोग किया जा सकता है। मोरिन्डा सिट्रिफोलिया के बीजों,

फलों तथा पत्तियों से फफूंदी नाशक पदार्थ निष्कर्षण हेतु मेथेनाल तथा एसीटोन को सबसे अच्छा वियालक पाया गया। फफूंदीनाशक पदार्थ की न्यूनतम प्रतिद्वन्द्वी प्रकिया से ज्ञात हुआ कि 3mg/ ml MIC मान वाले पत्तियों के सत्व द्वारा सबसे अच्छी किया प्राप्त हुई । तत्पश्चात बीज सत्व (3.5mg/ml) तथा फल सत्व (3.75mg/ml) का प्रदर्शन रहा।

- मोरिन्डा सिट्रिफोलिया के फलों के सत्व को 5% की दर से जापानी बटेरों के पीने के पानी में मिलाने पर देह भार वृद्धि तथा अंडा उत्पादन पर अच्छा प्रभाव पड़ा।
- तीस दिनों तक 50 ग्रा0 कैल्शियम प्रति गाय की दर से प्रतिपूर्ति करने पर दैनिक दुग्ध उत्पादन में सार्थक वृद्धि देखी गई।
- स्वस्थ तथा थनैला रोग ग्रस्त दुधारू गायों के थनों के अल्ट्रा सोनोग्राफिक अध्ययन से पता चला कि इसे स्वस्थ तथा बीमार गायों के थनों में रोग के कारण हुये परिवर्तनों के अध्ययन हेतु एक औजार के रूप में प्रयोग किया जा सकता है।
- अंडमानी स्थानीय बकरी तथा बोअर बकरी के संकर की उत्पादन तथा पुनर्उत्पादन क्षमता से ज्ञात हुआ कि बोअर संकर के नर तथा मादा बच्चों का जन्म भार अंडमान स्थानीय बकरी के अपेक्षा सार्थक रूप से ($P<0.01$) अधिक था।
- अंडमानी स्थानीय बकरी तथा टेरेसा बकरी के माइक्रोसेटेलाइट विश्लेषण से ज्ञात हुआ कि स्थानीय अंडमान बकरी के DNA नमूनों में छः एलील पाए गए। जिनमें BB एलील होमोजाइगस था तथा अन्य हिटरोजाइगस थे। जबकि टेरेसा बकरी के DNA नमूनों में चौदह एलील पाए गए।
- वृद्धिशील बत्तखों को प्रतिदिन 50 - 100 ग्रा0 अजोला खिलाने पर 12.5 % दाने की बचत हुई। तथा एक बत्तख को दस सप्ताह तक पालने पर दाना लागत में रूपये 20 की बचत हुई।
- अंडा देने वाली बत्तखों को 50 ग्रा 0 प्रतिदि की दर से अजोला खिलाने पर दाने में 16.6 % की बचत हुई तथा दाना लागत रूपये 5.85 प्रति पक्षी प्रति दिन कम हो गई।
- अंडमान द्वीप के विभिन्न भागों में किए गए सर्वेक्षण के अनुसार गाय तथा भैसों में पोषक तत्वों की भारी कमी परिलक्षित हुई क्योंकि दाने तथा हरे चारे की उपलब्धता कमशः मात्र 3461 MT तथा 600 MT प्रति वर्ष थी जबकि इनकी आवश्यकता कमशः 21546 तथा 218912 MT प्रति वर्ष आंकी गई।

मात्स्यिकी

- जल गुणवत्ता मानकों के सामयिक अध्ययन से पता चला कि अंडमान जल की प्रारम्भिक उत्पादकता में जून 2008 से फरवरी 2009 के मध्य में लगातार वृद्धि हुई है। औसत सफल तथा कुल उत्पादकता कमशः 298.33 तथा 115.27 mg C/m^3 /ha पाई गई।

- दक्षिणी अंडमान के विभिन्न स्थानों से पकड़ी गई ग्रूपर तथा स्नैपर मछलियों के अध्ययन से ज्ञात हुआ कि वंडूर तथा गुप्तापारा में ग्रूपर मछलियाँ अधिक है। ग्रूपर में मुख्यतः *Epinephelus malabaricus* तथा स्नैपर में मुख्यतः *Lutijanus gibbus* प्रजाति पाई गई।
- अंडमान के संरक्षित जल में व्यवसायिक रूप से महत्तपूर्ण मछलियों की पिंजडा खेती का शुभारम्भ किया गया। पिंजड़े में रखी गयी 26.98 से0मी0 आकार तथा 32.18 ग्रा0 भार वाली ग्रूपर मछलियों के औसतभार में तीस दिनों में 6 % की वृद्धि हुई। पिंजडा खेती जारी है तथा पिंजड़ों के रखरखाव तथा मछलियों के भोजन से सम्बन्धित आंकड़ों का संग्रहण किया जा रहा है।
- प्रजनक मछलियों हेतु रोटीफर एक महत्तवपूर्ण मछली खाद्य जीव है। अंडमान जल से *Brachionus Plicatilis, B. rotondiformis, B. Urceolaris B. murrayi, B. Calyciflorus , B. falcatus* तथा *Kellicotia spp.* को विलगित किया गया तथा इनकी पहचान की गई।
- *Trochus spp* नामक लट्टु शंख के पाये जाने की जगहों के अन्वेषी सर्वेक्षण से पता चला कि इसके प्राकृतिक आवास के रूप में मृत मूंगा चट्टाने तथा शैवाल (23.57 %), मृत मूंगा चट्टानें (19.3 %½] जीवित मूंगा (19.5 %), चट्टानें तथा छोटे पत्थरों का समूह (14.28 %), बालु (12.93 %), मुलायम मूंगा (4.01 %) आदि हैं।
- नार्थ बे, दक्षिणी अंडमान से संग्रहित की गई समुद्री स्पंज की दो जतियों *Stylissa sp.* तथा *Iricinia sp* का अध्ययन चुनिंदा रोगजनक जीवाणुओं के विरूद्ध जीवाणु नाशक गुणों को जानने के लिए किया गया। *Stylissa Sp.* से सम्बन्धित 70 % विलगनों से एंटीबायोटिक का उत्पादन हुआ तथा इनमें से एक 120% *Klebsiella pneumona* के विरूद्ध इरिथ्रोमाइसीन जितना प्रभावी पाया गया।
- द्वीप समूह में मागुर मछली के बीज की मांग को पूरा करने के लिए के0कृ0अनु0सं0 में एक स्फुटन शाला का निर्माण किया गया।
- संरक्षित रूप में मागुर का सफलतापूर्वक प्रजनन किया गया तथा किसानों को 1,200 बीजों का वितरण किया गया।

सामाजिक विज्ञान

- सूनामी प्रभावित अंडमान में कृषि, पशुपालन तथा मात्स्यिकी पर किये गये सामाजिक आर्थिक प्रभाव मूल्यांकन से ज्ञात हुआ कि खेती कार्यों में अधिकतर बूढे लोग लगे हुए हैं। सूनामी पश्चात् किसानों की आय में खेती से प्राप्त आय की हिस्सेदारी कम हुई है तथा पशु पालन तथा मात्स्यिकी से प्राप्त आय की हिस्सेदारी बढ़ी है। सूनामी उपरान्त सब्जियों तथा धान की खेती में कीटों के प्रकोप में वृद्धि हुई है।

- द्वीपों में फलों की खेती की बहुत क्षमता है मगर इनकी खेती में अधिक वर्षा, उत्तम गुणवत्ता वाले बीजों का अभाव तथा मानव श्रम की अनुपलब्धता मुख्य अवरोध हैं। इसके अतिरिक्त मूल्यों का उतार-उढ़ाव, शीत गृहों तथा विपणन सुविधाओं का अभाव अन्य अवरोधक हैं।
- दुग्ध उत्पादन को प्रभावित करने वाले कारक जैसे हरा चारा, दाना तथा मानव श्रम, दुग्ध उत्पादन से धनात्मक सम्बन्ध रखते हैं। अतः अधिक दुग्ध उत्पादन हेतु पशुओं को नियमित रूप से पोषण उपलब्ध कराया जाना चाहिए। विपणन हेतु दुग्ध की उपलब्धता दुग्ध उत्पादन, जोत क्षेत्र तथा मूल्य धनात्मक रूप से सम्बद्ध है। वैज्ञानिक दुग्ध उत्पादन पद्धतियों को के0कृ0अनु0सं0, पोर्ट ब्लेयर तथा सम्बद्ध विभागों द्वारा अधिक से अधिक प्रशिक्षण तथा विस्तार प्रकियाओं द्वारा किसानों तक पहुँचाई जानी चाहिए। दुग्ध उत्पादक सहकारी समितियों को मजबूत करने के लिए एक सुदृढ़ धरातल प्रदान किया जाना चाहिए।
- अंडमान निकोबार द्वीप समूह के पशु आनुवंशिक स्रोतों पर आंकड़ों का संग्रह किया गया तथा इसे *AGRANI* नाम दिया गया।
- मध्य तथा उत्तरी अंडमान के धान के आंकड़ों का संग्रहण पूरा कर लिया गया है। दस्तावेजों से क्षेत्रवार मौसम आंकड़ों का संग्रहण किया गया। इनको दर्ज करने तथा परखने का कार्य प्रगति पर है।
- अंडमान निकोबार द्वीप समूह के चारा स्रोतों के आंकड़े एकत्रित करने के लिए टेम्पलेट का निर्माण कर लिया गया है।
- स्वयं सहायता समूहों का साख सम्बन्ध मात्र 28.20 % है जो कि इन द्वीपों में स्थित 15 बैंकों में से मात्र 7 बैंकों के साथ है।
- प्रतिभागियों में प्रशिक्षण आवश्यकता हेतु बकरी पालन की पहले स्थान पर रखा। तत्पश्चात सब्जियों की खेती, फूलों की खेती, मुर्गीपालन, सूअरपालन, दस्तकारी तथा अंत में मशरूम उत्पादन को रखा।

कृषि विज्ञान केन्द्र

- विभिन्न प्रशिक्षण कार्यक्रमों के दौरान यह देखा गया कि क्षमता निर्माण सम्बन्धी कार्यक्रम बहुत ही आवश्यक हैं। इन सभी कार्यक्रमों में किसानों ने बड़े उत्साह से भाग लिया।
- क्षेत्रीय प्रदर्शनी से कृषक समुदाय को अधिक उत्पादन हेतु नई प्रोद्यौगिकियों को अपनाने के लिए उत्साह वर्धन हुआ है ।
- ऑन फार्म ट्रायलों से प्रोद्यौगिकीय परियार्जन तथा सुधार में बहुत सहायता मिली है।

EXECUTIVE SUMMARY

NATURAL RESOURCE MANAGEMENT

- On an average, net return of Rs 25600 can be obtained from fresh water based farming system in which animal and crop component contributed 92% and 6%, respectively under on-farm condition. Similarly, in brackish water based system, animal component contributed 97% towards the net returns.
- Water balance analysis in terms of water resource potential, realizable potential water requirement and water resource development was estimated for Kaju Nallah watershed.
- Based on monthly well recuperation test, it is recommended that the recharge structure-cum-well system should be developed in valley areas, where longitudinal slope of nallah is less, to get significantly enhanced and consistent well yield during the dry season.
- Silpaulin and geo-membrane are found as suitable lining materials for effectively controlling the seepage losses from the farm pond. However, lining material should be covered with suitable material for protection from higher daily insolation in A&N islands located close to equator for increased life.
- A new technique for lining of the tank with plastic film and reinforced plaster (1:6) on sides and 15 cm thick soil layer at bottom for higher life period has been evolved.
- Post-tsunami periodical soil and water sampling in selected locations of South Andaman during 2005-2009 revealed that the markedly increased soluble salt concentration was offset by rainfall in the four rainy seasons. This has resulted reduction in the salinity levels at most of the sites to almost close to the pre-tsunami levels.
- Spatial soil fertility map and drainage pattern maps for North, Middle and South Andaman Islands have been developed.
- Fifty per cent lower light availability in coconut plantation compare to open field led to lower yield of table purpose groundnut for seed purpose during monsoon season. However, it was found still economical compared to high seed cost @ Rs 111/kg when imported from mainland. Therefore, seed production can be tried in coconut plantations with pruning practices.
- Sowing of SG 99 or ICGS 76 of varieties of table purpose groundnut is recommended by manual line sowing during last week of December to first week of January. Net return of Rs. 56000/ha can be obtained in rice fallow lands having sandy or sandy loam soils. Further, two irrigations at life and pegging with paddy straw mulch on 45 DAS can be advocated for realizing higher pod yield, net returns, B:C ratio and water productivity. More than two irrigations leads to reduced pod yield.

- Analysis of the different cropping systems for beds and furrows in various seasons suggests that cucumber-chilli, amaranthus-cabbage-amaranthus-amaranthus, okra-amaranthus-coriander-okra are the options available for beds and long duration variety of paddy-groundnut combined with either cat fish or Indian Major Carps in furrows for realizing higher returns. Farmers can choose any one of the option for BBF based on their investment capability and labour availability.
- Ventilation area of more than 12% of polyhouse area is to be kept for maintaining the temperature inside the poly house. Spacing of 60 X 60 cm can be recommended for capsicum under polyhouse conditions in bay islands to realize higher yield. High value crops such as cauliflower, capsicum and lettuce can be recommended for higher yield and returns from the investment made for polyhouse.

Horticulture & Forestry

- G 600, Arka Vikash and Cherry-1 cultivars of tomato and Indra, California Wonder cultivars of capsicum performed well under polyhouse conditions.
- The 'Germplasm Blocks' of underutilized vegetables with 35 accessions of ten different vegetables and underutilized fruits with six species were developed and maintained at Garacharma Farm.
- The potato cv. TPS 92-PT-27 planted in first week of January performed well under North Andaman condition.
- Under AICRP (VC) trials, VRCP-6 and Arka Garima of cowpea, DWD-FB-1 of French bean, IIVR Sem-8 and IIVR Sem-11 of Dolichos bean, PB-70 and BS-54 of brinjal and Arka Vikash of tomato were found promising in Island conditions.
- Under AICRP (TC), DA-11 and CARI- DA-1of greater yam, Sree Pallavi and Sree Kiran of taro were found promising in Island conditions.
- Two sweet potato lines *viz*. CARI-SP1 (CARI-Swarna) and CARI-SP-2 (CARI- Aparna), selections from local collections from A&N Islands, submitted to State Variety Release Committee.
- Combined application of *Pseudomonas* 0.2% + *Trichoderma* 2.5kg/ha at 30 days interval performed well in terms of number of fruits/tree, fruit weight, cavity index, TSS and total sugars.
- Four dwarf lines *viz*., CARI-C-1(CARI-Annapurna), CARI-C-2 (CARI-Surya), CARI-C-3 (CARI-Omkar) and CARI-C-4 (CARI-Chandan) were submitted to State Variety Release Committee for release.
- A high yielding Arecanut selection (CARI-Sel-1) was made from the local materials from South Andaman.
- Gerbera cv. Manizales and Sonata performed well under polyhouse conditions.

- The organoleptic evaluation of mango products showed that mango toffee had excellent flavour, texture, taste and overall acceptability than mango leather.
- At 30 days interval Gliricidia leaves + Cowdung (4:1) recorded highest decomposition rate followed by Coconut leaves + Gliricidia leaves+Cowdung (4:1:1) while least with Coconut leaves + Gliricidia leaves(4:1).
- Under coconut based silvipasture system, percent cover of leaves was highest in May which declined in succeeding months and least production in month of April.
- Application of 40kgN/ha for para grasses was found optimum for desirable yield of para grass.
- Four indigenous fodder trees (*Grewia glabra, Mussaenda macrophylla, Treama tomentosa and Euphorbia* spp.) were identified for development of sivipasture system under natural forest condition.
- Fresh and dry biomass production was highest in Para grass (10.8 and 4.4t/ha, respectively) followed by guinea grass while least from indigenous grsses at nursery level.
- Application of 8 t of *Gliricidia* leaves /ha produced highest yield okra cv. Arka Anamika.
- Islands were explored and germplasm of Morinda was collected from A & N Islands. Fourteen accessions from each *Morinda citrifolia* and *Morinda trimera* has been submitted for getting IC No. at NBPGR, New Delhi.
- Diversity analysis through RAPD and ISSR markers showed existence of 55 % and 61 % genetic diversity, respectively in *Morinda citri-folia* and M. *trimera*.

Field Crops

- Five medium duration (110-120 days) lowland rice varieties viz. CARI Dhan-1, CARI Dhan-2, CARI Dhan-3, CARI Dhan-4 and CARI Dhan-5 are ready for release with average yield of 5.2-5.4 t/ha in Bay Island conditions. Moreover, varieties CARI Dhan-4 and CARI Dhan-5 are also suitable for saline soil with yield of 3.0-3.5 t/ha.
- Three hundred and nine accession of various crops (rice 334, green gram 16, black gram 7, sesame 29, red gram 1 and cowpea 3 were collected/ procured for evaluation and improvement.
- One hundred twenty one rainfed lowland early rice cultivars from IRRI were evaluated. Karjat-3 (6.88 t/ha) and IR-69716-87-1-3-1-3 (5.94 t/ha) were found most promising.
- Forty five irrigated lowland early rice cultivars of IRRI were evaluated. Cultivars IR-79233-1-2-1-2 and IRYN1068-7-1 were found to be promising with yield potentiality of 5.68 t/ha and 5.47 t/ha, respectively.
- Twenty improved eight lines of rice were analysed for quality characters. High hulling percent was recorded for UPR 1201-1-201 (82.06%) and Karajat-3 (81.83%). These lines were also had long and cylindrical grains with cooked rice grain elongation between 0.33 to 1.33%.

- Ten promising varieties of green gram were evaluated for yield. Varieties IPM-062, Puna-9072, MH-124 and Pusa-0771were found most promising with yield range of 0.29 to 0.18 t/ha.
- Four improved varieties of black gram were evaluated. Variety CBG-647 and TU 17-14 were found most promising with average yield of 0.81 and 0.77 q/ha, respectively.
- Twenty six sesame varieties were evaluated in *Rabi* season and variety PBS 9, PBS 18, PBS 17 and PBS 19 were found promising with yield potential of 1.41 to 1.09 t/ha.
- The combination of biocontrol agents + chemical fungicides at relatively lower concentration + neem cake was very effective in management of disease complex of tomato.
- Survey of pest and diseases of black pepper revealed that foot rot (*Phytophthora. capsici*) and pollu beetle (*Longitarsus nigripennis*) were most important disease and pest, respectively.
- All isolates of *Trichoderma* spp. from rhizosphere soil of black pepper were very effective in suppression of mycelial growth of *P. capsici* and *C. capsici*.
- Correlation analysis studies showed that incidence of tomato wilt, tomato leaf curl and chilli wilt with weather parameters (maximum RH, rainy days and rain fall) had positive effect on development of epidemics.
- Among substrates evaluated for *Pleurotus florida*, paddy straw had highest biological efficiency (77.35 %) followed by arecanut pericarp (57.00%), coconut leaf (51.25%) whereas 33.0 % biological efficiency was obtained when *Calocybe indica* on paddy straw as substrate.
- A total 128 bacterial isolates were studied for their antagonistic activity against *Sclerotium rolfsii, Colletotrichum gloeosporioides* and *C. capsici* and plant growth promoting properties viz., IAA production, phosphate solubilization and siderophore production. Out of which 40 were identified as *Bacillus* spp and 15 as *Pseudomonas* spp.
- The antagonistic bacterial isolates BB14, BL5 and BS1 inhibit both *S. rolfsii* and *C. capsici*. Isolates BB6, BR4, BR5, BR6, BR7, BR9, BL6, and BG6 inhibited more than 50% mycelial growth of *C. capsici*. PfR13 had strong phosphate and siderophore production property. PSN1 and PfB16 and BR7, BL5, BL6 and BS1 have strong phosphate solubilization and siderophore production property respectively. Isolates PfC3 and BSN3 produced more than 50 µg/ml IAA and isolates BSD1, BC6, BM16, BM17, BSN1, BM18, BSP2 showed 31-49 µg/ml IAA production.
- Twenty one isolates of *Trichoderma* were characterized. Out of that 17 were identified at species level, namely 5 *T. hamatum*, 2 *T. longibrachiatum,* 4 *T. koningii*, 2 *T. harzianum*, 2 *T. viride*, 1 each of *T. strictiple* and *T. oblongiosporum.*
- Antagonistic potential of 14 *Trichoderma* spp were screened against *S. rolfsii, C. gloeosporioides* and *C. capsici* and found that isolate TSD1 inhibit all the pathogens tested and TGD1, TND1, TGN1, TWN1, TMP1, TWC2 and TJP1 inhibit two pathogens significantly.

- The PCR- ITS amplicon of 5 *Colletotrichum* spp were sequenced and in that 1 unreported species of *Colletotrichum* causing anthracnose on black pepper was identified. The gene sequences were submitted in NCBI and cultures were deposited to NBAIM, Mau.
- Aqueous leaf extract of *Syzygium aromaticum* inhibited the growth and development of *Spodoptera litura* and affected the larval-pupal survival and adult emergence in a dose-dependent manner. It is clearly indicated that due to *Syzygium aromaticum* extracts intoxicated food, 90 per cent larvae died at early instars, hence the larval population could not reach the crucial late instar stage, which is actually responsible for crop damage.
- ISSR and RAPD markers were used to assess the genetic diversity across the four different species of *Annona*. Cluster analysis have grouped four species into three clusters, showing overall 51% si milarity. However, one sample of *Annona squamosa* showed very high similarity with *Annona muricata*. This species should be conserved and can be used in future breeding program of this fruit tree.

Animal Science

- Evaluation of different crosses of ducks revealed that the cross of Pekin X Chara chembali performed better in terms of growth performance, feed utilization, survivability, performance index and production number. The cross may be reared for meat purpose under backyard system of rearing.
- The productive performance of the large white Yorkshire revealed that weaning of piglets at six weeks of age increases the productivity of sows compared to eight weeks of weaning. Feeding of vegetable waste and poultry offal enhanced the growth performance compared to the home made concentrate along with kitchen waste and raw coconut.
- The antibacterial activity of *Morinda citrifolia* seed extract produced absolute inhibitory activity (100%) followed by leaf extract (92%), and fruit extract (37.33%). The MIC value of 2.0 mg/l may be used against different bacterial infection. The methanol and acetone are the best solvents used for extraction of the antifungal compounds from the *M.citirfolia* seed, fruit and leaf. The minimum inhibitory activity of the antifungal compounds revealed that the best activity was produced by leaf extract with MIC value of 3.0 mg/ml compared to seed extract with 3.5 mg/ml and fruit extract with 3.75 mg/ml.
- Feeding of *M.citrifolia* crude fruit extract @ 5% in drinking water to Japanese quail enhanced the body weight gain and egg production performance.
- Supplementation of Ca @ 50 gm per cow per day for 30 days significantly increased the daily milk yield than unsupplemented (control) cows.
- The Ultrasonograhpy study of healthy and mastitis affected udder of dairy cows showed that it may be used as a tool to study the pathophysiological changes of udder in relation to health and diseases.
- The productive and reproductive performance of the Andaman local goat and Boer cross

revealed that the birth weight of both male and female kids of Boer cross was significantly (P<0.01) higher than Andaman local goat.

- The microsatellite analysis of the Andman Local goat and Teresa goat revealed that six alleles were observed in DNA samples of Local Andaman goat and BB allele found to be homozygous and others were heterozygous whereas in Teresa DNA samples fourteen alleles were observed.
- Azolla supplementation to the grower duck at the rate of 50-100 gms per day saved 12.5% feed per duck and the feed cost of Rs.20 per duck up to the age of 10 weeks.
- Azolla supplementation (50 g per day per layer) to the layer duck could replace 16.6% concentrated feed with savings in feed cost of Rs. 5.85 per bird per day.
- Survey in different parts of the Andaman Islands revealed that there is severe deficiency of nutrients available to cattle and buffalo as the availability of concentrate and green fodder is only 3461 MT and 600 MT annually against the requirement of 21546 and 218912 MT respectively.

Fisheries Science

- Studies on the temporal variation in water quality parameters indicated that the primary productivity of Andaman waters progressively increased from June 2008 to Feb 2009. The average gross and net primary productivity were found to be 298.33 and 115.27 mg C/ m^3/ha respectively.
- A survey on the wild catch of groupers and snappers in various landing centres in South Andaman indicated that grouper landings are significant in Wandoor and Guptapara. Among groupers, *Epinephelus malabaricus* and among snappers, *Lutijanus gibbus* were the predominant species.
- Cage culture of commercially important fishes in protected waters in Andaman has been initiated. The grouper stocked at the size of 162 26.98 cm and weight 62.11 32.18gm recorded an increase in average weight of 6% in 30 days. The culture is in progress and observations are being recorded with respect to the issues related to maintenance of cage and feeding of fishes in cages.
- Rotifer is an important fish food organism for development of brood stock. From the Andaman waters, *Brachionus plicatilis, B.rotundiformis, B. urceolaris, B. murrayi, B. calyciflorus, B. falcatus* and *Kellicotia* sp. were isolated and identified.
- An exploratory survey on the habitat of top shell, *Trochus* sp indicated that its normal habitat consists of dead corals and algae (23.57%), dead corals (19.3%), live corals (19.5%), rock and rubbles (14.28%), sand (12.93%), soft corals (4.01%) and other components.
- Two marine sponges *Stylissa* sp and *Iricinia* sp collected from North Bay, South Andaman were studied for their antimicrobial properties against selected pathogenic bacteria. About

70% of the isolates associated with *Stylissa* sp were found to produce antibiotics and one of them was about 120% as effective as erythromycin against *Klebsiella pneumonia.*

- In order to cater to the needs of catfish seeds in the Islands, a magur hatchery has been developed at CARI. Magur was successfully bred in captivity and about 1,200 seeds were distributed to the farmers

Social Science

- Socio-economic impact assessment on Agriculture, Animal Husbandry & Aquaculture in the Tsunami-hit Andaman revealed that mostly older generation was engaged in agriculture. There was a drastic reduction in share of income from agriculture for the farmers and the share from animal husbandry and aquaculture has increased after tsunami. After tsunami vegetable and paddy cultivation has also suffered high pest incidence.
- Floriculture has huge potential in islands but the major constraints faced are high rains, lack of good quality seed material and manpower at cultivation level. Post cultivation constraints are price fluctuation and lack of cold storage and marketing facilities.
- The factor affecting the milk production viz. green fodder, concentrate and labour had positive correlation hence they should be fed regularly to the animals for higher production. Milk yield, land holding and price positively influencing the marketed surplus. More trainings and extension activities should be undertaken by line departments and CARI, Port Blair to disseminate the techniques of scientific dairy farming practices. Organized dairy cooperative should be strengthened with infrastructure.
- Data base developed for Animal Genetic Resources of Andaman & Nicobar Islands and it is named as AGRANI.
- Rice data collection for Middle and North Andaman has been completed. Region wise weather parameters were collected from records and its entry and testing is in progress.
- Designed templates for entering the data using with the help of ASP for fodder resource of A & N Island.
- The credit linkage of the SHGs accounts for only 28.20 percent which is facilitated by only seven banks out of 15 banks in these islands.
- Respondents ranked training needs on goat farming as the first followed by vegetable cultivation, floriculture, poultry, piggery, handicrafts and finally Mushroom cultivation.

Krishi Vigyan Kendra

- Capacity building programmes are very much essential as observed with the presence in the various training programmes, farmers have attended with enthusiasms.
- Field level demonstrations have encouraged the farming to adopt the new technologies for higher production.
- On farm trials have supported the technological refinement and improvement with field level database.

INTRODUCTION

Realizing the importance of island agriculture to meet the requirement of local population and tourists, Indian Council of Agricultural Research (ICAR) established Central Agricultural Research Institute, Port Blair on June 23rd, 1978 by merging different regional research stations of ICAR institutes located in islands. The ultimate aim of CARI is the Development of island agricultural production technologies which utilizes the strengths of the island and convert the constraints in opportunities, without causing any ill effect to the fragile ecosystem of the island.

MANDATE

- To provide a research base to improve the productivity of important agri-horticulture, livestock and fisheries of A& N islands through adaptive and basic research for attaining economic self-sufficiency.
- To develop appropriate plans for conservation of natural resources and their sustainable use.
- To standardize technologies for animal health coverage and livestock production.
- To standardize techniques for capture and culture fisheries including coastal aquaculture.
- First line transfer of technology and training to the relevant State Departments.

ORGANISATIONAL SET UP

Administration of the institute rests with the Director, who receives support from both research divisions and administration. The Research Advisory Committee (RAC), Institute Management Committee (IMC) and Institute Research Council (IRC) reviews and monitor the research programmes and facilitates to identify new research thrust areas for the Institute. To accomplish the mandate, the research activities are organized under five divisions namely, Natural Resource Management, Horticulture & Forestry, Field Crops, Fisheries Science, Animal Science and one section Social Science Section.

ORGANOGRAM

xxxxxxxx

VISION

- As the island level food security is not achievable, Panchayat level food requirement should be estimated and food production planning should be tailored to provide local level food security with town area being served by food import from mainland.
- Reorientation of agricultural production system to provide local level food security and to meet the demand of perishable products, viz. milk, egg, meat, fish, fruits, vegetables and flowers with specific reference to demand of booming tourism industry.
- Making the isolation as our strength, conversion of spices cultivation in an organic farming with a decoratively packaged Andaman brand organic spices being marketed.
- Preparation of disease map of livestock and poultry.
- Data base on disease monitoring and forecasting system.
- Development of suitable production to consumption level chain involving SHGs and retailers/ armed forces / processors.
- Biodiversity richness of the island should be preserved and exploited for national benefit.
- The technologies should be eco-friendly and sustainable.
- Proper rain water management technology to create micro level water resources to increase irrigated area from present 1% to a significant level.
- Making CARI a model for NARS of other small island nations.

THRUST AREAS FOR XI PLAN

- Conservation and management of natural resources.
- Intensification and diversification of the rice based integrated cropping system by including vegetables, pulses and oilseeds through land modification, moisture conservation and supplementary irrigation.
- Development of technology for water resource development through rain water management and its efficient utilization for diverse cropping system.
- Production technology for vegetable crops for increasing productivity.
- Improving the varietal productivity of plantation and horticultural crop based systems through intercropping of spices, vegetables, fodder etc. as well as irrigation from rain water harvesting system.
- Development of fish-poultry-crop farming system for fresh and brackish water.

- Improving the productivity of cattle, goat, pig, poultry and aquaculture by cross breeding, health care and nutrition.
- Frontier research for knowledge and increased productivity.
- Undertaking basic / strategic research for generating knowledge of applied significance.
- High value agriculture with special reference to vegetables and protected cultivation of high value crops.
- Minimizing post harvest losses and maximizing value through appropriate technological intervention.
- Integrated management of existing insect, weeds and abiotic stresses with special reference to salinity.
- Production technology for inputs and their optimal utilization in organic farming.
- Transfer of technology and socio-economic impact analysis.
- Identification of appropriate technological options for rehabilitation of tsunami affected farming community.

NEW RESEARCH INITIATIVES

- Introduction of table purpose rabi groundnut alongwith seed production facility during kharif.
- Evaluation of existing long duration paddy varieties(160-170 days) as well as breeding program for new strains to take advantage of long rainy season and adding fodder component in pre and post paddy to enhance the cropping intensity to 300% under rainfed conditions.
- Rain water management technology for water resource development at hill top and valleys.
- Fodder cultivation on hill slopes through grasses and fodder trees both as sole and intercrops.
- Intensification of work on mushroom cultivation.
- Intensification of work on flowers, banana, papaya, pineapple and off season mango.
- Evaluation of tropical potato varieties both TPS and tuber at Diglipur (North Andaman).
- Black pepper village with black pepper on Glyricidia and value addition through proper cleaning, grading, and packaging.
- Integrated farming system in fresh and brackish water areas.
- Induced breeding of cat fish and development of hatchery.

- Technology of captive breeding of Damsel ornamental fishes.
- Introduction of buffalos and management practices for indigenous cattle.
- Low cost and alternate feed for poultry.
- Protected cultivation for high value crops and their value addition.
- Identification of technology package for farmers of different socio-economic background.
- Germplasm collection of minor fruits viz. Rambutan, Durian, Mangostean, Wild Cashew, West Indian Cherry etc.
- Production technology including IPM & varietal evaluation of beans, okra, brinjal & tomato.
- Cage culture of groupers in creeks and bays to enhance livelihood options.
- Pulses & oilseed breeding programme.

STAFF POSITION

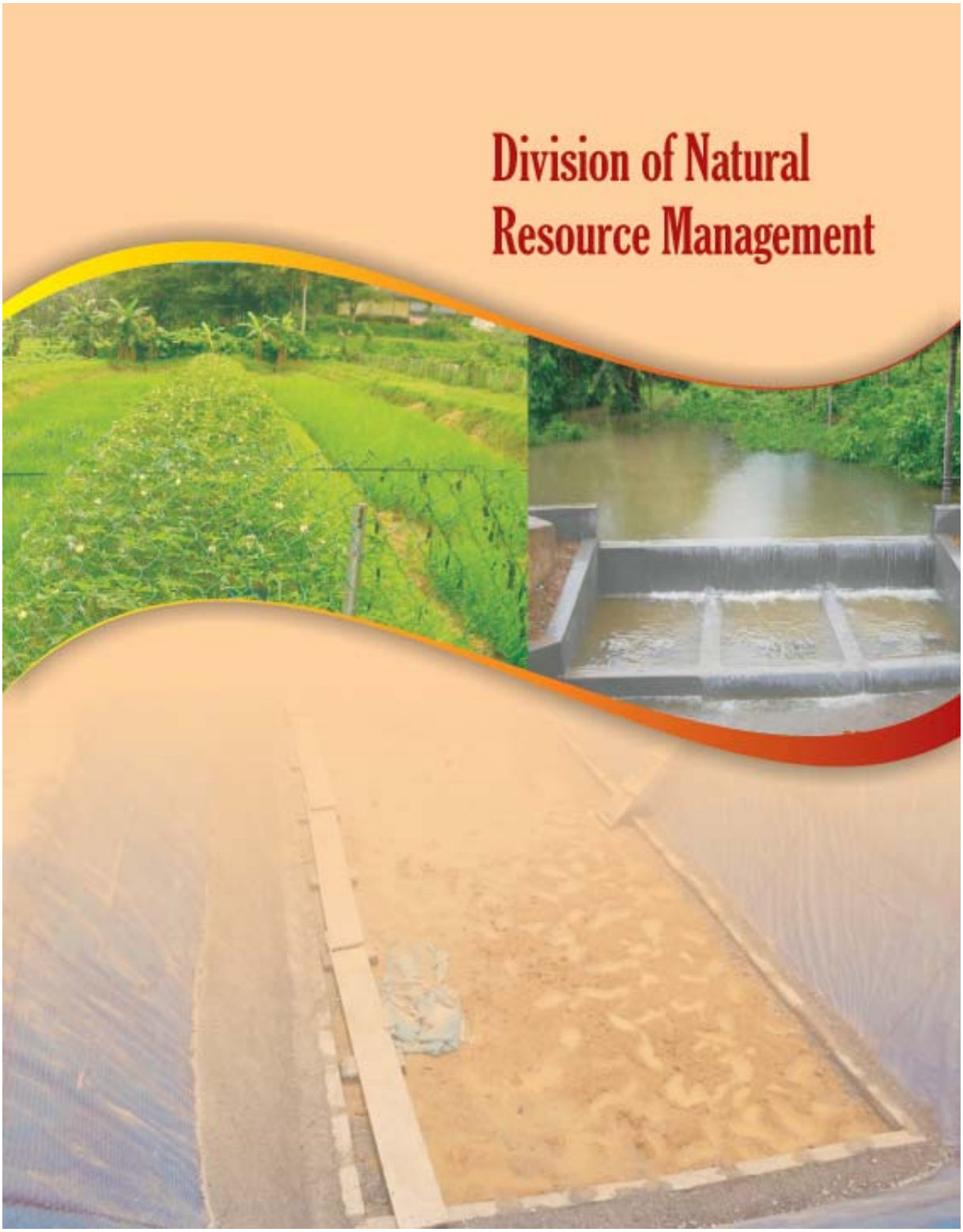
Sl. No.	Category	Sanctioned	Filled
1.	Scientific	56+1	31
2.	Technical	43	37
3.	Administrative	29	25
4.	Supporting	83	76

BUDGET UTILIZATION DURING 2008-2009

Head of Account	Plan(In Lakhs)		Non-Plan (In Lakhs)	
Particulars	**RE 2008-09**	**Expt. 2008-09**	**RE 2008-09**	**Expt. 2008-09**
Establishment Charges	-	-	651.00	650.37
Travelling Allowances	15.00	14.60	12.00	11.95
Other charges	141.00	142.68	108.00	90.64
Equipment	134.00	131.69	0.0	16.39
Library	25.43	25.44	0.0	0.66
Works	99.57	98.81	29.00	28.97
HRD	5.00	5.00	-	-
Total	**420.00**	**418.22**	**800.00**	**798.98**

RESEARCH ACHIEVEMENTS

Division of Natural Resource Management



Development of Fresh and Brackish Water Based Integrated Farming System (IFS) in Bay Islands

R.C. Srivastava, N. Ravisankar, S. Ghoshal Chaudhuri, T. Damodaran, Abhay Kumar Singh, Subhash Chand and Grinson George

Experiments on fresh and brackish water based integrated farming system were carried out at on farm and off farm conditions with an objective to identify, characterize and optimize the crop, animal, poultry and fish components.

Fresh water based IFS

Evaluation of crops: Among the vegetable crops evaluated on the embankment of pond during the wet season, okra, amaranthus and cowpea performed better in terms of yield (Table 1) compared to ridge gourd and bitter gourd. Due to heavy rainfall during the wet season, higher flower drop was observed in case of gourds compared to okra and cowpea. Total return of Rs 454 was recorded from crops grown in the embankment. Arecanut and papaya planted on the embankment have not yet come to yielding stage. Other components of IFS *viz.*, duckery and aquaculture are also integrated.

Table 1. Performance of crops in fresh water based system during wet season

Crop	No. of plants / area (m^2)	Yield (kg)	Returns (Rs)
Okra	27.5 m^2	20.0	240.0
Amaranthus	32.7 m^2	7.0	70.0
Cowpea	27.5 m^2	12.0	144.0
Arecanut + Black pepper	15 no's	*	*
Papaya	39 no's	*	*
Total	-	39.0	454.0

* crop not yet come to yielding stage

Plate 1. Amaranthus and okra on the embankment of fresh water system at Garacharma farm

Integration of duckery: The Khaki Campbell ducklings of 4 week age were reared under fresh water based IFS model. Body weight of ducklings at 6th and 12th weeks was 315 ± 7.4 g and 970 ± 12.7 g, respectively (Table 2). The average daily feed consumption was 104 gms/bird during 4-6 week whereas it was 115 gms/bird during 7-12 week. There was no mortality from 4th week onwards. Voids of ducks fell in the fresh water pond served as feed for fingerlings in the pond.

Table 2. Performance of ducks under fresh water system

Parameters	Khaki Campbell
Average body weight of ducklings at 4th week (g)	189 ± 4.6
Average body weight of grower ducks at 6th week (g)	324 ± 7.4
Average body weight of grower ducks at 12th week (g)	970 ± 12.7
Average feed consumption (4-6 week)/bird (kg)	2.2
Average feed consumption (7-12 week)/bird (kg)	4.8
Mortality (4th week onwards)	Nil

On-farm evaluation of fresh water based IFS : Fresh water based IFS was assessed in the field of Shri Paresh Chandra Das and Shri Krishna bairagi of Manglutan and Guptapara village, respectively in South Andaman. The details of the farm ponds are given in Table 3 & 4. Invariably, animal components such as milch cow, poultry and duckery recorded higher net returns and B:C ratio compared to crop and fish components. The contribution from crop component was Rs 990 and Rs 2080 from Shri Paresh Chandra Das and Shri Krishna bairagi, respectively. On an average B:C ratio of 2.1 is recorded from fresh water system. Fish yield was very low in both the farmers' field mainly due to overflow of water during heavy rainfall period. Over all, animal component comprising of milch cow, poultry and duckery contributed 92 % towards net return (Fig.1) followed by crop (6%) and fish (2%). The fodder crops like hybrid napier and paragrass grown on the embankment were fed to milch cows.

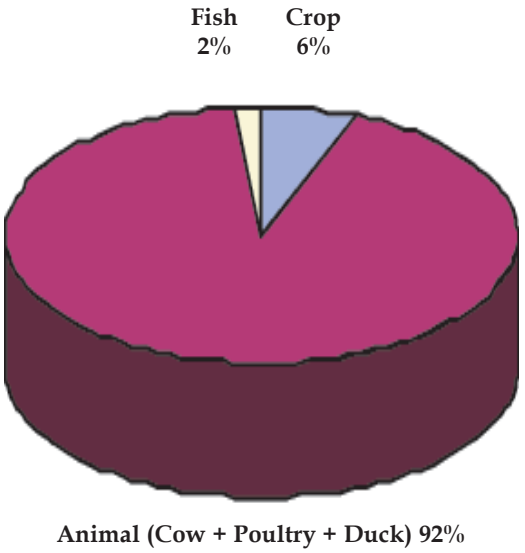


Fig.1. Contribution of different components to net returns in fresh water based IFS


Plate 2. Integration of crop & duckery components in fresh water based system at Guptapara

Table 3. Performance of various components of fresh water based IFS (Shri Paresh Chandra Das: size of pond - 0.11 ha, embankment - 2.7 m wide)

Component	Yield (kg)	Rate of selling (Rs/kg)	Gross return(Rs)	Cost of cultivation (Rs)	Net returns (Rs)	B:C ratio
I. Crop (from embankment only)						
Bottle gourd	52	5	260	810	990	1.22
Ridge gourd	35	5	175			
Banana	60	6	360			
Papaya	30	7	210			
Hybrid Napier	25			Used for animals		
Paragrass	10			Used for animals		
Total	**-**	**-**	**1800**	**810**	**990**	**1.22**
II. Animal component						
Cow (1 no's)	1080	18	19440	7000	13240	1.89
Poultry (3 nos)	100	5	500			
Duck (2 no's)	-	150	300			
Total	-	-	20240	7000	13240	1.89
III. Fish component						
Catla	3	50	150	-	380	-
Rohu	4	50	200			
Grasscarp	1.5	20	30			
Total	**8.5**	**-**	**380**	**-**	**380**	**-**
Grand Total (I+II+III)			**22420**	**7810**	**14610**	**1.87**

Table 4. Performance of various components of fresh water based IFS (Shri Krishna Bairagi: size of pond - 0.17 ha, embankment - 3.5 m wide)

Component	Yield (kg)	Rate of selling (Rs/kg)	Gross return (Rs)	Cost of cultivation (Rs)	Net returns (Rs)	B:C ratio
I. Crop (from embankment only)						
Amaranthus	100	10	1000	1200	2080	1.73
Brinjal	80	16	1280			
Cowpea	50	10	500			
Banana	40	15	600			
Total	-	-	3380	1200	2080	1.73
II. Animal component						
Cow (2 no's)	2520 lit	18	45360	14000	34010	2.43
Poultry (20 no)	300	5	1500			
Duck (6 no's)	100	6	600 + 550			
Total	-	-	48010	14000	34010	2.43
III. Fish component						
Catla	4.2	50	210	-	455	-
Rohu	4.5	50	225			
Grasscarp	1.0	20	20			
Total	9.7	-	455	-	455	-
Grand Total (I+II+III)			**51845**	**15200**	**36545**	**2.40**

Experiment on assessment of adaptation rate of ducklings to brackish water has been initiated at KVK complex, Sipighat, which is in progress.

On-farm evaluation of brackish water based IFS: Simultaneous evaluation of brackish water based IFS was initiated in the field of Shri Gaurango Suthradar of Manjery village in South Andaman. The brackish water salinity ranged between 12-27 ppt. The soil of the embankment was sandy loam in texture. Along the dyke, crops like bottle gourd, ridge gourd, bitter gourd and fodder have been taken in beds of 5 X 1 m size. Three rows of sweet potato were also taken along the slopes of the dykes. The naturally grown fodder buffalo grass in the embankment was used for animal component. The fodder is also palatable to the goat. Animal components comprising of cow and poultry recorded higher net return of Rs 27380 with B:C ratio of 2.3 (Table 5). Crop component did not perform well and recorded loss of Rs 330 which is mainly due to the poor performance of crops. Fish component also did not perform well due to heavy rainfall. Animal component contributed 97% towards net returns (Fig.2) followed by fish (2%) and crop (1%).

Table 5. Performance of various components of brackish water based IFS (Shri Gaurango Suthradar: size of pond - 0.08 ha, embankment - 2 m wide)

Component	Yield (kg)	Rate of selling (Rs/kg)	Gross return (Rs)	Cost of cultivation (Rs)	Net returns (Rs)	B:C ratio
I. Crop (from embankments only)						
Bottle gourd	30	5	150	810	-246	-0.30
Ridge gourd	22	5	110			
Bitter gourd	15	8	120			
Sweet potato	5	20	100			
Fodder (buffalo grass)	35*	6	84			
Total	-	-	564	810	-246	-0.30
II. Animal component						
Cow (2 no's)	2160	18	38880	12000	27380	2.28
Poultry (10 no)	100	5	500			
Total	-	-	39380	12000	27380	2.28
III. Fish component						
Parsa	4	50	200	-	500	-
Tiger prawn	1	300	300			
Total	5	-	500	-	500	-
Grand Total (I+II+III)				**12810**	**27634**	**2.16**

* Economics calculated based on 40% hay

Plate 3. Release of brackish water prawn by Dr Hamida Abdi, Director, DBT and naturally grown palatable fodder on the embankment of brackish water pond at Manjery

It can be concluded that, on an average, net return of Rs 25600 can be obtained from fresh water based farming system in which animal and crop component contributed 92% and 6% respectively under on farm condition. Similarly, in brackish water based system, animal component contributed 97% towards net return.

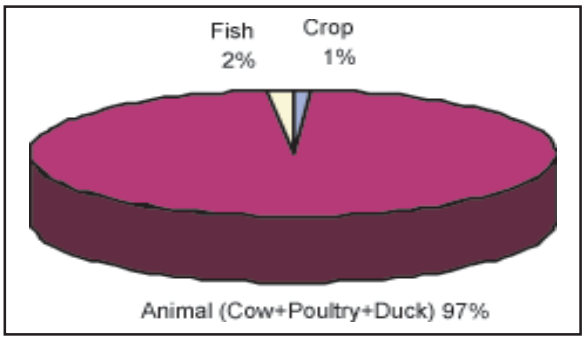


Fig. 2. Contribution of different components to net returns in fresh water based IFS

Planning, Augmentation and Efficient Utilization of Water Resources in Kaju Nallah Watershed

S.K. Ambast, R.C. Srivastava, T. Subramani, Babulal Meena and Subhash Chand

In order to assess the water balance in the Kaju Nallah watershed, estimates have been made on water resource potential, realizable water potential, water requirement of crops, livestock and human consumption, and surface plus ground water development (Table 6). It indicated development of about 3% of the realizable potential will meet the water requirement in the watershed but at present, there is a shortfall in water resource development by about 21% of the water requirement.

Table 6. Water resource potential of the Kaju nallah watershed (Garacharma farm)

Sl. No	Item	Value
1.	Micro-watershed area (Garcharma farm)	44 ha
2.	Average rainfall	3.180 m
3.	Water resource potential	14,00,000 m^3
4.	**Realisable water potential** (@75% of potential lost as runoff)	**10,50,000 m^3**
4.	Plantation and crop area	8.8 ha
5.	Crop water requirement during dry season (for 100 days)	28,910 m^3
6.	Human consumption (@500 lit/house/in alt days - 50 days)	2,500 m^3
7.	Livestock requirement (@10000 lit for 100 days)	1,000 m^3
8.	**Total water requirement**	**32,410 m^3**
9.	Developed surface water resources	15,500 m^3
10.	Developed ground water resources	10,000 m^3
11.	**Total water resources developed**	**25,500 m^3**

Further, as designed earlier, a check dam as a recharge structure along with dugout storage was constructed to harvest the rainwater from nallah. In order to plan efficient utilization of created water resources in the Kaju Nallah watershed through recharge structure-cum-well system, design of micro-irrigation system was prepared for different blocks of the crop and plantation area in the Garacharma farm.

Plate 4. Construction of check dam and installation of observation well

In order to study the impact of recharge structure-cum-well on water resource availability in the watershed, monthly recuperation test for different wells was conducted during dry season of 2008-09. The well 1, 2 and 3 are located close to the bed of nallah where longitudinal slope of the nallah is more compared to the well 4, 5, 6 and 7, which are located in the valley area. The observations of pump test and recuperation rate for typical wells are shown in Fig.3. It has been observed that the well yield reduced significantly over the dry season particularly in the wells located at higher longitudinal slopes (Fig.3a-b) in comparison to wells located in the valley areas where longitudinal slope was less (Fig.3c-d). It has also been observed that well 1 and 5 which were supported by dugout tank or check dam had higher well yield. However, the significant reduction in yield of well 1 was observed which was located on higher longitudinal slope. Thus it is suggested that tank-well system should be created at relatively less longitudinal slope along with tank or recharge structure to get significantly enhanced and consistently well yield during the dry season.

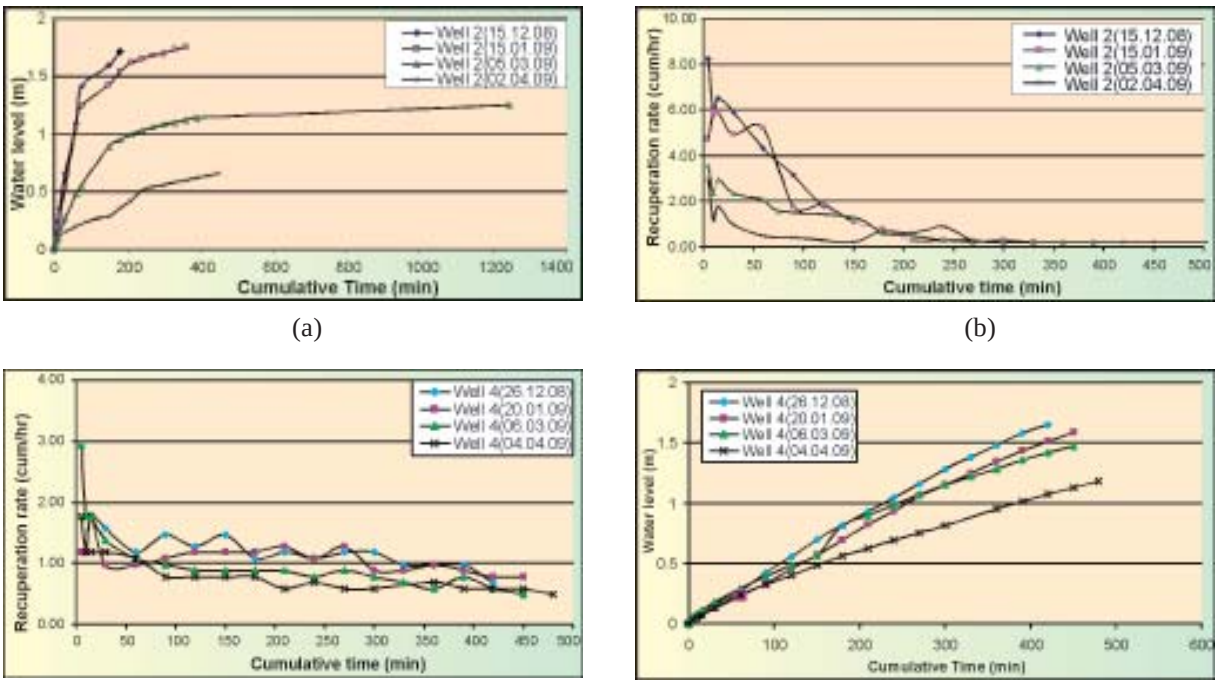


Fig.3. Observed water level during pump test and recuperation rate for well no 2(a-b) and well no 4(c-d) located in the Kaju Nallah watershed

Studies on Effective Storage of Water in Ponds

M. Din, R.C. Srivastava and S.K. Ambast

During the year 2008-09, water balance study was carried out in all the treatments i.e. (i) lining with geo-membrane (IITD material) (ii) lining with IITD material with cement concrete tiles (iii) lining with 250 µ LDPE film with cement concrete tiles (iv) lining with 200 gsm Silpaulin (v) lining with 200 gsm Silpaulin with cement concrete tiles and (vi) unlined dug out pond as control. Water level in ponds, rainfall and open pan evaporation were monitored on daily basis.

The analysis of the data indicated Silpaulin and geo-membrane as suitable lining materials for effectively controlling the seepage losses from the farm pond (Fig.4). The daily water losses from lined ponds were observed in the range of 3-6 mm/day whereas daily evaporation was observed in the range of 2.5-5.5 mm/day. In case of lining material with cement concrete as cover material, to protect from incoming solar radiation, losses were observed relatively high, it was mainly due to damage to lining material while laying cement concrete tiles. It was observed that the exposed areas to sunlight of both silpauline and LDPE are decaying faster indicating their sensitiveness to higher incoming solar radiation. Further,

it was also observed that covering these lining materials with cement concrete tiles not only helps in controlling seepage losses but also increases the life of the lining material from higher daily insolation in A&N islands located close to equator. The economics of these lining materials will depend on the life that will be accounted for estimation of techno-economic feasibility of the lining materials.

Plate 5. An overall view of the laid experiment and recording water level observation

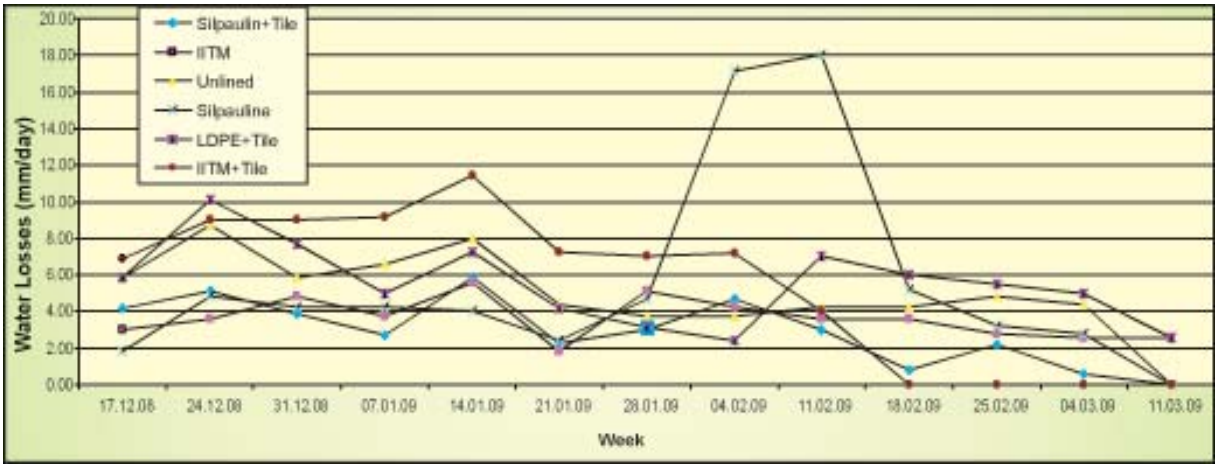


Fig.4. Observed water losses in ponds with different lining treatment during dry season

Considering the outcome of the project, a new technique for lining of the tank with higher life period has been evolved. A tank of 15 m x 8 m x 2.5 m size was constructed at hill top of Garacharma farm to cater the need of polyhouses. It involves lining by silpauline covered by reinforced plaster (1:6) on sides and 15 cm thick soil layer at bottom. Although the annual cost of water in lined tank is high (about Rs.30/m^3, varies from Rs 27/m^3 for 350 cu m capacity tank to Rs 81/m^3 for 80 cu m capacity tank) after accounting evaporation

losses, the returns from expected yield increase of about 1-2 kg/tree in case of arecanut due to irrigation during five dry months of December to April will make it cost effective. The water requirement of arecanut per tree is about 1200 litres. Assuming even minimum yield enhancement, the economic gain will be about Rs.70/tree and thus a benefit-cost ratio of more than 2. For one hectare of arecanut, a tank of about 1500 m^3 will suffice. This size need not be created at one site but can be distributed in the whole area. For wide spaced crops like coconut and cashew, the tank size requirement will be further less.

(a)

(b)

(c)

(d)

Plate 6. Process of lining of tank (a) dug out tank (b) laying of silpauline (c) reinforced plastering and (d) finished lined tank

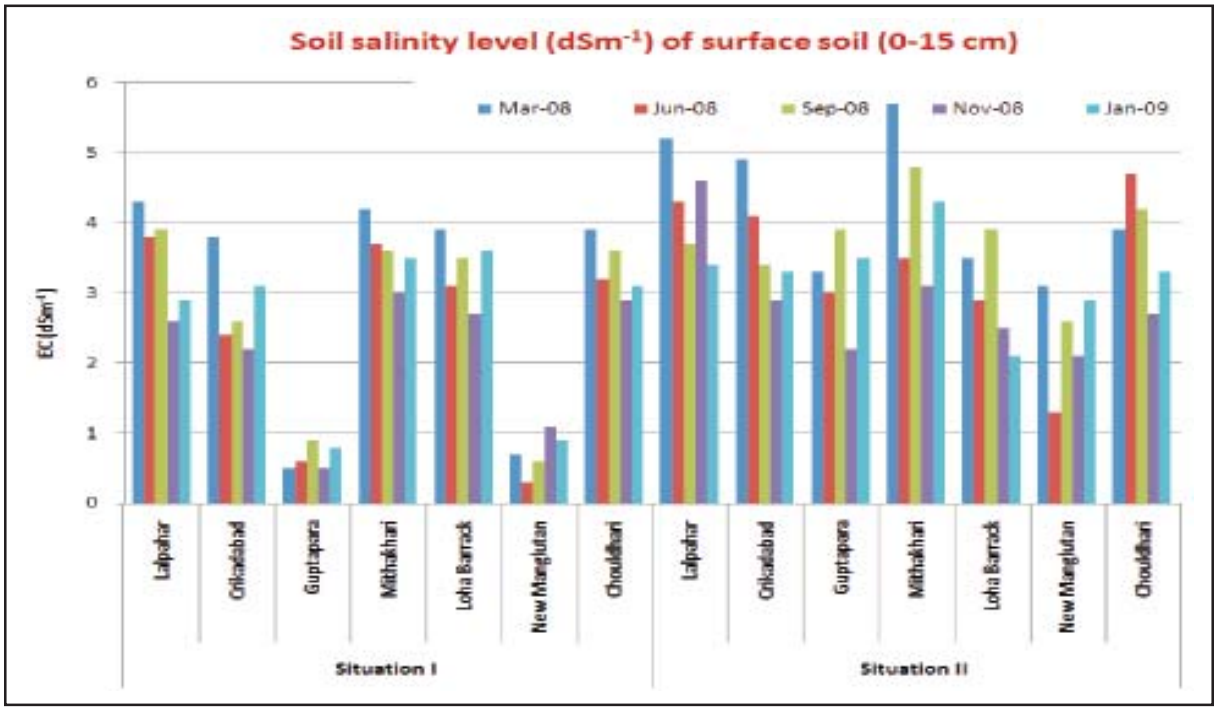
Assessment of Spatial and Temporal Variability in Soil Physico-Chemical and Biological Properties of Tsunami Affected Agricultural Lands of Andamans

S. Ghoshal Chaudhuri, R.C. Srivastava, N. Ravisankar, T.P. Swarnam, V. Jeyakumar, Babulal Meena and M. Balakrishnan

In order to assess the extent of damage to the soils due to salt accumulation in the post tsunami period, soil samples were collected at periodical intervals and analysed (Annual Reports, 2006-07; 2007-08). Further, the soil samples were collected at the end of four rainy seasons after the tsunami, during January to March 2009 in the tsunami affected sites from the surface (0-15 cm) and subsurface (15-30 cm) layers (Fig.5). The pH of surface soil under situation I indicated that there were several changes in pH and soluble salt content between pre tsunami and post tsunami conditions and the surface soil has become saline. But the subsurface soil had comparatively lesser amount of soluble salts. This trend clearly indicates that sea water intrusion during the tsunami did not affect the subsurface soil because the waves intruded in a flash and receded completely, leaving a layer of sodium and other soluble salts on the surface soil. Under situation II, the results revealed that irrespective of soil series and initial salinity level, the surface soil has become highly saline due to the percolation of soluble salts.

However, rains caused an appreciable reduction in soluble salt content. The reason for appreciable reduction in soil salinity in surface and subsurface soils may be attributed to the leaching of soluble salts by the high rainfall received during the 2005 rainy season. Though the salinity level has reduced from the initial (immediately after tsunami) value but it remained more than 4 dSm^{-1} for almost all the locations. This may be attributed to the soil texture of the different soil formations such as sandy clay loam which might have facilitated the removal of soluble salts through leaching, as against the clay loam texture which does not allow leaching of soluble salts. A larger fraction of rainwater also tends to either run off or evaporate from stagnant water on the surface of the soil due to the low infiltration rates of fine textured soils - having high clay content. This reduces the water available to displace the salts. But after four rainy seasons (2005-2008), there has been a drastic reduction in soluble salt concentration of tsunami affected agricultural lands although excess water has also resulted in the water stagnation in many places due to lack of drainage outlets.

Soil salinity reclamation requires analysis of sensitivity parameters that affect interactions between salinity and crop yield. Hence rehabilitation and management of salt-affected soils of these islands require a combination of engineering and agronomic measures depending upon different situations.



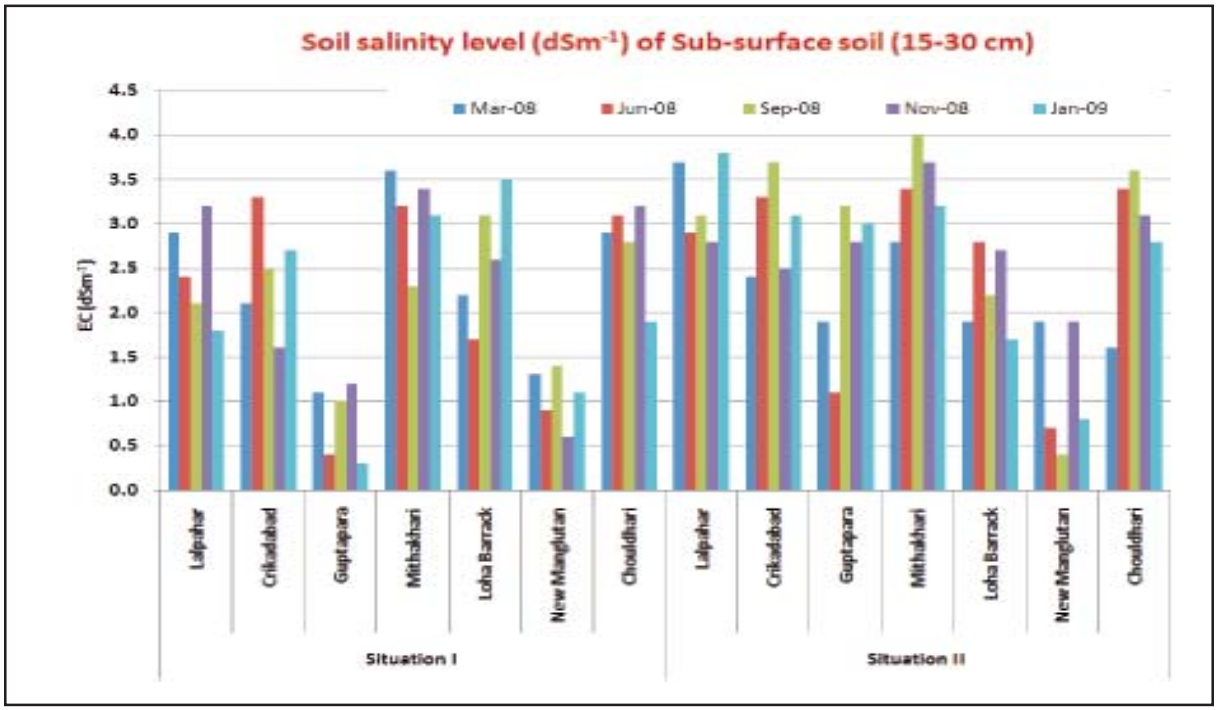


Fig.5. Soil salinity level of surface and sub-surface soil

Evaluation of Soil Management Techniques in Problem Soils of South Andaman

T.P. Swarnam, S. Ghoshal Chaudhuri, B.L. Meena, T. Damodaran, V. Jeyakumar and R.C. Srivastava

Evaluation of coconut husk as liming material

Acid soil, which do not respond to normal management practices, are often considered as problem soils and can be treated using neutralizing chemical agents such as lime. Lime has been used over the years for this purpose. Lime is required in large quantities (1-10 t/ha) after every 3-4 years for better crop performance but is very costly in A&N Islands because of high transportation cost from mainland. Coconut husk is available in plenty in A&N Islands and can be used as neutralizing material in low input agriculture. Keeping in view the pot and field experiments were conducted to study the effect of coconut husk in reducing soil acidity.

Pot experiment: The soil samples were taken at three monthly intervals and analysed for change in pH under various treatments. The soil pH has significantly increased under various treatments (Table 7). The coconut husk along with compost significantly increased the pH after three months. After six months coconut husk, compost and coconut husk + compost showed pH values at par.

The soil samples were also analysed for organic carbon (OC) and available nutrients (N, P and K) under various treatments and the results are given in Table 8. There was insignificant difference in organic carbon and available nutrient status after 6 months of application. However, soil samples after a year showed significant differences in OC, and available P and K content between the treatments. The coconut husk, compost and coconut husk + compost all have on par results after a year of application of the treatments in organic carbon content. The organic carbon content was observed the lowest in lime treated plots and highest in compost treated plots at the end of the year.

The available N content has also increased in compost and coconut husk + compost treatments. The application of lime

Table 7. Effect of incorporation of coconut husk on soil pH

Treatments	Soil pH	
	March, 2008	March 2009
Control	5.5	5.5
Coconut husk	5.6	6.1
Compost	5.9	6.6
Coconut husk + Compost	6.2	6.9
Lime	8.0	7.8
SED	0.19	0.21
CD(P=0.05)	0.41	0.36
CV	4.2%	4.6%

Table 8. Effect of coconut husk and compost application on soil nutrient parameters (March 08-Jan 09)

Treatments	O.C. (%)		Available N		Available P		Available K	
	Mar,08	Jan,09	Mar,08	Jan,09	Mar,08	Jan,09	Mar,08	Jan,09
Control	0.48	0.41	413	402	8.6	9.	54	72
Coconut husk	0.50	0.55*	385	431	9.3	10.2	83*	249**
Compost	0.61*	0.54*	430*	469*	9.5	11.1*	93*	205*
Coconut husk + Compost	0.60*	0.49*	436*	462*	9.1	11.3*	92*	244**
Lime	0.49	0.30	402	409	10.6*	12.5*	52	106
SED	0.04	0.06	19.1	15.7	0.98	1.1	5.73	24
CD(P=0.05)	0.08	0.08	41.7	34.2	2.15	2.19	22.5	52
CV	10.8	12.3	6.4	5.09	15.4	13.6	14.8	15.0

significantly increased the available P content because of its conversion into soluble forms with increase in soil pH. Application of compost and coconut husk + compost treatments also resulted significant increase in available P and was on par compared to lime. Similarly, available K increased significantly under coconut husk and coconut husk + compost treatments followed by compost.

Effect of coconut husk on CEC and exchangeable cations: The soil samples were also analysed for cation exchange capacity and exchangeable cations viz., Ca^{2+}, Mg^{2+}, Na^{+} and K. The analysis showed not much difference in CEC between the treatments. Similar results were also observed for concentration of exchangeable cations as well (Table 9).

Table 9. Effect of coconut husk on soil CEC and exchangeable cations

Treatments	CEC(c.molkg^{-1}Soil)	Ex. Cations (c.molkg^{-1}Soil)			
		Ca2+	Mg2+	Na+	K+
Control	12.79	5.35	3.81	3.21	0.29
Coconut husk	12.86	5.68	3.53	3.04	0.29
Compost	13.59	5.28	3.57	3.69	0.32
Coconut husk + Compost	14.19	5.48	3.59	3.34	0.36
Lime	14.82	6.05	4.26	3.62	0.38

Impact of coconut husk on soil microbial diversity :

The collected soil samples from different treatments were also analysed for microbial diversity viz., bacteria, fungi and actinomycetes. The results are presented in Fig.6. The bacterial analysis showed a significant difference between the treatments. The coconut husk + compost treatment recorded highest number of colonies in the subsoil (15-30 cm), but other treatments showed on par results. The higher population in the above treatment might be due to multiplication of cellulolytic bacteria, growth of which is facilitated by compost application. The significant difference between the surface and subsurface soil might be due to surfacing scorching of the soil by intensive radiation thus limiting the microbial growth. The fungal population also showed the similar trend indicating fast multiplication and growth of cellulolytic fungi in the coconut husk + compost treated plots. While the actinomycetes population is highest in lime treated plots due to the favorable pH created by application of lime promoting their growth.

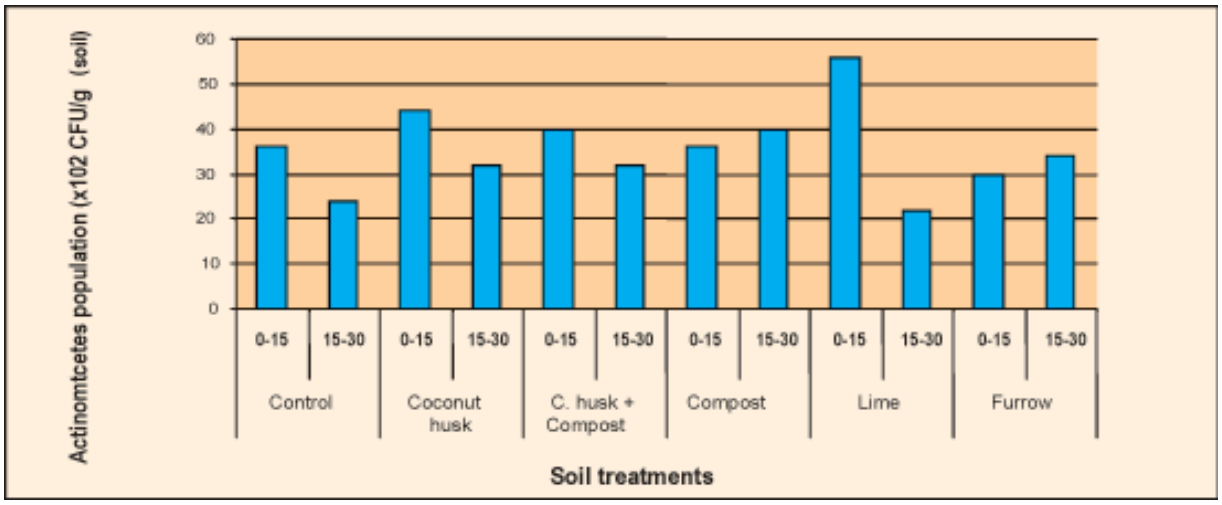


Fig. 6. Actinomycetes population in response to various soil treatments

Confirmation trial on broad bed and furrow system: In order to confirm the findings of the pot experiment, a field experiment with same treatments was also conducted in the beds of BBF at Bloomsdale research farm. The coconut husk and the compost (vermin-compost) were analyzed and the compositions are presented in Table 10. The experiment was carried out in RBD and the plot size was 16 m^{-2}. The coconut husk and compost were applied at the rate of 12 t/ha. Lime was applied based on lime requirement of the soil. Okra hybrid SOH is sown on the beds and normal cultural practices were followed. Soil samples were taken up at 15 days interval and pH measurements were observed periodically.

Table 10. Initial soil properties and composition of coconut husk and vermicompostused in the study

Parameter	Soil	Coconut husk	Vermicompost
Soil Texture	Loam	-	-
pH(1:2)	5.4	6.3	6.8
EC (dSm-1)	0.25	-	-
OC %	0.79	-	-
Available N(kg/ha)	251	-	-
Available P(kg/ha)	15	-	-
Available K(kg/ha)	137	-	-
Total N (%)	-	0.47	0.5
Total P (%)	-	0.03	0.7
Total K (%)	-	0.72	2.8
Total Ca (%)	-	0.39	1.9
Total Mg (%)	-	0.13	0.12
Total Na (%)	-	0.16	0.21

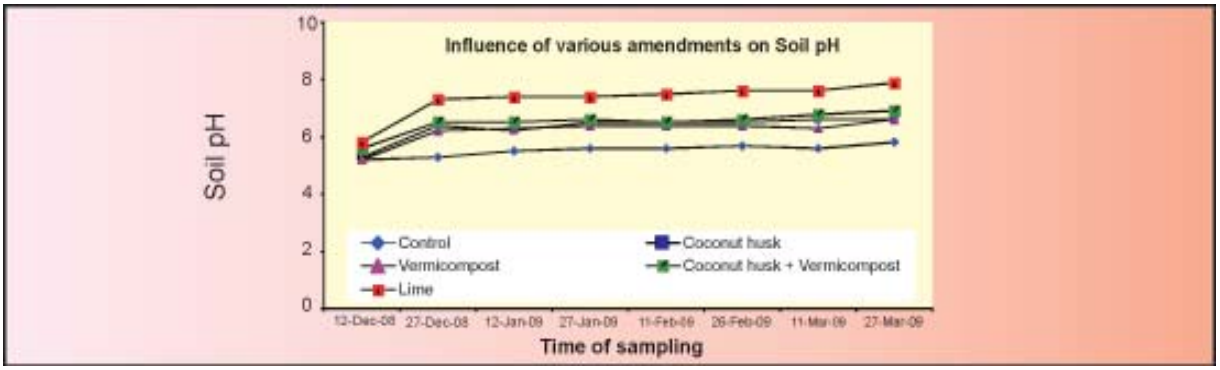


Fig.7. Periodical observations on soil pH for different treatments

Based on presented results, it may be concluded that the acid soils, apart from lime, can be treated using organic materials as neutralizing agents to ameliorate the soil acidity. It is important, particularly, in low input agro-ecosystem where lime is not available. As coconut husk is available in plenty in these islands, it can be used effectively for amelioration of the acid soils. The application of coconut husk has significantly increased the soil pH after 6 months of incorporation. The mixing of compost with coconut husk facilitated the improvement by hastening the decomposition of the husk. Besides, soil nutrients i.e. available P and K have significantly improved with coconut husk application.

Broad Bed

Spreading the respective materials

Coconut husk

Lime applied plot

Plate 7. Application of lime, coconut husk and compost on the bed of BBF system

Natural Resources Degradation and Socio Economic Impact of Leased Farming in Andaman

S. Ghoshal Chaudhuri, Subhash Chand, T. Subramani & L.B. Singh

Like other part of India, the settlers/land owners in Andaman are also adopting/ experiencing contract farming to get easy money though without adopting proper farming practices. The land owners have given their lands to contract farmers on the basis of essentiality in which the leasee is contracted to plant the crop on land, harvest and deliver to the landowner or give money as per verbal agreement at pre agreed price for a fixed tenure. As a result, intensive cultivation, singular focus on supported crops without diversification, over fertilization and excessive use of insecticides by the contract

farmers to get more income from the leased area leads to soil degradation. Keeping this in mind, a study has been initiated to study the soil degradation in leased lands at three locations i.e. Wondoor, Ferrargunj and Bambooflat. The physico-chemical properties to the soil of the selected farms are given in Table 11 and the relevant morphological features are given in Table 12. The analysis work is in progress to quantify nutrient levels, soil erosion rate, sediment characteristics etc in the leased farming areas.

Table 11. Salient physico-chemical properties of leased area under different land use

Land use pattern	Bulk density (g/cc)			Drainage			Structure		
	W	F	B	W	F	B	W	F	B
Control	1.56	1.43	1.47	Good	Good	Good	WG	G	WG
Disturbed(Arecanut)	1.38	1.22	1.18	Poor	Good	Poor	WSBK	MSBK	G
Disturbed(Vegetable)	1.41	1.34	1.26	Poor	Poor	Poor	MSBK	MSBK	G
(Forest)	1.25	1.16	1.09	Good	Good	Good	G	WG	MSBK

Table 12. Relevant morphological features of leased area under different Land use

Land use pattern	Parent material			Topography			Previous vegetation		
	W	F	B	W	F	B	W	F	B
Control	Shale	Sand stone and Shale	Shale	Mod Steep slope	Gentle slope	Mod sloping	Tropical moist deciduous	Semi evergreen forest	mixed evergreen
Disturbed(Arecanut)	-do-	-do-	-do-	Mod Steep slope	Gentle slope	Mod sloping	-do-	-do-	-do-
Disturbed(Vegetable)	-do-	-do-	-do-	Steep slope	Gentle slope	Mod sloping	-do-	-do-	-do-
Undisturbed (Forest)	-do-	-do-	-do-	Mod Steep slope	Gentle slope	Mod sloping	-do-	-do-	-do-

*W- Wondoor, F- Ferrargunj, B- Bambooflat, G. Granular, WG- Weak granular, WSBK – Weak sub angular blocky, MSBK – Medium sub angular blocky

Impact of Integrated Nutrient Management on Soil Quality under Rice-Maize Cropping System in Andaman

Babu Lal Meena, S. Ghoshal Chaudhuri, T. Subramani and M. Din

During the year, confirmatory trial was taken with nine treatments comprising of different nutrient management practices *viz.*, Control, 100% NPK recommended dose of fertilizer (RDF); 75% NPK (25% N substituted by FYM); 75% NPK (25% N substituted by Green Manure, GM); 75% NPK (25% N substituted by compost); 75% NPK (25% N substituted by Poultry Manure, PM); 75% NPK (25% N substituted by Bio Fertilizer); 50% NPK (50% N Substituted by FYM); Fully organic (25% FYM + 25% PM + 25% compost + 25% GM) in randomized block design with 3 replications. The recommended dose of fertilizer (RDF) adopted for rice in the experiment was 120:60:40 kg N, P_2O_5 and K_2O ha^{-1}. Half of the fertilizers N and K, full dose of P were applied as basal. Remaining half of N and K was applied in two equal splits at the interval of 25 days in both crops. Organic manures were applied just before last ploughing and incorporated as per the schedule. Among the INM treatments tested, highest rice grain yield of 4.3 t/ha was obtained from 75% NPK+25% nitrogen substitute by PM followed by 75% NPK+25% nitrogen substitute by FYM (Table 13). On the other hand, the lowest yield of rice was recorded in control. Similar results were also obtained during previous year. Maize crop during the year could not be taken due to waterlogging in the field up to 1st week of February 2009. Like previous year, nutrient status of soil after the harvest of rice has increased with inorganic and organic sources (Table 14). 75% NPK+25% PM recorded highest total N and P after harvest of rice. 75% NPK+25% compost recorded higher K status as compared to application of inorganic fertilizer.

Table 13. Effect of integrated nutrient management on yield of rice

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)
Control	2120	2422
100% NPK	3820	4011
75 % NPK (25%N by FYM)	3978	4536
75 % NPK (25% N by GM)	3520	4219
75 % NPK (25% N by compost)	3128	3846
75% NPK (25% N by PM)	4300	4650
75 % NPK (25%N by BF)	3301	32561
50 % NPK (50% N by FYM)	2689	3128
Fully organic	2820	3126
CD (P= 0.05)	342	412

Table 14. Soil fertility status after harvesting of rice under INM practices

Treatment	Total N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Control	982	5.6	69.3
100% NPK	1231	10.2	82.6
75% NPK (25% N FYM)	1418	11.6	71.3
75% NPK (25% N by GM)	1126	13.2	92.5
75% NPK(25% N by Compost)	1825	12.6	83.6
75% NPK (25% N by PM)	1312	14.9	84.5
75% NPK (25% N by BF)	1416	12.8	83.6
50%NPK (50% N by FYM)	1210	10.5	83.4
Fully organic	1083	12.5	82.4
CD (P= 0.05)	112	2.6	10.3

Soil and Crop Mapping of North, Middle and South Andaman using Remote Sensing and GIS

S.K. Ambast, R.C. Srivastava, N. Ravisankar and T.P. Swarnam

Considering the growing importance of agriculture in A&N Islands, macro-management of agriculture is necessary for proper planning and evaluation of options for possible interventions for improvements. Therefore, a project was initiated with the objectives of (i) mapping of cropping pattern during wet and dry seasons, (ii) production and productivity mapping of major field crop, (iii) soil fertility mapping for field and plantation crops and (iv) drainage map for North, Middle and South Andaman Islands.

Survey of India topo-sheets (Scale 1:50,000) were procured, scanned, mosaicked and digitized for generating the base map for North, Middle and South Andaman Islands. The area under paddy cultivation during 1980-83 (as per SOI maps) and in 2008 (using IRS-P6 data; path/row-114/64 and 114/65; DOP-15.03.2008) were generated to extract the information on change in paddy area in the selected islands. The updated information on current paddy land is in progress. The information can be pooled for estimating the total area under paddy cultivation in different blocks/districts for planning purpose.

Soil mapping: An exhaustive soil survey was conducted in North, Middle and South Andaman Islands. Survey was conducted for paddy as well as plantation area. Global positioning system (GPS) was used for identifying the ground point so that the same can be identified on the spatial map. The collected soil samples were analyzed to

estimate the fertility and chemical parameters and generated spatial map. A typical soil fertility map is shown in Fig.8.

Estimation of paddy yield: Crop cutting experiment for short duration high yielding variety of rice at the end of October 2008 in North, Middle and South Andaman Islands and long duration variety of rice at the end of December 2008 in South Andaman Island. GPS was used to identify the location of the crop cutting points. The average yield of short duration high yielding variety was estimated 2.74 t/ha whereas for long duration paddy was estimated 1.8 t/ha.

Drainage pattern map: SoI maps along with remote sensing data were used to generate drainage network map for North, Middle and South Andaman Islands (Fig.9). Drainage network on paddy cultivated area was superimposed for North, Middle and South Andaman, which can be used for planning, implementing and developing water resources in a watershed area for a drainage line.

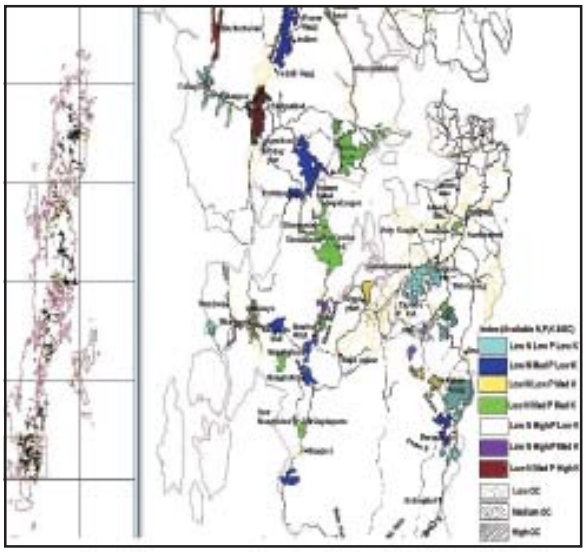


Fig.8. Soil fertility map for North, Middle and South Andaman Islands

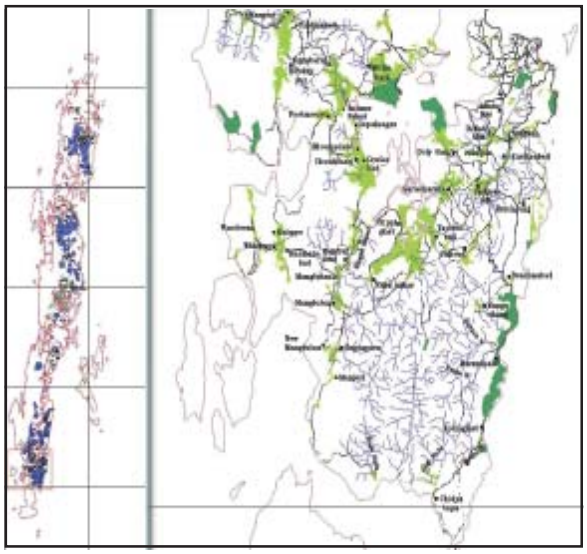


Fig.9. Drainage pattern map for North, Middle and South Andaman Islands

Crop Diversification through Broad Bed and Furrow Based Farming System in Valley Areas of Bay Islands

N. Ravisankar, R. Raja, M. Din, P. Krishnan S. Ghoshal Chaudhuri, R.C. Srivastava and T. Damodaran

In order to identify the different combinations of cropping for beds and furrows of broad bed and furrow (BBF) system, performance of different crops along with its input requirement were taken in to consideration.

Cropping system for beds

Based on the evaluation of cropping system

in the beds and furrows of BBF system, net returns and B:C ratio has been taken in to account for preparing a cropping calendar. Accordingly, the season of growing has been divided in to three phases namely, first phase of wet season comprising mostly July to October, second phase of wet and post wet season comprising mostly November to February and dry season (March-June). Since, the crops studied (vegetables) are having different duration, there is much overlapping in the period. The classification of season also overlaps due to the variable duration of vegetables. However, in order to have the idea to select the most profitable crops, the season are divided. Among the different crops tested during the wet season, okra, amaranthus, cowpea, cucumber performed better compared to the radish, bitter gourd and pumpkin. Crossandra is a perennial flower crop grown in A & N islands and it costs around Rs. 250 to 300 / kg in the market (Fig.10). Hence, for the first season, any one of the seasonal vegetables such as cucumber, amaranthus, okra and cowpea can be advocated. Among the four vegetables, cucumber registered higher net returns and B:C ratio followed by amaranthus and okra.

Among the crops tested in the second season (second phase of wet season and post wet season falling between November-February), chilli (var. Fire bomb) resulted extremely high net returns and B:C ratio (Fig.11). The crop planted in October continued up to June. Cauliflower, cabbage, amaranthus-coriander and brinjal also performed good in terms of net returns and B:C ratio during the period. Hence, for the second season, crops namely chilli, cabbage, amaranthus-coariander and cabbage may be choosen according to the market demand and preference of farmers. Among the crops, chilli recorded higher returns, followed by cabbage and amaranthus-coriander in the same order.

Plate 8. Okra in flowering and harvesting stages in bed and long duration paddy in furrows during rainy season

In the third season, amaranthus-amaranthus, groundnut-amaranthus, okra, cowpea were

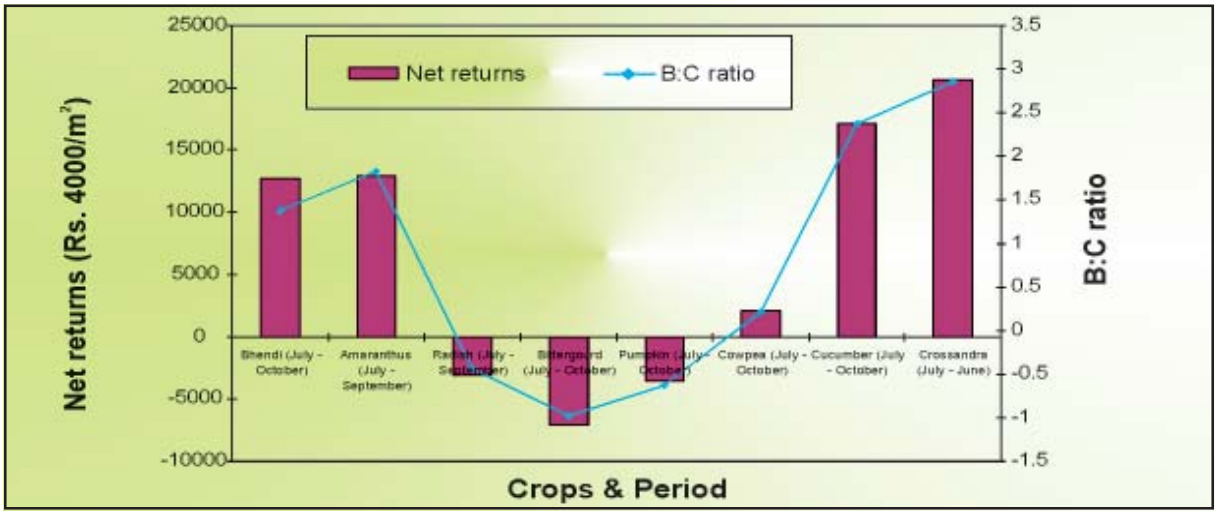


Fig.10. Performance of crops in the beds of BBF during first phase of wet season

Plate 9. Cabbage and cauliflower in beds of BBF system during second phase of wet and post wet season

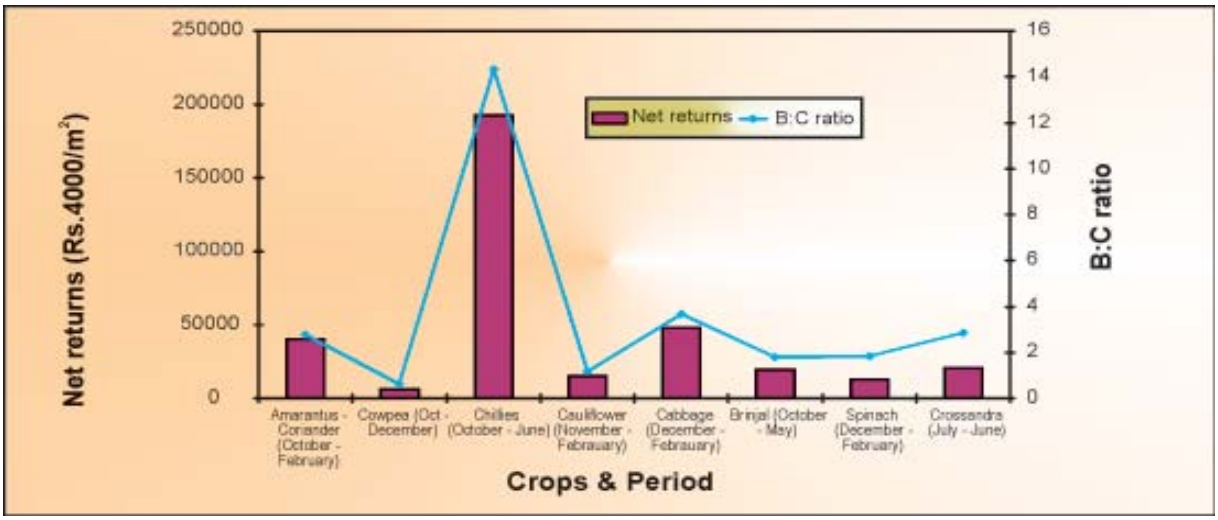


Fig.11. Performance of crops in the beds of BBF during second phase of wet & post wet season

compared along with perennial crop crossandra. Since amaranthus is a short duration crop, two crops have been taken in the same period, whereas in case of okra and cowpea, only one crop is taken. In the case of groundnut-amaranthus sequence, the period is from January to June. Among the crops and cropping sequences tested, amaranthus-amaranthus registered the higher net returns and B:C ratio due to its short duration and higher price especially for red amaranthus. The second best sequence for third season is groundnut-amaranthus (Fig.12). Okra and cow pea also performed better. Hence, for the third crop in the sequence any one of the above sequence may be selected for realizing higher profitability.

Based on the above analysis, suitable sequences suggested for 4000 m^2 bed area of

Plate 10. Chilli in dry season on the beds of BBF system and visit of DBT team to BBF model at Indiranagar village

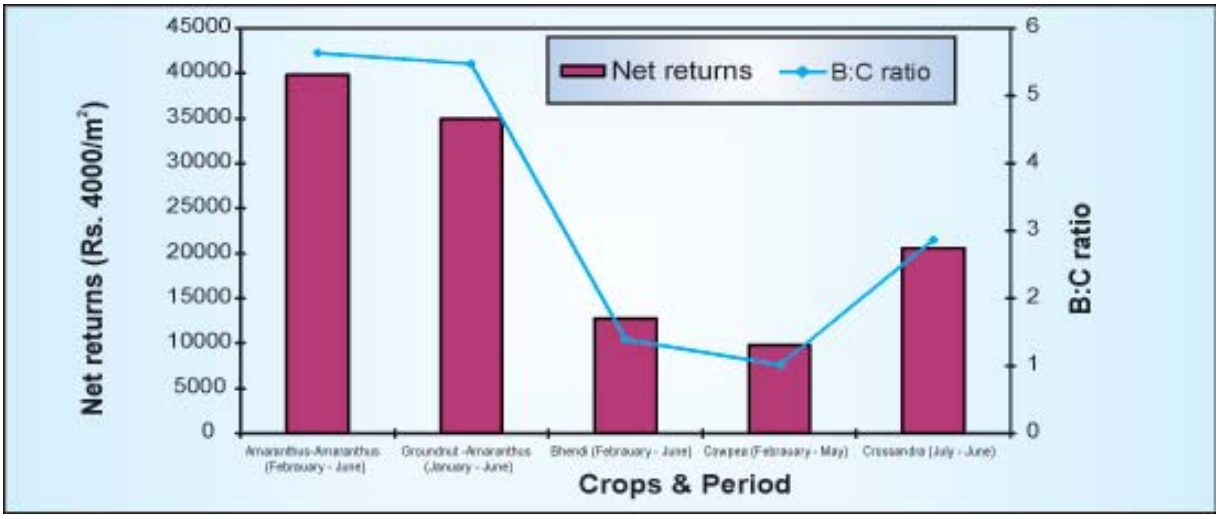


Fig.12. Performance of crops in the beds of BBF during dry season

BBF system are presented in Table 15. According to the resource (land, labour and capital) availability, the farmers may choose the system for maximum net returns.

Cropping programme for furrows

In the furrows, evaluation of four cropping suggests maximum net returns and B:C ratio for (rice-ratoon) + (singhi+magur)-groundnut (var. ICGS 76) followed by the same sequence with TG37A variety of groundnut (Fig.13). Among the rice crops, ratoon did not perform well, which led to loss in investment. Since fish was integrated in the furrows, single crop of long duration rice with improved varieties was found better option.

Based on the analysis of the different cropping

Table 15. Options of cropping programme for beds of BBF

Cropping sequence	Period	Expected net returns (Rs. 4000/m²)
Option 1		
Cucumber	July -October	17136
Chilli	October - June	192570
Total		**209706**
Option 2		
Amaranthus	July - September	12932
Cabbage	November - February	48394
Amaranthus	February - March	15164
Amaranthus	May - June	24656
Total		**101146**
Option 3		
Okra	July - October	12676
Amaranthus	October - November	13916
Coriander	December - February	26068
Okra	February - June	12784
Total		**65444**
Option 4		
Crossandra	July - June	**20625**

Net returns (Rs. 4000/m2)

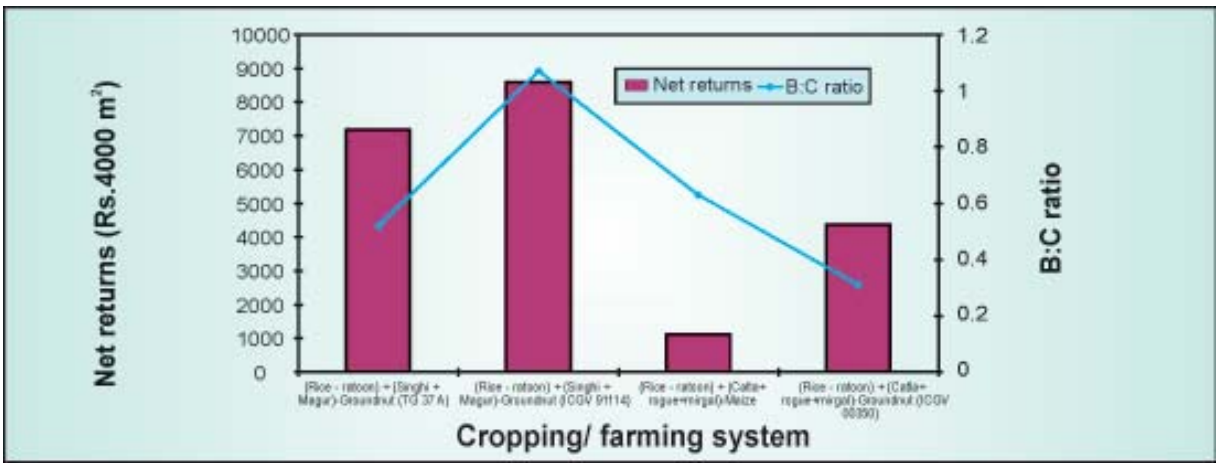


Fig.13. Performance of cropping system in furrows of BBF

systems for beds and furrows in different seasons, it can be concluded that farmers can choose any cropping system among four options mentioned above for beds of BBF based on their investment capability, labour availability among other criteria. In the furrows, long duration variety of paddy-groundnut combined with either cat fish or Indian Major Carps have been recommended.

Standardization of Package of Practices for Table Purpose Groundnut in Andamans

N. Ravisankar, M. Balakrishnan, S. Ghoshal Chaudhuri, S.K. Ambast and R.C. Srivastava

During the year, three experiments were conducted in order to address the potential of seed production of table purpose groundnut varieties under coconut plantations during wet season and to standardize the package of practices especially on date, method of sowing, varieties, irrigation and mulching materials during dry season.

Evaluation of table purpose groundnut varieties for seed production

Experiment was conducted during wet season of 2008 at Sippighat farm. Eight varieties *viz.*, HNG 10, CSMG 84-1, Somnath, M 335, SG 99, ICGS 76, GG 7 and TPG 41 were sown in randomized block design with three replications in coconut plantation having the spacing of 7.5 m between rows. Pod yield was recorded and economics was calculated as per standard procedures. All the varieties registered very low pod yield, green haulm

yield and kernel yield. Among the varieties, M 335 registered significantly higher pod yield of 333 kg ha^{-1} followed by ICGS 76 (302 kg ha^{-1}) (Table 16). Haulm yield also followed almost similar trend. M 335 and ICGS 76 recorded kernel yield of 267 and 241 kg ha^{-1} respectively. Gross returns were estimated based on the cost of seed including transportation cost (Rs 111 kg^{-1}) from Indian mainland. M 335 registered higher net return of Rs 14370 ha^{-1} and benefit cost ratio of 1.9 followed by ICGS 76 (Rs 11313 ha^{-1} and 0.9 respectively). This is mainly due to higher kernel yield from these two varieties. Light availability was also recorded during critical growth stage of flowering (Fig.14). The available light under coconut plantation was observed 50% less than the open field conditions which might be the cause for lanky plants and low pods yield in all the varieties. Therefore, further experiments may be conducted with recommended varieties for dry season viz., SG 99 and ICGS 76 can be experimented for seed production in coconut plantation with pruning/trimming of coconut plants.

Table 16. Performance of different varieties of table purpose groundnut for seed production in coconut plantations

Varieties	Pod yield (kg ha^{-1})	Green haulm yield(kg ha^{-1})	Kernal yield (kg ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:Cratio
HNG 10	262	1460	210	24717	8217	0.50
CSMG 84-1	63	1270	51	6908	-9592	-0.58
Somnath	87	437	70	8189	-8311	-0.50
M 335	333	1270	267	30870	14370	0.87
SG 99	151	571	121	13962	-2538	-0.15
ICGS 76	302	1032	241	27813	11313	0.69
GG 7	206	627	165	18951	2451	0.15
TPG 41	119	333	95	10905	-5595	-0.34
SEd	13	81	11	888	65	0.01
CD (*P=0.05*)	26	172	25	1905	140	0.03

Cost of seed: Rs 111/kg, Cost of cultivation: Rs 16500 /ha

Plate 11. General view of the experiment on seed production in coconut plantation and number of pods / plant

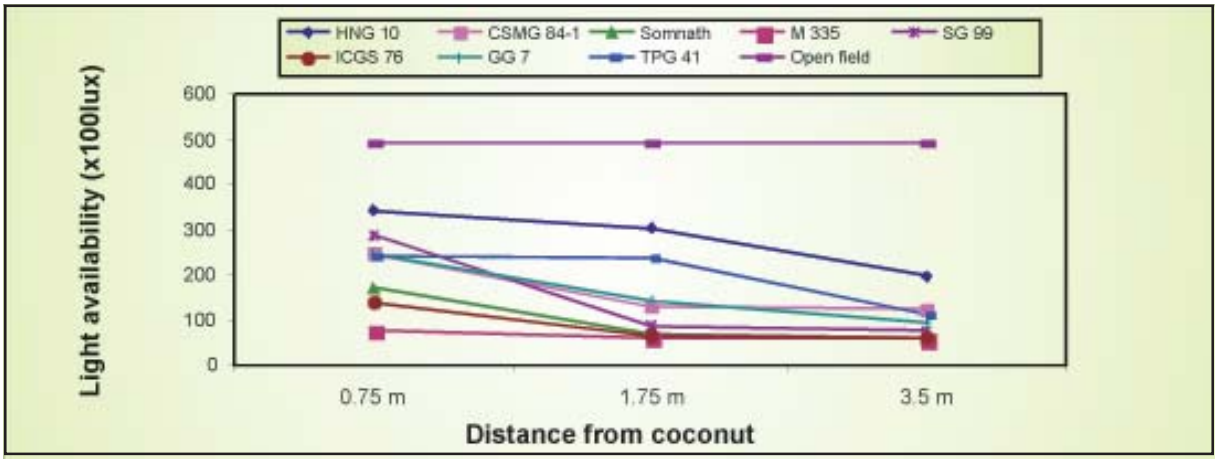


Fig.14. Light availability in coconut plantation

Evaluation of method, date of sowing and varieties of table purpose groundnut

Confirmatory experiment on evaluation of method, date of sowing and varieties of table purpose groundnut was undertaken during 2008-09 at field crops experimental research farm, Bloomsdale. The soil was sandy loam with pH 6.4, 0.81 % organic C, medium in available N, P and K. The experiment was conducted in split plot design by assigning two method of sowing (manual line sowing and manual dibbling) in main plots and three date of sowing (24 Dec 2008, 7 Jan 2009 and 22 Jan 2009) and two varieties (SG 99 and ICGS 76) in sub plots with three replications. Yield parameters and yield were recorded and economics was worked out by using standard procedures. Soil samples were collected in every standard week during the cropping period to monitor soil moisture status.

Like previous year, rainfall received during 48th standard meteorological week led to higher moisture which delayed field preparation. Soil moisture reached around 10-15 % in 51st week only. Hence two years results suggests that the soil is suitable for field preparation in 51st week only (Fig.15) and sowing can be taken in 52nd week (24-31 Dec). Unlike previous year, not much rainfall was received during critical crop growth stages and hence, irrigation at life, flowering, pegging and pod development stages were given. Methods of sowing did not influence significantly the number of pods plant^{-1}, pod yield haulm yield and net returns (Table 17). Although, manual dibbling led to slightly higher net returns but B:C ratio was slightly higher under manual line sowing. Date of sowing significantly influenced the number of pods/plant, pod yield, haulm yield, net return and B: C ratio. Early sowing (24 Dec 2008) led to higher number of pods plant^{-1} (20.6), pod yield (4076 kg ha^{-1}) which is at par with sowing in the first fortnight of January (7th Jan 2009) whereas

delayed sowing (22 Jan 2009) led to lower yield. Similar result was observed for net return and B: C ratio also. Yield parameters, yield, net returns and BC ration for SG 99 and ICGS 76 varieties were found non significant. Interaction of factors studied was absent. The results confirm the previous year findings.

Plate 12. General view of the experiment on date, method of sowing and varieties and size of the pods in first date of sowing

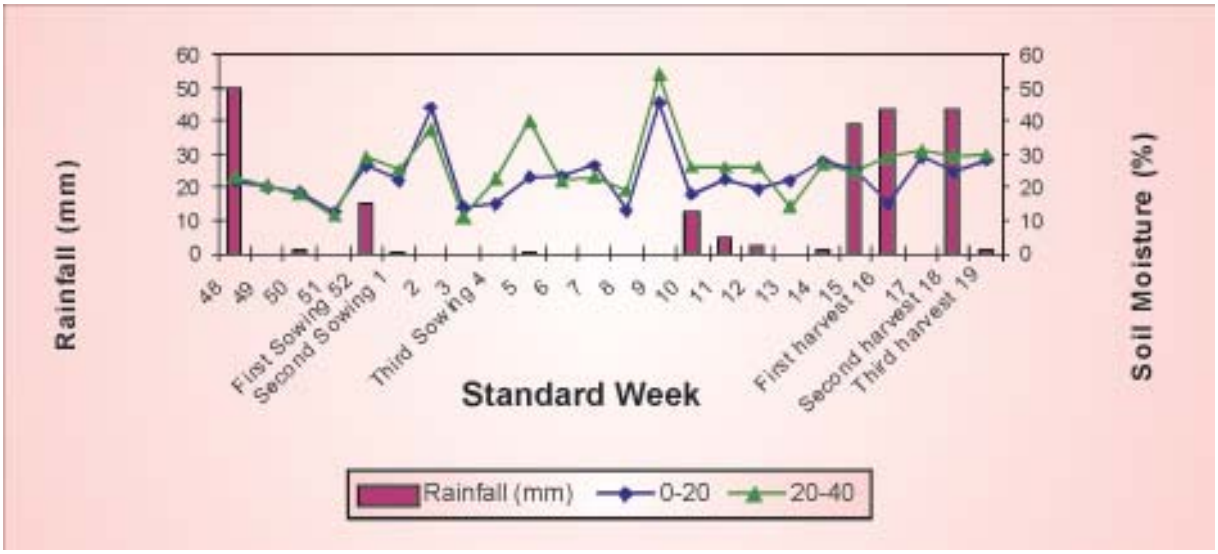


Fig.15. Soil moisture pattern of table purpose groundnut during various date of sowing

It can be concluded that, sowing of table purpose groundnut should be preferably done between last week of December to first week of January (SG 99 and ICGS 76 varieties) using in manual line sowing method. Net return of Rs. 56000/ ha can be obtained from rice fallow lands having sandy or sandy loam soils.

Table 17. Influence of method, date of sowing and varieties on number of pods/ plant, yield and economics of table purpose groundnut

Treatments	Number of pods/plant	Pod yield (kg ha^{-1})	Green haulm yield (kg ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Method of sowing						
Manual line sowing	17.1	3742	20459	76588	56138	2.74
Manual dibbling	18.7	3802	21605	78634	56884	2.61
SEd	3.4	298	2332	6711	6710	0.32
CD *(P=0.05)*	NS	NS	NS	NS	NS	NS
Date of sowing						
24 Dec 2008	20.6	4076	23413	84553	63453	3.00
07 Jan 2009	17.4	3910	22222	80872	59772	2.83
22 Jan 2009	15.7	3329	17460	67395	46295	2.19
SEd	1.9	215	1331	3580	3580	0.17
CD *(P=0.05)*	4.0	448	2776	7648	7468	0.36
Varieties						
SG 99	19.6	3750	21076	77319	56220	2.67
ICGS 76	16.2	3794	20988	77902	56803	2.69
SEd	7.8	175	1087	2923	2923	0.14
CD *(P=0.05)*	NS	NS	NS	NS	NS	NS

Evaluation of irrigation and mulching practices for table purpose groundnut

An experiment was also conducted to evaluate irrigation and mulching practices for table purpose groundnut during dry season of 2008-09 at field crops experimental research farm, Bloomsdale. The soil was sandy loam with pH 6.3, 0.72 % organic C, medium in available N, P and K. The experiment was conducted in split plot design with irrigation treatments (no irrigation, one irrigation at pegging, two irrigation at life and pegging, three irrigation at life, flowering and pegging and four irrigation at life, flowering, pegging and pod development stages) in main plot and mulching treatments (paddy straw, banana leaf, *Gliricidia* leaf and no mulch) in sub plot with three replications. The depth of irrigation applied was 5 cm. The period coinciding with critical stages *viz.*, life, flowering, pegging and pod development stages are 3, 45-50, 50-55 and 65–85 DAS

respectively. Mulching treatment was imposed on 45 DAS. Soil moisture was monitored throughout the crop growth period besides recording of yield parameters and yield. Economics and water productivity in terms of kg m^{-3} and Rs m^{-3} were also worked out using standard procedures.

The results revealed that application of two irrigations at life and pegging led to higher pod yield of 3771 kg ha^{-1} compared to three and four irrigation that recorded lower but yield at par of 3645 kg ha^{-1} and 3412 kg ha^{-1}, respectively (Table 18). Pod yield of 2852 kg ha^{-1} was recorded in case of no irrigation. Among the mulching materials, paddy straw registered significantly higher pod yield of 3594 kg ha^{-1}. Mulching with banana and *Gliricidia* recorded on par yield with no mulch proving its ineffectiveness which might be due to the quick drying nature of these materials leading to low coverage of soil surface. Interaction between irrigations and mulching materials was found significant. Paddy straw mulching proved to be highly effective at no irrigation, one irrigation, two and three irrigations compared to four irrigations in which no mulch registered higher yield of 3546 kg ha^{-1}. Higher pod yield in no mulch at four irrigations could be attributed to easy pegging with sufficient water. Combination of no irrigation and no mulch recorded lowest yield of 2689 kg ha^{-1}.

Irrigation at critical stages has significantly influenced the green haulm yield. Four irrigation led to higher haulm yield of 13316 kg ha^{-1} which might be due to more vegetative growth under higher water regimes. However it is at par with all the other treatments except no irrigation. Similarly paddy straw mulching recorded higher haulm yield of 13404 kg ha^{-1} which is at par with banana and *Gliricidia* mulch.

The moisture content pattern at 0–20 cm soil depth during the crop growth period shows

Plate 12. Over all view of the experiment after mulching and comparison of mulching between paddy straw and *Gliricidia*

that different irrigation treatments are having different peak soil moisture at critical stages as per the applied irrigation water and rainfall. Irrigation at life and pegging received total quantity of 130.7 mm of water including rainfall as against 233.8 mm in four irrigations (Fig.16). Highest pod yield was recorded with 130.7 mm of water. More than two irrigations led to lower yield.

Higher net return of Rs. 46210 ha^{-1} with B:C ratio of 2 was recorded in two irrigations which is due to higher pod yield. Similarly paddy straw mulching registered net return of Rs. 43350 ha^{-1} with B: C ratio of 1.81 (Table 19). Higher B: C ratio of 1.95 in no mulch is due to no cost involved in mulching. Owing to the fact that, with less water maximum yield recorded by two irrigations, water productivity of 3.65 kg m^{-3} and Rs 44.79 m^{-3} (Table 20) was recorded in the same treatment which is much higher than the three and four irrigations. Though the higher water productivity of 6.46 kg m^{-3} and Rs. 76.1 m^{-3} was recorded with one irrigation, the pod yield is significantly lower.

It can be concluded that two irrigations at life and pegging with paddy straw mulch on 45 DAS can be advocated for realizing higher pod yield, net returns, B: C ratio and water productivity.

Table 18. Influence of irrigation and mulching on pod and haulm yield of table purpose groundnut

Treatments	Pod yield (kg ha^{-1})					Green haulm yield (kg ha^{-1})				
	Paddy straw	Banana	*Gliricidia*	No mulch	Mean	Paddy straw	Banana	*Gliricidia*	No mulch	Mean
No irrigation	3091	2772	2854	2689	2852	12346	11640	13051	11288	12081
One irrigation	3228	3884	3391	2817	3330	12346	13404	12346	10934	12258
Two irrigation	4021	3638	3692	3729	3771	14462	10934	13756	12345	12875
Three irrigation	4349	3182	3164	3884	3645	15520	11287	13051	11640	12875
Four irrigation	3282	3264	3556	3546	3412	12346	14109	13404	13404	13316
Mean	3594	3348	3332	3334		13404	12275	13122	11922	

	SEd	CD (*P=0.05*)	SEd	CD (*P=0.05*)
Irrigation	185	425	480	1107
Mulching	123	250	641	1309
Irrigation at mulching	489	1077	1621	NS
Mulching at irrigation	356	728	1433	NS

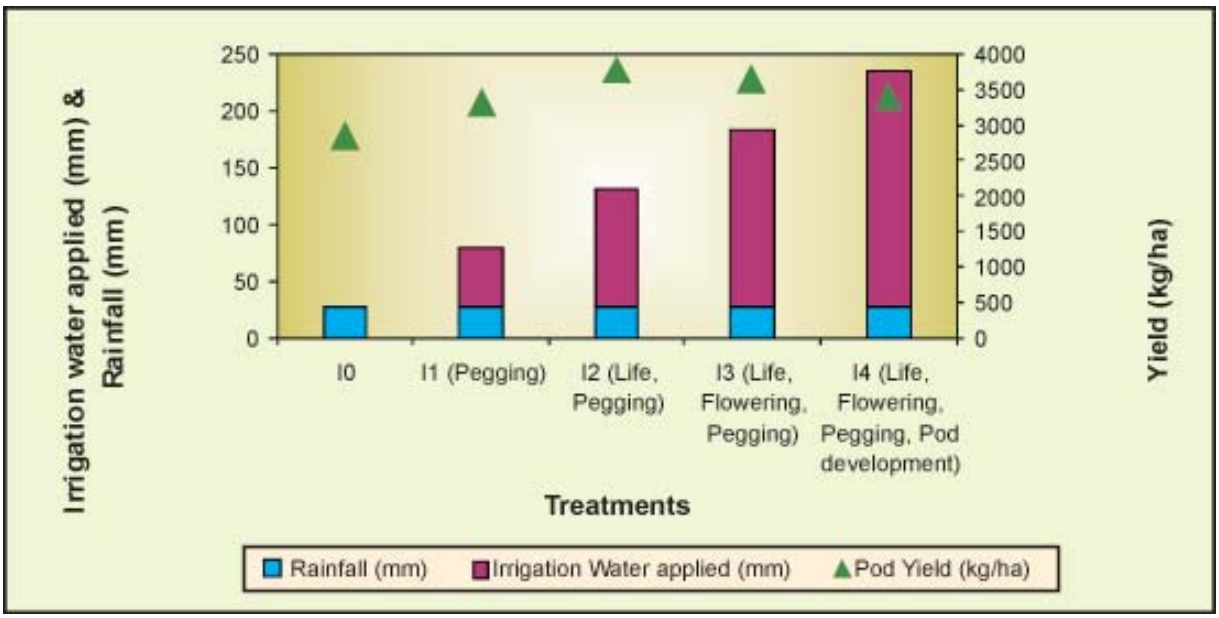


Fig.16. Influence of irrigation at critical stages on yield of table purpose groundnut

Table 19. Influence of irrigation and mulching on economics of table purpose groundnut

Treatment	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Irrigation at critical stages			
No irrigation	54857	32157	1.42
One irrigation	62214	39254	1.71
Two irrigation	69430	46210	2.00
Three irrigation	67550	44070	1.89
Four irrigation	64503	40763	1.73
SEd	5508	5508	0.24
CD (*P=0.05*)	12701	12701	0.55
Mulching			
Paddy straw	67320	43350	1.81
Banana	62498	38528	1.61
Gliricidia	63098	39128	1.63
No mulch	61927	40956	1.95
SEd	2381	5508	0.12
CD (*P=0.05*)	4863	12701	0.25

Table 20. Influence of irrigation and mulching on irrigation water productivity of table purpose groundnut

Treatments	Irrigation water productivity				
	kg m^{-3}/ Rs m^{-3}				
	Paddy straw	Banana	*Gliricidia*	No mulch	Mean
No irrigation	-	-	-	-	-
One irrigation	6.26/71.84	7.53/92.98	6.58/76.61	5.46/62.98	6.46/76.10
Two irrigation	3.90/49.25	3.53/43.80	3.58/43.80	3.62/45.87	3.65/44.79
Three irrigation	2.81/36.53	2.06/22.48	2.04/23.45	2.51/31.46	2.36/28.48
Four irrigation	1.59/17.98	1.58/18.70	1.72/20.48	1.72/21.87	1.65/19.76
Mean	3.64/43.90	3.67/43.61	3.48/41.08	3.33/40.54	

Effect of Supplemental Irrigation on Crop Yield and Water use Efficiency in Rice Based Cropping System of A&N Islands

R. Raja, T. Subramani, S. Ghoshal Chaudhuri, M. Din, Subhash Chand, S.K. Ambast, S.K. Zamir Ahmed and S.K. Verma

Productivity enhancement of rice by use of long duration varieties and adoption of improved management practices during monsoon season (Jun-Nov, 2008)

High yielding long duration rice varieties *viz*., Ranjit (155-160 days), Savitri (145 days) Varshadhan (160 days) and Gayatri (160 days) along with Taichung sen Yu and C14-8, as local check, were evaluated at research farm and farmer's field during 2008 to utilize the available growing period to the maximum extent under island ecosystem. In the Bloomsdale research farm, Ranjit recorded highest grain yield (3.3 t ha^{-1}) followed by medium duration Taichung sen Yu (2.5 t/ha) compared to other varieties those recorded lesser yield mainly due to lodging. The higher yield of Ranjit could be attributed to its better growth and yield attributes over other varieties (Table 21 & 22). In farmer's field, long duration varieties produced significantly higher grain yield (Varshadhan: 3.2 t ha^{-1}; Gayatri: 2.4 t ha^{-1}; Ranjit: 2.3 t ha^{-1}; Savitri: 2.0 t ha^{-1}) than C 14-8 (1.8 t ha^{-1}) in spite of minimal management practices adopted by the farmer during the crop growth period (Table 23). The increased yield of long duration varieties over the local checks under on-station and on-farm conditions has resulted in increased gross and net income per hectare and in turn resulted in higher B:C ratio (Table 22 & 23).


Plate 13. Long duration rice variety along with local check

Table 21. Growth and yield attributes of rice varieties in Bloomsdale Research Farm

Varieties	Height (cm)	DMP at harvest(kg/ha)	Ear bearing tillers/hill	No. offilled grains/hill	1000 grain weight(g)
Ranjit	147	8480	16.30	570	21.20
Savitri	135	7647	13.52	522	22.72
Varshadhan	156	9233	15.37	490	23.90
Gayatri	123	7043	11.48	440	20.96
TSY	102	6632	10.21	382	21.94
SEd	4.96	426	1.78	37.63	0.88
CD (P=0.05)	10.78	929	3.90	81.98	1.91

Table 22. Yield and economics of rice varieties in Bloomsdale Research Farm

Varieties	Grain yield (kg/ha)	Straw yield (kg/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B: C ratio
Ranjit	3273	4125	31946	17206	2.17
Savitri	1778	4107	19220	4480	1.30
Varshadhan	1535	3836	16883	2143	1.15
Gayatri	1576	4551	17947	3207	1.22
TSY	2505	3858	25151	10411	1.71
SEd	101	211	-	-	-
CD (P=0.05)	221	458	-	-	-

Table 23. Yield and economics of rice varieties at Farmer's field

Varieties	Grain yield (kg/ha)	Straw yield (kg/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Ranjit	2333	3833	23664	10224	1.76
Savitri	2000	3771	20771	7331	1.55
Varshadhan	3200	4339	31539	18099	2.35
Gayatri	2400	3900	24300	10860	1.81
C 14-8	1840	3686	19326	5886	1.44
SEd	65	297	-	-	-
CD (P=0.05)	142	NS	-	-	-

Table 24. Details of supplemental irrigation provided at different crop growth stages

Crop	Supplemental irrigation levels				
	I_1	I_2	I_3	I_4	I_5
Maize	*TI*	*TI and GF*	*KHS, TI and GF*	*KHS, TI, Early GF and M*	*Eight* ***irrigations***
Green gram	F	F and PS	Pre-F (25 DAS), F and PS	Pre-F, F, Early PS and Early M	Four irrigations
Sesamum	F	F and PS	4-5 leaf stage (25 DAS), F and PS	4-5 leaf stage, F, Early PS and Early M	Six irrigations
Okra	F	F and FF	EVS, F and FF	EVS, F, FF – 1 and FF – 2	Eight irrigations
Chilli	F	F and FF	EVS, F and FF	EVS, F, FF – 1 and FF – 2	Eight irrigations

TI- Tassel initiation; F- Flowering; GF: Grain filling; PS- Pod setting; FF- Fruit formation; KHS- Knee high stage; EVS- Early vegetative stage; M- Maturity

Supplemental irrigation for crops during post monsoon season (Feb–May, 2009)

In order to optimize the supplemental irrigation (SI) schedule for different crops for getting maximum profit during dry season, field trial was taken up with different supplemental irrigation treatments (No irrigation, one, two, three and four supplemental irrigations and farmer's practice) as main plots and crops (maize, green gram, sesamum, chilli and okra) as subplots during 2009 in the rice fallows of Bloomsdale research farm. The details of applied supplemental irrigation (5 cm /irrigation) at critical crop growth stages are given in Table 24. However, in case of farmer's practice (I_5), due to intermittent rainfall only six irrigations were given to maize, okra and chilli instead of eight irrigations proposed in the treatment

received during crop growth period. The supplemental irrigation had a significant effect on growth of post monsoon crops (Table 25). In general, the yield of post monsoon crops during 2009 was comparatively lesser than previous year due to late sowing and high rainfall at harvesting stage.

Table 25. Effect of supplemental irrigation on yield of post monsoon crops

Irrigation levels	Yield (kg ha^{-1})*				
	Maize	Green gram	Sesamum	Okra	Chilli
I_0	2371	250	781	8287	825
I_1	2975	276	826	8755	872
I_2	2934	295	992	9900	1167
I_3	3130	340	1014	10298	1723
I_4	3292	328	1136	11766	2012
I_5	3553	304	1089	11994	2429
SEd	129	11	35	452	84
CD (P=0.05)	274	25	75	963	179

* Average yield of maize, green gram and sesamum are reported at 10 % moisture level while the yield of okra and chilli are reported as weight of the fresh harvested produce

In maize, providing four supplemental irrigations (I_4) has resulted in yield (3292 kg ha^{-1}) at par with I_5 (3553 kg ha^{-1}). Providing three supplemental irrigations (I_3) has resulted in significantly higher yield (3130 kg ha^{-1}) than that of I_0 where no irrigation was given and yield at par with I_4. The percent yield increase over I_0 due to SI was 26, 24, 32, 39 and 50 % in I_1, I_2, I_3, I_4 and I_5, respectively. With respect to green gram, providing three supplemental irrigations (I_3) has resulted in higher yield (340 kg ha^{-1}) than all other treatments. In case of sesamum, four supplemental irrigations (I_4) has registered higher yield (1136 kg ha^{-1}) than six irrigations (I_5) generally practiced by the farmers (1089 kg ha^{-1}). In case of vegetables, supplemental irrigations have significantly increased the yield levels and economic returns. The maximum yield was achieved under I_5 in both okra (11994 kg ha^{-1}) and chilli (2429 kg ha^{-1}). However, providing supplemental irrigations has resulted in significantly higher yield to the tune of 6, 19, 24 and 42 % in case of okra and 6, 41, 109 and 144 % in chilli for I_1, I_2, I_3, and I_4 treatments, respectively over I_0 (no irrigation), which enhanced both economic and water productivity (Table 26 & 27).

Table 26. Economics of supplemental irrigation

Irrigation levels	Net returns (Rs. ha^{-1}) and B:C ratio				
	Maize	Green gram	Sesamum	Okra	Chilli
I_0	8618 (1.83)	-2300 (0.73)	3165 (1.37)	80394 (5.22)	7320 (1.68)
I_1	13190 (2.24)	-1910 (0.78)	3580 (1.41)	85750 (5.44)	8094 (1.73)
I_2	12602 (2.16)	-1695 (0.81)	5810 (1.64)	99230 (6.07)	14324 (2.26)
I_3	13910 (2.25)	-830 (0.91)	5880 (1.63)	103746 (6.23)	26296 (2.26)
I_4	14946 (2.31)	-1390 (0.86)	7450 (1.78)	121102 (7.03)	32394 (3.73)
I_5	16514 (2.39)	-1910 (0.81)	6825 (1.72)	123318 (6.98)	41048 (4.31)

Table 27. Water productivity under different irrigation levels for post monsoon crops

Irrigation levels	Water productivity									
	Maize		Green gram		Sesamum		Okra		Chilli	
	kg m^{-3}	Rs/m^3	kg m^{-3}	Rs/m^3	kg m^{-3}	Rs/m^3	kg m^{-3}	Rs/m^3	kg m^{-3}	Rs/m^3
I_0	1.62	5.90	0.42	-3.89	0.53	2.16	8.05	78.05	0.57	5.01
I_1	1.52	6.73	0.25	-2.11	0.42	1.83	5.72	56.05	0.44	4.13
I_2	1.19	5.12	0.19	-1.20	0.40	2.36	4.88	48.88	0.47	5.82
I_3	1.06	4.50	0.16	-0.81	0.34	1.99	4.07	41.01	0.58	8.88
I_4	0.95	4.32	0.13	-0.54	0.33	2.15	3.88	39.97	0.58	9.36
I_5	0.80	4.17	0.12	-0.62	0.24	1.72	2.98	34.93	0.54	10.37

*Water productivity is taken as the ratio of yield and total water supply (rainfall (146 mm for maize, sesamum and chilli, 103 mm for okra and 59 mm for green gram , respectively) + SI)

Maize

Okra

Sesamum

Chilli

Plate 14. View of post monsoon crops with supplemental irrigation

Performance Evaluation of Different Structures of Protected Cultivation in the Humid Tropics of Bay Islands

M. Din, R.C. Srivastava, N. Ravisankar, D.R. Singh, Krishna Kumar and Subhash Chand

Cultivation of high value crops become difficult due to high inside temperature and humidity than the ambient conditions in closed type greenhouse. It is mainly due to poor air exchange in absence of ventilation facility. A natural ventilated even span with saw tooth shape type greenhouse (size - 25 m x 10 m; gutter height - 2 m, centre heights - 3.5 m) was constructed at Central Agricultural Research Institute, Port Blair. The performance of high value crops like capsicum, lettuce, cauliflower, okra and coriander was evaluated. During the year, two experiments were conducted to study the influence of spacing on capsicum and performance evaluation of different crops apart from regular recording of observations on temperature, light availability and humidity.

Micro climate

Diurnal temperature, humidity and light availability at inside and outside the poly house were recorded at regular intervals. Air temperature inside the poly house varied between 28-34 °C and 26-28 °C and humidity 85% during the month of August. Throughout the day, the temperature inside the poly house was higher compared to open conditions (Fig. 18). Misting was operated when inside temperature reached to 34 °C. For each 3 minutes duration of misting, the temperature inside greenhouse dropped to 1.8 °C and it required around 168 litres of water. The temperature inside the poly house was more than optimum and ambient conditions indicating need for increase in ventilation area to more than 12%. Light availability inside the poly

house was almost 20-25 % lesser than the outside throughout the day except at 1 PM when it was recorded almost same. The effect of ventilation area on the micro climate of poly house was also evaluated. When ventilation was provided up to 11.95% of area of greenhouse, the temperature inside the greenhouse ranged between 30.6-38.5 °C. Solar radiation ranged between 98-800 W/m² with an average solar radiation of 449 W/m² during March 2009. Hourly observations on temperature, relative humidity and solar radiation were recorded in even span type of poly house with fully open from top and side walls during March 2009. Ambient temperature varied from 27.9 °C to 33.4 °C and humidity ranged from 59 to 82 % whereas solar radiation varied from 162 W/m² to 982 W/m².

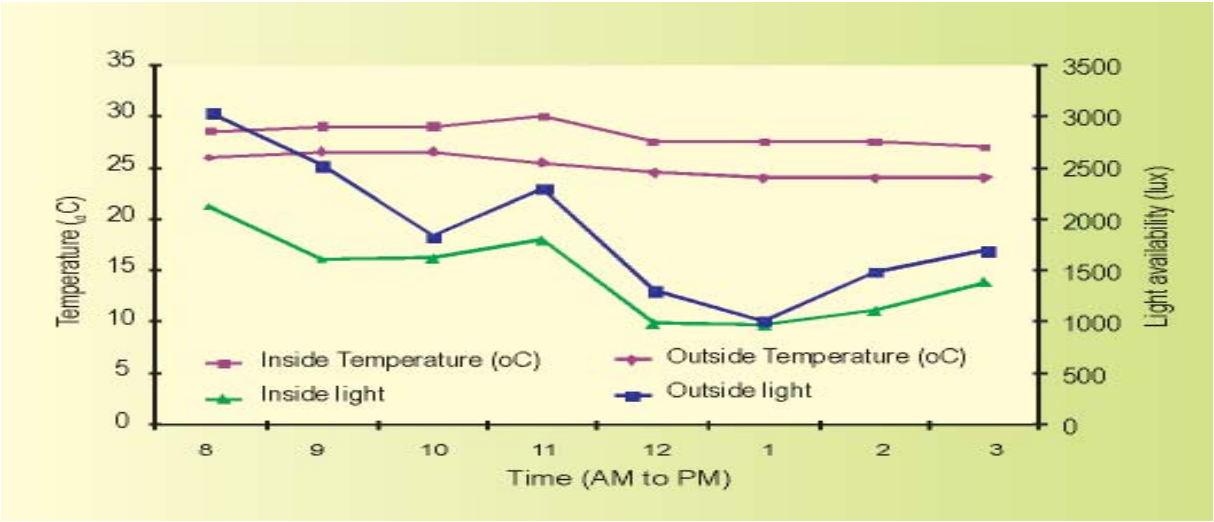


Fig. 18. Comparison of inside and outside temperature and light availability in Poly house on 8 August 2008

Influence of spacing on capsicum

Experiment was conducted to find out the optimum spacing for cultivation of capsicum in the poly house under humid Islands condition. Intra row spacing was altered so as to provide more growing space to the capsicum plants. Three spacing *viz.*, 60 X 30 cm, 60 X 45 cm and 60 X 60 cm were experimented in randomized block design with seven observations in each treatment making the replications. Observations on fruit weight, fruit volume and yield were recorded. Among the different spacing evaluated, wider spacing of 60 X 60 cm recorded significantly higher fruit weight (231 g/fruit) and volume (500 cc/fruit) followed by 60 X 45 cm spacing (Table 28). Closer intra row spacing of 60 X 30 cm led to significantly lower fruit weight and volume. Further, 60 X 60 cm spacing recorded significantly higher yield of 138 and 4620 kg in 300 m² and 1 ha

respectively. Closer intra row spacing of 45 and 30 cm recorded yield at par. Higher yield in wider intra row spacing of 60 cm might be due to better micro climatic conditions which favoured the higher fruit weight and volume.

Table 28. Influence of spacing on fruit weight, volume and yield of capsicum

Spacing	Capsicum weight (cc/capsicum)	Volume (CC/capsicum)	Yield (kg)	
			300 m^2	1 ha
60 X 30 cm	146	250	110	3654
60 X 45 cm	188	300	108	3600
60 X 60 cm	231	500	138	4620
SEd	19	36	11	384
CD (*P=0.05)*	41	78	25	837

Plate 15 Capsicum experiment in poly house and harvested capsicum

Plate 17. Comparative performance of different spacing in capsicum and fruit size in 60 X 60 cm

Performance evaluation of crops

Five crops *viz.*, okra, cauliflower, coriander, capsicum and lettuce were evaluated in randomized block design with four replications in order to assess the performance of these crops under poly house. Observations on yield were recorded. Among the different crops evaluated, cauliflower registered higher yield of 7707 kg/ha (Table 29) followed by capsicum (6682 kg/ha) and lettuce (3540 kg/ha). Comparatively lesser performance of okra in poly house conditions is attributed to higher pest and disease attack under high humid conditions.

Table 29. Performance of different crops in protected cultivation structures

Crop	Yield (kg)	
	300 m^2	1 ha
Okra	58	1920
Cauliflower	231	7707
Coriander	88	2935
Capsicum	200	6682
Lettuce	106	3540
SEd	7	247
CD (*P=0.05*)	16	537

Plate 17. Performance of cauliflower and lettuce in poly house

It can be concluded that, ventilation area of more than 12% of poly house area is to be kept for maintaining the temperature inside the poly house. Spacing of 60 X 60 cm can be recommended for capsicum under poly house conditions of bay islands to realize higher yield. Similarly, high value crops such as cauliflower, capsicum and lettuce can be recommended under poly house for higher yield and returns from the investment.

Farmers Participatory Action Research Programme (FPARP)

R.C. Srivastava, S.K. Ambast, N. Ravisankar, S. Jeyakumar, Kamal Sharma and S.K. Zamir Ahmed

The project was initiated with the objective to demonstrate institute technologies to increase productivity and profitability of farms along with overall objective of achieving high water productivity as per the concept of more income per drop of water. Four technologies *viz.*, tank-well system, micro irrigation, pond based integrated farming system and crop diversification through broad bed and furrow system were selected for demonstration in 48 farmers field of South Andaman, Little Andaman, Havelock and Neil Islands. The name of the villages covered in each island is presented in Table 30. Out of 48 demonstrations, 21 have been completed during the year.

Table 30. Island wise villages covered under FPARP

S. No.	Islands	Villages
1.	South Andaman	Chouldari, Port Mout, Indiranagar, Manjeri, New Manglutan, Guptapara, Calicut, Maccapahar, Anicut, Miletilak and Hazaribagh
2.	Little Andaman	R.K.Puram, Netajinagar and V.K. Puram
3.	Havelock Island	Syamnagar, Vijaynagar, Govindnagar and Kala Pathhar
4.	Neil Islands	Ramnagar, Laxmanpur, Bharatpur, and Sitapur

Plate 18. Site selection and completed well for demonstration of tank cum well system

Plate 19. Poultry shed in the pond and distribution of chicks for pond based IFS demonstration

Plate 20. Making of BBF and bitter gourd grown (pandal system) in the beds for demonstration of BBF technology

Division of Horticulture & Forestry

Standardization of Technologies for Protected Cultivation of Vegetable Crops Under A & N Conditions

Shrawan Singh, V.B. Pandey and M. Din

Varietal evaluation of tomato and capsicum under protected conditions in Bay Islands

The climatic conditions and geographical location of Andaman & Nicobar Islands are highly suitable for protected cultivation of vegetable crops. The prolonged rainy period from May to December make it difficult to grow vegetable crops under open conditions and creates deficiency of vegetables in market (fig.-1). Therefore, to standardize production technology for protected cultivation of vegetables, experiments were conducted to identify the most promising cultivar(s) of tomato and capsicum for protected cultivation under humid tropical islands conditions.

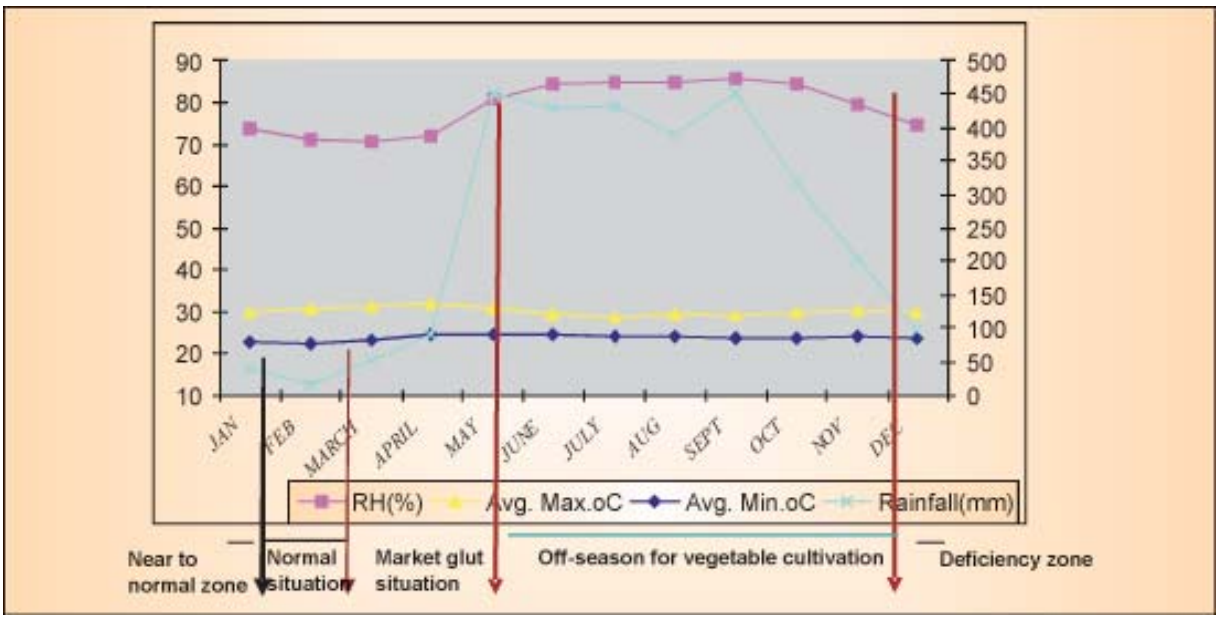


Fig.1. Characterization of vegetable production and market cycle in A & N IslandsTomato

Tomato: Six varieties of tomato *viz*. two indeterminate (Cherry tomato, G 600), two semi-determinate (Laxmi, Saktiman) and two determinate (Arka Ananya, Arka Vikash) were evaluated under polyhouse conditions. The experiment was conducted under randomized block design with four replications. The earliest flowering was observed in Saktiman (35DAT). The maximum fruits/cluster was recorded in Cherry Tomato (12.47) which was significantly higher than G 600 (4.1) (Table 1). The highest number of clusters/plant was recorded in determinates *viz*. Saktiman (10.5) and Laxmi (10.32), but number of fruits/plant was maximum in Cherry Tomato (109.8). The

fruits/plant was highest in G 600 (37.4) followed by Laxmi (30.58). The maximum fruit weight was recorded in Arka Vikash (67.25g) followed by G 600 (57.32g). The highest yield was recorded from G 600 (79.47 t/ha) followed by Arka Vikash (70.17t/ha). The lowest yield was recorded in Saktiman (50.71t/ha) and Arka Ananya (51.22 t/ha). However, the low yield of indeterminate Cherry tomato (58.05 t/ha) can be compensated by higher price.

Capsicum : Seven varieties of capsicum *viz*. Indra, California Wonder, Arka Gaurav, Arka Basant, Arka Mohini, Yolo Wonder (all green) and Orobelle (yellow colour) were collected from IIHR, Bangalore, IARI Regional Station, Katrain (Himachal Pradesh) and Centre for Protected Cultivation, IARI, New Delhi. Raised beds of 75cm width and 15 cm height were prepared at 30cm spacing between beds. Two rows of capsicum were planted on each bed with 40cm plant to plant spacing. Shadenet and intermittent misting in afternoon hours were used to reduce the inside temperature of polyhouse. The earliest 50% flowering was recorded in Yolo Wonder (41.33 days) while maximum number of fruits per plant was recorded from Indra (10.26) followed by California Wonder (8.76). The highest marketable yield was recorded from Indra (47.63t/ha) followed by California Wonder (38.66t/ha). The highest loss in terms of malformed/damaged fruits was recorded in Yolo Wonder (2.5fruits/plant) followed by Arka Gaurav (2.10 fruits/plant). But highest marketable fruit yield was observed in Orobelle (48.38%) followed by Yolo Wonder (40.69%) and minimum loss was recorded in Indra (14%) (Table 2).

Table 1. Performance of tomato cultivars under polyhouse conditions in A & N Islands

Cultivars	Plant height (cm)	Days to 50% flowering	Fruits/ cluster	Cluster/ plant	No. of fruits/ plant	Fruit weight (g)	Yield/ Plant (g)	Yield (t/ha)
Cherry	181.25	40.47	12.47	8.80	109.86	14.22	1,567.22	58.05
G 600	158.75	39.77	4.10	9.10	37.34	57.32	2,145.72	79.47
Laxmi	61.75	35.12	2.96	10.32	30.58	55.42	1,697.27	62.86
Arka Ananya	66.50	36.50	3.07	10.32	31.75	43.67	1,382.85	51.22
Saktiman	55.50	35.00	2.30	10.50	24.12	56.82	1,369.10	50.71
Arka Vikash	76.50	36.17	3.28	8.57	28.23	67.27	1,894.65	70.17
SE(d)	3.05	1.14	0.32	0.52	4.00	1.39	152.28	5.28
C.D.	6.58	2.45	0.68	1.12	8.61	2.99	327.55	11.36
C.V. %	4.32	4.34	9.64	7.69	12.96	4.00	12.84	10.17

Table 2. Performance of capsicum cultivars under polyhouse conditions in A & N Islands

Cultivars	Plant height (cm)	Days to 50% flowering	Plant spread (cm)	No. of fruits/ plant	Fruit weight (g)	Yield/ plant (kg)	Yield (t/ha)	No. of unmarke table fruits/ plant	Yield loss (t/ha)	Marketable yield t/ha
Indra	69.33	42.00	43.66	10.26	123.80	1.27	63.62	1.5	9.26	47.63
California Wonder	65.66	44.00	43.43	8.76	110.13	0.96	48.34	1.76	9.68	38.66
Arka Basant	57.66	44.33	37.56	8.26	85.16	0.70	35.23	1.56	6.68	28.55
Arka Gaurav	57.33	45.33	36.50	7.16	73.70	0.52	26.28	2.10	7.66	18.62
Arka Mohini	59.66	45.66	32.16	7.00	74.70	0.52	26.16	1.91	7.16	19.00
Yolo Wonder	60.00	41.33	32.90	6.16	76.90	0.47	23.85	2.50	9.57	14.28
Orobelle	45.66	50.00	30.36	3.93	56.33	0.22	11.06	1.90	5.36	5.70
SE(d)	3.01	1.45	1.71	0.48	6.36	0.07	3.80	0.20	0.92	3.47
C.D.	6.64	3.20	3.77	1.06	14.03	0.16	8.371	0.46	2.03	7.66
C.V.	6.22	3.98	5.73	8.04	9.09	13.8	13.88	13.54	14.281	17.29

Plate 1. Capsicum cv. Indra in fruiting stage

Plate 2. Tomato cv. G-600 in fruiting stage

Plate 3. Capsicum trial in polyhouse

Plate 4. Cherry tomato from polyhouse

Collection, Conservation, Characterization and Documentation of Indigenous Vegetables of A & N Islands

Shrawan Singh, D.R. Singh, V.B. Pandey, M. Balakrishanan, S.K. Zamir Ahmed and L.B. Singh

Collection and multiplication of local/ indigenous vegetables from A & N Islands

The richness of Bay Islands for flora and fauna diversity signifies their bioprospective utility. To ensure proper conservation and utilization of existing diversity of local/indigenous vegetables of these Islands, survey and collection trips were conducted in Neil, South and North Andaman Islands. In all, 35 collections were made in ten different vegetables from these islands (Table 3 and Plate 5). Simultaneously, the indigenous knowledge of local vegetable was also collected to document it under this experiment. The collected materials are under multiplication phase at CARI, Port Blair

Ipomea aquatica

Enhydrous flactuans

Centella asiatica

Plate 5. Indigenous/ local vegetables from A & N Islands

Table 3. Collection and cataloguing of selected indigenous/local vegetables and their indigenous knowledge from Bay Islands

Sl. No.	Local Name	Botanical Name	Family	No. of collections	Edible portion	Use in food	Remark
1.	Marsha bhaji	*Amaranths sp.*	*Ameranthaceae*	2	Leaf	Leafy vegetable	Eye related problems
2.	Kadwa bhaji	*Anhydrous flactuans*	*Oxiladaceae*	4	Leaf	Vegetable soup	Jaundice, Worms clearance
3.	Nali bhaji	*Ipomea aquatica*	*Convulvulaceae*	3	Leaf	Chutney, Vegetable	As treatment on poisonous insect biting, Nerve system,
4.	Kakrol	*Momordica dioica*	*Cucurbitaceae*	3	Fruit	Vegetable, colouring matter	Eye vision, Red colour for food colouring

5.	Khatta bhaji	*Oxalis corniculata*	*Oxiladaceae*	2	Leaf, unripe fruit	Salad, Chutney Soup, Pickle, vegetable	Dyspepsia, Bloodlessness, piles, ear and hair related problems
6.	Madrasi bhaji	*Alternanyar a philocus ridous*	Ameranthaceae	3	Leaf	Chutney, mix vegetable	Constipation, animal milk enhancer, blood clotting
7.	Ghunya leaf	*Colocasia sp.*	*Araceae*	8	Leaf	vegetable	Anti-heat strock, ringworm
8.	Dal bhaji	*Portulaca sp.*	*Portulaceae*	3	Leaf and stem	Taste of dal, chutney	Ulcers, Liver, Kidney, urine problems
9.	Chaku-rmanis	*Saursops androgynus*		1	Leaf	Mix vegetable	Eye and skin related problems
10.	Mendak bhaji	*Centella asiatica*	*Ambelifereae*	7	Leaf	Vegetable chutney	Skin and tooth problem, memory enhancer
11.	Kukri bhaji	*Cycas rumphii*	*Cycaceae*	-		Vegetable chutney, pickle	Cholera, stomach problem

Development of Agro Techniques for Potato in Bay Islands

M. Sankaran, V.B. Pandey, Shrawan Singh, T. Subramani and S. Bhagat

Varietal evaluation of Potato

Two TPS (True Potato Seed) namely HPS 7/67 and 92-PT-27 were tried under South Andaman and North Andaman conditions. Maximum plant height (61.0cm) and plant spread (44.622cm) was recorded in Kufri Chipsona-III. However, maximum number of branches was observed in TPS 92-PT-27 (10.5/plant) (Table 4). The TPS 92-PT-27 was planted in first week of January and this line performed well (163.10 t/ha) under Diglipur condition (Table 5). TPS 92-PT-27 was also planted at Garacharma Farm, CARI in first week of February but yielded very small sized tubers (Plate 6&7).

Table 4. Growth Parameters recorded 50 days after sowing

S. No.	Variety	Plant height (cm)	Plant spread (cm)	No. of branches
1.	Kufri chipsona-III	61.00	44.62	5.61
2.	Kufri Badsha	35.37	26.80	3.45
3.	Kufri Bahar	41.37	44.55	4.02
4.	Kufri Anand	44.77	39.45	3.82
5.	TPS HPS 7/67	43.35	26.50	3.37
6.	TPS 92-PT-27	57.47	30.36	10.50
7.	Kufri Jyothi	64.57	41.36	7.32
	SEd	1.84	1.80	0.26
	CD	0.87	0.85	0.12
	CV	2.47	3.32	3.19

Table 5. Tuber parameters and yield of potato

S. No	Cultivers	No. of tuber/ plant	Length of tuber(cm)	Girth of tuber(cm)	Weight of tuber(g)	Weight of tubers/ plant (g)	Yield t/ha
1.	Kufri Chipsona-III	-	-	-	-	-	-
2.	Kufri Badshah	-	-	-	-	-	-
3.	TPS HPS 7/67	-	-	-	-	-	-
4.	Kufri Bahar	3.57	5.05	11.49	41.87	154.00	11.3
5.	Kufri Anand	4.47	6.05	14.61	43.04	198.00	14.5
6.	TPS 92-PT-27	6.32	5.93	14.27	54.39	372.25	16.3
7.	Kufri Jyoti	4.30	6.77	15.30	100.50	431.00	31.9
	SEd	0.15	0.18	0.58	2.05	5.36	3.99
	CD	0.36	0.42	1.33	4.70	12.29	9.16
	CV	4.81	4.41	5.91	4.83	2.62	3.05

Plate 6. Potato trial at Diglipur

Plate 7. Tuber harvested using TPS

All India Coordinated Research Project on Vegetable Crops

Shrawan Singh, D. R. Singh and V. B. Pandey

Cowpea:A varietal evaluation trial was conducted with four accessions of cowpea *viz*. ACP-1, Ankur Gomati, VRCP-6 and Arka Garima in Randomized Block Design. The highest yield was recorded in VRCP-6 (3.58t/ha) and Arka Garima (3.16t/ha).

French bean: Out of six germplasm accessions of French bean including check Contender were evaluated in Multi location trial, DWD-FB-1 (11.34 t/ha) was found to be promising for vegetable pod yield.

Dolichos bean: Varietal evaluation trail of Dolichos bean was conducted with 23 germplasm accessions. Two accessions namely IIVR Sem-8 (9.65t/ha) and IIVR Sem-11 (9.28t/ha) were found to be promising for vegetable pod yield.

Brinjal : Among twenty accessions of brinjal evaluated under multi location trial under AICRP (VC), two accessions namely PB-70 (30.3t/ha) and BS-54 (23.73t/ha) were found promising for yield.

Tomato : Thirty two entries of tomato were evaluated for yield and related parameters. Only eight survived upto fruiting stage and among them Arka Vikash (25.0 t/ha) out performed all other entries including local check Laxmi (23.6 t/ha).

All India Coordinated Research Project On Tuber Crops

T. Damodaran, D. R. Singh, R.C. Srivastava, Shrawan Singh, R. Sudha, M. Sankaran and V. Damodaran

Germplasm collections conserved at CARI
This year the existing tuber crops gene bank was enriched by the local collections from Diglipur, North Andaman district and as such a total of 31 accessions and varieties are being maintained in the germplasm pool of tuber crops. Among them 2 in sweet potato, 3 in taro, 1 in elephant foot yam, 2 in greater yam, 1 in arrow root and 2 in Xanthosoma are local collections from the South Andaman and Diglipur, North Andaman districts.

Submission of sweet potato varieties for state variety release committee: Based on the performance and high yield, the local selection CARI-SP1 (CARI-Swarna) and CARI-SP-2 (CARI- Aparna) from A&N Islands has been submitted to state variety release committee. The descriptors of CARI SP-1 and CARI SP- are given in Table 6.

Evaluation of sweet potato varieties CARI-SP1 and SP2 (URT) : Planting materials of sweet potato varieties CARI-SP1 and SP2 was multiplied and supplied to farmer's field for conducting URT at different villages of South Andaman district *viz* Chouldhari, Memyo, Wandoor, Namunaghar and two different

Table 6. Brief description of the proposed varieties under Island conditions

S.No	Characters	CARI-SP-1	CARI-SP-2
1.	Twining	Non-twining	Twining
2.	Plant type	Spreading	Spreading
3.	Vine growth rate	Slow	Intermediate
4.	Vine internode length	Short	Intermediate
5.	Vine pigmentation	Moderately purple	Moderately purple
6.	Vine tip pubescence (apical 10 centimeters of immature leaves)	None	Sparse
7.	Mature leaf lobing	Slight	Slight
8.	Mature leaf size	Medium	Medium
9.	Mature leaf colour	Green	Green
10.	Immature leaf colour	purplish –green	purplish –green
11.	Abaxial leaf vein colour	Half of main rib purple	Purple spotting
12.	Petiole length	Intermediate	Long
13.	Petiole pigmentation	Purple	Moderately purple
14.	Storage root skin colour	Purple	Pink
15.	Storage root skin colour intensity	Pale	Dark pink
16.	Storage root flesh colour	Orange	White
17.	Storage root flesh colour intensity	Pale	Pure white
18.	Flowering habit	Profuse	Moderate
19.	Flower colour	Light purple limb with purple throat	Light purple limb with purple throat
20.	Flower length (Average of 10 flowers, expressed in cm)	4.70 cm	4.48 cm
21.	Flower width (Average of 10 flowers, expressed in cm)	3.50 cm	3.94 cm
22.	Equality of sepal length	Equal	Equal
23.	Number of sepal veins	3-5	3-5
24.	Sepal shape	Elliptic	Elliptic
25.	Sepal apex	Acute	Acute
26.	Individual vein length	2.6 m	2 m
27.	Storage root length (Average length of 10 storage roots in cm)	12.86 cm	12.26 cm
28.	Storage root diameter	8.56 cm	8.58 cm
29.	Number of storage roots per plant	9	4
30.	Storage root shape variability	Moderately variable	Moderately variable
31.	Storage root size variability	Moderately variable	Moderately variable
32.	Individual tuber weight	81 g	93 g
33.	Length of individual tuber	7.7 cm	7.8 cm
34.	Girth of individual tuber	7.3 cm	12.60 cm
35.	Average yield	20.87t/ha	21.01t/ha

villages at Diglipur, North Andaman district. The evaluation is under progress.

Evaluation of sweet potato varieties CARI-SP1 and SP2 (IET) : 135 number cuttings of sweet potato (CARI-SP1) have been sent to AICRP centre, Faizabad for conducting IET for 2008-2010.

Varietal evaluation of greater yams : Ten varieties/genotypes of greater yams were evaluated. All recommended practices were followed. Growth and yield parameters were recorded, statistically analyzed and tabulated. Among the varieties, maximum number of tubers/vine (3.6 nos), maximum tuber length (23.8 cm) and highest individual plant yield (1.85 kg/plant) was obtained in the local collection CARI- DA-1 which also recorded highest yield (18.3 t/ha) followed by Sree Rupa (13.2 t/ha) and DA-215. However maximum individual tuber weight (1128g) was recorded in the variety DA-11 followed by CARI- DA-1(900g) whereas the least tuber weight was recorded in the variety DA-173 (235g). Based on the performance of local collection from A&N Islands, the entry CARI-DA-1 has been included for IET from the year 2008.

Varietal evaluation of taro: Three varieties of taro namely Sree Pallavi, Sree Kiran and Sree Rashmi were evaluated. All recommended agronomical practices were followed for trial. Growth and yield parameters were recorded, statistically analyzed and tabulated. Among three varieties, maximum number of suckers (8.2) was produced in variety Sree Pallavi followed by Sree Kiran (6.6) whereas the plant height was highest (120cm) in Sree Pallavi.

With regard to the yield attributing parameters the variety Sree Pallavi recorded the highest number of corms/plant (22.8) with highest corm weight (68.5 g) followed by Sree Kiran while the highest plant yield was recorded in Sree Kiran (1.45 kg) followed by Sree Pallavi(1.4 kg). However the maximum yield was recorded in Sree Pallavi (30t/ha) followed Sree Kiran (16.7 t/ha) whereas the lowest yield of 15.0 t/ha was recorded in Sree Rashmi.

Collection, Conservation and Molecular Characterization of Early Flowering Open Pollinated Mango Clones of Bay Islands

M. Sankaran, D.R. Singh, R. Sudha, V. Damodaran and T. Damodaran

The highest plant height was recorded (3.5m) in B1 clone followed by ML 5 (2.10m) where as the lowest height (38 cm) wa recorded in ML-7 (Table-7) .The early flowering was observed in ML9 and M2 clones during February, 2009.

Table 7. Vegetative growth parameters of OP clones mango in CARI

Sl.No	Name of the clone	Plant height (cm)	No. of branches	Flowering
1.	KL 1	130, 100 (115.00)	7 , 12 (9.00)	NO
2.	KL 2	150, 400 (275.00)	16, 16 (16.00)	NO
3.	B1	300, 400 (350.00)	12, 17 (14.50)	NO
4.	CL 1	130, 100 (115.00)	3, 3 (3.00)	NO
5.	CL 2	100, 125 (112.50)	3, 5 (4.00)	NO
6.	ML 8	150, 160 (155.00)	4, 5 (4.500)	NO
7.	ML 9	400, 130 (265.00)	9, 8 (8.50)	YES
8.	ML 10	100, 400 (200.00)	10, 17 (13.50)	NO
9.	ML 6	80, 70 (75.00)	2, 5 (3.50)	NO
10.	ML 7	75 (75.00)	4 (4.00)	NO
11.	ML 3	140, 150 (145.00)	9, 6 (7.50)	NO
12.	ML 4	300, 150 (225.00)	10, 5 (7.50)	NO
13.	ML 5	220, 200 (210.00)	12, 10 (11.00)	NO
14.	GL 4	130 (130.00)	7 (7.00)	NO
15.	M 1	70, 145 (107.50)	2, 8 (5.00)	NO
16.	M 2	300, 200 (250.00)	16, 9 (12.50)	YES
17.	GL 1	210, 190 (200.00)	5, 2 (3.50)	NO
18.	GL 2	36, 240 (138.40)	4, 6 (5.00)	NO
19.	GL 3	250, 140 (195.00)	8, 5 (6.50)	NO

Studies on Effect of Plant Growth Promoting Biocontrol Agents on Growth and Yield of Papaya

R. Sudha, T. Damodaran, D.R. Singh and Krishna Kumar

An experiment was conducted to study the effect of plant growth promoting biocontrol agents on the growth and yield of papaya (local selection). Accordingly, the treatments viz., *Pseudomonas, Trichoderma, Pseudomonas* + *Trichoderma*, chemical fungicide were applied at 30 days interval in papaya variety GL-1. Morphological and biochemical parameters were recorded at regular intervals during reproductive phase. Among the various treatments, combined application of *Pseudomonas* 0.2% + *Trichoderma* 2.5kg/ha at 30 days interval performed well in terms of number of fruits/tree, fruit weight, cavity index, TSS and total sugars.

Yield parameters : Maximum no. of fruits per tree was recorded in T3 (combined application of Pseudomonas and Trichoderma) followed by T1 (Pseudomonas 0.2% spraying). Highest fruit weight (670.25) was recorded in T1 (Pseudomonas 0.2% spraying). Maximum fruit length (21.50 cm) and fruit girth (34.00 cm) was recorded in T3 (Table 8). The treatment T3 also registered highest fruit volume (1022.30 CC), cavity volume (210.10 CC), cavity index (20.55%), TSS (14.73^0 Brix) and ascorbic acid content (36.80 mg/100 gm) which was followed by T1. Maximum total sugar (12.26%), reducing sugar (11.00 %) and non-reducing sugar content (1.26%) was observed in T3 treatment (Table 9 and Fig. 2).

Nutrient status of the plant : Among the treatments, there was no significant difference of nitrogen, phosphorus and potassium content in matured petiole. However the highest nitrogen, phosphorus and potassium content was registered in combined application of Pseudomonas and Trichoderma treatment (4.86%, 0.38% and 3.77% respectively) which was on par with T2 (Soil application of Trichoderma 2.5kg/ha). The highest nutrient content in biocontrol agents treated plants might be due to the mechanism of asymbiotic nitrogen fixation

Table 8. Effect of plant growth promoting biocontrol agents on Fruit volume (cc), Cavity volume (cc), cavity index (%) of fruits of papaya (GL-1)

Treatments	No. of fruits/ tree	Weight of the fruit (gm)	Fruit volume (cc)	Cavity volume (cc)	Cavity index (%)
Seedling treatment of Pseudomonas + spraying @0.2% at 30 days interval	30.50	670.25	1018.30	204.20	20.05
Seedling treatment of Trichoderma + soil application @2.5kg/ha at 30 days interval	27.80	425.56	994.20	212.60	21.38
Pseudomonas seedling treatment + spraying @0.2% Pseudomonas and soil application of Trichoderma @ 2.5kg/ha at 30 days interval	31.66	600.23	1022.30	210.10	20.55
Pseudomonas seedling treatment + spraying @0.2% Pseudomonas, soil application of Trichoderma @2.5kg/ha and spraying of dithane M 45 at 30 days interval	28.30	525.80	986.10	224.30	22.74
Seedling treatment of chemical fungicide + spraying of dithane M 45 at 30 days interval	21.50	475.50	984.30	236.40	24.01
Control	23.50	342.48	980.20	226.40	23.09
SEd	0.28	1.15	0.54	0.87	0.40
CD(0.05)	0.63	2.56	1.20	1.94	0.89
CV	1.29				2.26

Table 9. Effect of plant growth promoting biocontrol agents onTSS, acidity, Ascorbic acid total sugars, reducing sugars and non – reducing sugars of fruits of papaya (GL-1)

Treatments	TSS (%)	Acidity (%)	Ascorbic acid (mg100 g-1)	Total sugars (%)	Reducing sugars (%)	Non – reducing sugars (%)
T1	14.70	1.36	33.80	12.13	10.95	1.18
T2	14.33	1.42	34.10	11.74	10.53	1.21
T3	14.73	1.33	32.40	12.26	11.00	1.26
T4	14.33	1.42	35.70	11.79	10.63	1.16
T5	13.90	1.46	36.80	11.75	10.68	1.07
T6	13.83	1.52	38.80	11.68	10.57	1.17
Sed	0.25	0.07	0.31	0.19	0.18	0.03
CD(0.05)	0.56	0.15	0.68	0.41	0.41	0.08
CV	2.17	6.02	1.07	1.92	2.10	3.63

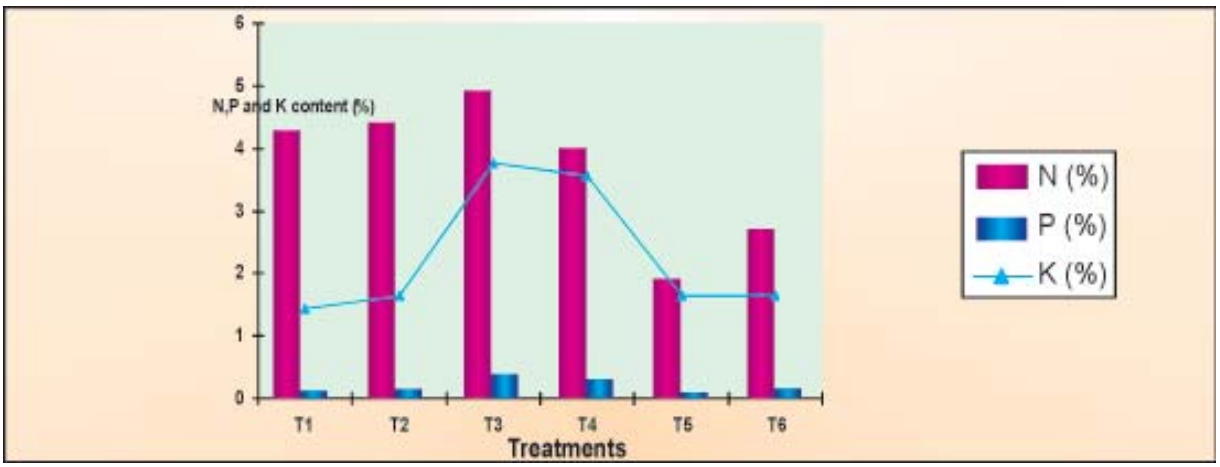


Fig. 2. Effect of plant growth promoting biocontrol agents on N, P and K content of matured leaf of papaya at harvest

and solubilization of mineral phosphates and other nutrients.

Root health status: There was no incidence of root rot till harvest stage in T3 (combined application of Pseudomonas and Trichoderma) and T4 (combined application of *Pseudomonas, Trichoderma* and Diathane M45) treatments whereas the root rot incidence was recorded upto 25.00% in T6 (control).

Soil biological properties : T1 (Pseudomonas 0.2% spraying) registered the highest bacterial population (96 CFU x 10^6) whereas T5 (Chemical spraying) and T6 (control) recorded the lowest bacterial population in the soil of 38 CFU x $10^6$and 55 CFU x 10^6 respectively . T2 registered the highest fungi population (15 CFU x 10^3) at the time of harvest (Fig. 3).

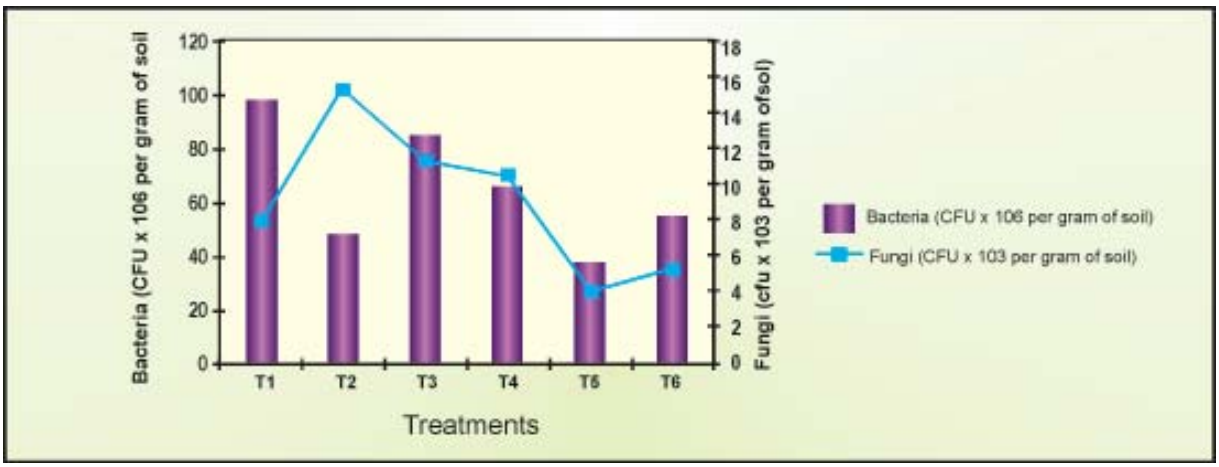


Fig. 3. Effect of plant growth promoting biocontrol agents on total population of bacteria and fungi in soil

Improvement of Coconut and Arecanut

T. Damodaran, D. R. Singh, R. C. Srivastava, V. Damodaran

Maintenance of World Coconut Germplasm Centre

A total of 24 Pacific Ocean Islands collection (exotic) and 6 indigenous accessions from Nicobar Island are well maintained by timely weeding, basin opening, fertilizer application and mulching the basin of palm etc through contract. Individual palm wise yield data recorded (Table 10).

Submission of dwarf coconut varieties for state variety release committee : The continuous evaluation of 24 Pacific Ocean Islands collection (exotic) and 6 indigenous accessions from Nicobar Island maintained at WCGC, Sipighat resulted in selection of four dwarf cultivars for tender nut and ornamental purpose and the selected varieties were submitted for state variety release committee. The brief descriptions of the selected cultivars are presented in Table 10.

CARI-C-1(CARI-Annapurna) : It is a dwarf palm with large size nuts and high copra content (245g/nut) and copra out turn of 12.49kg/palm. It is a variant of the Niu-lekha, one of the collections from Fiji Islands. The peculiar feature of this selection is that it is dwarf to semi-tall with the nut characters of tall which is desirable for copra yield. The productivity is also high under rain fed conditions. It also exhibited drought tolerance. This makes the palm a promising cultivar for the island conditions. Palms were short and dwarf with closer internodes, compressed crown and short petioles. Crown shape is circular. Colour of fruits is green and round shape.

CARI-C-2 (CARI-Surya) : It is a dwarf palm. Nuts were persistent and do not shed even when they are completely dry. Crown shape is circular and nut shape is spherical with fruit of red colour. The productivity is high even under rainfed conditions. It also exhibited

Table 10. Qualitative parameters of the varieties

Qualitative characters	CARI-C-1	CARI-C-2	CARI-C-3	CARI-C-4
Weight of fruit (gm)	1521	410.5	432.5	545
Length of fruit (cm)	22.15	15.5	18.77	18.08
Breadth of fruit(cm)	18.27	12.04	11.04	11.94
Thickness of husk (cm)	2.58	1.0	1.5	1.46
Weight of husk(gm)	590	140.5	143.5	168.12
Weight of nut(gm)	873.75	250.5	277.5	359.68
Volume of nut water(ml)	178.75	28	26	58.75
Volume of cavity(ml)	315	119.0	114.1	121.56
Thickness of Kernal(cm)	1.32	0.98	0.98	1.14
Thickness of Shell(cm)	0.81	0.45	0.43	0.37
Weight of wet kernal(gm)	426.25	155.5	152.5	207.8
Weight of shell(gm)	288.75	100	106	106.25
Weight of copra/nut(gm)	245.0	70.0	73.5	101.56
Oil percentage (%)	63.5	62.5	64.5	66

drought tolerance. This makes the palm a promising cultivar for the island conditions and coastal ecosystem. Palms were dwarf with closer internodes, compressed crown, and shorter petioles. The palms are very attractive and have a good ornamental value. It can be promoted for tender nut and ornamental value.

CARI-C-3 (CARI-Omkar): It is a dwarf palm with close internodes, short petioles and compressed semi-circular crown with less than 20 leaves on the crown. Fruit shape is of pear shape with less meat content. This makes the palm a promising cultivar for the island conditions and coastal ecosystem. The palms are very attractive and have a good ornamental value. It can be promoted for ornamental value.

CARI-C-4 (CARI-Chandan) : It is dwarf palms with close internodes, short petioles and compressed, semi-circular crown. Fruit shape is long and smooth with out prominent ridges. Nut shape is spherical. This makes the palm a promising cultivar for the island conditions and coastal ecosystem. The palms are very attractive and have a good ornamental value. It can be promoted for tender nut and ornamental value.

Inter-se-mating/selfing in coconut: Inter- se-mating and selfing was carried out in the selected accessions from the 24 exotic germplasm and 6 indigenous accessions from Nicobar Islands. The inter-se-mating/ selfing work was initiated during the third week of October and as on 31.3.09 a total of 5776 female flowers as detailed below were pollinated. The

seed nuts obtained from the crossing work will be sent to CPCRI, Kasaragod for planting and evaluation at International Coconut Gene Bank at Kidu, Karnataka.

Identified high yielding Arecanut local selection (CARI - Sel - 1): A new high yielding Arecanut selection (CARI-Sel-1) was made from the local population of Arecanut grown in Garacharma farm and KVK, CARI. The CARI - Sel -1 has giving 15.8 percent higher yield as compared to the check variety Mangla. The brief description of the arecanut new selection (CARI - Sel - 1) and it's comparison with the other cultivable varieties in the Islands are as detailed Table 11.

Production and supply of quality planting materials : About 275 dwarf coconut seedlings (orange, yellow and green), 12,950 areca nut seedlings/seed nuts (Mangala & Samrudhi), 528 Morinda seedlings and 59 banana suckers were supplied to the farmers.

Table 11. Description of arecanut cultivars in A & N island conditions

Sl.No.	Character	Mangla	Samrudhi	Calicut 35	CARI-Sel-1
1.	Plant height(m)	5.25	5.4	7.2	6.3
2.	Plant girth(cm)	43	40	46	45
3.	No. of scars in 1m length	7	8	13	9
4.	Inter nodal distance(cm)	14	16	13	15
5.	No. of leaves in crown	10.5	10	10	10
6.	Length of leaf(m)	2.1	1.9	1.8	2
7.	Width of the leaf(cm)	85	80	83	84
8.	No. of bunches/tree	6.5	7	6	6
9.	Av. no. of nuts/ bunch	161	157	209	184
10.	Bunch weight(kg)	7.5	8	10	8.3
11.	Individual fruit weight(g)	61.8	56.5	41.66	57.34
12.	Length of fruit(cm)	5.95	6.1	5.87	5.47
13.	Girth of fruit(cm)	15.7	18.5	14	15.59
14.	Husk weight(g)	21.4	22.9	16.22	23.2
15.	Chali weight(g)	11.45	10.99	8.39	12.5
16.	Girth of chali(cm)	8.8	8.42	7.48	8.74
17.	Length of chali(cm)	2.9	2.7	2.69	2.77
18.	Husk/Nut ratio (%)	34.62	40.53	38.93	40.46

Standardization of Micro-Propagation Techniques for Potential Orchids and Ferns of A & N Islands

D. R. Singh, R. Sudha and L. B. Singh

Different explants *viz*. leaf bits, suckers and spores were tried with different media and different concentration of hormones for each explants. Callus production was observed from leaf bits inoculated with MS + 2, 4- D 2 mg/lt. Spores were germinated in media containing MS+BAP+ Charcoal. The germinated spores and callus were transferred to multiplication media and the trial is in progress.

Standardization of Technology for Production of Quality Flowers Under Island Ecosystem

R. Sudha, Din and T. Damodaran

Varietal evaluation of rose and gerbera under protected condition in Bay Islands

Development of location specific cultivation practices is must under polyhouse condition. Hence experiments were conducted to evaluate varieties of gerbera and rose under polyhouse to identify the most promising cultivar under Island ecosystem.

Gerbera: Fifteen varieties of gerbera viz., Marinilla, Pia, Province, Antonio, Villssar, Ravel, Lorca, Galileo, Loriana, Teresa, Judy, Manizales, Figaro, Palmira and Sonata were collected from Bangalore. Raised beds of 18 m length, 1m width and a height of 30 cm were prepared by maintaining a spacing of 30 cm in between the beds. Spacing of 40 cm x 30 cm was followed. Among the varieties, maximum plant spread (74.50 cm) and number of leaves was observed in Marinilla. Antonio took minimum days for flowering (52.25 days). In case of flower diameter Galileo recorded the highest flower diameter of 13.70 cm followed by palmira (11.40 cm). Maximum stalk length of 73.10 cm was recorded in Palmira. Manizales recorded maximum no. of flowers (40 flowers/plant/season) followed by Sonata (35 flowers/plant/season) (Table 12 & Plate 8).

Production of quality economic flowers during rainy season under Island ecosystem

Tuberose : Two varieties viz., Shringar and Culcutta double of tuberose were evaluated under polytunnel structures for their performance and yield during rainy season. The experiment was laid out in randomized block design with five treatments. Four different types of naturally ventilated crop protection structures were constructed with different covering materials like polyethylene sheets, insect proof net and shade net and open field condition was treated as control. Locally available low cost materials used for construction of the structures. Among the structures, structure covering with shade net

shows minimum cost (Rs. 147/m^2) for construction while structure covering with insect proof net recorded highest cost for construction (Rs.210/m^2) (Plate 9a-d).

Table 12. Evaluation of gerbera varieties under polyhouse

Varieties	Plant spread (cm)	No. of leaves	Days to flowering	Flower diameter (cm)	Stalk length (cm)	No. of ray florets	No. of flowers/ plant/season
Marinilla	74.50	17.60	75.22	8.50	62.80	152.20	20.00
Pia	64.00	13.80	66.15	8.86	58.20	135.60	24.00
Province	60.50	18.00	60.34	10.16	56.40	185.25	20.50
Antonio	63.25	17.40	52.25	10.80	55.35	243.50	6.50
Villssar	66.23	14.50	61.75	10.85	54.00	148.00	22.00
Ravel	62.32	20.00	59.42	10.50	54.64	210.10	16.00
Lorca	70.26	12.00	54.12	8.73	41.40	224.00	8.00
Galileo	69.00	14.00	57.47	13.70	57.00	225.20	25.00
Loriana	68.75	10.50	58.16	8.20	52.00	150.60	28.00
Teresa	64.20	15.20	56.32	10.10	55.40	152.00	15.00
Judy	64.56	24.00	78.20	10.82	39.20	350.60	8.00
Manizales	64.00	25.40	58.46	11.10	40.66	196.50	40.00
Figaro	65.75	14.20	57.66	9.83	48.80	230.00	6.50
Sonata	65.30	31.40	57.30	10.72	56.54	193.30	35.00
Palmira	55.20	14.50	55.60	11.40	73.10	230.00	12.50
SEd	0.704	1.01	1.10	0.30	0.74	1.72	2.24
CD(0.05)	1.43	2.07	2.25	0.62	1.52	3.51	4.58
CV	1.32	7.61	2.23	3.65	1.71	1.05	14.23

Value Addition to Horticultural Crops, and Fisheries Products through Application of Renewable and Non-Renewable Sources

R. Sudha, R.C. Srivastava, N. Ravisankar, Grinson George and M. Balakrishnan

Value added products from mango were prepared and dried by different methods viz., dried under solar dryer, mechanical dryer and open sun drying to test the equipments developed under the project for suitability. Among the fruit crops, mango is the second most important fruit both in area and production wise in Andaman and the peak

availability period is March-June. Hence products like leather and toffee were prepared from mango. For preparation of mango leather, uniform and matured mango fruits were washed and cut into pieces. Pulp was extracted and added 0.6g KMS/kg of pulp. This pulp was spreaded into the butter smeared trays and allowed for drying. After drying of the first layer, second layer of pulp was added and repeated till a thickness of 1cm was achieved. Drying was carried out under three different methods to a required moisture level. The prepared leather was cut into pieces, wrapped with butter paper cover and stored under ambient conditions. For toffee preparation, pulp was extracted from mango fruits, heated till it reaches 1/3 of the quantity. Added sugar (700g) and glucose (100g) and continuously heated till it reduced to 1/3 of the total quantity. 150 g of milk powder and butter was added and stirred continuously till the end point. After that it was spreaded into the trays and allowed for drying. The toffee thus prepared was cut into pieces and wrapped with butter paper cover for storage study.

The stored samples were analysed at fifteen days intervals for their sensory and biochemical evaluation. The results revealed that the leather dried under mechanical dryer took 10.5 hours whereas solar dryer took 15 hours for drying and 24 hours in open sun drying (Table 13). The toffee dried under solar dryer took two hours for drying while open condition took 5 hours for drying. The moisture content and TSS of both the produce decreased with the advancement of storage period while the total sugar content increased during storage. The organoleptic evaluation of the products shows that mango toffee had excellent flavour, texture, taste and overall acceptability when compare to mango leather (Table 14).

Table 13. Chemical changes of mango leather and toffee during storage

Storage period (days)	Moisture (%)			TSS (° Brix)			Total sugar (g /100 g)		
	0 day	15 days	30 days	0 day	15days	30 days	0 day	15 days	30 days
Mango leather	17.10	16.02	16.00	63.37	62.32	62.30	55.52	55.45	55.4
Mango toffee	15.95	15.8	15.75	62.3	62.26	62.2	55.62	55.59	55.55
SEd	0.52	0.72	0.96	0.59	0.60	0.57	0.58	0.72	0.83
CD(0.05)	1.44	2.01	2.68	1.65	1.66	1.59	1.61	2.01	2.33
CV	3.90	5.61	7.47	1.16	1.18	1.13	1.28	1.60	1.85

Table 14. Changes in organoleptic characteristics of mango leather and toffee during storage

Products	Colour		Flavour		Texture		Taste		Overall acceptability	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
MangoLeather	4.50	4.45	3.50	3.20	4.50	4.32	4.00	3.65	3.75	3.56
MangoToffee	4.00	3.50	4.50	4.20	4.50	4.30	4.25	4.00	4.20	4.00
SEd	0.55		0.38		0.38		0.47		0.35	
CD(0.05)	1.36		0.93		0.93		1.17		0.86	
CV	19.17		13.94		11.68		17.47		12.5	


Plate 8. Performance of gerbera under polyhouse

a. Polytunnel covering with 200 micron
b. LDPE sheet

b. Structures covering with Agro shade net

c. Structures covering with insect proof net

d. Structures covering with polythene sheet and insect proof net for side ventilation

Plate 9. (a-d). Structures covering with polythene sheet and insect proof net for side ventilation

Standardization of Agro- Technique for Organic Black Pepper Cultivation in Andaman and Nicobar Islands

I. Jaisankar, C. B. Pandey, Krishna Kumar and B. L. Meena

Standardization of decomposition rate, time of organic matter with red earth worm and estimation of the dose of vermicompost to black pepper

For standardization of decomposition rate, and time with red earth worm and estimation of the dose of vermicompost to black pepper, experiment was laid with six treatments: T_1: Gliricidia leaves+ Cowdung(4:1), T_2: Gliricidia leaves+ Cowdung(2:1), T_3: Coconut leaves + Gliricidia leaves(4:1), T_4: Coconut leaves + Gliricidia leaves+Cowdung (2:1:1), T_5: Coconut leaves + Gliricidia leaves+Cowdung(4:1:1) and T_6: Coconut leaves+Cowdung(4:1) in randomized block design with four replications. Observations were taken 0, 30, 60, 90, and 120 days after heaping the compost in to the rings. The result revealed that at 30 days interval T1 recorded highest decomposition rate(10.7%) followed by T5(9.3%) while least in T3(Table 15 and Plate 10), whereas at 60 days interval the decomposition rate was faster in T2(32.7%) followed by T1. The similar trend of decomposition rate was observed at 90 and 120 days interval. However the lowest decomposition rate (30%) was recorded in T4 at 120 days interval. This may be due to the highest lignin content in the coconut fronds which lead to poor decomposition.

Table 15. Rate and time of decomposition of organic matter with red earth worm

Treatments	Duration and decomposition percentage			
	0-30 days	0-60days	0-90days	0-120days
T1	10.7	26.7	37.3	48.8
T2	8.0	32.7	41.3	48.0
T3	5.1	16.8	26.4	45.6
T4	7.0	11.5	20.5	30.0
T5	9.3	11.6	20.9	39.6
T6	7.2	18.9	28.5	47.7
SEd	0.14	0.52	0.64	0.72
CD (0.05)	0.29	1.11	1.35	1.54
CV	2.45	3.73	3.08	2.34

Plate 10. Experiments on Decomposition rate

Silvipasture System: Effect of Fertilizer and Cutting on Nut Primary Production (Herbage Production) in Humid Tropical Climate of Bay Islands

I. Jaisankar, S. K. Verma and C. B. Pandey

Evaluation of coconut based silvipasture system was evaluated

Coconut based silvipature system was evaluated at Sipighat farm with three grasses para (*Brachiaria mutica*) guinea grasses (*Panicum maximum*) and hybrid napier (*Panicum purpurium*) in three different situations between canopy, under canopy and open condition with three different levels (20,40,60 kg/ha) of nitrogen . Three grasses were grown under existing coconut trees planted at 7.5 x 7.5 m distance. Spacing of the grasses was 50 x 50cm (Plate 11). The experiment was laid out in randomized block design with three replications for estimation of the potential of grasses under the palm tree. The observations are made on the basis of selected tillers. The result revealed that in all the three grasses the percent cover of leaves was the highest in the month of May (Stem Leaf ratio= 0.28, 0.33, 0.26 respectively) and declined with the succeeding months. However the least leaf production was observed in the month of April (Stem Leaf ratio= 6.69, 6.14, 6.14 respectively) (Fig. 4.).

Plate 11. (a-b). Establishment of coconut based silvispasture agroforestry model at Sipighat farm

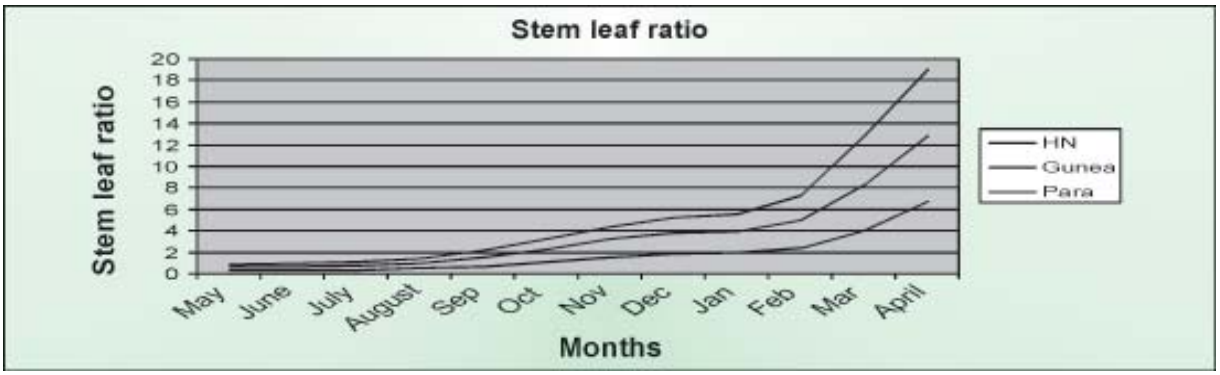


Fig. 4. Stem/ leaf cover ratio in different grasses under coconut trees

These grasses were fertilized with different doses of nitrogen: 20kg ha^{-1}, 40kg ha^{-1} and 60kg ha^{-1} at three locations: under the tree canopy, between the tree canopy and open (without tree) Table 16. The time and intensity of Subabul tree fodder production was estimated and the result revealed that the maximum fodder production was recorded in the month of October (13.98Kg/tree).

Light available under the locations is given in Table 16. Phosphorus and potassium were applied at 80 kg ha^{-1} and 120kg ha^{-1}, respectively. Herbage production recorded in all the grasses declined at the both canopy positions compared to open (Table 16) and the similar trend was also recorded in the previous year. Herbage production was highest with the increased dose of N. Para grass resulted in higher herbage production followed by guinea grass both under and between canopy with a fertilizer dose of 40and 60kg/ha. However, there was not much variation in the yield with the application of N at 60kg/ha so application of 40kgN/ha for para grass is optimum to achieve desirable yield. Under open condition hybrid napier resulted maximum herbage yield compared to the other grasses which indicates its suitability.

Table 16. Herbage production (t ha^{-1}) in different under coconut trees and between coconut trees

Grass	Under canopy			Between canopy			Control		
	Nitrogen (kg ha^{-1})			Nitrogen (kg ha^{-1})			Nitrogen (kg ha^{-1})		
	20	40	60	20	40	60	20	40	60
Hybrid napier (t/ha)	21	25	27	24	29	35	27	47	66
Para grass(t/ha)	18.5	28	29	23	27	34	29	41	61
Guinea grass(t/ha)	18	26.5	28	21	26	32	25	40	58
SEd	0.55	0.63	0.63	0.66	0.62	0.20	0.66	0.52	0.66
CD(0.05)	1.36	1.54	1.55	1.63	1.52	0.49	1.63	1.28	1.63

Under canopy lux = 19000; Between canopy lux = 42000; Control conditions lux = 48000; P and K = 80 and 120 kg ha^{-1})

Identification, Evaluation and Development of Silvipastoral System for Bay Island Condition

I. Jaisankar, T.P. Swarnam, S. Jeyakumar, M. Sankaran, N.C. Choudhuri

In Bay Islands the demand for dairy products is increasing day by day due to continuous population growth. At present very less area is under fodder crops which are insufficient to meet the current green fodder demand. The expected demand of green fodder in coming years will be high and there is a remote possibility for area expansion exclusively under fodder crops. Therefore, establishment of silvipastoral system in forest area is one

of the options available to meet out the expected demand. However silvipastoral system in forest area is least studied in these Islands even though many systems exist in the country. With this background the experiment was initiated to collect and identify indigenous fodder trees and grasses in natural forest, to establish silvipastoral system and evaluate the yield potential of indigenous fodder trees and grasses under natural forest condition, to estimate the soil fertility status under established silvipastoral system and to evaluate the nutritive value and palatability of tree and grasses. Accordingly four indigenous fodder trees (*Grewia glabra, Mussaenda macrophylla, Treama tomentosa and Euphorbia spp*) were identified in the natural forest and three fodder grasses (Guinea, Para and Ischaemum rubosum) were selected for developing the sivipasture system under natural forest condition.

Fodder grasses nursery

Field view

Plate 12 (a-b). Fodder planting under natural forest conditions

The experiment was laid out in randomized block design with three replications to evaluate yield of the three fodder grasses including one indigenous grass at nursery level (Plate 12 a-b). Accordingly the seeds and slips of the grasses were sown/planted in the nursery of plot size of 12 m^{2}. Growth and yield parameters were recorded at 45DAS and 90DAS. The result revealed that the growth parameters like plant height (38.2cm, 102cm) (Fig.5) and number of tillers (6.6, 13.5) (Fig.6) was maximum in Para grass at both the stages followed by Guinea grass. The fresh and dry biomass production was highest in Para grass (10.8, 4.4t/ha respectively) followed by Guinea grass where as the indigenous grass recorded the least biomass production at nursery level.

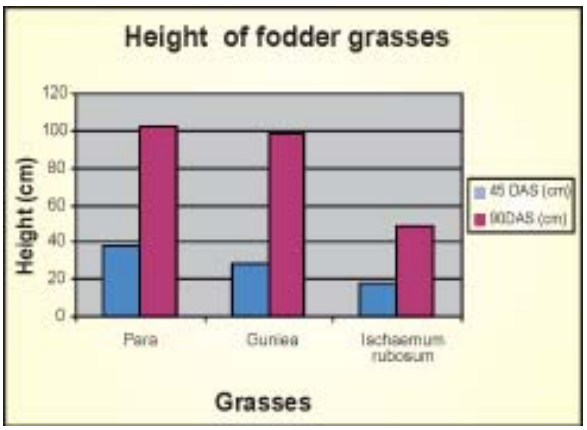


Fig 5. Plant height of the grasses

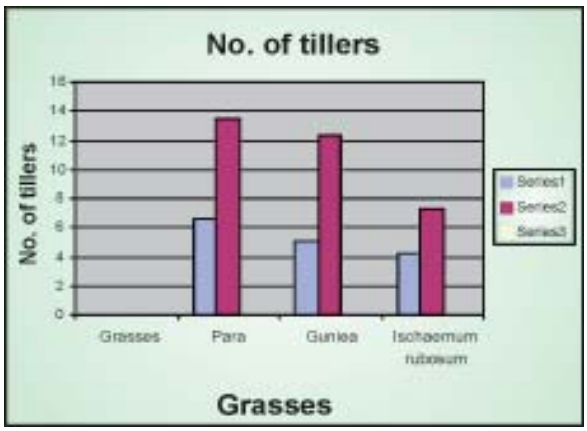


Fig. 6. Tiller production of the grasses

Role of Alley Cropping System in Nutrient Conservation (Nutrient Build Up + Protection of Fine Soil Particles From Erosion), and Selection of Suitable Crop Sequence for the Cropping System for the Andaman Islands.

I. Jaisankar, B. L. Meena, T.P. Swarnam, C.B. Pandey

In low input agriculture prevailing under the Island condition the alley cropping is the viable option to provide N nutrition besides preventing soil erosion.The project is envisaged to study the impact of application of Gliricidia prunings on soil aggregate formation and evaluating suitable cropping system. An experiment was initiated in RBD to evaluate the performance of Bhendi during the post monsoon period. Total of 1150kg pruned biomass were procured from the hedge rows and incorporated in the alleys. The result revealed that in Bhendi (var. Arka Anamika) the highest yield (11.9t/ha) was obtained from (T4) but it was at par with T3 (Table 17). A similar trend was also recorded in Brinjal in year 2007-08.

The soil samples were collected up to 30cm depth from the alleys and analyzed. The result revealed that there was an reduction in gravel percentage (22.9%) as compared to the previous year(23.8%) while the silt content(2.6%), soil pH (6.2) and soil nitrogen level(1325.5Kg/ha) (Table 18) increased in comparison with same (2.2%,5.9 and 1232kg/ha respectively) recorded in last year. This may be due to continuous application of Gliricidia green leaf manure in the soil and due to its decomposition it has influenced the physicochemical properties of the soil as well as resulted in slow and steady supply of N which in turn favored the growth of crops.

Table 17. Effect of *Gliricidia* pruned leaves on yield of Okra

Treatments	Yield (t/ha)
T1: Control	9.7
T2: 3 t of *Gliricidia* leaves /ha	10.6
T3: 5 t of *Gliricidia* leaves /ha	11.2
T4: 8 t of *Gliricidia* leaves /ha	11.8
SEd	0.53
CD (p=0.05)	1.19
CV	0.69

Table 18. Physico-chemical properties of soil in Gliricidia alleys

Parameter	Value	
	2009	2008
Texture loam	Red sandy loam	Red sandy
Gravel(%)	22.9	23.8
Silt(%)	2.6	2.2
pH	6.2	5.9
Total N (kg/ha)	1325.5	1232

Collection, Conservation, Characterization and Identification of Superior Clones of *Morinda Citrifolia*

D.R. Singh and R.C. Srivastava

Collection of germplasm from A & N Islands: In Andaman and Nicobar islands, particularly in South Andaman, the *Morinda citrifolia* is abundant in Port Blair with more prevalence in Jungligaht, Premnagar, Phonixbay, Sippighat and Garacharma area and *Morinda trimera* profusely distributed in Little Andaman, Wandoor, Brichgunj, Chidiyatapu and sparsely scattered in Jungligaht and Sippighat area. The species *Morinda umbellate* are mainly confined to Shadipur, Dilthaman, Saddle peak and Lauria Bay. *Morinda trimera* are more commonly found at seashore, within low land whereas *Morinda citrifolia* are found in the costal strand, moist low and high land. Different areas of Andaman and Nicobar were explored and the accessions from different places were collected for evaluation of their production potentials as well as physiochemical properties.

Population density of *Morinda citrifolia* in Car Nicobar : An exploration was done to estimate plant population of *Morinda citrifolia* in Car Nicobar Island. It was revealed that the plant had very long and close association with tribal culture. The Nicobarese ate the fruits raw with salt and even in cooked form. They used it as traditional medicine and health enhancing food supplement. Plant population of Morinda citrifolia was estimated from 15 villages of Car Nicobar. The plant was present in most of the villages and population per village ranged from 0.05 to 10.80 plants per km^2. In Malacca village highest plant population (6.40 plants / sq.km) was recorded followed by Chuck Chucka village (2.25 plants/ sq.km) and only 0.12 plants/sq.km was recorded from New Kimus village.

Registration of Germplasm: Various accession with different phenotypic characteristics were collected and 14

germplasm each from *Morinda citrifolia* and *Morinda trimera* has been submitted for getting IC nos. at NBPGR, New Delhi.

Study on sprouting and survival of different accessions of *Morinda citrifolia*: A study was conducted to evaluate the sprouting percentage and survivability of cuttings of *Morinda citrifolia* accessions collected from different parts of these Islands. The results revealed that the accessions viz. WAND, SPG-1(R) and SPG-2(R) performed comparatively better in terms of sprouting percentage and survivability percentage.

Rooting pattern of cuttings in different accessions of *Morinda citrifolia*: A study was conducted to evaluate the rooting patterns of cuttings which indicated that the accession viz. WBJ, SPG (F) and JGH exhibited profuse rooting pattern where as ABF, WAND-4, MEM-3, BP, BRJ, GAH and PB can be categorized as high rooting pattern and the rest were having lower rooting pattern. This has given a clear indication of the vigor of the planting materials from different accessions.

Fruits qualities of *Morinda citrifolia* accessions : The comparative study of the fruit characteristics revealed that, the average fruit weight ranged from 65 to 245 g. The highest fruit weight was observed in HBAY-11a accession with other good qualities *viz*. juice percentage (40.60%), TSS (8.5° Brix) and vitamin C content (112.50 mg/100g). when juice percentage is compared, it ranged from 31 to 66 %. The highest juice percentage was found in HD-6a. The accession was having an average fruit weight and vitamin C content of 178.90g and 145.50mg/100g, respectively. The comparative evaluation of vitamin C content in different collected accession revealed that it ranged from 90 to 145 mg/ 100gm. The maximum vitamin C content was found in HD-6a. The results on fruit quality parameter revealed that some of the accessions were having extraordinary quality attributes which can be exploited for increasing the quality and quantity of *Noni* in these islands. The best accession as per the study was HD-6a with good weight as well as other qualities. Other accession with good fruit qualities are HBAY-11a, CHTAP-13a, HD-6, PBAY-7, JGH-5, MK *etc*.

Seed germination in different accessions of *Morinda citrifol*ia: Studies on variation in seed germination of different accessions of *Morinda citrifolia* was carried out which indicated seed germination ranging from 10 to 80 percent. The days taken for germination ranged from 6 to 28 days.

Growth and reproductive parameters of *Morinda Citrifolia* accessions

The accessions collected from different parts of these Islands were raised for studying its growth and production parameters. From the present results it is evident that some of the accessions are performing better than other accessions. The accessions namely HD– 6, HBAY– 11a, HD– 6a, CHTAP – 13a, HBAY – 11, PBAY – 7, MEM – 3, JGH – 5 etc. were shown better growth and productive traits.

The study will significantly help in to identify the accession with good growth and production attributes.

Germination percentage of various accession from Nicobar group of Islands : The Noni seed of various accessions collected from Nicobar group of Islands were assessed for its days taken for germination and percentage of germination. The germination percentage varied from 10 to 100 % in different accessions. The maximum germination (100%) was observed in Nic-11 followed by Nic-7, Nic-15 and Nic-17 (80% each). The lowest germination percentage was found in Nic-12. The days taken for germination varied from 24 to 66 days.

Genetic Relationships of *Morinda citrifolia* & Morinda *trimera* accessions : Out of 811 bands, 335 bands were polymorphic. The study showed 41% polymorphism among the 14 accessions of *Morinda citrifolia.* The result indicated that despite of their morphological identity, substantial polymorphism was observed among *Morinda citrifolia* accessions collected from different Islands.

The dendrogram based on RAPD marker separated *Morinda citrifolia* and *Morinda trimera* accessions in to two clusters (Fig 7). First cluster included all accessions of *Morinda citrifolia* and 2nd cluster included all accessions of *Morinda trimera*. It was observed that the genetic diversity in between *Morinda citrifolia* and *Morinda trimera* was about 55%. First sub cluster was further divided in to 2 sub clusters having 18% variation. Second sub cluster was divided in to 2 sub clusters having 25% variations.

The dendrogram based on ISSR marker separated *Morinda citrifolia* and *Morinda trimera* accessions in to two clusters (Fig 8). First cluster included all accessions of *Morinda citrifolia* and 2nd cluster included all accessions of *Morinda trimera*. The genetic diversity in between *Morinda citrifolia* and *Morinda trimera* was found to be 61%. First sub cluster was further divided in to 2 sub clusters having 22% variation. Second sub cluster was divided in to 2 sub clusters having 28% variations.

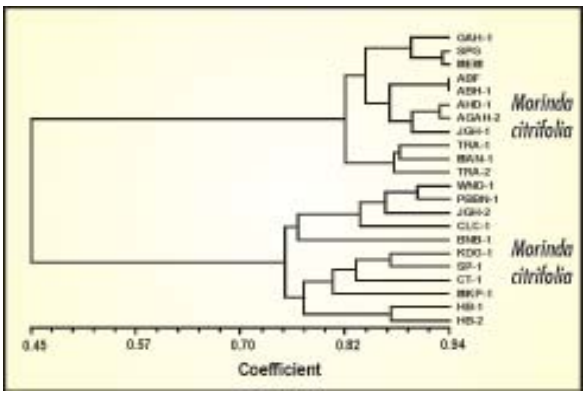


Fig 7. Dendrogram showing diversity of *Morinda citrifolia* and *Morinda trimera* accessions based on RAPD markers

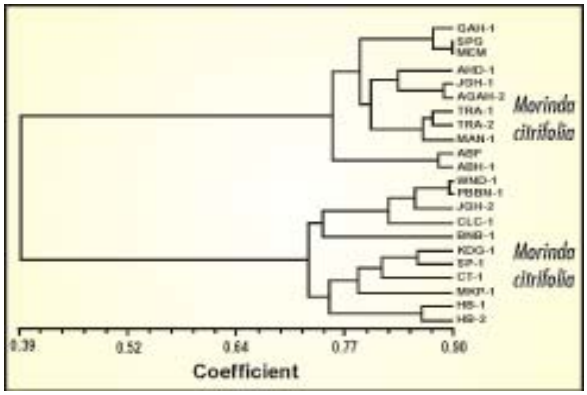


Fig 8: Dendrogram showing diversity of *Morinda citrifolia* and *Morinda trimera* accessions based on ISSR markers

Technological Innovations for Commercial Exploitation of *Morinda Citrifolia* as a Livelihood for Island Farmers

D.R. Singh, R.C. Srivastava, Subhash Chand, Jai Sunder and R. Sudha

The NMPB funded project has been initiated at this institute as lead centre and three collaborative Centres namely Central Horticulture Experiment Station (CHES-IIHR), Bhubaneswar, Central Drug Research Institute (CDRI), Lucknow and Health India Laboratories (HIL), Chennai. Following progress has been made in the first year of the project.

Grafting of Morinda

The study on vegetative propagation of *Morinda citrifolia* through grafting was undertaken and the results were encouraging. A total of 260 grafting was done with an overall success rate of 88.10 percent (Plate 13 (a-c).

Plate 13. (a-c): Grafting of Morinda

Influence of pruning on growth and production of fruits

To standardize the cultivation practices of *Morinda citrifolia*, an experiment has been designed and is being carried out in the field for evaluating the influence of pruning on growth, production and fruit quality. Different treatment viz. Alternate removal of branches (T1), Alternate removal of branches + cutting of tip portion of Central leader (T2), Cutting of tip portion of Central leader (T3), Cutting of tip portion of Central leader + 50% removal of leaf (Overall) (T4), Cutting of tip portion of Central leader + cutting the tips of all primary branches (T5), Alternate removal of branches + cutting of tip portion of Central leader + 50% removal of leaf (Overall) (T6) and Control were employed. The result for first year of the experiment revealed that T1 attained highest height (191 cm) followed by T2 and T6 (166 cm), T5 (139 cm), T4 (137 cm), T7 (132 cm) and T3 (125 cm). Highest yield (g / Plant) was observed in T4 (6230 g) followed by T2 (4340 g), T3 (3720 g), T1 (3190 g), T5 (3080 g), T6 (2420 g) and T7 (1820 g). The results are preliminary and need many observations to get a real picture of the influence. The observations are taken every 3 months interval which will be continued till a conclusion is derived.

Evaluation of Bush-Type accessions of *Morinda Citrifolia* (8 months after planting)

Bush type accessions of *Morinda citrifolia* were collected and were established for evaluation and conservation of these germplasm (Plate 18). The seedlings were raised which were subsequently transplanted in the field. The observations taken at 8 months of age indicated that out of the two accession of bush type variety TRA-1 performed better in growth and production parameters than TRA-2. The physicochemical analysis suggested that the TRA-2 accession had higher acidity and total soluble solids (TSS). The Proline content was higher in TRA-2 suggesting higher stress tolerance of the accession than TRA-1.

Plate 14: Bush type accessions of *Morinda citrifolia*

Effect of mulching with different plant parts on bush type accessions: A study is being carried out to evaluate the effect of mulching on growth and reproductive parameters of bush type accessions. Six different mulches were used *viz*. coconut husk (T1), arecanut husk (T2), coconut leaves (T3), areca leaves (T4), banana leave (T5) and different grass species (T6). The observation taken 4 months after mulching revealed encouraging results in T5 group i.e. banana leaves mulching (Plant height 121 cm and girth 9.29 cm) followed by arecanut leaves (Plant height 120 cm and girth 8.23 cm) and husk (Plant height 103 cm and girth 8.55 cm).

Evaluation of under arecanut plantations : Study is being undertaken to evaluate *Morinda citrifolia* under arecanut plantations. Three different treatment regimes on the basis of quantity of NPK applied through manure were taken 7 replications in RBD. The spacing of 3x3m was maintained. The initial observation on Proline content of leaves interestingly indicate a negative correlation between the Proline content and the quantity of manure applied. Maximum Proline content of 0.20 µ mole/ g tissue was found in T1 followed by T2 (014 µ mole/ g tissue) and T4 (0.10 µ mole/ g tissue). The data on various growth and production parameters are being taken every 3 months interval. The height of the average plant ranged from 52 to 61 cm and the average stem girth ranged from 6.28 to 6.47 in different treatments (7 months of DAT).

Evaluation under coconut plantations : Study to evaluate *Morinda citrifolia* under coconut suggests that T2 (50:25:50 g NPK/Plant/year) is supporting better growth of the plants under coconut plantation with average plant height and girth to the tune of 149 cm and 14.2 cm respectively (at 18 month of DAT). Further frequent observations will be required to draw a final conclusion. The initial

observation on Proline content of leaves interestingly indicate no variation among the treatment with a uniform level of proline content i.e. 0.14 µ mole/ g tissue. Fruit weight showed a positive correlation with the quantity of manure applied and negative correlation with vitamin C content.

Studies on organic farming standardization: To standardize the appropriate doses of nutrients for *Morinda citrifolia* cultivation a study has been initiated with different treatments viz. T1 (0 kg manure), T2 (5 kg manure), T3 (10 kg manure) and T4 (15 kg manure). The data on various growth and production parameters are being taken at every 3 months interval. The initial observation on Proline content of leaves interestingly indicate that there a negative correlation between quantity of NPK applied and Proline content. It was also evident that there was no variation in the treatment T3 and T4 with a uniform Proline content *i.e.* 0.10 µ mole/g tissues. There was no significant variation in the 7 month after DAT in plant height and girth ranging from 37.00 to 37.75 cm and 5.48 to 6.01 cm, respectively.

Leaf area of *Morinda citrifolia* under different cropping system : For assessing the leaf area third leaf from top was selected and measured. The leaf area ranged from 204.87 to 272.22 cm^2 in different cropping system viz. Noni + coconut, Noni + Arecanut, Organic Noni, Bush type Noni with maximum age of 1½ years (DAT).

Status of soil fertility : It was observed that pH of soil was alkaline in Morinda + Coconut block (7.16) whereas in other blocks the soil was acidic (5.12 to 5.61). Electric conductivity and organic carbon content was also highest in Morinda under coconut block to the tune of 3.81 (dSm-1). The NPK content of Morinda + Coconut (564:15:162) and bush type blocks (564:12:190) were higher compared to Morinda + Arecanut (251:9:151) and organic block (250:9:142).

Growth and yield influenced by spacing : A block with an area of 0.45 ha has been developed to assess the influence of spacing on growth and yield of *Morinda citrifolia.* Altogether 5 spacing regime was maintained. In each spacing regimes, experiment to standardize the requirement of NPK and another to study the influence of plant architecture on yield was initialized. The initial observation indicated the 3 x 3m spacing supports good growth and production qualities followed by 4 x 4m. Other spacing regimes *viz*. 2 x 2m, 1.5 x 1.5m and 1 x 1m performed inferior to earlier mentioned spacing.

Influence of intercropping of banana and arecanut on growth and yield parameters: Another block has been developed to assess the influence of intercropping of banana and arecanut on growth and yield of *Morinda citrifolia.* In each intercropping system, two experiments were initialized; one to standardize the requirement of NPK and another to study the influence of plant architecture on yield. The results revealed

that, Noni can be cultivated as intercropping successfully with some effected on its growth and production parameters. The observation recorded on influence of different quantity of vermicompost and intercropping has been initiated and the data on various parameters will be collected every 3 months interval.

Harvesting and Storage : An experiment was conducted to assess the affect of storage on different quality parameters. It was found that the physiological loss of weight was highest (28.28 %) in non-pedicellate fruits. Ascorbic acid and acidity content decreased in fruits during storage and rate of reduction was slow in fruits harvested with pedicel. Maximum ascorbic acid content (115.32 mg/ 100 gm on 9 days after storage) was observed in fruits harvested with pedicel and minimum acidity (1.04% on 9 day after storage) and highest spoilage (50 %) was noted in fruits without pedicel. It was observed that *Morinda citrifolia* L. fruits harvested with pedicel maintaining better storage quality and market acceptability and a protocol for packaging and shipment for Noni fruits has been developed with maximum hygiene and quality (Plate 15).


Harvesting of Fruits


Harvested Fruits


Grading of Fruits


Graded & Selected Fruits


Preparationof Dip


Cleaning of Dipping


Draining & Packing


Sealing Packets


Stored in Containers

Plate 15. Protocol for Noni from harvesting to Packing

Nutrient content -different parts of *Morinda citrifolia* : The analysis of mineral content viz. Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe) and Copper (Cu) concentration in different parts of *Morinda citrifolia* plant and comparative mineral content of leaf of *M. citrifolia* and *M. trimera* was done. It was found that concentration of K was higher in fruit followed by leaf whereas in wood and bark the K level was trace. Ca concentration was higher in leaf followed by bark, wood and fruits. Assessment of magnesium revealed that the concentration of Mg was higher in leaf followed by fruits. The concentration of Mg was comparatively lower in wood and bark. In case of iron content the trend was just reversed i.e. the highest concentration was observed in wood followed by bark. The concentration of Fe in fruits and leaf was comparatively lower. The concentration of Cu was found to be higher in fruit followed by wood bark and leaf.

Pest and Disease on Morinda: The survey and collection of infected sample is being done and characterization and identification of the infective agent is in progress. So far in the nursery and field several pests and diseases viz. Anthracnose, viral infestation, leaf spot and shot hole, insect egg mass, larval infection and ant infestation have been identified.

Assay of antimicrobial activity of *Morinda citrifolia* solvent extracts : The study was conducted to determine the minimum inhibitory concentration of various solvent extracts against various microorganisms. It was screened for antimicrobial effect on various field and reference strains (like *Escherichia coli, Pseudomonas aeruginosa, Bacillus subterminale Staphylococcus aureus Salmonella Arizona,e Citrobacter freundii, Proteus rettergeri, Klebsiella pneumoniae, Shigella sp, Bacillus megaterium, Shigella flexneri, Klebsiella ozaenae, Proteus mirabilis,Bacillus cereus, Enterobacter aerogenes, Escherichia coli, Proteus hauseri, Pseudomonas diminuta 0,Bacillus licheniformis, Salmonella sp, Pseudomonas fluorescens, Enterobacter cloacae, Pseudomonas sp, Pastuerella multocida, Bacillus alvei, Proteus inconstans Salmonella pullorum, S.aureus ATCC 6538, Escherichia coli ATCC 25922*.T). It was found that the zone of inhibition was more in ethanol extract (7.36) compared to ethyl acetate (6.55) and methanol (6.54) extract respectively (Plate 16 to 18). Overall, the average zone of inhibition in leaf extract was found to be more than fruit and stem bark extracts.

Assay of Minimal Inhibitory Concentration (MIC) of various extracts by disc diffusion method : Minimal inhibitory concentration of the plant extracts were tested against *Salmonella pullorum, Staphylococcus aureus ATCC 6538, E.coli ATCC 25922, Enterobacter aerogenes, Pseudomonas aeruginosa, Bacillus megaterium.* It was found that, the ethanol, methanol, ethyl acetate leaf extracts of Morinda citrifolia, have produced maximum zone of inhibition against the reference strain of *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 6538 and *Salmonella pullorum* than other field isolates. The ethanol extract of all the parts inhibited most of the bacteria than methanol and ethyl acetate. The ethanol

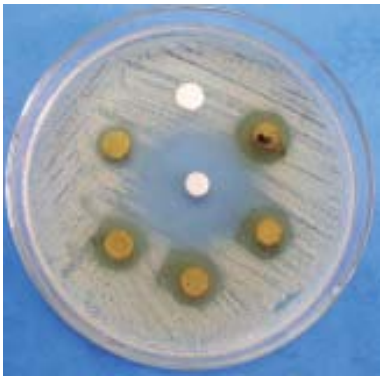


Plate 16. Leaf (ethanol extract)

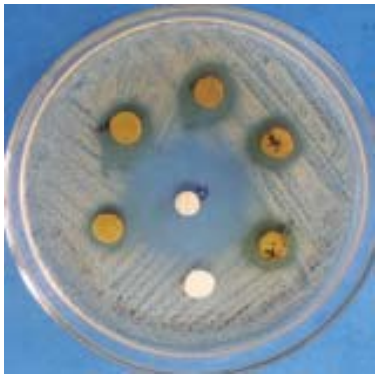


Plate 17. Leaf (methanol extract)

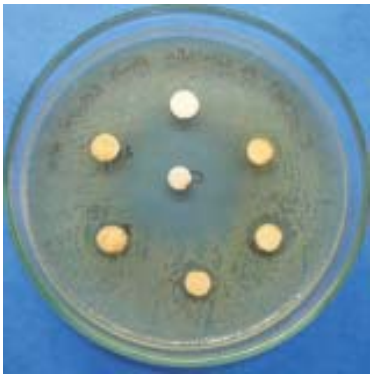


Plate 18. Leaf (ethyl acetate ext.)

extract of *Morinda citrifolia* leaf showed maximum activity against the bacteria when compared to methanol and ethyl acetate extracts. The low MIC values confirm high activity of the extract at low concentration against the bacteria. The presence of antibacterial compounds in *Morinda citrifolia* fruit ethanol extract is active against 28 bacteria out of 29 bacteria which have been tested for antibacterial activity and the MIC values are between 2 to 3 mg/ml. This confirms that, the fruit can be used to treat bacterial infections. The positive control Chloramphenicol (30 ug) inhibited all the 26 bacteria tested.

Assay of antifungal activity of *Morinda citrifolia* solvent extracts : With an objective to prepare extracts from *Morinda citrifolia* (leaves, stem bark and fruit) by using solvents (Methanol, ethanol, ethyl acetate) for screening antifungal activity of it against *Aspergillus niger, A.fumigatus, Rhizopus spp., Cryptococcus neoformans, Candida albicans, Tricophyton mentagrophytes* etc through determining the minimum inhibitory concentration (MIC) the study was undertaken.

The result revealed that, in overall, the average antifungal activity of M. citrifolia leaf was found to be more (97.79%) followed by fruit (53.83%) and stem (37.5%) extract respectively (Fig 9). The ethanol and methanol extracts of *M.citrifolia* leaf showed 100 % antifungal activity. The best antifungal activity was obtained with methanol leaf extract (3.7mg/ml) followed by ethanol (3.7mg/ml) and ethyl acetate (4.75 mg/ml). The average zone of inhibition was 11.8 mm with methanol extract followed by 11.1 mm with ethanol extract and least 9.3 mm with ethyl acetate extract against the entire tested organism (Fig 10). The minimum inhibitory concentration of the leaf extract was found to be 3.55 mg/ml followed by stem and fruit extract (4.3 mg/ml) (Fig 11). Based on the present finding it may be concluded that the leaf of *M. citrifolia* showed best antifungal activity and the ethanol and methanol may be used as solvents for extraction antifungal active compounds.

It was concluded that, the antimicrobial activity of the *M. citrifolia* may be useful in treatment of various kinds of illness and injuries against the drug resistant microorganism. The broad range of antimicrobial activity of the *M .citrifolia* may be studied and exploited in detail as these plants are available in plenty and the activity may be useful in identification of some novel antimicrobial compounds from this plant. The MIC of the various extracts of the *M. citrifolia* was found to be 2-3 mg/ml. The ethanol extract exhibited best antibacterial activity. The methanol, ethanol and ethyl acetate extracts of *Morinda citrifolia* leaf has high percentage of activity than fruit and stem extracts.

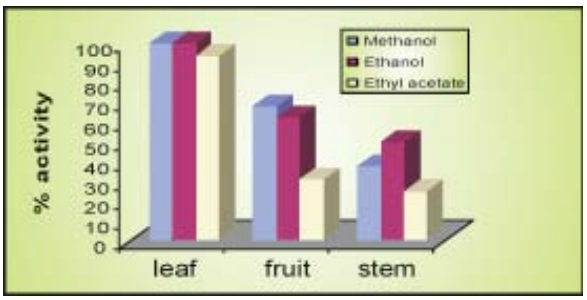


Fig 9. Average antifungal activity (%)

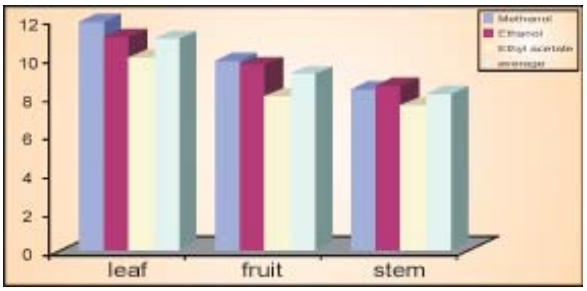


Fig 10. Average zone of inhibition

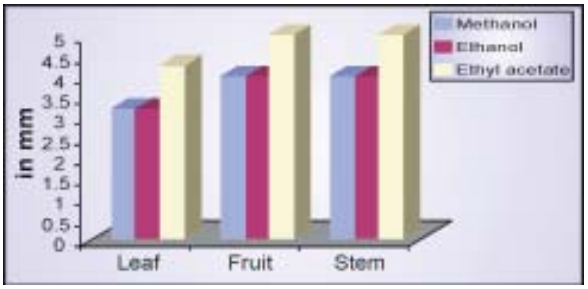


Fig 11. Average Minimum inhibitory concentration

Effect of *Morinda citrifolia* fruit extract on growth and production performance of Japanese Quails : It was found that the total egg production /50 days in Morinda group (11 Female) were 312 eggs with an average of 28.36 eggs / quail. But in control it was less with a total egg production /50 days (10 female) 242 eggs averaging 24.2 eggs / quail. The observation on Mortality indicated no ill effects of feeding Morinda and mortality was nil in both the groups.

Immunoenhancer effect of *Morinda citrifolia* in poultry : A study was conducted to assess the immune enhancer effect of crude juice extracted from fruit of *Morinda citrifolia* in poultry. The birds were fed @ 5% crude fruit juice from day old till 6th week of age. The birds were divided into 2 groups as control (normal basal ration) and Morinda group (normal basal ration + 5% Morinda juice) and were maintained under deep litter system . No medication and additional supplements were fed except the normal basal ration throughout the experiment. During the experiment body weight and feed conversion ratio (FCR) were observed. The humoral immune response was assessed by injecting goat red blood cells (GRBC) and cellular mediated immune response by PHA-P response. The sera samples from birds were collected at weekly intervals to assess the

antibody response. During the experiment phase mortality % was recorded.

The body weight gain showed significant difference in all the groups ($p<0.05$). The overall results revealed a higher body weight gain in Morinda fed group (1262.1±27.72) and lowest in control group (974.15±32.8). However, no significant difference was recorded in terms of FCR in the entire group but the FCR of the Morinda group was recorded better than control group. The feed efficiency of Morinda fed group (0.48±0.07) was also found to be significantly higher ($p<0.01$) than other groups. The overall performance index of Morinda fed group was found to be superior (93.6±16.15) than other groups.

To assess the immune response in all the groups GRBC was injected and blood samples were collected at weekly interval to assess the anti GRBC antibodies by HA test. The results revealed the appearance of antibody in both the group on 0 day of immunization. The HA titer values in Morinda fed group was found to be significantly higher ($p<0.05$) than other group. The antibody titer reaches its peak at 1 week PI in all the groups. The peak log2 titer of the Morinda group was found to be highest among all the groups with peak value of 1.48 ± 0.18 at 7^{th} day PI. Statistical analysis revealed the significant difference ($P<0.05$) of the HA value at different days of antibody titer in the entire group. The interaction between all the groups was also found to be significant ($P<0.05$) at different days intervals of antibody titer.

The cellular mediated immune response was also assessed by injecting PHA-P through intradermal route in interdigital space of footpad. No significant T cell response was observed in all the groups; however, higher T cell response was observed in the Morinda fed group. The values were Morinda group (0.35 ± 0.08) and control group (0.2 ± 0.08).

The overall growth performance and performance index of Morinda fed group was found to be better than control group in terms of body weight gain, FCR, mortality percent, immune response and direct challenge test with IBDV infection. The survivability percent of the Morinda fed group was also found to be better than control group. In the present study both humoral and cellular immunity has been increased by the *Morinda citrifolia*, which might have played a key role in protection against the direct challenge test of IBDV and eliciting the higher immunity level in the birds. The present study revealed the overall nutritional effect and immune enhancer effect of *M. citrifolia* in poultry.

Trainings need of Morinda growers in Bay Islands : A study was conducted to assess the training needs of the farmers interested in Noni cultivation. It was observed that the farmers needed training on most of the important aspects. Hence more efforts are to be made on capacity building programme since, this is a new plant to the farmers.

National Network Project on Underutilized Fruits

R. Sudha and D.R. Singh

Field gene bank for minor fruits from Indigenous sources : Seven accessions each of mangosteen, durian and rambutan were collected from Regional station, IIHR, Chettali and Horticulture farm of Kallar and Burliar from Tamil Nadu and introduced in the field gene bank established at Garacharma farm. Two accessions of avocado and one accession each of longan, Garcinia and passion fruit were also collected from diverse sources and introduced.

Standardization of propagation techniques through conventional techniques : Seeds of mangosteen, rambutan and passion fruit were collected from local while avocado seeds were collected from Chettali were sown in the nursery for their germination studies**.** The germination percent was highest in Passion fruit (55%), followed by Mangosteen (45%) and Avocado (40%) with least in Rambutan (25%). The minimum time for germination was 7 days for Passion fruit followed by 15, 21 and 22 days for Rambutan, Avocado and Mangosteen respectively.

Studies on fruit set and fruit development

Mangosteen : The flowering of mangosteen was observed during January – April but more profuse flowering was observed during February-March (Plate 19). For flower bud development and fruit maturity observation, 25 just emerged flower buds were tagged and time taken for complete development till anthesis (flower opening) and anthesis to fruit maturity was recorded. The time taken for complete development of flower bud from its visible initiation to blooming was 52 days. Fruit development took 112.40 days from anthesis. Maturity of fruits takes place in May and continues up to August with peak production during May-June.

Rambutan : The major flowering period of rambutan was recorded during March-May

a. Flower bud

b. Fully opened flower

c. Developing fruit

d. Colour changes of fruit at maturity

Plate 19. (1-d). Flowering and fruiting in Mangosteen

and fruit maturatures during June-July. It took 126.30 days from flowering to fruit maturity. The average length of inflorescence was 28 cm and contains an average of 340 greenish yellow coloured flowers. Fruit set of 20% was recorded but heavy fruit drop was observed. At maturity an average of 24.3 fruits were observed (Plate 20).

Physico-chemical characteristics of minor fruits : Physico-chemical characteristics of mangosteen, rambutan and passion fruit were analysed and presented in Table 19. Among the fruits, maximum TSS content was recorded in mangosteen (19.6 ^{0}Brix) followed by rambutan (19.6 ^{0}Brix). Highest percent of juice (28.93 %) and acidity (1.80 %) was recorded in passion fruit.

a. Flowering in rambutan

a. Fruiting in rambutan

Plate 20. Flowering and fruiting in Rambutan

Table 19. Physico-chemical characteristics of mangosteen, rambutan and passion Fruit

Physico-chemical parameters	Mangosteen	Rambutan	Passion fruit
Fruit length (cm)	4.10	3.42	5.95
Fruit breadth (cm)	4.05	2.66	6.45
Fruit weight (g)	33.33	14.90	76.84
Fruit skin colour	Dark purple	Yellowish Red	Yellow
T.S.S. (^{0} Brix)	19.6	19	14.5
Pulp (%)	24.76	40.75(Aril)	32.14
Rind (%)	67.18	43.47	25.52
Juice (%)	20.58	23.33	28.93
Acidity (%)	0.32	0.72	1.80

Division of Field Crops

Improving the Quality and Productivity of Rice Based Cropping System

T.V.R.S. Sharma, P.K. Singh, N. Ravisankar and Krishna Kumar

Rice

Germplasm introduction/collection: To strengthen the germplasm bank, total 309 accessions of various crops viz. rice, green gram, black gram, red gram, cowpea and sesame genotypes/varieties were collected/procured. The collection/procurement was carried out from different parts of India/other countries (Table 1).

Table 1. Germplasm collected/procured of different crops during 2008-09

Sl. No.	Crop	No. of genotypes/ varieties	Source
1	Rice	334	DRR, IRRI and different parts of Andaman and Nicobar Islands
2	Green gram	16	Indian Institute of Pulse Research, Kanpur and different parts of Andaman and Nicobar Islands
3	Black gram	7	Indian Institute of Pulse Research, Kanpur and different parts of Andaman and Nicobar Islands
4	Red gram	1	Indian Institute of Pulse Research, Kanpur
5	Cowpea	3	Different parts of Andaman and Nicobar Islands
6	Sesame	29	All India Coordinated Research Project on Sesame and Niger, Jabalpur
Total		390	

National trials : Eleven All India Coordinated Varietal Trials (AVT 7, IVT 3, Hybrid 1) on rice were conducted during *Kharif* season (Table 2). Under these trials 279 improved lines were evaluated in eleven experiments for yield and its attributing characters. Few promising lines have been selected for further evaluation and breeding program. As per the guidelines of DRR spacing and replications were followed. The data has been communicated to DRR as per their proforma.

International trials (IRRI) : Two international trials on rice were conducted during *Kharif* season. Under these trials total 166 improved lines (121 for rainfed lowland and 45 for irrigated lowland) were evaluated for yield and its attributing characters. Out of these 32 promising lines were selected for further evaluation and to be utilized in breeding program.

International rice trials conducted during *Kharif* 2008 : One hundred twenty one rainfed lowland early IRRI rice cultivars were evaluated in the randomised block design

Table 2. AICRP trials conducted during 2008-09

Sl. No.	Name of trial	No of entries	Promising over check
1	AVT-VE	19	12
2	AVT1-IM	35	17
3	AVT1-L	22	9
4	AVT 1-E	7	7
5	AVT 2-L	8	Nil
6	AVT-2-E	12	8
7	AVT2-IM	14	Nil
8	IVT-E	49	17
9	IVT-VE	30	Nil
10	Hybrid	23	Nil
11	IVT L	49	Nil
Total	268	70	

with three replications. A dose of 90:60:40 kg NPK/ha was applied and the crop was transplanted in plots of 2.7 m^2 at 15x10 cm spacing. Out of these cultivars best performing 19 cultivars were selected for further evaluation and improvement (Table 3). The top performing cultivars were KARJAT-3 (6.88 t/ha) followed by IR-69716-87-1-3-1-3 (5.94 t/ha) and IR-80411-13-28-4 (5.55 t/ha).

Forty five irrigated lowland early IRRI rice cultivars were evaluated in the randomized block design with three replications. The crop was transplanted in the month of June. Fertilizer was applied @ 90:60:40 kg NPK/ha and crop was transplanted in plots of 2.7 m^2 at 15x10 cm spacing. Best performing thirteen cultivars were selected for further evaluation and improvement (Table 4). The highest yield were recorded for IR-79233-1-2-1-2 (5.68 t/ha) followed by IRYN1068-7-1 (5.47 t/ha) and YN-2883-12-2-1 (5.24 t/ha) and IR-73546-20-2-2-2 (5.02 t/ha).

Quality analysis of rice : Qualitative analyses of 28 selected lines were carried out (Table 5). The highest hulling percent was recorded for UPR 1201-1-201 (82.06%) followed by KARJAT-3 (81.83%), IR 69716.87-13-1-13 (81.80%) and IR 64 (81.60%). These lines were also had long and cylindrical grains. The cooked rice grain elongation was between 0.33 to 1.33%.

Evaluation and improvement of pulses and oilseeds in *Rabi* season

Green gram : Ten promising varieties of green gram along with two local check varieties were evaluated during December to March. The crop was sown with a spacing of 30x10 cm in three replications. Fertilizer was

Table 3. Performance of rainfed early rice cultivars

Lines	Days to flowering	Plant height (cm)	Panicle length (cm)	Tiller/ plant	Five plants yield (g)	Yield t/ha
NAN SAGUI-19	79	155.0	31.5	18.4	120	4.44
IR 78029-34-1-31	71	97.6	29.0	15.2	180	3.88
IR74371-54-1-1	63	107.4	24.4	11.8	130	4.44
IR-78555-3-2-2-2	66	96.8	27.4	11.2	140	4.72
IR-69716-87-1-3-1-3	69	83.2	27.0	14.4	140	5.94
UPR-1201-1-20-1	69	95.8	25.6	14.8	135	4.55
IR 64	66	89.4	27.4	13.6	130	3.55
IR -77701-50-2-2-3-1	76	102.0	26.4	7.9	150	5.00
KARJAT-3	66	98.5	29.2	12.2	200	6.88
IR-62266-42-6-2	76	128.6	29.2	14.6	125	5.00
IR-20	76	107.4	25.2	14.0	160	4.50
IR-78089-44-2-1-3-3	69	89.6	26.4	14.6	175	4.44
SABITA (NC-492)	76	117.6	28.8	11.0	140	3.05
IR 75417-R-R-R-R-267-3	64	116.4	28.0	14.6	145	4.22
IR 78168-51-1-3-16	76	117.6	26.2	13.0	120	3.05
IR-80411-13-28-4	66	107.4	24.0	16.8	180	5.55
IR-78581-12-3-2-2	76	105.2	25.2	15.0	120	3.33
IR-78585-64-2-4-3	76	115.8	24.8	14.2	130	4.66
IR-78585-98-2-2-1	69	115.8	24.6	14.0	140	2.27
Mean	71	107.74	26.85	13.75	145.26	4.39
SE	1.16	3.75	0.46	0.52	5.34	0.24
CD	2.02	6.49	0.80	0.90	9.24	0.42
CV	7.18	15.19	7.56	16.58	16.04	24.64

applied @ 30:40:60 NPK/ha. Observations were recorded for ten quantitative characters. In the order of merit variety viz. IPM-062, Puna-9072, MH-124 and Pusa-0771 were found most promising with yield range 0.29 to 0.18 t/ha (Table 6). These varieties were also found free from diseases.

Black gram : Four improved varieties of black gram were evaluated with local check (Table7). The varieties were sown in the month of January at spacing of 30 x 15 cm. Recommended fertilizer doses were applied. Observations were recorded for yield and attributing characters. Variety CBG-647 and

Table 4. Performance of selected irrigated early rice cultivars

Variety	Days to flowering	Plant height (cm)	Panicle length (cm)	Tillers/ plant	Yield t / ha
IRYN 1068-7-1	76	97.2	25.0	8.6	5.47
PSB RC18(IR51672-62-2-1-2-3)	78	110.6	27.2	9.2	4.37
ADRON 125	61	93.0	23.6	9.6	4.37
TOX 3416-170-2-1-1(WITAII)	76	113.6	30.2	8.8	2.19
YN 2883-12-2-1	75	111.4	26.0	11.8	5.24
IR 79216-8-2-3-1	71	115.2	28.2	8.8	3.58
PSB RC2(IR32809-26-3-3)	75	99.0	24.2	10.4	3.71
IR 79233-1-2-1-2	68	94.8	29.2	9.8	5.68
PSBRC 18(IR51672-62-2-1-1-2-3	78	119.8	26.2	9.6	3.06
IR 79195-42-1-3-1	75	117.6	27.2	6.8	4.15
IR 73546-20-2-2-2	71	108.2	26.8	9.2	5.02
ADRN-124	61	98.2	25.8	10.2	4.37
IR 78101-68-1-1-2-2	76	118.6	25.6	7.2	4.37
Mean	72.38	107.47	26.55	9.23	4.27
SE (m)	1.61	2.69	0.52	0.36	0.27
CD	2.85	4.77	0.92	0.63	0.48
CV	8.02	9.04	7.08	14.09	22.96

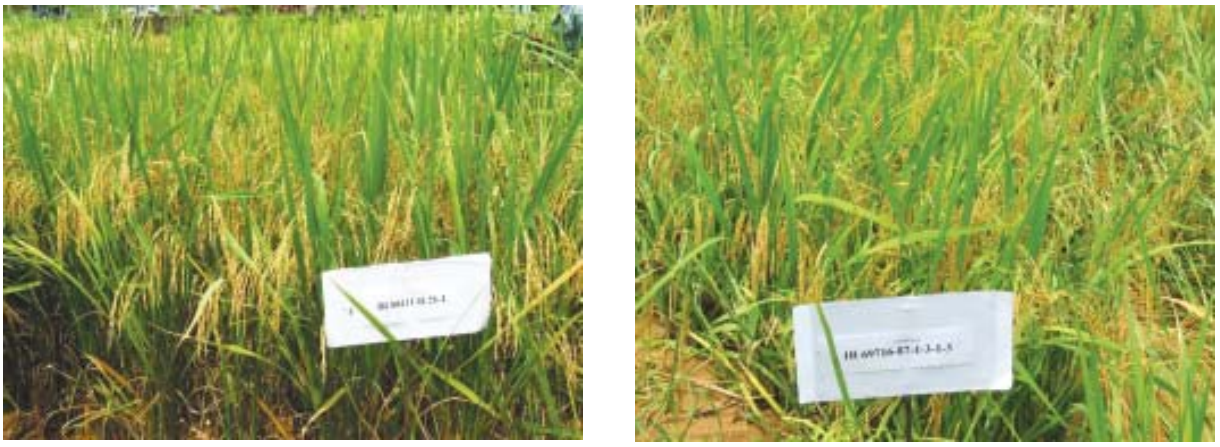


Plate 1. Superior lines of Rice (a) IR 80411-B-28-4 and (b) IR 69716-87-1-3-1-3

Table 5. Quality performance of rice cultivars

Lines	Kernel length (mm)	Kernel width (mm)	Length/ width ratio	1000 kernel weight (g)	Grain elongation	Hulling %	Size and shape
IR78089-44-2-1-3-3	6.50	2.33	2.79	16.19	1.15	76.00	MM
IR-77701-50-2-2-3-1	8.50	2.00	4.25	22.87	1.17	74.90	SVL
IR-20	8.00	2.06	3.87	19.74	1.22	80.60	SVL
IR-78168-51-1-3-16	7.50	2.25	3.34	24.07	1.26	80.60	SL
IR-78581-12-3-2-2	8.00	2.25	3.58	24.38	1.25	80.90	SVL
NAN SAGUI-19	7.50	2.25	3.33	23.03	1.20	81.10	SL
IR-74371-54-1-1	6.50	2.00	3.25	19.63	1.16	79.90	SM
IR-75417-R-R-R-267-3	5.50	2.25	2.44	17.23	1.26	77.90	MS
IR-78029-34-1-3-1	7.00	2.00	3.50	18.55	1.40	77.90	SL
IR-69716-87-1-3-1-3	7.00	2.25	3.10	24.42	1.20	81.80	SL
KARJAT-3	7.50	2.25	3.33	19.75	0.33	81.83	SL
SABITA(NC492)	7.00	2.25	3.11	22.41	1.42	74.00	SL
IR78585-64-2-4-3	8.00	2.00	4.00	25.26	1.25	81.53	SVL
UPR1201-1-20-1	7.00	2.25	3.11	25.00	1.21	82.06	SL
IR-78555-3-2-2-2	8.00	2.25	3.56	18.53	0.25	75.00	VL
IR-69716-87-1-3-1-3	7.00	2.25	3.11	19.85	1.28	79.50	SL
IR-6266-42-6-2	7.50	2.50	3.00	26.48	1.26	81.00	ML
IR-80411-13-28-4	7.00	2.25	3.11	22.56	1.28	80.66	SL
IR-64	7.50	2.00	3.75	22.87	1.33	81.60	SL
Taichung Sen Yu	6.91	2.25	3.06	19.55	1.10	77.30	SL
IR 148	6.58	2.10	3.14	19.01	1.04	77.60	MM
IR 145	7.16	2.25	3.17	21.22	0.36	80.00	SL
Nanging	6.50	2.30	2.84	18.54	1.19	77.00	MM
Quing Livan No.1	6.16	2.23	2.75	18.14	1.15	77.00	MM
BTS 24	5.81	2.50	2.42	16.95	1.13	79.00	MS
MLT 13	6.18	2.00	3.09	19.80	1.18	80.00	SL
MLT 10	5.83	2.41	2.42	19.25	1.10	78.50	MS
Zengul	6.83	2.00	3.41	22.29	0.23	81.16	SM
Mean	7.01	2.20	3.21	20.98	1.08	79.15	
SE(m)	0.24	0.07	0.15	0.21	0.02	0.40	
C.D.	0.70	0.22	0.43	0.61	0.05	1.15	
C.V.	6.14	6.08	8.23	1.79	3.32	0.88	

Table 6. Performance of green gram cultivars

Genotypes	Plant height (cm)	Days to flowe-ring	Days to maturity	No. of bran-ches/ plant	No. of pods/ plant	No. of seeds/ pod	Pod length (cm)	100 seed weight (g)	Grain yield/ plant	Grain yield t/ha
MH-125	23.26	39.66	71.33	0.80	10.20	6.20	10.06	4.10	10.80	0.17
MH-124	20.73	43.66	71.33	0.26	7.57	6.26	8.93	4.40	11.10	0.14
MP-6	19.60	41.00	66.00	0.20	6.73	6.73	9.00	4.32	11.00	0.20
TM -20	16.60	34.00	74.33	0.20	5.20	5.93	8.00	4.75	6.00	0.11
Pusa 9072	23.00	39.00	69.33	0.20	8.06	5.73	9.66	4.03	11.60	0.26
MH-216	17.00	42.00	69.33	0.73	5.40	5.20	8.66	3.86	6.20	0.16
CG-9-972	24.26	50.66	78.66	0.33	7.20	6.06	8.00	4.22	9.13	0.14
Pusa 0771	21.60	31.66	68.66	0.20	5.20	5.73	8.33	5.05	7.13	0.18
IPM 06-2	24.00	29.00	66.00	0.33	8.06	7.46	10.00	5.59	12.80	0.29
MLT 3	17.96	42.00	68.66	0.26	8.06	5.13	9.00	4.20	9.50	0.16
Diglipur local 1	21.66	47.00	68.66	0.20	4.33	7.86	9.33	5.48	6.46	0.10
Diglipur local 2	25.06	49.00	68.00	0.20	5.00	6.00	9.66	3.97	5.00	0.05
Mean	23.26	39.66	71.33	0.80	10.20	6.20	10.07	4.10	10.80	0.17
SE(m)	1.76	1.58	1.05	0.08	1.20	0.28	0.47	0.09	1.22	0.45
C.D.	5.20	4.67	3.12	0.25	3.56	0.84	1.41	0.27	3.62	1.34
C.V.	14.37	6.74	2.61	45.89	30.97	7.97	9.16	3.60	23.91	46.74

Plate 2. Best performing green gram variety (a) Pusa 9072 and (b) IPM 062

Table 7. Performance of black gram cultivars

Genotypes	Plant height (cm)	D. F.	D.M.	No. of branches/ plant	No. of pods/ plant	No. of seeds/ pod	Pod length (cm)	100 seed weight (g)	Grain yield/ plant	Grain yield t/ha
TU17-14	37.15	38	103	4.35	34.10	4.25	6.35	5.53	36.65	0.77
TU-40	41.50	38	103	3.45	34.70	4.82	7.05	4.85	33.31	0.74
CBG-703	34.65	44	112	3.05	31.10	3.92	6.30	4.91	31.63	0.71
CBG-647	40.85	45	113	3.05	38.20	3.90	5.55	6.34	44.32	0.81
Local	34.70	45	119	4.60	23.20	4.47	6.55	5.21	27.50	0.66
Mean	37.77	42	109	3.70	32.26	4.27	6.36	5.36	34.68	0.74
SE(m)	1.58	0.21	0.60	0.31	2.71	0.10	0.20	0.08	4.55	0.41
C.D.	4.92	0.68	1.89	0.98	8.44	0.31	0.62	0.25	N.S.	N.S.
C.V.	8.36	1.04	1.10	17.03	16.80	4.77	6.31	2.98	26.28	11.02

a

b

Plate 3. Best performing varieties of black gram (a) CBG 647 and (b) TU 17-14

a

b

c

d

Plate 4. Sesame varieties (a) PBS 9, (b) PBS 18, (c) PBS 17 and (d) PBS 19

TU 17-14 were found most promising with average yield of 0.81 and 0.77 t/ha respectively.

Sesame : Twenty six sesame varieties were evaluated in randomized block design with three replications (Table 8). The crop was sown in the month of February. The plot size was 4.5 m^2 and the spacing of 40 x 15 cm row to row and plant to plant respectively. Recommended fertilizer doses were applied. Ten biometrical observations were recorded and analysed. The highest yield was recoded for variety PBS 9 (1.41 t/ha) followed by PBS 18 (1.28 t/ha), PBS 17(1.23 t/ha) and PBS 19 (1.09 t/ha). The varieties were also found free from disease and pests.

Breeder seed production: Breeder seed production was undertaken for different varieties of rice and green gram. Given the poor indent, only 54 kg of rice seed (eight varieties) and 4 kg of green gram seed was produced.

Rice varieties ready for release : Five varieties of lowland rice viz. CARI Dhan-1, CARI Dhan-2, CARI Dhan-3, CARI Dhan-4, CARI Dhan-5, are ready for release. These are medium duration (110-120 days) and gives average yield of 5.2-5.4 t/ha in bay islands conditions. Moreover, varieties CARI Dhan-4, CARI Dhan-5 are also suitable for saline soil with yield of 3-3.5 t/ha.

Evaluation of rice Germplasm : Six genotypes of local rice viz, Gol Dhan, Burma Dhan, Jeera Rice, Black Burma, Swarna Jaya and Ratna collected from North Andaman were evaluated for yield and its attributing character.

Table 8. Performance of sesame cultivars

Genotypes	Plant height (cm)	Days to flowering	Days to maturity	No. of branches/ plant	Capsule length (cm)	No. of capsule/ plant	No. of seeds/ capsule	1000 seed weight (g)	Seed yield/ plant (g)	Seed yield t/ha
PBS 1	116.10	40.33	93.00	2.20	2.98	88.43	54.26	3.52	20.80	0.94
PBS 2	123.30	39.00	94.00	2.56	2.10	68.86	46.53	3.53	14.13	1.02
PBS 3	126.86	38.33	95.66	2.10	2.13	83.36	55.40	3.80	14.66	0.98
PBS 4	105.73	36.33	93.00	2.00	2.38	54.10	63.40	3.30	11.33	0.72
PBS 5	88.55	36.00	93.00	3.23	2.42	74.33	49.86	4.01	12.73	0.72
PBS 6	90.08	35.66	93.00	2.73	2.63	69.26	48.60	2.92	11.26	0.95
PBS 7	81.86	37.00	91.00	2.63	2.04	60.04	49.80	3.91	9.60	0.71
PBS 8	101.78	37.66	95.00	2.83	2.20	59.56	58.73	3.57	11.73	0.84
PBS 9	129.80	40.66	93.00	2.93	2.17	98.46	58.06	3.04	16.66	1.41
PBS 10	89.93	37.66	97.33	2.43	2.63	59.43	66.33	3.01	13.20	0.81
PBS 11	90.36	44.33	93.00	2.06	2.34	62.46	50.53	3.46	14.20	0.66
PBS 12	102.13	39.00	92.00	2.36	2.78	46.80	66.73	3.35	21.53	1.06
PBS 13	92.43	37.66	99.33	2.46	2.11	76.77	53.60	3.12	11.86	0.83
PBS 14	100.16	39.00	97.00	2.70	2.36	77.57	52.80	3.32	14.46	0.80
PBS 15	79.66	37.33	92.00	4.00	2.80	64.40	54.93	3.44	13.33	0.78
PBS 16	94.28	39.33	95.00	2.53	2.72	89.80	43.13	3.21	12.86	0.78
PBS 17	110.46	40.33	90.33	2.66	2.39	63.88	61.80	3.01	15.60	1.23
PBS 18	106.80	42.00	95.00	3.93	1.99	96.26	63.60	2.92	12.00	1.28
PBS 19	116.83	39.00	93.00	2.93	2.64	84.00	67.40	3.18	15.33	1.09
PBS 20	109.90	40.00	100.66	3.86	2.07	122.00	41.73	3.81	15.40	0.73
PBS 21	91.60	36.00	92.00	2.36	2.01	65.93	33.86	3.46	8.53	0.78
PBS 22	91.03	35.00	92.00	2.16	2.03	57.73	39.60	3.80	9.40	0.84
PBS 23	96.20	38.33	87.00	2.60	2.24	82.96	48.06	3.70	7.73	1.01
PBS 24	82.86	39.33	90.66	2.56	2.52	64.20	60.86	3.93	10.53	0.77
PBS 25	94.36	38.00	92.00	2.36	2.42	54.20	57.26	3.57	11.46	0.85
PBS 26	109.53	37.33	97.33	2.93	2.29	58.66	58.00	3.18	10.53	1.04
Mean	100.90	38.48	93.70	2.69	2.36	72.44	54.03	3.42	13.11	0.91
SE(m)	4.04	1.09	1.14	0.19	0.08	7.21	4.60	0.20	1.77	1.12
C.D.	11.52	3.12	3.26	0.54	0.23	20.56	13.12	0.57	5.05	3.19
C.V.	6.94	4.93	2.11	12.16	6.15	17.26	14.76	10.12	23.42	21.26

Development of IDM Modules for Tomato

Someshwar Bhagat, Krishna Kumar and A. K. Tripathi

Vegetable crops rank second most important crop after plantation crops. Among the vegetables, tomato is one of important vegetable crop in these Islands. Due to congenial climatic and weather condition coupled with intensive cultivation, heavy pest and disease incidence occur in vegetable crops. Thus the farmers try to save their crops from pest and disease attack at any cost, which ultimately lead to the indiscriminate use of chemical pesticides. Considering this point of view, this project has been initiated to develop different IDM modules for the management of disease complex of tomato.

Survey of major diseases of Tomato

An extensive survey on disease incidence in tomato was carried out in North and South Andaman district including Havelock, Neil Islands, Little Andaman, Rangat, Billiground, Myabunder and Diglipur areas during November, 2008 to Feb-March, 2009. The incidence of major and minor diseases in tomato was recorded in farmer's field. The results on incidence pattern of diseases in tomato (Table 10) revealed that bacterial wilt is most important disease of tomato in these Islands with 12-35% disease incidence followed by tomato leaf curl (10-20%), damping off (10-18%), basal stem rot (8-18%), fusarium wilt (5-11%), blossom end rot (5-10%) and tomato mosaic virus disease (4-8%).

Table 10. Disease incidence pattern in tomato

Sl. No.	Diseases	% Incidence
1	Damping off of seedlings (Pythium sp., Phytophthora sp., Rhizoctonia solani, Sclerotium rolfsii, Fusarium solani)	10-18
2	Bacterial wilt (Ralstonia solanacearum)	12-35
3	Fusarium wilt (Fusarium oxysporum f sp. lycopersici)	5-11
4	Basal stem rot (Sclerotium rolfsii)	8-18
5	Mosaic (Tomato Mosaic Virus)	4-8
6	Leaf curl (Tomato Leaf Curl Virus)	10-22
7	Blossom end rot (physiological disorder-calcium deficiency)	5-10

Isolation of plant pathogens of tomato

The pathogens, viz., *Pythium* sp., *Phytophthora* sp., *Rhizoctonia solani, Sclerotium rolfsii, Fusarium oxysporum f.* sp. *lycopersici* were isolated from the infected plant parts by following tissue segment method. These pathogens were tested against five most promising *Trichoderma* isolates isolated from rhizosphere soil of tomato, viz., Th-CARI-5, Th-CARI-7, Tv-CARI-3, Tv-CARI-5 and lone isolates of *Pseudomonas fluorescens* (Psf-AN-1). The

results presented in table 11 revealed that all isolates of biocontrol agents significantly parasitized the test pathogens but the isolate Tv-CARI-3 was most effective in percent inhibition of all pathogens tested followed by Th-CARI-5, Tv-CARI-5 and Th-CARI-7. The lone isolate of *Pseudomonas fluorescens* was also very effective in suppression of mycelial growth of all test pathogens.

Table 11. In vitro antagonistic potential of biocontrol agents against some plant pathogens of tomato

Biocontrol agents	Radial mycelial growth* (mm)				
	Pythium sp.	Phytophthora sp.	R. solani	S. rolfsii	F.o.f sp. lycopersici
Th-CARI-5	29.8 (#66.7%)	30.0 (66.7%)	25.5 (71.7%)	32.8 (63.5%)	33.2 (63.1%)
Th-CARI-7	34.6 (61.5%)	35.2 (60.9%)	28.6 (68.2%)	36.2 (59.8%)	35.4 (60.7%)
Tv-CARI-3	28.5 (68.3%)	29.4 (67.3%)	24.6 (72.7%)	30.7 (65.9%)	30.5 (66.1%)
Tv-CARI-5	31.8 (64.7%)	32.0 (64.4%)	26.0 (71.1%)	33.0 (63.3%)	32.4 (64.0%)
Psf-CARI-1	32.0 (64.4%)	32.5 (63.4%)	29.6 (67.1%)	35.1 (61.0%)	34.8 (61.3%)
Control	90.0	90.0	90.0	90.0	90.0
SEd	0.58	0.66	0.49	0.78	0.55
CD (0.05)	1.26	1.40	1.06	1.46	1.18

*Means of four replication; #The values in the parentheses indicates percent inhibition of test pathogens

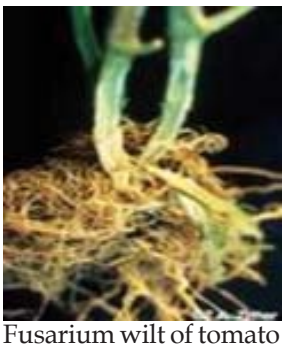
Field trial for the management of disease complex of tomato

Field trial at Garacharma Farm was conducted exclusively by using biocontrol agents for the management of disease complex of tomato. The variety of tomato used was Azad-1. Three biocontrol agents, viz., Th-CARI-5 (*T. harzianum*), Tv-CARI-3 (*T. viride*) and Psf-CARI-1(*Ps. fluorescens*) were used in different combination in thirteen treatments including control. All treatments significantly reduced the disease incidence of major diseases in tomato as compared to control but the T_{10} (Seed treatment + Seedling dip for half an hour + Soil drenching with Th-CARI-5) treatment was most effective in reducing disease incidence and corresponding yield increase. The other best treatments were T_{11} (Seed treatment + Seedling dip for half an hour + Soil drenching with Tv-CARI-3) and T_{12} (Seed treatment + Seedling dip for half an hour + Soil drenching with Psf-CARI-1). The incidence of leaf curl and mosaic virus diseases were also reduced by soil application of neem cake along with biocontrol agents at the time of transplanting and two sprays with *neem* oil at 30 and 50 DAT as the population of whitefly (*Bemisia tabaci*) was reduced to below economic threshold level.

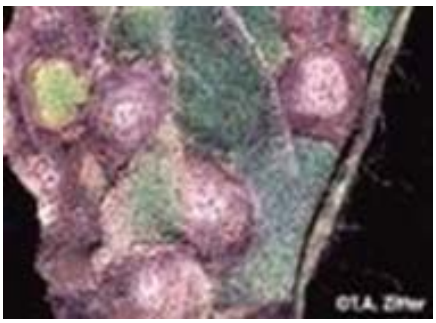
Similarly, the field trial was also conducted at Sippighat farm with same variety with a combination of biocontrol agents, chemical fungicides and neem cake. Three biocontrol

agents viz., Th-CARI-5 (*T. harzianum*), Tv-CARI-3 (*T. viride*) and Psf-CARI-1(*Ps. fluorescens*) Th-CARI-5 (*T. harzianum*), Tv-CARI-3 (*T. viride*) and Psf-CARI-1(*Ps. fluorescens*) were used and three most commonly used fungicides viz., Copper oxychloride, Carbendazim and Krilaxyl were used. Among the fungicides alone, Copper oxychloride (Seed treatment +Seedling dip + soil drenching/foliar spray) was most effective in reducing disease complexes in tomato, followed by Krilaxyl and Carbendazim. The isolate Th-CARI-5 (*T. harzianum*) was most effective in reducing disease complexes and corresponding yield increase in test variety of tomato. However, the combination of biocontrol agents with chemical fungicides at relatively lower concentration gave better result in response to management of disease complexes in tomato as compared to either biocontrol agents or chemical fungicides alone. The incidence of leaf curl and mosaic virus diseases were also reduced by soil application of neem cake along with biocontrol agents at the time of transplanting and two sprays with neem oil at 30 and 50 DAT as the population of Whitefly (*Bemisia tabaci*) was reduced to below economic threshold level.

Damping off and collar rot of tomato seedling



Fusarium wilt of tomato



Septoria leaf spot of tomato

Bacterial wilt of tomato

Basal stem rot of tomato

Blossom end rot of tomato

Tomato leaf curl

Integrated Disease and Pest Management of Black Pepper

Someshwar Bhagat, Ajanta Birah, Krishna Kumar and M. Shankaran

Black Pepper occupies major position among spices in the Bay Islands both in the term of area and production as well as economic return. However, there is lack of information on disease and pest management of Black pepper which is affected by number of pests and diseases. So, this project was initiated to fill in this gap to manage the pest and disease incidence in Black pepper by integrating different control measures especially by botanical and biopesticides. An extensive survey was carried out to assess the incidence of major diseases and pests of Black pepper in the Andaman districts including Diglipur, Mayabunder, Billiground, Rangat and their adjoining areas, Little Andaman, Havelock, etc. The incidence pattern of major diseases and pests in the Bay Islands are presented in table 12.

Isolation of pathogens: Eight isolates of *Phytophthora capsici* were isolated from infected plant samples from different places which have been coded: Sipighat (Ph-CARI-1, and Ph-CARI-6), Garacharma (Ph-CARI-2), Keralapuram, Diglipur (Ph-CARI-3), Panchwati (Ph-CARI-4, and Ph-CARI-5), Rangat (Ph-CARI-7) and Calicut (Ph-CARI-8) . Furthermore, 6 isolates of *Collectotrichum capsici* were also isolated from infected leaf samples.

Isolation of antagonistic fungi : Ten isolates of *Trichoderma* sp. were isolated from the rhizosphere soil of Black pepper by following soil dilution technique and by plating it on TSM (*Trichoderma* specific medium). All the isolates were purified and preserved in refrigerator for subsequent studies. These isolates of *Trichoderma* were identified to species level based on morphological characters by using slide culture technique

Table 12. Incidence of diseases and pests in Black Pepper

Diseases		
Sl. No.	**Name of disease**	**% incidence**
1.	Foot rot (Quick wilt) (Phytophthora capsici)	20-50
2.	Stem rot/basal wilt (Sclerotium rolfsii)	5-12
3.	Slow wilt/decline (Fusarium, Rhizoctonia, Diplodia, Meloidogyne incognita, Radophilus similis, P. capsici)	5-10
4.	Anthracnose (Pollu) (Colletotrichum gloeosporioides)	8-18
5.	Stunted disease (Cucumber mosaic virus)	>5
6.	Bacterial Leaf spot (Xanthomonas beticola)	10-15
7.	Yellow Mottle (Badna virus)	>5
Pests		
1.	Pollu beetle (Longitarsus nigripennis)	10 - 35
2.	Top shoot borer (Cydia hemidoxa)	>5
3.	Scale insects (Lapidosaphes piperis, Aspidlotus destructor)	5-15
4.	Leaf gall thrips (Liothrips karny)	10-20

Colletotrichum leaf spot

Phytophthora leaf spot

Bacterial blight

CMV

Leaf gall thrips infestation in Black pepper

Pollu beetle infestation in Black pepper

and comparing with the standard monographs. The details of these isolates of *Trichoderma* are presented in table 13.

In vitro study of all antagonistic fungi against *Phytophthora* sp. and *Colletotrichum* sp. revealed that all isolates of *Trichoderma* significantly inhibited the growth and multiplication of test pathogens but the degree of antagonistic potential of these isolates varied with the pathogen tested. The *Trichoderma* isolates are being characterized at physiological and biochemical level. The test of virulence of the pathogens *in vivo* is also being evaluated.

Table 13. Isolates of Trichoderma spp. from rhizosphere soil of Black pepper

Sl. No.	Isolate code	Place/Habitat	Species identified
1.	Th-CARI-B-1	Keralapuram, Diglipur	T. harzianum
2.	Th-CARI-B-2	Panchwati	T. harzianum
3.	Tv-CARI-B-1	Panchwati	T. viride
4.	Th-CARI-B-3	Sippighat	T. harzianum
5.	Tv-CARI-B-2	Rangat	T. viride
6.	Tv-CARI-B-3	Calicut	T. viride
7.	Th-CARI-B-4	Meethakhari	T. harzianum
8.	Th-CARI-B-5	Garacharma	T. harzianum
9.	Tv-CARI-B-4	Sippighat	T. viride
10.	Th-CARI-B-5	Minnibay	T. harzianum

Assessment of Crop Losses and Epidemiology of Major Vegetable Diseases of South Andaman

Krishna Kumar, V Jayakumar and M. Balakrishnan

Experiment was laid out in RBD with four treatments. Among four dates of transplanting (25th Jan, 10th Feb, 25th Feb. and 10th March) in tomato, lowest 49.98 % wilt incidence was recorded in Sel. 22 in 10th March transplanted tomato whereas 48.16 % in Pusa Ruby in 10th February transplanted crop (Fig 1-2). Wilt incidence in chilli was recorded 22.66 % in both 25th and 10th Feb transplanted crops whereas lowest leaf curl incidence (30%) was recorded in case of 10th February (Fig 3). The result on correlation analysis between incidence of tomato wilt, chilli wilt and curl with weather parameters had positive effect on development of epidemics. Tomato wilt in both cultivars had positive correlation with maximum RH, rainy days and rain fall. There was positive correlation between chilli leaf curl and minimum RH and rainy days in 10th and 25th March transplanted crops. A similar trend was also noticed in case of chilli wilt influenced by minimum RH and rainy days in 10 Feb to 10 March (Fig 4).

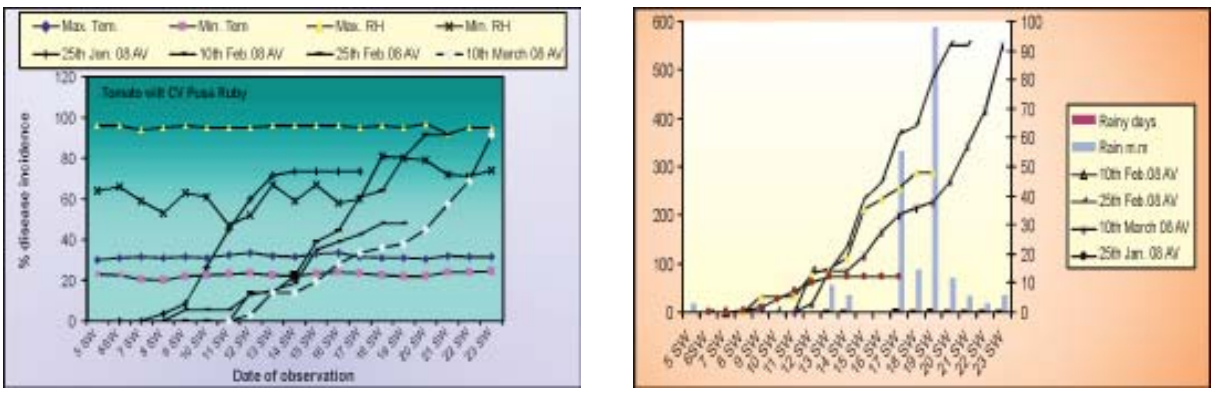


Fig. 1. Effect of date of transplanting and influence of weather factors on incidence of wilt of tomato cv. Pusa Ruby

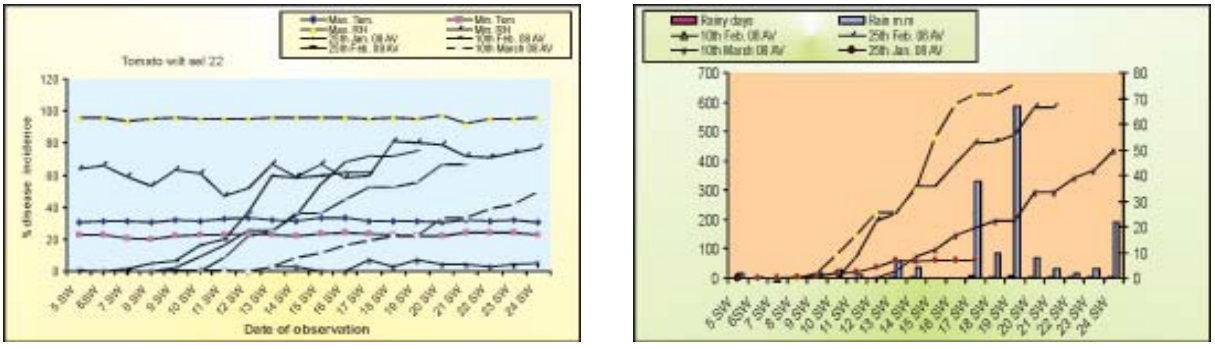


Fig. 2. Effect of date of transplanting on incidence of wilt of tomato cv. Sel-22

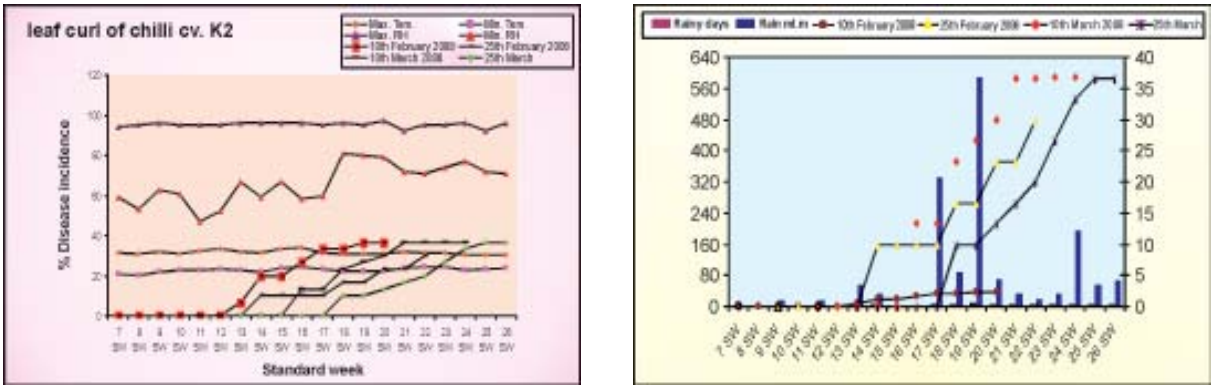


Fig. 3. Effect of weather parameters and date of transplanting on incidence of leaf curl of chilly cv. K2

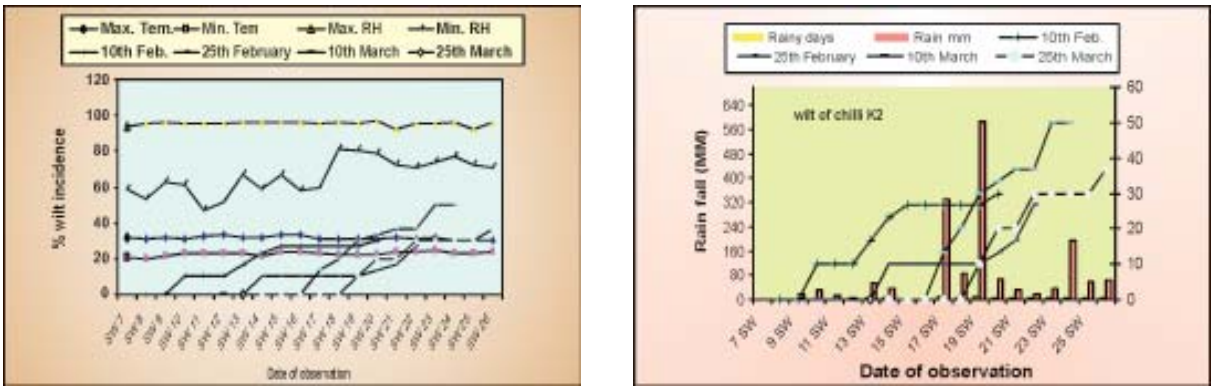


Fig. 4. Effect of date of transplanting on incidence of wilt of chilly K2

Standardization of Production and Protection Technology of Tropical Mushrooms

Krishna Kumar, Someshwar Bhagat and Ajanta Birah

Eight locally available substrates were evaluated for yield and biological efficiency of *Pleurotus florida*. Among tested substrates, paddy straw had highest biological efficiency (77.35 %) followed by arecanut pericarp (57.00%), coconut leaf (51.25%) and rest were less than 50.00% (Plate 7)

Standardization of production technology of milky mushroom (*Calocybe indica*)

In order to introduce milky mushroom in island preliminary investigation was carried out to standardize production technology of milky mushroom. Paddy straw was used as substrate to evaluate biological efficiency of milky mushroom in these islands. Various casing material were tested in different combinations to obtain good yield. Thirty three percent biological efficiency was obtained on paddy straw when used as substrate (Plate 8).


Plate 7. Developmental stages of *Pleurotus florida*


Plate 8. Milky mushroom (*Calocybe indica*)

Exploration of Plant Pathogenic and Antagonistic Microbial Resources Associated with Vegetable and Spice Crops of Andaman and Nicobar Islands

Krishna Kumar, Someshwar Bhagat and V. Jayakumar

Survey and collection of soil samples

Middle and North Andaman Tehsils viz., Rangat, Mayabunder and Diglipur were surveyed and collected infected leaf samples and rhizosphere soils from vegetable and spice crops. Data on longitude, latitudes and cropping systems in these areas were recorded. From the initiation of the project a total of 126 villages were surveyed for collection of samples (Table 14).

Isolation of antagonistic microorganisms

In the reported period, thirty soil samples from rhizosphere of vegetable crops were collected from Middle Andaman district and 92 antagonistic bacteria were isolated. The detailed lists of microorganisms isolated so far are maintained at CARI, Port Blair is listed in table 15.

Table 14. Geographical locations surveyed for collection of samples

Name of the district	Total no. of villages surveyed			
	2006-07	2007-08	2008-09	Total
South Andaman	35	26	10	71
Middle & North Andaman	-	20	30	50
Nicobar	5	-	-	05
Total	40	46	40	126

Table 15. Microorganisms isolated from vegetable and spice crops

Isolate	Year			Total
	2006-07	2007-08	2008-09	
Fungal pathogens	20	13	-	33
Bacterial pathogens	23	8	-	31
Bacterial antagonist (isolated on KB)	104	100	40	244
Bacterial antagonist (Isolated on NA)	90	105	44	239
Mycoparasitic fungi (Isolated on SM)	22	58	08	88
Total	259	284	92	635

Characterization of microorganisms

Morphological and biochemical characterization : The antagonistic bacterial isolates were subjected to morphological, cultural and biochemical tests, i.e., color, form, elevation, margin, texture, motility and morphology, Gram's reaction, presence of catalase and oxidase, fluorescence test, utilization of organic compounds and carbohydrates. The characterized organisms were tentatively identified as genus *Bacillus* spp. (40 nos). A total of 21 mycoparasitic fungal isolates from spice crops has been studied for their colony radius, growth pattern, cultural and morphological properties using TSM, PDA, OMA and CMD (Plate 9). The characters were assessed with standard procedure and the genus and species were identified. Among 21 isolates 17 were identified at species level, i.e., 5 *T. hamatum*, 2 *T. longibrachiatum,* 4 *T. koningii*, 2 *T. harzianum*, 2 *T. viride*, 1 each of *T. strictiple* and *T. oblongiosporum*.

Antagonistic property : Fourteen isolates of *Trichoderma* spp. from South Andaman associated with rhizosphere soil of spice were tested for antagonistic property against *Sclerotium rolfsii, C. capsici* and *C. gloeosporioides*. A total of 81 bacterial isolates, 34 isolates from South Andaman (associated with rhizosphere soil of spice) and 47 isolates from Neil and Havelock Islands (associated with rhizosphere soil of vegetable), respectively were tested for antagonistic property against phytopathogens i.e., *Sclerotium rolfsii*, *Colletotrichum capsici,* and *C. gloeosporioides* by dual culture assay (Plate 10).

TMP1

THB1

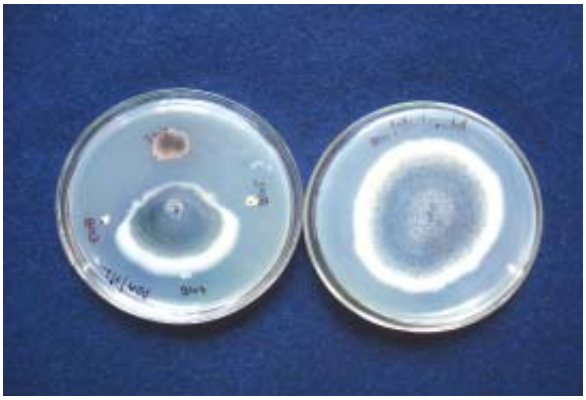
TNB1

TWP1

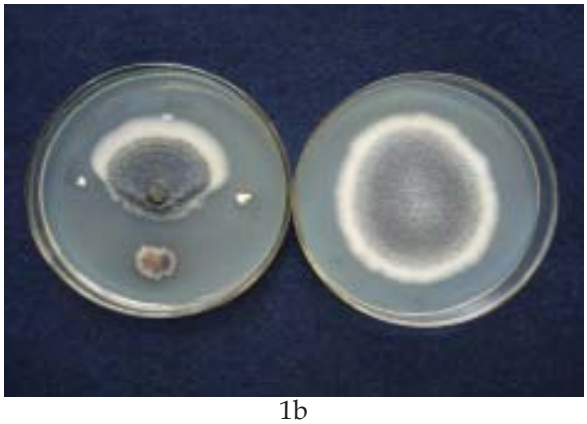
TSD1

TND1

Plate 9. Cultural variation among *Trichoderma spp.*

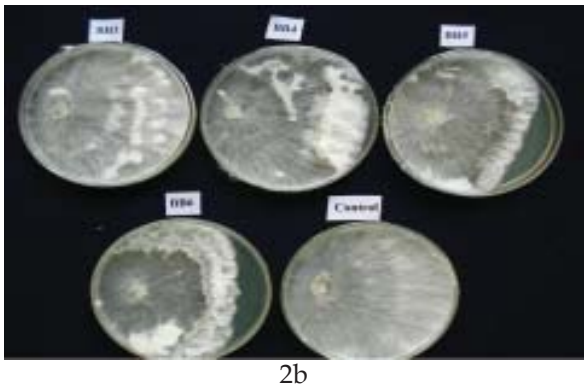


1a

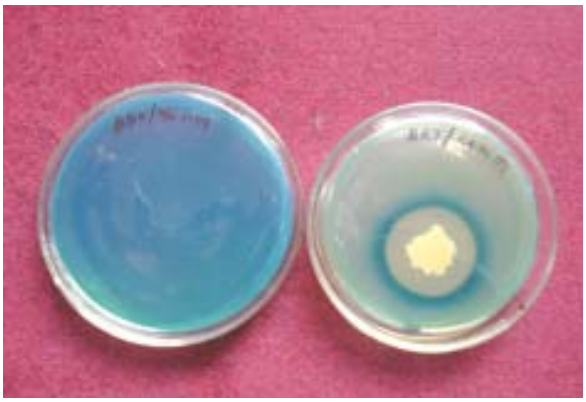


1b

2a



2b



3a

3b

Plate 10. Characterization of bacterial antagonists, 1a & 1b. Inhibition of mycelial growth of *C. capsici*, 2a & 2b. Inhibition of mycelial growth of *S. rolfsii* and 3a & 3b. Siderophore production

Plant growth promoting property : These isolated were also screened for IAA production, siderophore production and phosphate solubilization properties.

Molecular characterization and diversity analysis

***Colletotrichum* spp. :** For molecular characterization, the ITS region of 10 *Colletotrichum* spp. were amplified with ITS1

and ITS4 primers and obtained PCR products of about 500-600bp. The 10 PCR- ITS amplicon samples were submitted for gene sequencing and results of 5 were obtained. The BLAST analysis revealed that 3 are *C. gloeosporioides* (Genebank accession Nos: EU697202, EU697203, EU697200), 1 *Glomerella cingulata* (Genebank accession No: EU697201) and 1 of unreported species of *Colletotrichum* (Genebank accession No: EU744584).

Development of Ecofriendly IPM Modules for OKRA and Cucurbits in Andaman

Ajanta Birah, Shrawan Singh, Subhash Chand, Krishna Kumar and Someshwar Bhagat

Insect survey

Indiscriminate use of insecticides and intensive agronomic practices has disrupted the delicate balance between the insect pests and their natural enemies. Vegetable crops suffer heavily from infestation of insect pests. An extensive survey was carried out to find out the major pest problems in okra and cucurbits that can help to developing an appropriate IPM packages. Surveys on insect pests of okra and cucurbits were conducted during 2008-09 in 14 different locations of Andaman. Fields were surveyed diagonally and records of infestation levels were noted as follows: Nil (no infestation); Very low (< 5% infestation); Low (< 20% infestation); Moderate (<40% infestation); High (< 60% infestation); and Very high (> 60% infestation) (Table 16).

The important insect-pests causing significant damage to okra in different locations of Andaman were leaf hopper (*Amrasca bigutulla bigutulla*) and whitefly (*Bemicia tabaci*) among the sucking pests whereas shoot and fruit borer (*Earias vitella*) and tobacco caterpillar (*Spodoptera litura*) among the borer pest. Fruit fly (*Dacus cucurbitae*), serpentine leaf miner (*Liriomyza trifolii*) and aphids (*Aphis gossypii*) were observed as major pests of cucurbits (bottle gourd, ridge gourd, bitter gourd and cucumber) (Plate 11). The detailed pest incidence of okra and cucurbits are described in table 17. In all the locations, farmers applied insecticides irrespective of pest species and their infestation intensity.

Effect of plant extracts on growth and development of *Spodoptera litura*

Nucleus culture of the test insect *Spodoptera litura* was collected from the farmers fields of South Andaman and reared on the most suitable and easily available natural host, castor leaves (*Ricinus communis*) in laboratory conditions, for several generations to ensure genetic homogeneity (Table 18 and figure 5). Studies were conducted to assess the biological efficacy of aqueous leaf extracts of Karanja (*Pongamia glabra*), Cloves (*Syzygium aromaticum*) and *Gliricidia* spp. against tobacco caterpillar (*Spodoptera litura*) under laboratory conditions using 'leaf dip method' (Plate12). Larvae of F3 generation were used for conducting the laboratory

Table 16. Insect pests of okra and cucurbits in different locations of South Andaman in 2008-09

Location	Okra				Cucurbits		
	Fruit borer	Leaf hopper	Whitefly	Tobacco caterpillar	Fruit Fly	Leaf miner	Aphids
Calicut	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate
Macca Pahar	Low	Low	Moderate	Low	Low	Moderate	Moderate
Baramnala	Low	Low	Moderate	Low	Low	Low	Low
Telrabad	Low	High	Low	Low	Low	Low	Nil
Gupta Para	Low	Moderate	Moderate	Low	Moderate	High	Low
Sipighat	Low	Moderate	Moderate	Low	Moderate	High	Moderate
Manglutan	Low	High	Low	Moderate	Nil	High	Moderate
Garacharma	Very low	Low	Low	Low	Low	Moderate	Moderate
Havelock Island	Low	Low	Moderate	Low	Low	High	Moderate
Neil Island	Low	High	High	Moderate	Moderate	High	Moderate
Little Andaman	Low	Low	High	Nil	Low	Low	Nil
Diglipur	Low	High	High	Low	Low	Low	High
Mayabunder	Low	High	High	Low	Low	Low	Moderate
Rangat	Low	High	High	Low	Low	Low	High

Nil (no infestation); Very low (< 5%infestation); Low (< 20% infestation); Moderate (< 40% infestation); High (< 60% infestation); and Very high (> 60% infestation).

experimentation. Out of three plants tested, *Syzygium aromaticum* extract possess the maximum insecticidal and juvenomimetic properties against *S. litura,* as total growth and development was reduced which will ultimately affect the future generation of the test insect. Data presented in tables 19 and figure 6 shows that leaf extract of *Syzygium aromaticum* inhibited the growth and development of *S. litura* and affected the larval and pupal survival and adult emergence in a dose-dependent manner. **It is clearly indicated that due to** *Syzygium aromaticum* **(20%)** extracts intoxicated food, 90 per cent **larvae died at early instars, hence t**he larval population could not reach the crucial late instar stage, which is actually responsible for crop damage. Consequently, the survival of the test insect was reduced (12.22% in 15% concentration), whereas in control it was as high as 76.5%. Larval growth index and total development indices of the test insect were drastically reduced 1.12 and 0.28 in *Syzygium aromaticum* intoxication (15% concentration) whereas in control it was 5.20 and 2.70, respectively. The leaf extracts of this plant also affected the fecundity and fertility of the test insect adversely as there was very less chance of the future generation. Such plant extract can well be used as one of important component while developing pest management strategy for *S. litura.*

Table 17. Growth and development of *Spodoptera litura* on natural food (castor leaf)

Parameters	Generation					Mean± SD	SEm±	CD (P≥ 0.05)
	G_1	G_2	G_3	G_4	G_5			
Larval	22.89±	16.50±	17.71±	16.22±	15.90±	17.84±	0.98	2.19
period (days)	1.64	1.31	1.04	1.36	0.93	2.92		
Pupation	90.00	89.50	85.00	85.00	84.00	86.73±	2.64	5.90
(%)	(71.62)	(71.42)	(67.40)	(67.40)	(66.45)	4.00		
Pupal	355.60±	326.40±	348.40±	362.20±	348.00±	348.12±	7.31	16.29
weight (mg)	46.26	27.03	20.67	42.24	9.26	14.07		
Pupal	10.82±	9.65±	10.65±	12.50±	9.96±	10.72±	1.03	2.30
period (days)	1.64	1.04	1.06	0.89	1.06	1.52		
Adult	91.67	85.00	92.00	85.00	82.50	87.23±	2.80	6.24
emergence (%)	(73.30)	(67.40)	(73.92)	(67.40)	(65.29)	5.29		
Developm-	33.71±	26.15±	27.36±	28.72±	25.86±	28.36±	1.36	3.04
ental period (days)	1.98	3.01	4.76	3.62	3.56	3.52		
Survival	82.50	76.07	82.80	76.50	70.30	77.63±	0.99	2.21
(%)	(65.29)	(60.71)	(65.34)	(61.01)	(56.97)	5.21		
Fecundity	473.80±	449.30±	469.00±	439.40±	419.80±	450.26±	13.66	30.44
(no.)	45.88	74.92	70.99	9.63	81.03	23.47		
Fertility	85.20	90.90	93.90	94.57	93.33	91.58±	2.61	5.82
(%)	(67.57)	(72.45)	(75.73)	(77.25)	(75.06)	4.33		

± SD: Standard deviation; CD: Critical Difference; value in parenthesis are arcsine transformed values

Plate 11. Infestation of tobacco caterpillar, *Spodoptera litura* and serpentine leaf miner (*Liriomyza trifolii*) in field

Plate 12. Laboratory experiment of testing of aqueous leaf extract of *Syzygium aromaticum* on growth and development of *Spodoptera litura*

Table 18. Effect of crude leaf extract of Syzygium aromaticum on growth and development of Spodoptera litura

Parameters	Concentration (%)						Control	SEm±	CD (P≥0.05)
	0.5	1	5	10	15	20			
Larval period (days)	18.70± 6.54	20.10± 6.78	22.10± 6.02	24.30± 5.06	26.90± 4.75	27.50± 2.82	17.3± 0.90	1.72	3.68
Pupation (%)	85.52 (67.84)	79.42 (63.02)	65.62 (54.13)	43.59 (41.31)	30.30 (33.39)	10.20 (18.57)	90.00 (71.62)	1.87	4.02
Pupal weight (mg)	253.59±1 14.49	243.65±1 04.74	231.14±9 7.65	201.4± 95.42	156.49±6 3.04	130.2± 57.22	303.1± 33.35	5.50	11.80
Pupal period (days)	12.52± 4.96	13.65± 5.33	15.42± 4.52	15.5± 3.01	16.92± 3.72	—	11± 3.94	1.41	3.03
Adult emergence (%)	82.92 (65.61)	85.46 (67.78)	75.42 (60.35)	60.32 (50.95)	40.31 (39.33)	(4.05)	85.00 (67.40)	2.81	6.03
Develop-mental period (days)	31.22± 12.42	33.75± 13.03	37.52± 13.14	39.8± 12.16	43.82± 11.41	—	28.3± 1.14	1.19	2.56
Survival (%)	70.91 (57.41)	67.87 (55.47)	49.49 (44.70)	26.29 (30.83)	12.22 (20.42)	(4.05)	76.50 (61.03)	1.44	3.06
Fecundity (no.)	392.15±1 64.84	201.18±8 1.23	0.00	0.00	0.00	—	480± 122.02	13.06	28.00
Fertility (%)	28.4 (32.16)	0.00 (4.05)	- (4.05)	- (4.05)	- (4.05)	(4.05)	94.32 (76.87)	1.83	3.93

±SD: Standard deviation; CD: Critical Difference; value in parenthesis are arcsine transformed values

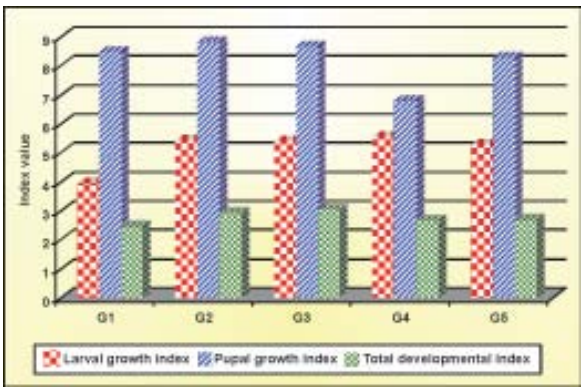


Fig. 5. Growth and development of *Spodoptera litura* on natural food (castor leaf)

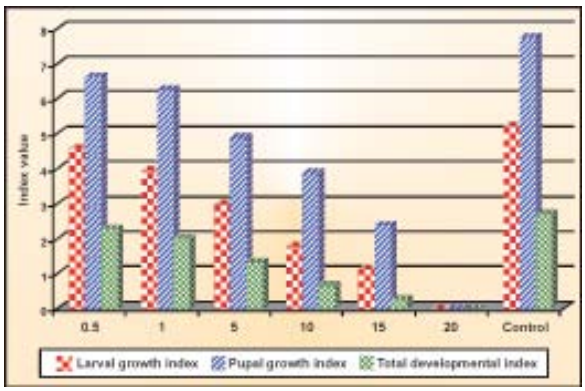


Fig. 6. Effect of crude leaf extract of *Syzygium aromaticum* on growth and development indices of *Spodoptera litura*.

Molecular Characterization of Economically Important Flora and Microbes of Andaman and Nicobar Islands

Israr Ahmad, TVRS Sharma, Krishna Kumar, V. Jayakumar and D.R. Singh

Molecular characterization of important underutilized wild fruit crop (*Annona* spp.) of Andaman

Sample collection, DNA Isolation, PCR and data analysis

A total of 17 samples from all four reported species were collected from different parts of South Andaman (Table 20). The total genomic DNA was extracted from fresh young leaf by CTAB method with slight modification. PCR reaction was performed in final volume of 20µl containing 10X assay buffer 2.5mM dNTPs, 0.5 unit of *Taq* DNA polymerase, 10 Pmols/reaction ISSR/ RAPD primer and 100 ng of templet DNA. ISSR was done with 30 primer of ISSR series (Table 21) and RAPD was done with using 20 primer of OPA, OPE, OPF, OPX series (Table 22). The PCR was performed by initial denaturation at 94^{0}C for 5 minutes followed by 45 cycle of denaturation at 94^{0}C for one minutes, annealing at 37^{0}C for one minutes, and extension at 72^{0}C for two minutes and final elongation of at 72^{0}C for 7 min. For ISSR the annealing temperature were taken as per company recommended. The PCR products were run on 1% Agarose gel prepared in 1xTAE buffer containing 0.5µg/ml of the ethedium bromide at 100V for 2.0 hrs. The gel was photographed under UV-transilluminator. All the genotypes were scored for presence and absence of the ISSR and RAPD bands, and the data were entered into a binary matrix as discrete variables. 1 for presence and 0 for absence of character and this data matrix was subjected to further analysis. The 0/1 matrix was used to calculate similarity as DICE coefficient using SIMQUL

subroutine in similarity routine. The resultant similarity matrix was employed to construct dendrogram using SAHN based UPGMA to infer genetic relationship.

Table 20. Annona species collected from different part of South Andaman

Annona spp.	Sample-S	Location
A. squamosa	S-1	CARI Gene garden
A. squamosa	S-2	Herpatabad
A. squamosa	S-3	CARI Residiential area
A. squamosa	S-4	Bambooflat
A. squamosa	S-5	Wandoor
A. squamosa	S-6	Mount Harriate
A. muricata	S-7	Herpatabad
A. muricata	S-8	Gene garden
A. muricata	S-9	Schoollines
A. muricata	S-10	Bloomsdales
A. muricata	S-11	Wandoor
A. muricata	S-12	Bloomsdales
A. muricata	S-13	Ograbraz
A. reticulata	S-14	Wandoor
A. reticulata	S-15	CARI Gene garden
A. glabra	S-16	CARI Gene garden
A. glabra	S-17	Wandoor

Table 21. ISSR primer used to amplify four species DNA of of Annona

Sl. No.	ISSR Primer No.	Sequence (5'-3')
1.	7	AGAGAGAGAGAGAGAGT
2.	8	AGAGAGAGAGAGAGAGC
3.	9	AGAGAGAGAGAGAGAGG
4.	10	GAGAGAGAGAGAGAGAT
5.	11	GAGAGAGAGAGAGAGAC
6.	12	GAGAGAGAGAGAGAGAA
7.	13	CTCTCTCTCTCTCTCTT
8.	14	CTCTCTCTCTCTCTCTA
9.	15	CTCTCTCTCTCTCTCTG
10.	18	CACACACACACACACAG
11.	20	GTGTGTGTGTGTGTGTC
12.	22	TCTCTCTCTCTCTCTCA
13.	23	TCTCTCTCTCTCTCTCC
14.	24	TCTCTCTCTCTCTCTCG
15.	25	ACACACACACACACACT
16.	28	TGTGTGTGTGTGTGTGA

Table 22. RAPD primer used to amplify DNA of four species of Annona

Sl . No.	Primer No.	Sequence (5-3)
1	OPA1	CAGGCCCTTC
2	OPA2	TGCCGAGCTG
3	OPA4	AATCGGGCTG
4	OPA5	AGGGGTCTTG
5	OPA6	GGTCCCTGAC
6	OPA7	GAAACGGGTG
7	OPA9	GGGTAACGCC
8	OPE1	CCCAAGGTCC
9	OPE2	GGTGCGGGAA
10	OPF 1	ACGGATCCTG
11	OPF2	GAGGATCCCT
12	OPF3	CCTGATCACC
13	OPF4	GGTGATCAGG
14	OPF5	CCGAATTCCC
15	OPX3	TGGCGCAGTG

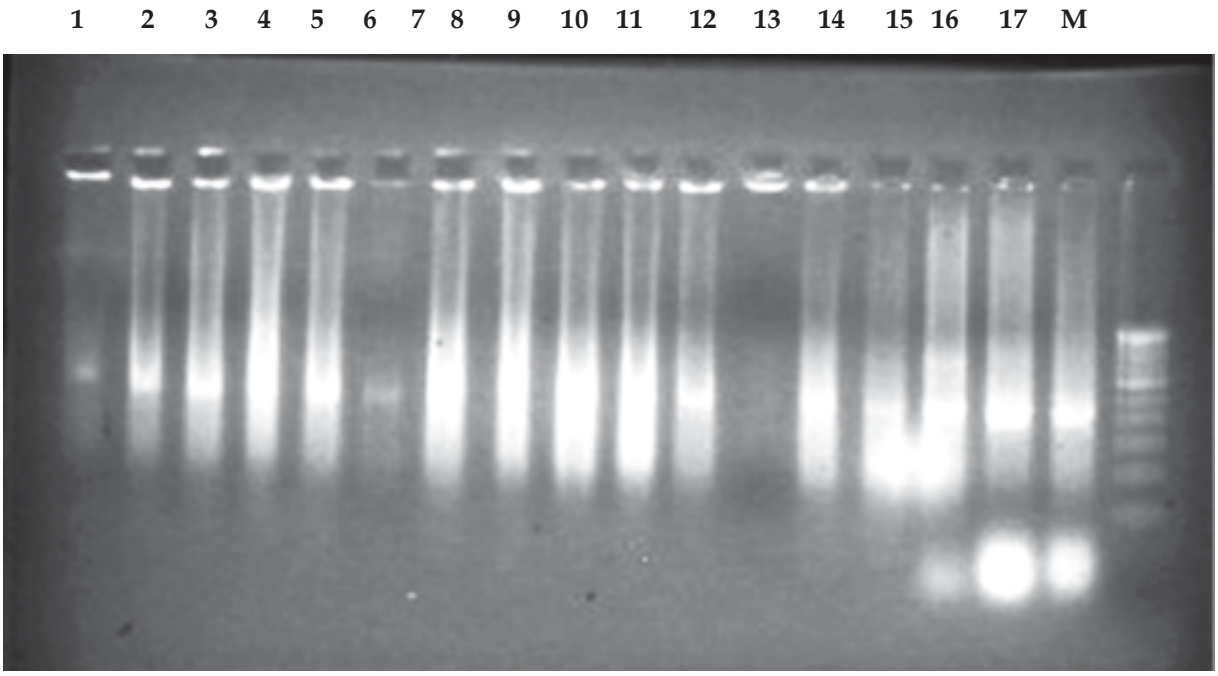


Fig. 7. PCR profile of four *Annona* spp. using ISSR primer 9. Lane 1-17 sample DNA, M-Molecular weight marker

A total of 30 ISSR and 20 RAPD primers were used to study the genetic diversity among four different species of *Annona*. Among 30 ISSR primers used, 14 primers produced amplification and produce a total of 31 amplicons of which 18 were found to be polymorphic with the level of polymorphism of 58%. Primer ISSR7 and ISSR9 (Fig.7) produced maximum number of amplicons, while primer ISSR8 produced minimum number of amplicons. No single primer produces unique banding pattern for all the four species. Only combination of primer (ISSR7 & ISSR9) could identify all the four species.

The dendrogram generated by UPGMA (Fig. 9) could differentiate between all the four species of *Annona* at 53% similarity. Dendrogram could be clearly divided into three different clusters i.e. cluster one contain all the sample of *A. muricata* (S7,S8,S9,S11,S12,S13) and two sample of *A. squamosa* (S1 & S6), showing high similarity of 83% and 94% with *A. muricata*. Cluster two contains all the sample of *A. squamosa* (S2, S3, S4, S5) differentiating at 67% similarity. However, two sample of *A. squamosa* (S2, S3) showed 100% similarity with each other. Cluster two also contain both the sample (S14, S15) of *A. reticulate*, and one sample (S10) of *A. muricata* showing very high similarity between these two species. Cluster three contains both the sample (S16, S17) of *A. glabra* with 75% similarity.

Similar results were obtained with 14 RAPD primers (Fig.8) which produced 48 amplicons of which 25 were polymorphic and the level of polymorphism was 52%. Dendrogram generated by UPGMA (Fig.10) could differentiate between all the four species at 51% similarity, and divided all the four species into two major clusters. Cluster one contain four sample of *A. squamosa* and both the sample of *A. glabra*. Cluster two contains all the sample of *A. muricata* and both the sample of *A. reticulate*. This low genetic difference among four species of *Annona* suggests that there was more gene flow within agro-ecological zone. The high gene flow is due to random mating with very little selection.

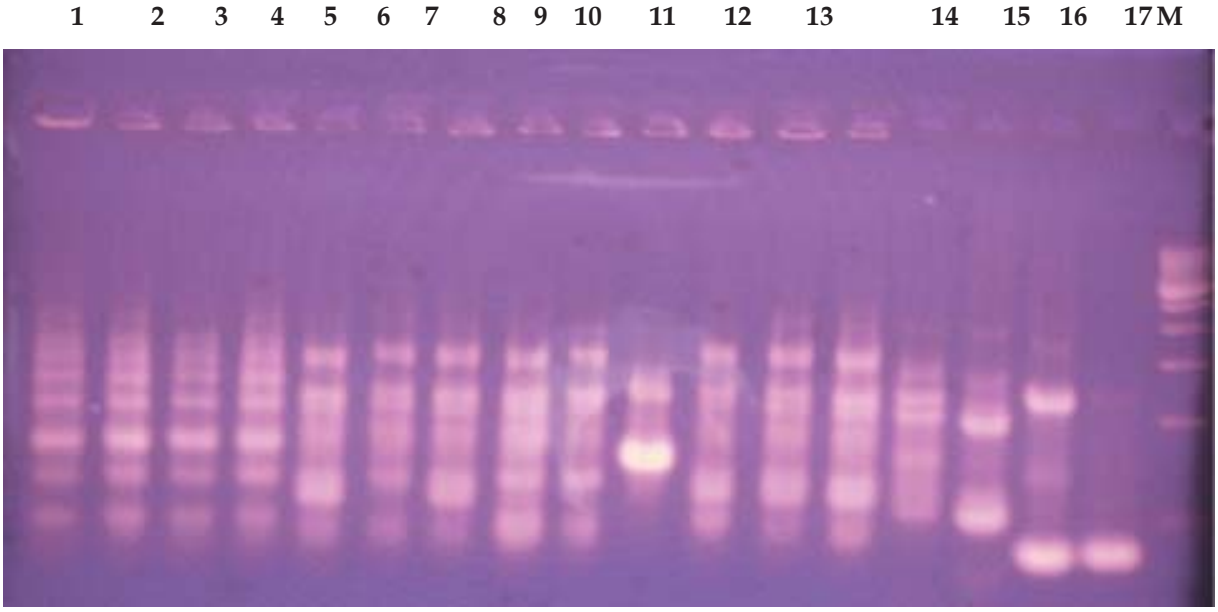


Fig. 8. PCR profile of four *Annona* spp. using RAPD primer OPA, Lane 1-17 sample DNA, M-Molecular weight marker

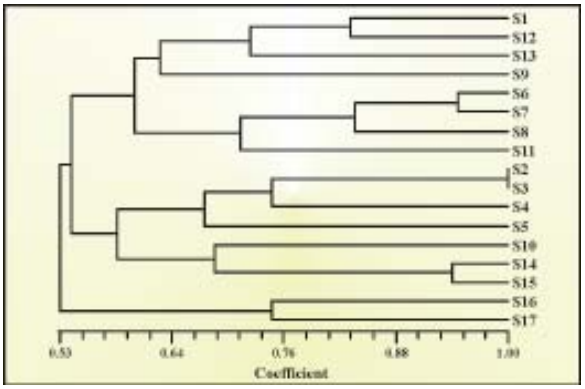


Fig. 9. Dendrogram constructed of four species of *Annona* by ISSR primers

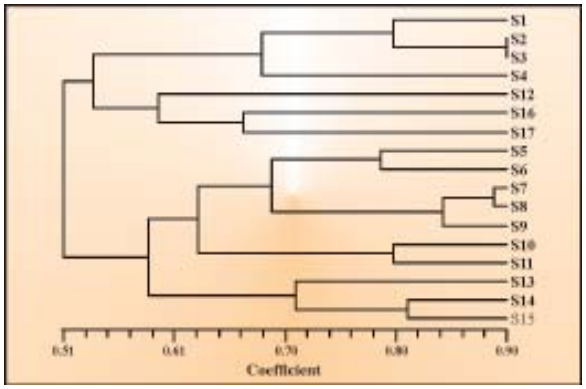
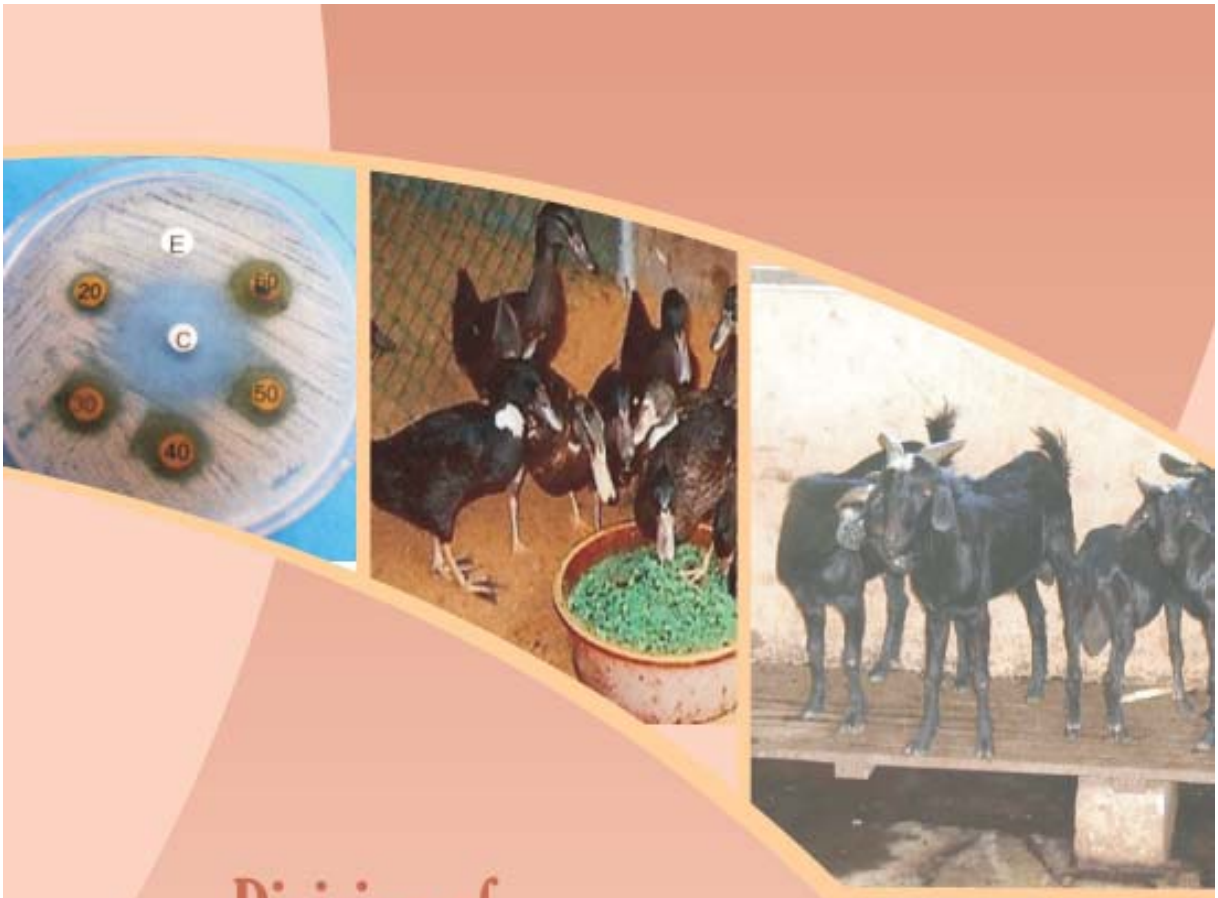


Fig. 10. Dendrogram constructed of four species of *Annona* by RAPD primers



Division of Animal Science

Improvement, Evaluation and Propagation of Indigenous Nicobari Fowl and Ducks and Dissemination of Technology in Tsunami Affected Area

A. Kundu, S.Jeya Kumar, T.Sujatha and Jai Sunder

Eight different genotypes of day old ducklings of mixed population of Andaman local- Chara-Chembelli (CC) (mixed population), Khaki Campbell(KC),Pekin (P) and its various crosses viz PxP, PxCC, PxKC, KCxKC, KCxCC, CCxCC, CCxP, and CCxKC., were produced from the existing parent stocks of CC,KC and P and were evaluated to investigate for their growth performance. A total of 128 healthy day old ducklings 16 in each group of genotype were reared in deep litter floor pen system of open sided poultry house. All the ducklings were provided with similar feeding and management conditions. Ducklings were kept in well cleaned and disinfected separate pens up to 21 days of age and thereafter transferred to 8 separate growing houses. The same population density was maintained for all the genotypes by providing surrogate birds of the same group required due to death of the ducklings. The ducklings were provided a temperature of 35 ^{o}C at first week of age decreasing gradually at the rate of 2.8^{o}C per week up to 21 days of age, and thereafter the birds were transferred to the separate growing pens. Duck starter ration was provided up to 14 days of age and thereafter grower ration was provided up to the age of 56 days. All mash dry feed and *ad libitum* water was provided through out the experimental period. Feed intake was recorded at the end of each week up to 8 weeks of age. The total feed consumption by each duckling was calculated. The ducklings were weighed at the beginning and then once in a week thereafter through out the experimental period. Feed efficiency and survivability of ducklings were recorded. Performance Index and production number were calculated as per standard formula.

The results are presented in Table1.The day old body weight, final body weight and live weight gain at 56 days of age, feed conversion efficiency, performance index, and production number were observed highest in PXP and lowest in local CC where as the ducklings of PxCC cross showed second highest next to PxP ducklings in respect of final body weight (1817.4±99.44 g), live weight gain (1783.54±99.44 g), feed conversion efficiency (3.12), performance index (58.25%), and production number (Fig1 to Fig 4). The differences among the treatment groups were statistically significant (P<0.01). The lowest feed intake was observed in CCx KC group (4448.02g) and highest in PxP group (6675.44g). The PxD group consumed

5564.64 g of feed which was next to the PxP group. The survivability was highest in local CCxCC group (94.34%) followed by PxCC (92.22%) ,CCXP (90.12%),KCXCC(88.89%) and PxP group (88.82%).The Lowest survivability was observed in KCXKC(77.82%) The highest production number was found in PxP (121.70) and lowest in CCxKC (51.29) with local CCxCC having 52.35 than other genotypes. It also indicates that the use of sire from PxP genotype having higher growth rate with dam of other genotypes of relatively lower growth rate than PxP, results in improved production number (Table1).

Considering the growth performance (growth rate, feed utilization, survibability, performance index and production number), the PxCC crossbred showed better results than all other crosses and may be used as meat purpose duck.

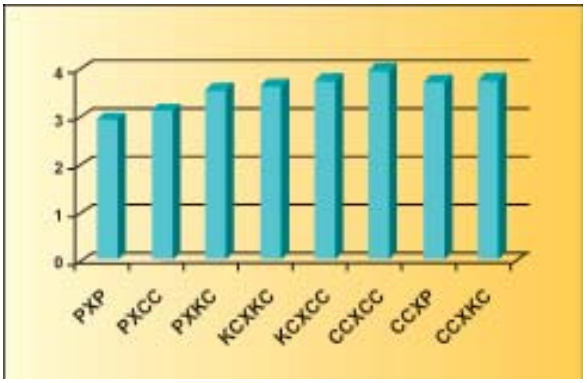


Fig. 1. Feed conversion ratio of various genotypes of duckling crosses

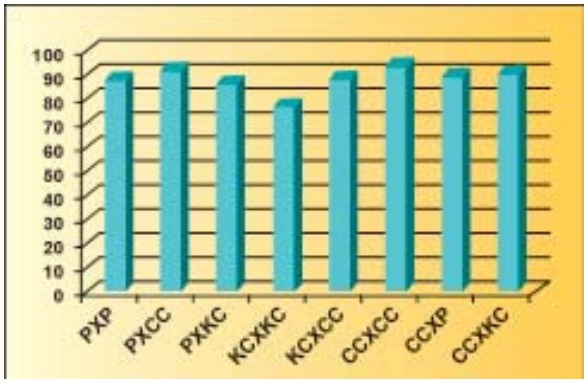


Fig. 2. Survivability% of various genotypes of duckling crosses

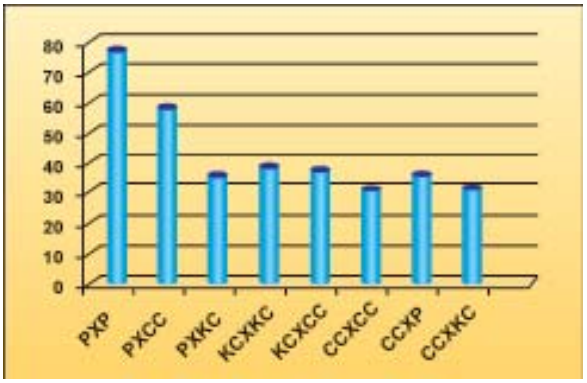


Fig. 3. Performance index % of various genotypes of duckling crosses

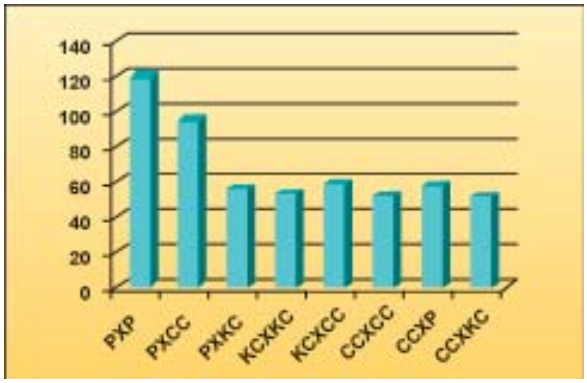


Fig. 4. Production number of various genotypes of duckling crosses

Table 1. The growth performance of pure and crossbred ducklings during the experimental period of 0- 8 weeks

Parameters	PXP	PXCC	PXKC	KCXKC	KCXCC	CCXCC	CCXP	CCXKC	Level of significance
Initial body weight (g/duckling)	46.50 ±1.64^{a}	33.88 ±1.83^{bcd}	37.88 ±2.15^{b}	36.81 ±2.24^{bc}	35.38 ±2.01^{bcd}	30.81 ±1.75^{d}	33.13 ±1.63^{bcd}	32.13 ±1.83^{cd}	**,P<0.01 CD(0.01) = 6.909 CD(0.05)= 5.255
Final body wt(g/ duckling)	2286.6 ±107.35^{a}	1817.4 ±99.44^{b}	1305.8 ±86.50^{cd}	1406.3 ±65.39^{c}	1405.0 ±73.95^{c}	1105.5 ±67.57^{d}	1338.9 ±54.42^{c}	1199.6 ±54.33^{cd}	** CD(0.01) = 279.361 CD(0.05)= 212.556
live wt. gain (g/56 days)	2240.08 ±107.35^{a}	1783.54 ±99.44^{b}	1267.92 ±86.50^{cd}	1369.52 ±65.39^{c}	1369.66 ±73.95^{c}	1074.7 ±37.51^{d}	1305.79 ±54.42^{c}	1167.46 ±54.33^{cd}	** CD(0.01) = 276.112 CD(0.05)= 210.089
Feed Intake (g/ duckling)	6675.44	5564.64	4577.19	4998.75	5163.62	4799.88	4896.71	4448.02	
Feed conversion ratio	2.98	3.12	3.61	3.65	3.77	3.98	3.75	3.81	
Survivability%	88.82	92.22	87.12	77.82	88.89	94.34	90.12	91.23	
Performance Index%	76.73	58.25	36.17	38.53	37.27	31.08	35.70	31.48	
Production Number (PN)	121.70	95.93	56.27	53.54	59.16	52.35	57.46	51.29	

P=Pekin,CC=Chara-Chembelli,kC=Khaki Campbell,

**=Significant(P<0.01) Values (in the same row) with different superscripts differ significantly (p<0.01).

Productivity Enhancement of Pigs Under Island Ecosystem

M.S. Kundu, A. Kundu, Jai Sunder, S. Jeyakumar, S.K. Verma, S.P.Yadav and T. Sujatha

Productive performances of large White Yorkshire breed of pigs

A total number of 87 live piglets were born out of 14 farrowing occurring during the period of study, out of which 70 piglets were successfully weaned. The different litter traits like litter size at birth, still birth, pre weaning mortality and litter size at weaning were

observed to be 6.46 ± 0.55, 2.00 ± 0.31, 1.41 ± 0.23 and 4.66 ± 0.62 respectively . In dry season (December-April) performances was better which were reported to be 7.14 ± 0.91; 0; 2.5 ± 0.8 and 6.28 ± 0.94 where as in the wet season (May – November) it was 5.88 ± 0.67; 2.25 ± 0.44 ; 1.20±0.15 and 3.50±0.5 respectively (Table 2) for different litter traits like litter size at birth, still birth, pre weaning mortality and litter size at weaning.

Table 2. Farrowing performance of pigs

Season	Litter size at birth	Still birth	Preweaning mortality	Litter size at weaning
Dry	7.14 ± 0.91	0	2.5 ± 0.8	6.28 ± 0.94
Wet	5.88 ± 0.67	2.25 ± 0.44	1.2 ± 0.15	3.5 ±0.50

Farrowing performances under different age of weaning

A total of 16 large white Yorkshire breed sows were used in this study. They were randomly divided into two groups (10 Sows for six-week weaning and 6 sows for eight –week weaning). The results showed that the farrowing interval of sows decreased significantly ($p<0.01$) when piglets were weaned at six weeks (162 ± 4.5days) of age compared to eight weeks (183.5 ±2.1 days). The lower farrowing interval in six weeks group has significantly increased the number of litters per sow per year. The number of piglet produced per sow per year was 15.2 and 13 for six and eight week weaned groups respectively. The results obtained from this study suggests that weaning of piglets at six weeks of age increases the productivity of sows in compare to eight weeks of weaning .

Growth performances under back yard system with different types of feeding.

The growth traits under backyard management system with different types of feeding were investigated in this experiment. A total numbers of 16 piglets of two months old were divided into 4 groups. Control (T1) group received rice bran and colocasia leaves as a sole feed. Similarly in treatment 2 (T2) broken rice/ broken wheat were added in addition to the diet of control. However in treatment-3 (T3) feed was home made concentrate along with kitchen waste and raw coconut whereas in treatment-4 (T4) vegetable waste and poultry offal from the poultry slaughter house were given. The average initial body weights of piglets were 9.25±0.25, 7.75 ± 0.32, 12.87 ± 0.88 and 8.4 ± 0.41 kg respectively (Table 3). At the end of the 90 days of feeding regime, the respective mean body weights were 26.25± 1.75, 28.75± 0.85, 39.25±4.17 and 39.25±0.63 kg and the group difference were significant ($p<0.01$). The total weight gain after 90 days in different treatment groups were 17.00±1.83, 21.00±0.54, 26.37±3.34, and 30.85 ± 0.22 kg respectively. The respective daily live weight gain calculated were 0.189±0.02, 0.233±0.01, 0.293±0.04 and 0.358±0.01 kg in treatment T1, T2,T3, and T4 groups. Up to 4^{th} weeks of age T2 and T4 recorded comparable growth to

control but T3 recorded higher growth rate than T1, T2 and T4. After 8th weeks T3 (home made concentrate along with kitchen waste and raw coconut) and T4 (vegetable waste and poultry offal from the poultry slaughter house) performed better and recorded a significant ($p<0.01$) growth rate.

Table 3. Body weights of pigs under different feeding regime.

Body Weight	T1	T2	T3	T4
Initial	$9.25^{b} \pm 0.25$	$7.75^{b} \pm 0.32$	$12.87^{a} \pm 0.88$	$8.4^{b} \pm 0.41$
1st month	$14.25^{b} \pm 0.85$	$15.5^{b} \pm 1.02$	$21.37^{a} \pm 1.21$	$23.25^{a} \pm 2.36$
2nd Month	$19.5^{b} \pm 1.71$	$22.50^{b} \pm 1.19$	$28.62^{a} \pm 2.08$	$32.87^{a} \pm 1.05$
Final	$26.25^{b} \pm 1.75$	$28.75^{b} \pm 0.85$	$39.25^{a} \pm 4.17$	$39.25^{a} \pm 0.63$

Values (in the same row) with different superscripts differ significantly ($p<0.01$).

To Study the Feasibility and Convergence on Subsistence Pig Rearing to Commercial Pig Farming Inclusive of its Process.

M. S. Kundu, A. Kundu, S. Jeyakumar, Subhash Chand, S.K. Zamir Ahmed, P. Balakrishan, SVO Car Nicobar and R.C. Srivastava.

A survey was conducted to assess the knowledge level of the pig farmers at Car Nicobar in respect of scientific housing, advantages of proper cleaning of pig shed, knowledge on diseases, knowledge for pig feeds, and availability of critical inputs in the local market and the marketing of the produce. It was observed that 100 percent respondent in a negative manner about knowledge of scientific housing required for pig. All the respondents under survey opined about higher cost and non availability of critical input in the local market. Whereas 69.23 per cent respondent agreed that they have little knowledge about diseases of the pigs and 38.46 percent agreed that cleaning of the shed have a positive effect of the pig health. However 87.09 per cent respondent did not agree about feeding the balance feed

Plate 1. Housing for the pigs at Nicobar Islands

for rearing of the pigs. It was also recorded that there is no tradition for marketing of the pork in the Nicobari society. Traditionally the knowledge about pig rearing is being percolated from the neighbors (53.84 per cent) only (Plate 1).

Evaluation of Therapeutic and Immunomodulatory Properties of *Morinda citrifolia* in Poultry

Jai Sunder, D.R. Singh, A. Kundu and S.P. Yadav

The antibacterial and antifungal activity of *Morinda citrifolia* leaf, fruit and seed extract was assessed *in–vitro* by using disc diffusion method. The effect of feeding fruit extract on Japanese quail was also studied and the results of the experiments are presented below:

Antibacterial activity of *Morinda citrifolia* leaf, seed and different stages of fruit extracts

A total of five different accessions (plants) of *M.citrifolia* plants grown in the Horticulture farm were randomly selected. Fruits, leaves, and seeds were collected, weighed and kept for drying at room temperature. The dried samples were weighed again and the moisture content of the samples was calculated. The samples were grounded to powder and kept in the air tight container for further use. The dried samples were mixed with solvents viz. methanol, chloroform and acetone and kept at room temperature for 2-3 days with stirring in between. The samples were filtered through Whatman filter paper no. 43 and the extract were used as crude extract and kept at -20^{0}C for further use. Similarly all the samples of seeds, fruits and leaves were extracted by using all the solvents.

The antibacterial activity of the extracts was assayed by using disc diffusion method. Standard disc of 6 mm diameter were prepared and sterilized for disc diffusion assay. A total of five bacterial strains viz. *Salmonella spp., Pseudomonas spp., Staphylococcus aureus, Klebsiella spp.,* and *E.coli* were used for the antibacterial assay. About 20 ìl of 10^{-5} dilution of bacterial cultures were poured over the Nutrient Agar plate surface. Then the filter paper discs soaked with different extracts were placed on the surface of the agar and allowed to dry. Standard antibiotics disc viz gentamicin (10µg) and Chloramphenicol (10 µg) were used as positive control while the solvents were used as negative control. The plates were incubated at 37^{0}C for overnight and the zone of inhibition was recorded with the Himedia antibiotic scale.

Seed extracts: The seed extracts of all the accessions showed antibacterial activity against the different microorganisms. Among the different seed extract the best inhibitory activity was produced by S1 with average

zone of inhibition of 13.1 mm followed by S3, S2, S5 and S4 respectively. No significant difference was observed between the different solvent extracts (P>0.05), however, the methanol extract showed better zone of inhibition compared to acetone and chloroform extracts (Table 4). All the solvent extract produced zone of inhibition against all the bacterial isolates. However, no significant difference was observed with respect to the inhibition of bacterial strains (P>0.05). Best inhibition was observed against *Pseudomonas* spp.The antibacterial activity of the seed extracts revealed that the solvent extract of seed may be effectively used against the infection caused due to these organisms.

Table 4. Zone of inhibition produced by seed extracts (in mm)

Microorganisms	Solvent Extract		
	Methanol	Chloroform	Acetone
E.coli	12.8±1.24	11.6±0.6	11.8±0.58
Pseudomonas spp.	12.4±0.74	12.6±1.47	13.6±0.93
Salmonella spp.	12.0±0.32	11.2±0.73	12.2±0.8
Staphylococcus aureus	13.4±1.53	13.0±1.76	11.4±0.92
Klebsiella spp.	12.0±0.31	11.2±0.73	12.2±0.8
Average	**12.52±0.26**	**11.92±0.37**	**12.24±0.37**

Fruit extracts: All the fruit extracts produced zone of inhibition against *E.coli* and *Pseudomonas spp*. Only. However, no inhibitory activity was produced against *Salmonella spp.*, *Staphylococcus aureus* and *Klebsiella spp* (Table 5). The result of the fruit extract revealed that only fruit extracts F1 and F2 showed inhibitory activity and the same may be used against *E.coli* and *Pseudomonas* spp. infection. No significant difference was observed with respect to the diffeneret solvent extracts (P>0.05). The antibacterial activity of the different stages of fruit extract revealed that the best zone of inhibition was produced by matured stage of fruit. Among the solvents, methanol extract produced best inhibitory activity against all the bacterial isolates and the same could be used for

Table 5. Zone of inhibition produced by fruit extracts (in mm)

Microorganisms	Solvent extract		
	Methanol	Chloroform	Acetone
E.coli	13±1.04	11.2±0.73	9.2±2.35
Pseudomonas spp.	9.4±2.6	13±1.30	11.2±0.58
Salmonella spp.	0	0	0
Staphylococcus aureus	0	0	0
Klebsiella spp.	0	0	0
Average	**11.2±1.8**	**12.1±0.9**	**10.2±1.0**

extraction of antibacterial compounds from the matured fruits of *M.citrifolia*. *E.coli* and the *Pseudomonas spp* were the most inhibited organism against all the extract however, there was no inhibition against *Staphylococcus aureus*, *Salmonella spp* and *Klebsiella spp*. The result of the finding revealed that the immature and matured fruits contain more antibacterial compound compared to the ripened fruit. . The fruit at matured stage should be collected for extraction of antibacterial compound.

Leaf extracts: The leaf extracts from all the accessions produced antibacterial activity against the tested organisms. Among the different accessions, the best antibacterial activity produced by L5 followed by L1, L3, L4 and L2 respectively. Significant difference was observed between the different solvent extract (P<0.05). Among the various solvents used for extraction, the acetone extract produced best zone of inhibition against all the bacterial isolates (Table 6). All the extracts produced better zone of inhibition against *Salmonella spp* and the least zone of inhibition was obtained against *Klebsiella spp*.

Table 6. Zone of inhibition produced by leaf extracts (in mm)

Microorganisms	Solvent extract		
	Methanol	Chlorofom	Acetone
E.coli	10.8±0.37	8.8±2.22	14.2*±2.01
Pseudomonas spp.	8.8±2.22	8.4±2.11	11±0.44
Salmonella spp.	12.6±1.12	11.6±0.93	13.2±1.28
Staphylococcus aureus	11.6±0.67	11±0.44	11.2±0.58
Klebsiella spp.	8.2±2.05	8.4±2.11	8.6±2.18
Average	10.4±0.83	9.64±0.68	11.64±0.97

*differ significantly at P<0.05

The antibacterial activity of all the extracts against the bacterial isolates revealed that the seed extract produced absolute inhibitory activity (100%) followed by leaf extract (92%), and fruit extract (37.33%).Among the different stages of fruit extract, the best inhibitory activity was produced by immature and matured fruit extract compared to the fully ripened fruit extract. The result indicates that the seed has got the best antibacterial compounds and the same could be exploited for identification and utilization of novel antibacterial compounds. Among the different solvents used for extraction of the antibacterial compounds all the solvents showed similar inhibitory activity thus indicated that all the solvents could be used for extraction of antibacterial compounds. The best antibacterial activity was produced by plant 5 followed by plant 1, plant 2, plant 3 and plant 4 respectively. Seed extract of all plant showed better inhibitory activity compared to the other plant extracts. The minimum inhibitory activity of the all the plant extracts were done by using disc diffusion method. The best minimum inhibitory activity was produced by leaf extract followed by seed and fruit extract. From the MIC value it is

inferred that the seed and leaf may be used at concentration of 2.0 mg/ml (0.2%) against the different organisms.

Antifungal effects of *Morinda Citrifolia*: The antifungal activity assay of the different plant extracts were done by using disc diffusion method. The extracts were screened against *Aspergillus spp., Penicillium spp., Candida spp.* and *Nocardia spp.*

Seed extracts: The methanol and acetone extracts of all the seeds produced antifungal activity against all the fungal isolates. However, chloroform extract did not produce antifungal activity with any seed extract (Table 7). No significant different was observed between the different extract (P>0.05). However, the average zone of inhibition with methanol extract was better than the acetone extract. Among the different seed extracts, the best inhibition was produced by S2 extract. *Candida spp* was the most sensitive against all the extract with average zone of inhibition of 12.3 mm.

Table 7. Zone of inhibition produced by seed extracts (in mm)

Fungal isolates	Solvent extract		
	Methanol	Acetone	Chloroform
Aspergillus spp.	12.8±1.39	7±3	0
Pencillium spp.	5±3.09	4.4±2.71	0
Candida spp.	17.6±2.92	19.2±1.8	0
Nocardia spp.	9.8±2.57	12.4±3.69	0
Average	11.3±2.64	10.75±3.270	0.0

Fruit extract: The average inhibitory activity of the methanol extract was better compared to the chloroform and acetone extract (p<0.05). Among the different fruit extracts, the F4 extract produced best inhibition zone (8.7) against all the fungal isolates (Table 8). All the extracts exhibited good antifungal activity against all the fungal isolates. However, the activity against *Candida spp* was found to be the best. The antifungal activity of different stages of fruit extract showed that the best zone of inhibition was produced by immature fruit extract followed by matured and fully ripened fruit extract.

Table 8. Zone of inhibition produced by fruit extracts (in mm)

Fungal isolates	Solvent extract		
	Methanol	Acetone	Chloroform
Aspergillus spp.	7.4±3.12	8.4±3.61	5±3.16
Pencillium spp.	13±3.27	8.8±3.67	0.00
Candida spp.	15.6*±4.34	10.8±2.95	0.00
Nocardia spp.	13.2±1.24	12.4±1.50	0.00
Average	**12.3±1.73**	**10.1±0.92**	**1.25±1.25**

*differ significantly at P<0.05

Leaf extracts: The best antifungal activity was produced by methanol extract compared to the acetone and chloroform extract ($p<0.05$) (Table 9). The leaf extract L5 produced maximum inhibition zone of (7.8 mm) against all the isolates. Best antifungal activity was found against the *Aspergillus* spp. compared to the other fungal isolates. From the results it may be inferred that the methanol may be used for extraction of antifungal compounds and the same may also be used against the different fungal isolates.

Table 9. Zone of inhibition produced by leaf extracts (in mm)

Fungal isolates	Solvent extract		
	Methanol	Acetone	Chloroform
Aspergillus spp.	10.4±2.76	8.4±3.47	4±2.44
Pencillium spp.	10±2.68	7.8±3.38	0.00
Candida spp.	18*±1.94	2±2	0.00
Nocardia spp.	12±0.83	5.2±3.24	0.00
Average	12.6±1.85	5.85±1.45	1±1

*differ significantly at $P<0.05$

The overall antifungal activity of all the leaf, fruit, different stages of fruit and seed extract revealed that the best zone of inhibition was produced by fruit extract compared to the seed and leaf extract. The methanol extract showed the best zone of inhibition against all the isolates followed by acetone extract while the chloroform extract showed almost negligible inhibitory activity. The percent inhibition of the fruit extract was slightly better than the seed and the leaf extract. The methanol extracts inhibited almost 83.3 % of the total fungal isolates compared to the 60.7 % inhibited by the acetone extract. Chloroform extracts produced only 7 % inhibitory activity against the fungal isolates. Thus it can be concluded that the methanol and acetone are the best solvents used for extraction of the antifungal compounds from the *M.citirfolia* seed, fruit and leaf. The minimum inhibitory activity of the antifungal compounds revealed that the best activity was produced by leaf extract with MIC value of 3.0 mg/ml compared to the 3.5 mg/ml with seed and 3.75 mg/ml with fruit extract. Among the various solvents the best activity was produced by acetone extract compared to the methanol extract. No inhibitory activity was produced by chloroform extract. Thus, it is inferred that both the acetone and methanol could be used for extraction of the antifungal compounds and the compounds may be effectively used against *Aspergillus spp.* and *Candida spp.*

Evaluation of *M.citrifolia* fruit extract on production and growth performance of Japanese Quail

Ripened fruit of *Morinda citrifolia* was crushed to prepare the extract of fruit juice. The crude juice was used for feeding of quails. A total of 56 day old quail chicks were used for the

experiment. The birds are divided into 2 groups with 28 birds in each group. Group A (Morinda group) was fed with 5% fruit extract along with normal basal ration. The birds of group B (Control group) was fed with basal ration only. The birds were kept under standard deep litter system of rearing and fed with normal quail ration. Standard feeding and managemental conditions were followed. Fresh water was given *ad libitum*. During the whole experimental period no medication, antibiotics, dewormer etc were given to the birds. Daily mortality and health status were also noted in all the groups. The body weight gain, FCR and performance index {live weight (g)/FCR}, egg production performance of both the groups were recorded.

The growth performances depicting the body weight gain, FCR, feed efficiency and performance index at weekly interval of both the groups are presented in the Table 10. The body weight gain, FCR and performance index were higher in Morinda fed group than in control group. The overall results revealed higher body weight gain in Morinda fed group (162.11±0.06 g) compared to control group (153.005±1.05 g) for 0 to 7 weeks of age. FCR of the Morinda fed group (5.99 ± 0.17) was recorded better than control group (6.18 ± 0.16). The feed efficiency of Morinda fed group (0.22 ± 0.05) was also found to be higher ($p<0.05$) than control group (0.20±0.08). The overall performance index of Morinda fed group was better than the control group. At the age of sexual maturity a total of 10 females were there in control and 11 in Morinda fed group. The age at egg production was earlier in control birds than the Morinda fed birds. The control birds starts laying on 41st day onwards while the Morinda fed birds started laying on 56th day onwards. However, the total egg production in the Morinda fed group was found more than the control group.

Table 10. Growth performance at different weeks

Week	Body Weight Gain		Feed Conversion Ratio		Performance Index	
	Control	Morinda	Control	Morinda	Control	Morinda
0-3	47.20±0.03	58.25±1.1	2.95±0.03	4.77±0.13	6.59±0.18	5.91±0.20
4-7	51.91±0.78	54.07±0.34	8.61±0.26	6.91±0.20	5.43±0.06	6.21±0.24
0-7	**153.005±1.05**	**162.11±0.06**	**6.18±0.16**	**5.99±0.17**	**5.93±0.11**	**6.08±0.22**

The hen day egg production was recorded better in the Morinda fed group compared to the control group (Table 11). The peak production in both the groups reached at 11th week and declined after 12th week. At 11th week almost 93% of the birds of Morinda groups laid eggs compared to only 63 % by control groups. The hen housed egg production in the Morinda groups was also better than the control group. At 11th week the Morinda fed groups laid 6.44 eggs /bird/ week compared to only 4.4 eggs/bird/week by control group. The Morinda fed birds produced 30.90 eggs / hen housed for a

period of 50 days while only 20.9 eggs/hen housed produced by control birds. No mortality was recoded in both the group duding the whole phase of experiment. The overall analysis of the growth and production performance of both the groups revealed that the *M.citrifolia* crude fruit extract fed @ 5% daily enhanced the body weight gain and the egg production performance of the Japanese Quail.

Table 11. Egg production performance at different weeks

Weeks	Hen day egg production (%)	
	Control	Morinda
7	3.5	29.87
8	15.4	55.84
9	28.5	54.54
10	51.19	83.11
11	63.09	93.50
12	42.85	36.63
13	55.95	41.55
14	38.09	46.75
	37.32	55.22

Humoral immune response

The method of Siegel and Gross (1980) with slight modification was followed for assaying the immune response to goat red blood cells (GRBCs). To assess the humoral immune response the haemagglutination test (HAT) was conducted with GRBC in the experimental birds. The goat RBC was used as an antigen and 2% suspension was prepared in PBS (pH-7.2) and injected into wing vein of the birds @ 0.25 ml per bird through I/V route. The blood samples before the injection and at every week interval were taken from each bird till 9th week of age. The sera samples were separated and were assessed for presence of anti GRBC antibodies by HA test. The titer was expressed as the $\log_2$ of the reciprocal of the highest dilution giving visual agglutination (button formation) and the data were statistically analyzed. The results revealed the appearance of antibody in control and Morinda group after 7th day of injection of GRBCs. The HA titer values in Morinda fed group was found more (0.425±0.06) than the control group (0.35±0.05). The antibody titer reached its peak at 1 week PI in both the group. The peak titer of the Morinda fed group was 0.9 at 7th day of PI. The result revealed the immnopotentiating effect of Morinda citrifolia fruit extract in Quail fed at the rate of 5% in drinking water.

Enhancement and Sustainable Dairy Cattle and Buffalo Production in Bay Islands

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The average performance of crossbred cows (n=6) revealed that the lactation yield (lit.) and lactation length (days) was 1312.25±202.10 and 339.67±4.83 days respectively. The duration to attain peak yield (days) and the peak yield (lit.) was 19.17 and 7.12 respectively. Average daily milk yield of

a cow per lactation was 3.74±0.54 lit. Wet average (average daily milk yield) during the period of observation (June 08 to May 09) was 4.09±0.13 lit/cow and the average number of cows on lactation was 7.58±0.22 per month.

Effect of calcium supplementation on lactation performance of cows

Calcium is one of the critical nutrients that influence the productivity and their requirement is higher in lactating cows. A pilot study was conducted to observe the effect of calcium supplementation in the form of feed pellets to lactating cows. A total of 8 lactating crossbred cows under standard managemental condition were divided into supplemented (n=4) and unsupplemented (n=4) group. The supplemented group was fed with commercially available calcium supplement (Calsagar®, Indian Immunologicals) @ 50 gm (containing calcium 10 gm, 5 gm phosphorous and 200 IU of Vit D_3) per cow for 30 days. Milk yield characteristics were recorded for both the groups and the milk yield of the supplemented group were compared among them i.e prior to and after supplementation and also with unsupplemented group. The results revealed that, in the supplemented group, the average daily milk yield of a cow was significantly higher ($p< 0.01$) during supplementation (5.74 ± 0.06) than before (4.86 ± 0.07) and after (5.42 ± 0.07) supplementation (Fig 5). Similarly, the average daily milk yield of a cow was significantly ($p<0.01$) higher in supplemented group (5.58 ± 0.06) than unsupplemented (control) cows (3.24 ± 0.05). It is suggested that, exogenous calcium supplementation is very essential in lactating cows and supplementation in the form of feed pellets is an economical and effective source of calcium which significantly improves the milk production of lactating cows.

Ultrasonographic characterization of the bovine udder and teat

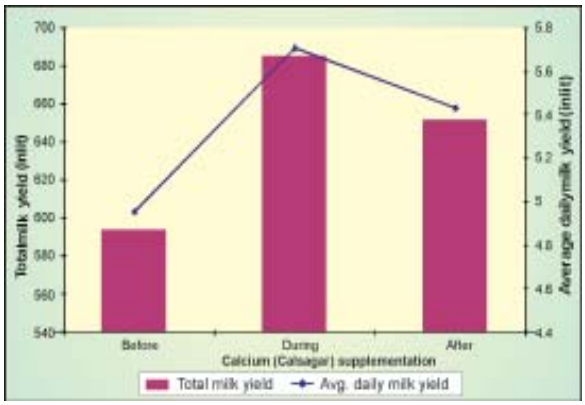


Fig. 5. Effect of Calcium supplementation on total and average daily milk yield of lactating crossbred cows

Udder health is important in modern dairy farming and is the basis for economical and hygienic milk production. Ultrasonography is considered as a valuable non-invasive research tool to study the physiopathology of the bovine udder. In the present study the udder and teat characteristics of lactating cross bred cows were examined by brightness mode (B-mode) ultrasonography using a newly developed modified water bath method (Plate 2). A 7.5 MHz linear array transducer was used for scanning. In lactating cows, the teat sinus, teat cistern, gland cistern and lactiferous ducts were imaged easily by water bath method. The sonographic image

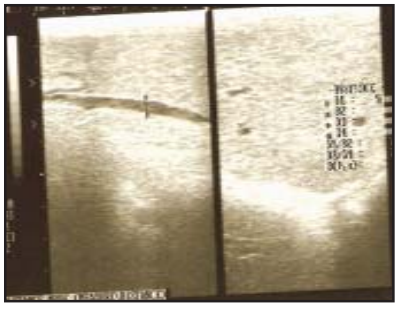
also allowed visualization of layers or mucosal folding of the teat wall (Plate 3). Teat appeared as hypoechoic structures with an unechoic lumen. Udder parenchyma was hypoechoic and the milk was appearing as anechoic in teat and gland cistern and lactiferous ducts. The blood vessels appeared as hypoechoic streaks or spherical structures. Transcutaneous ultrasonographic examination using water bath method allowed clear visualization of teat characteristics (teat canal length, diameter, teat wall thickness, teat length and thickness) than directly placing the probe. The present findings suggest that ultrasonography provides accurate features of bovine teat and udder characteristics in relation to health (lactation physiology) and disease.

Plate 2. Ultrasonography of cow's udder.

Teat wall-hyperechoic threefold layer structure

Teat canal appear as hyperechoic streak structure

Teat cistern with milk appear as hypoechoic cavity



Glandular parenchyma (udder) - hyperechoic and blood vessel – hypoechoic sreak or circular structure

Gland cistern with milk-hypoechoic cavity structure

Large milk ducts and alveolar parenchyma-hypoechoic three fold layer structure

Plate 3. Sonographic image characteristics of teat and udder of cow

Productivity Enhancement of Goats in Bay Islands

S. Jeyakumar, S.P. Yadav, Jai Sunder, M.S. Kundu, A. Kundu, S. K. Verma, M. Balakrishnan, Subhash Chand, S.K. Zamir Ahmed and R.C. Srivastava

Productive and reproductive performance of goats

Productive and reproductive performance data of goats maintained under semi-intensive system were analysed for the last three years (2006 - 09). Results (mean±SE) revealed that the age at first kidding (n=6) was 457.5±38.8 days (15.23 months). The dams weight at kidding (n=16, 2nd to 5th kidding) was 23.97±0.97 kg and gestation length (n=82) was 149.19 ±0.19 days. Out of 82 kidding observed from March 2006 to May 2009, 63.41(n=52) and 36.59 (n=30) per cent goat kidded during monsoon and dry season respectively. The average number of goats kidded during dry and monsoon season was 7.50±2.75 and 6.50±1.65 respectively and maximum number of goats became pregnant during monsoon season (n=55) than dry season (n=27) (Fig 6). Kidding interval of Andaman local goats (n=24) and Teressa goats (n=2) were 252.71±12.13 days (8.42 months) and 284.33±61.60 (9.47 months) respectively. The average number of kids born per kidding (litter size) was 1.61 and 1.75 for Andaman local goat and Teressa goat respectively.

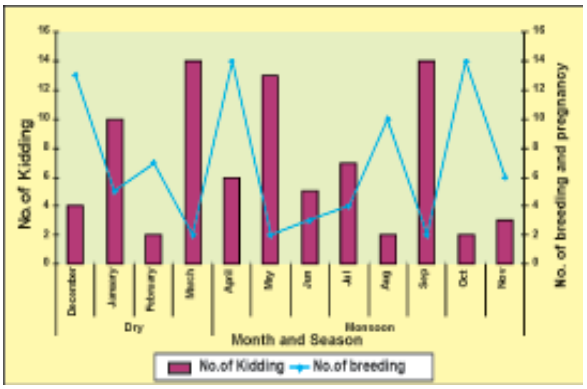


Fig. 6. Seasonal pattern on breeding and kidding in goats

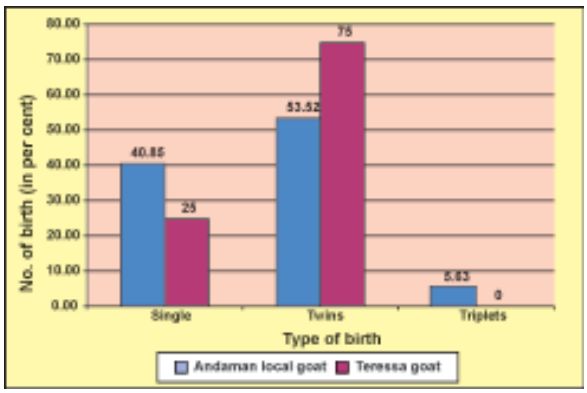


Fig. 7. Composition of birth type in Andaman local goat and Teressa goat

Composition of birth (Fig 7) revealed that the usual number of kids born at one time varied from single to triplet, of which twin (53.52 and 75.00 per cent) were the most frequent than single (40.85 and 25.0 per cent) and triplet (5.63 and 0.00 per cent) birth in Andaman local goat and Teressa goat respectively. The sex ratio of male to female kids was 0.45:0.55 and 0.43:0.57 in Andaman local goat and Teressa goat respectively.

The overall birth weight (kg) of kids born to Andaman local goat (n=69) and Teressa goat (n=7) were 1.44±0.05 and 1.65±0.18

respectively. Birth weight of male kids (n=31) were significantly (P<0.05) higher (1.65±0.08) than female (n=38) kids (1.36±0.07) of Andaman local goat. However no significant difference was observed in respect to birth weight among the kids of Teressa goat.

The overall mortality rate of goats revealed that the kids recorded highest (73.91 per cent) mortality than grower and adult (13.4 per cent). Mortality in kids during monsoon season was higher (64.71 per cent) than dry season (35.29 per cent) and the major causes of pre weaning mortality was still birth, lower birth weight (< 1 kg), disease and inclement weather.

Productivity enhancement

The F1 generation goats were produced by crossing Boer (male) and Andaman Local Goat (female) and the crosses born appeared phenotypically similar to Boer with a specific brown/tan colour pattern of the head and neck and few females had supernumerary teats . The phenotypic characteristics of adult goats (Table 12) revealed sexual dimorphism between male and female cross bred goats. The sex ratio of male to female kids born was 0.47:0.53. The birth weight of male (n=19) and female (n=21) kid was 2.16±0.16 and 1.77±0.14 respectively. Comparative evaluation showed that the birth weight of both male and female kids of Boer cross was significantly (P<0.01) higher than Andaman local goat.

Table 12. Phenotypic characteristics of adult Boer cross (F1) goats

Phenotypic characters (in inch)	Male (n=4) (mean±SE)	Female (n=4) (mean±SE)
Body weight (kg)	44.25±3.19	27.75±5.22
Chest girth	34.18±1.41	26.75±1.89
Height at withers	28.13±0.72	22.75±0.75
Body length	26.75±5.03	20.38±0.75
Head length	7.35±0.29	7.38±0.43
Horn Length	12.5±0.35	4.38±1.09
Horn base circumference	5.13±0.13	2.88±0.43
Horn orientation	Outward curvature	Outward curvature
Ear length	6.7±0.12	6.50±0.68
Ear width	2.65±0.09	2.83±0.20
Ear base circumference	5.03±0.10	4.13±0.31
Ear orientation	Drooping	Drooping
Neck length	8.53±0.21	7.75±1.01
Neck Circumference	22.38±0.90	12.83±0.99
Abdominal Circum	38.75±0.48	31.38±2.30
Hoof circumference	6.75±0.10	5.13±0.69

Tail length	5.03±0.17	5.25±0.32
Tail orientation	Upwards	Upwards
Scrotum circumference	10.0±0.20	Nil
Testis length	4.95±0.05	Nil
Udder length	Nil	3.88±1.33
Teat length	Nil	1.13±0.38
Udder and teat conformation	Nil	Udder-Tight conformation and carried high, with conical shape small teat.

Conservation and Phenotypic and Molecular Characterization of Indigenous Goats of Andaman and Nicobar Islands

S.P. Yadav, S. Jeyakumar, Jai Sunder, A. Kundu and V. Thiagarajan

Two population of goat viz. Local Andaman and Teressa belonging to Andaman Nicobar islands were phenotypically characterized. The highest body weight (kg) was recorded in Teressa goat (male 34.92±4.26; female 32.36±1.47), followed by Malabari goat (male 30.44±7.09; female 27.68±1.69) and Local Andaman goat (male 28.21±0.95; female 23.45±0.70). Sexual dimorphism in some parameters were statistically significant ($p<0.05$) in Local Andaman and Malabari goat. The conservation programme revealed that the goat population (n=90 farmers) per family was increased ($p<0.05$) from 2.03 to 6.07 (Plate 4).

To assess the genetic variability within the goat population blood samples were collected from Local Andaman goat (n=85) and Teressa (n=35). The ISAG/FAO recommended goat specific 30 sets of microsatellite primers were selected for screening. The results of various loci specific sequences have been amplified and genotypic and allele frequencies are depicted in the Table 13 & 14 for loci BTA 16 and CH 16 respectively. Sizing was done in order to get precise allele by using software. During the initial awareness cum survey conducted in the year 2007 and 2008, ninety farmers were chosen and sensitized for the

Plate 4. Conservation of Local goat

conservation of germplasm and recorded 185 numbers of local Andaman goat in the South Andaman where as in the final survey although few of them sold the goats but there was marked increased in the number of the goats i.e. 547 numbers of goat have been recorded. When microsatellite primer was amplified with BTA16 in Local Andaman goat breed; three genotypes were observed AA, BB and AB; Two alleles were observed A and B and the allelic frequencies for A and B are 0.54 and 0.46 respectively and genotypic frequencies for AA BB and AB were observed as 0.24, 0.16 and 0.60 respectively; BB allele was homozygous and others are heterozygous. Allele A showed highest frequency i.e., 0.54 where as allele B showed lowest frequency 0.46 (Plate 5).

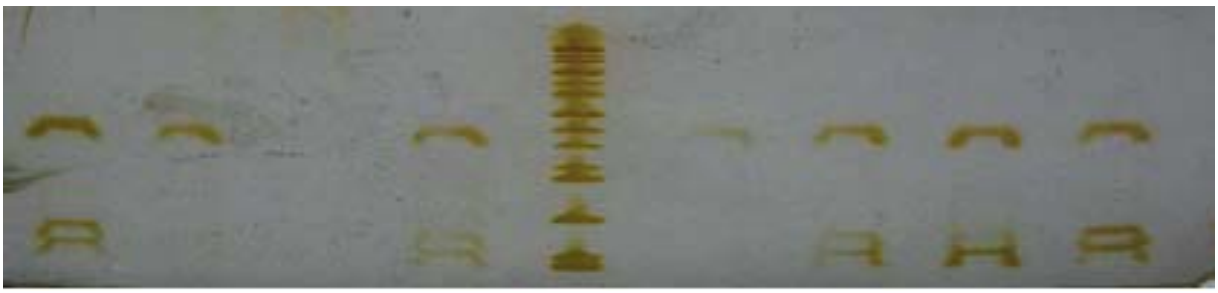


Plate 5. Microsatellite loci BTA in Local Andaman goat

Table 13. Genotype and allele frequency of the microsatellite BTA 16 in Local Andaman goat

Genotype	AA	BB	AB
No. of animal	12	8	30
Genotype frequencies	0.24	0.16	0.60
Alleles	A	B	
Allele frequencies	0.54	0.46	

Locus BTA10 showed five genotypes AA, BB, BC, AB and AD and its genotypic frequencies were found 0.065, 0.0312, 0.5, 0.156 and 0.25 respectively and allelic frequencies of A,B,C and D was observed 0.141, 0.359, 0.25 and 0.25 respectively in Local Andaman goat; BB allele was homozygous and others are heterozygous. Allele B showed highest frequency i.e., 0.359 where as allele A showed lowest frequency 0.141. For Microsatellite locus OAR2 amplfied with Teressa goat DNA, one genotype AB was observed and its genotypic frequency was found 1; allelic frequencies for A and B were found same i.e.0.5. Teresssa goat DNA samples amplified with Microsatellite locus CH15 revealed two genotypes AB and AC and its genotypic frequencies were found to be 0.55 and 0.45 respectively. The allelic frequencies for A, B and C were found to be 0.5, 0.275 and 0.225 respectively. OAR14 microsatellite locus showed one genotype AB with genotypic frequency 1; Allelic frequencies for allele A and B were found to be 0.5 and 0.5 respectively in Teressa goat. Locus CH16 exhibited three genotypes AB, BB and BC with genotypic frequencies of 0.6, 0.3 and 0.1 respectively and three alleles A, B and C were observed with allelic frequencies of 0.3, 0.65 and 0.05 respectively in Teressa

goat breed (Plate 6). BB allele was homozygous and others were heterozygous. Allele B showed highest frequency i.e., 0.65 where as allele A showed lowest frequency 0.05.

Six alleles were observed in DNA samples of Local Andaman goat and BB allele found to be homozygous and others were heterozygous. Fourteen alleles were observed in Teressa DNA samples, locus CH16 exhibited both heterozygous and homozygous combination of alleles, allele BB was observed to be homozygous and others were found to be heterozygous.

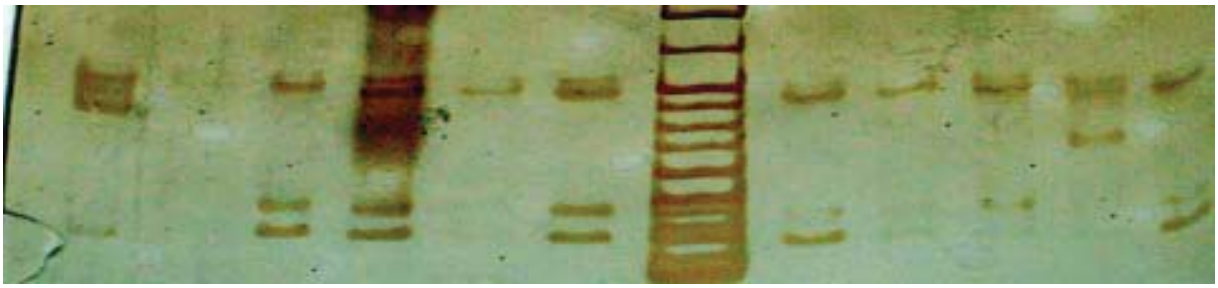


Plate 6. Microsatellite loci CH16 in Teressa goat

Table 14. Genotypic and allele frequency of Microsatellite loci CH16 in Teressa goat

Genotype	Genotype frequency	No of Genotypes
AB	0.6	6
BB	0.3	3
BC	0.1	1

Allele	Size	Allele Frequency
A	183	0.3
B	425	0.65
C	329	0.05

Characterization of LHß and FSHß and their Receptor Genes in Goat Breeds of Andaman and Nicobar Islands

S.P. Yadav, S. Jeyakumar, M. Balakrishnan and Jai Sunder

Andaman & Nicobar Islands have two endemic goat breeds *viz.* Local Andaman and Teressa goat. The characterization of the endemic goat germplasm is very important for future research and breeding programme. The study was aimed to understand the molecular mechanism and role of FSHβ and LHβ gene in regulation of the goat reproductive physiology.

Variation of FSH β exon 3

Of the Local Andaman goat population the Single strand confirmation polymorphism (PCR-SSCP) of FSHβ exon revealed four variants where as one variant was observed in Teressa goat breed.

Sequencing and Sequence Analysis (LHß exon1 & 2)

In Local Andaman goat population the Single strand confirmation polymorphism (PCR-

SSCP) of LHβ exon 1 & 2 (combined) revealed two variants. The sequencing result showed that there are mutation at nucleotide position 182 (A - T) and 184 (C - G). Both the nucleotide positions present in the intron-1 of LH beta gene (Fig 8).

Fig. 8. Nucleotide sequence of goat LHβ exon (1 & 2 combined) mutations positions are depicted in boxes.

Goat pituitary/ cumulus cells Isolation

LH and FSH receptors are present on the cumulus cells. The cumulus cells were obtained from the goat ovaries. The aspiration method (with an 18 gauge needle) was used to obtain cumulus oocytes complexes (COCs). For amplification of LH beta and FSH beta cDNA goat pituitary glands were collected from goat skulls after removing the brain. The pituitary gland was located in front of the hypothalamus and below the optic chiasm. The pituitary glands were triturated in mortar and pestle (pre-cooled with liquid nitrogen) and powder was stored in 2-ml cryovials in a liquid nitrogen flask for RNA isolation.

The information about genetic variation in the sequence of the FSHβ or LHβ gene will help in more accurate genotyping assays of breeds and will also help in selecting the animals having better reproductive efficiency. The functional studies are required to ascertain the roles of the mutation in the FSH and LH genes in goat that will give more insight about the reproductive physiology of the goats.

Evaluation and Utilization of Azolla as Feed Supplement for Backyard Poultry in Bay Island

T. Sujatha, A.Kundu, S.Jeyakumar, Jai Sunder and Abhay Kumar Singh

Azolla supplementation in growing ducks

A 70 days period of trial with Azolla supplementation was conducted using ducklings of day old. Two groups were fed *ad libitum* with chicken starter mash. In one group, Azolla was supplemented along with starter mash at the rate of 50 gms /bird/day in the initial days. Then gradually the quantity was increased to 100 gms /bird/day in the latter age. And the other group was fed with starter mash alone without any

Plate 7. Ducks feeding azolla

supplementation and kept as a control group. Azolla was highly palatable in ducks (Plate 7). Ducks were found to be very fond of Azolla compared to other species of poultry. Body weights of azolla fed and control group at 10th week did not differ significantly. Average body weight at 10 weeks of age was 1230±2.1 gm for Azolla fed group and 1212±3.01 gm for control group. Azolla supplementation in duck feed up to the age of marketing (10 weeks) did not affect feed intake adversely. Azolla supplementation at the rate of 50-100 gms per bird per day saved 12.5% feed per duck and the feed cost of Rs.20 per duck up to the age of 10 weeks.

Azolla supplementation in laying ducks

Twenty days old ducklings (Khaki Campbell) with 10 in each were divided into two groups. The feed of one group was supplemented with Azolla at the rate of 50 gms per bird per day and another group was kept as control group without any supplementation. The Azolla fed group attained the age of sexual maturity at 16 weeks of age and the control group at 18 weeks of age. The weight at sexual maturity was 1.49±0.03 kg and 1.24±0.05 kg respectively. Feed intake and egg productivity were monitored for a period of 14 weeks. The results revealed that Azolla supplementation could replace 16.6% concentrated feed with hen day egg production percent of 39.94 vs control 38.88 and savings in feed cost of Rs. 5.85 per bird per day. There was no significant difference in egg productivity between Azolla supplemented and control group.There was no adverse effect on egg production with Azolla supplementation in laying ducks (Table 15).

Table 15. Effect of Azolla supplementation on duck

Weeks	Production Percent		Duck per Week		Gm per bird per day	
	Control	Azolla	Control	Azolla	Control	Azolla
20	12.86	12.50	1	1	0.214	0.179
21	28.57	26.79	2	2	0.214	0.179
22	32.86	39.29	2	3	0.214	0.204
23	31.43	74.00	2	5	0.214	0.204
24	35.71	71.43	3	4	0.214	0.177
25	37.14	57.14	4	4	0.214	0.164
26	58.71	55.36	3	2	0.214	0.175

27	62.86	30.36	4	4	0.214	0.143
28	57.14	62.50	4	4	0.214	0.175
29	44.14	50.00	4	4	0.214	0.200
30	44.29	38.43	4	4	0.214	0.189
31	28.57	24.57	3	3	0.240	0.189
32	32.86	22.29	2	1	0.233	0.189
33	25.71	18.57	2	1	0.231	0.195
Average	38.88	39.94	3	3	0.219	0.183

Characterization of Livestock Production Sub System and Assessment of Critical Nutritional Gap in Bay Islands

S.K. Verma, M.S. Kundu, Subhash Chand, Jai Sunder, I. Jaisankar and Abhay Singh

A total of 135 farm families were surveyed belonging to North, Middle and South Andaman for characterization of livestock production sub-system and assessment of critical nutritional gap in Bay Islands. The analysis of sample survey revealed that most of the farmers have small land holdings. The average land holding in North, Middle and South Andaman was 1.31, 0.79 and 1.26 ha/family respectively. The overall average land holding (ha) per family in Bay Islands was 1.16 ha. Most of the farmers followed mixed farming system comprising of multiple component viz. crops, livestock, plantation and horticultural crops. In North Andaman, most of the farmers had paddy land and they were engaged in vegetable cultivation along with plantation crops. In south Andaman, the livestock species generally reared were cattle and goat, while in middle Andaman farmers were having cattle, goats and pigs.

Farmers had fish ponds and ducks also. Adult livestock Units (ALU) reared by North Andaman Farmers were 3.025 while Middle and South Andaman farmers reared 2.135 and 2.897 ALU respectively. On an average 1.935 ALU were reared by the Andaman Farmers (Table 16).

Table 16. Composition of livestock in farm families of Andaman

	Cattle	Buffalo	Goat	Pig	Poultry	Total ALU*
North Andaman	2.72	0.64	2.16	0.68	16.64	3.025
Middle Andaman	2.70	0.00	1.90	0.37	0.03	2.135
South Andaman	3.68	0.05	1.56	0.31	5.63	2.897
Total	**2.10**	**0.15**	**1.75**	**0.39**	**6.42**	**1.935**

ALU = Adult livestock units

Buffalo = 1.0; Cattle = 0.7; Goat = 0.08; Pig = 0.25; Poultry = 0.012

Most of the farmers faced shortage of fodder during dry period in South and Middle Andaman. In North Andaman farmers faced shortage of fodder round the year due to the fact that during Kharif season most of the farmers grew paddy. Therefore there was no land left for production of wild grasses and after harvesting of paddy there was no wild grasses due to dry spell. Cultivation of fodder crops was almost nil. Due to shortage of fodder, milk production was very less.

Critical analysis of the secondary data (Andaman & Nicobar Administration, 2005) revealed that presently total population of cattle and buffalo in the Andaman Nicobar group of Islands is 47200. Out of which only 12192 animals are in milk and the milk production is 12023 MT/annum. In 2011, the estimated population of milch animals will be 13411 and the target milk production will be 16531 MT/annum. Likewise in 2021 and 2031, the estimated population of milch animals will be 18105 and 25348 respectively and the targeted milk production will be 30128 and 59051 MT/ annum respectively (Table 17).

Table 17. Present and future status of animal population and milk production in Bay Islands

Animal Spp.	Present Population*	No. of milch animals	Present Production (MT/ annum)	Estimated milch animals in 2011	Target milk production in 2011 (MT)	Estimated milch animals in 2021	Target milk production in 2021 (MT)	Estimated milch animals 2031	Target milk production in 2031 (MT)
Indi. Cattle	20000	4706	3561	5177	4896	6988	8923	9784	17489
CB Cattle	13000	4000	5141	4400	7069	5940	12882	8316	25250
Buffalo	14200	3486	3321	3835	4566	5177	8322	7248	16312
Total	**47200**	**12192**	**12023**	**13411**	**16531**	**18105**	**30128**	**25348**	**59051**

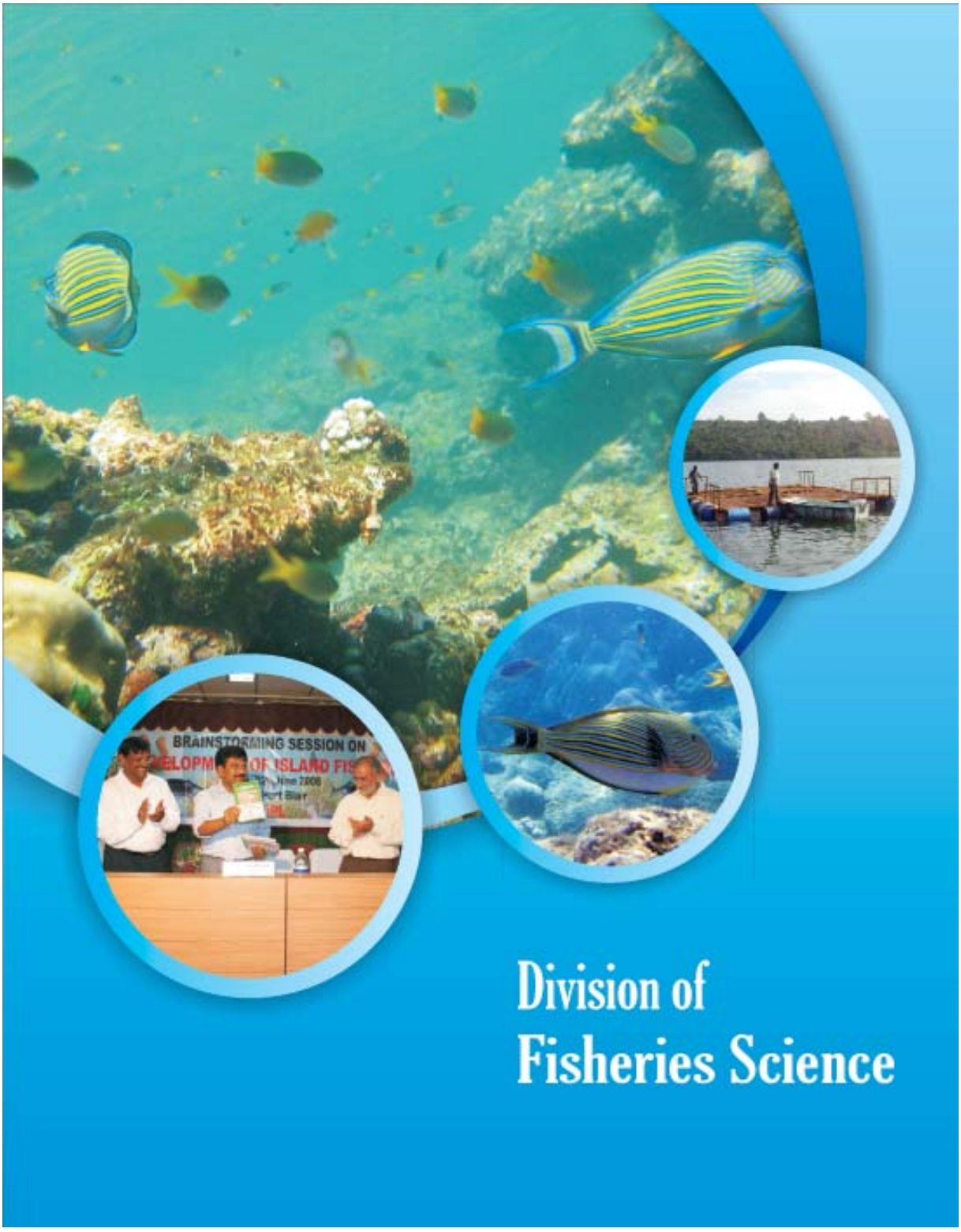
* Andaman & Nicobar Administration, 2005

Based upon the present cattle and buffalo population, requirement of concentrate, green and dry fodder was estimated. The availability of concentrate, green and dry fodder was also estimated for whole Andaman & Nicobar Islands (Table 18).

Table 18. Requirement of concentrate, green and dry fodder for cattle and buffalo in Andaman Nicobar Islands

Animal Species	Estimated requirement and availability (MT/annum)		
	Concentrate	Green fodder	Dry fodder
Indigenous Cattle	7665	86870	15330
Cross bred Cattle	6643	63109	9965
Buffalo	7256	68934	10884
Total Requirement	21546	218912	36179
Total Availability	3461	600	38425
Deficit or Excess	Deficit	Deficit	At Par

It was found that there was a great deficit in the availability of concentrate as almost negligible area was dedicated for production of grains or oil cakes for feeding to the animals. The concentrate available was the form of rice bran and husk and some amount of oil seed cake. Availability of dry fodder was at par with the requirement. But the availability of green fodder was far behind the requirement of the animals which resulted in the very low milk production.



Division of Fisheries Science

Cage Culture of Commercially Important Marine and Brackishwater Fishes in Protected Bays and Creeks of Andamans

S. Dam Roy, P. Krishnan, Kamal Sarma, Grinson George, S. Murugesan and Benny Varghese

Andaman and Nicobar islands situated in Bay of Bengal have numerous bays, creeks, lagoons and islets with varying depths and different substrate which are suitable for several types of mariculture operations particularly cage culture. In an effort to popularize cage farming in the Bay islands, this project was conceived with an objective of designing cages suitable for protected bays in Andamans and evaluating the socio-economic feasibility of culture of groupers and snappers. Four cages of 5x4x3m each were fabricated using wooden frames and made afloat using 24 empty barrels and are anchored with two anchors (50kg) at Minnie Bay, adjacent to the NIOT campus. The net webbing procured from CIFA, Bubaneswar were fit in the mainframe and tied to the vertical supports.

Plate 1. Cages under construction

Plate 2. Fishes being released into the cages by Dr. H.P. Singh, DDG (Horticulture) and Dr. R.C. Srivastava, Director, CARI

210 individuals of groupers were collected from North Bay and Chunnapatta offshore area and stocked in 2 cages. They were identified as belonging to 10 species namely, *Cephalopholis argus*, *C. miniata*, *C. boenek*, *C. milliaris*, *Epinephalus merra*, *E. fasciatus* and *E. quoyanus*, *E. areolatus*, *E. hexagonatus* and *E. longispinis*). Fishes were collected in batches, segregated on size and species and stocked in two cages. The length ranged between 90–280mm with an average of 162.10±26.95mm and the weight ranged between 8-320g with an average of 62.11±32.18g. As the collections were essentially from wild, the variation in the size of the fishes was inadvertent. They were fed everyday with low value fishes like *Sardinella sp* at 5% of body weight.

The net webbings of the cages were scrubbed at fortnightly intervals to maintain water flow. After one month of culture period, the average length and weight were 166.70±26.39 mm and 65.81±39.20g. The fishes recorded an increase in average weight to the extent of 6% in 30 days with a survival of 95.24%. The study leads to the hypothesis that cannibalism among the fishes may be controlled by proper feed management, even if the fish stocked are not of uniform size. In order to study the effect of stocking density on the growth and survival of fishes, they are reared in two different stocking densities (138 fishes in one cage and 72 in another). The water quality parameters of the cages were monitored regularly and it was found that DO (4.5-5.0ppm), salinity (30-33ppt) pH (7.8-8.3) and alkalinity (120-130ppm) were within the acceptable limits for fish culture. The fishes will be reared in cages for a period of six months and the economics of operation calculated subsequently.

Temporal and Spatial Variability of Water Quality Parameters and Mineral Profile of Waters of Andaman and their Impact on Shellfishes and Finfishes

Kamal Sarma, S. Dam Roy, Grinson George, C. S. Chaturvedi, Benny Varghese, S. Murugesan

The main objective of the project is to study the variability of water quality parameters in Andaman water and their implication on the organisms. To study this, samples were collected since March 2008 from six locations *viz*. Chatam, Phoenix jetty, tsunami inundated site with brackishwater potential at Sipighat, mangrove site of Sipighat, coral reef site at Wandoor and North Wandoor. Different important water quality parameters like water temperature, primary productivity, dissolved oxygen (DO), pH, carbon-dioxide, salinity, alkalinity, phosphate and nitrate were estimated following standard methodology. It was observed that average water temperature among all the sampling

sites lies between 29.3 -30.4^{0}C with range of 25-34^{0}C. Water pH ranged between 6.8-8.4 . Relatively low pH was recorded in Sipighat area, probably due to low soil pH in that area and excess organic matter accumulation. DO concentration was low (0.6 ppm) in Phoenix Jetty area, which could be attributed to excess accumulation and discharge of organic sewage. In other areas, DO concentration was around 4-6 ppm. The CO_2 concentration varied from 0 to 43 ppm in all the sites with maximum in the month of February in the Sipighat mangrove areas. This might be due to high level of putrification and degradation of organic matter. On an average, Sipighat area showed high accumulation of CO_2 followed by Phoenix Jetty area. Alkalinity of water on an average was similar in all the sampling sites except in the Phoenix jetty area where it was always higher and the highest alkalinity (168ppm) was recorded in August '08. Nitrate, was always more in Phoenix jetty area (1.75±0.39). Not much variation was recorded in accumulation of nitrate in Chatam, Sipighat mangrove area and tsunami inundated area (0.75-0.82ppm). However, nitrate level was low in North Wandoor and Wandoor area. Phosphate ranged between 0.02 -0.73 ppm among the sites, with Phoenix jetty recording high phosphate accumulation. However, December onwards in all the areas, there was a gradual increase in phosphate concentration, which may be due to decrease in precipitation and increase in evaporation. Salinity is another important parameter as far as aquaculture is concerned. Due to heavy rainfall, there is a constant fluctuation in salinity of Andaman waters. Maximum fluctuation in salinity was recorded in the aquaculture site (1.95-34.55 ppt) followed by Sipighat mangrove area. As both the areas are associated with large catchment area, immediately after rain salinity of these areas almost becomes zero. Minimum fluctuation of salinity throughout study period was recorded in Wandoor and North Wandoor area. To assess the productivity of Andaman waters, primary productivity of waters were estimated from Marine Hill area. It was found that primary productivity of water of Andaman is relatively less. However, Net Primary productivity (NPP) and Gross Primary productivity (GPP) were progressively increasing from June '08 to Feb' 09. This can be attributed to higher quantum of light available after the rainy season. The average gross productivity and net productivity were 298.33 and 115.27 mg C/ m^3/ h respectively.

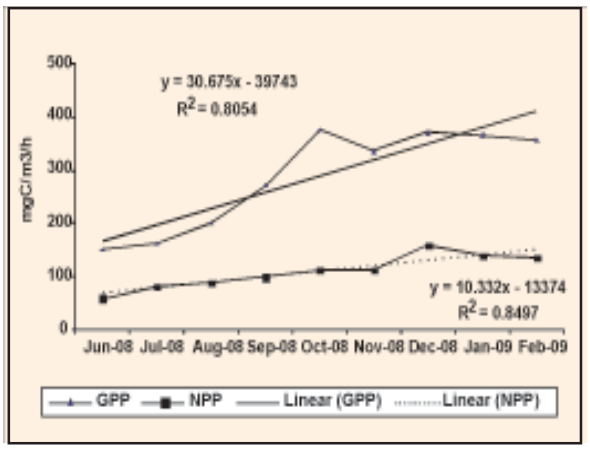


Fig. 1. Monthly variation of Net Primary Product and Gross primary productivity from Andaman waters

Broodstock Development and Breeding of Damsel Fishes

Grinson George, S. Dam Roy, C.S. Chathurvedi, Kamal Sarma, S. Murugesan and Benny Varghese

Damsel group of fishes are very beautiful ornamental fishes, having lot of demand for export. Different varieties of damsel fishes are available in Andaman waters. Development and standardization of breeding techniques of few readily available damsel fishes is the main objective of this project. Specimens of three damsel fish species *viz. Amphiprion alkallopsis, Amphiprion ephippium* and *Premnus biaculeatus* were collected from the nature by skin diving and using scoop net and bought to the MRL in aerated condition. These species were maintained in the hatchery for the development of suitable breeding pair. Fishes along with anemones were kept in various tanks with higher stocking density (10-15 fishes and 5-6 anemones). Most of the damsel fishes are hermaphrodites in nature and they change sexes and form a breeding pair under optimum conditions. After fishes form pairs, the pairs were carefully separated and kept in separate tank for the maintenance. Several sets of pairs were maintained separately species-wise in aquarium along with sea anemones to simulate natural condition. As food is one of the important criteria for their growth and sexual development, mass culture of phytoplankton and zooplankton (rotifers) were carried out at Marine Hill Research Laboratory for feeding brooders fishes. Other feed ingredients that were given included prawn meat, Artemia nauplii, fish eggs, etc. and they were fed till satiation.

To see the distribution and abundance of rotifer in Andaman, a survey was conducted from brackishwater areas in South Andaman. Rotifers were collected using 40µm mesh bolting cloth from different locations of Sipighat Brackishwater area. The collected samples were transferred to a 100ml sampling bottle and fixed with 5% formaldehyde immediately to avoid the clumping of rotifers. Various species like *Brachionus plicatilis, B. rotundiformis, B. urceolaris, B. murrayi, B. calyciflorus, B. falcatus and Kellicotia sp* have been identified from Andaman waters. The presence of *Brachionus plicatilis* species complex is a notable character of the rotifers present in Andaman waters.

Plate 3. *Amphiprion ephippium*

Plate 4. *Amphiprion alkallopsis*

Plate 5. *Premnus biaculeatus*

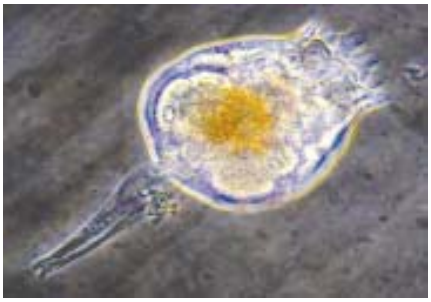


Plate 6. *Brachionus plicatilis*

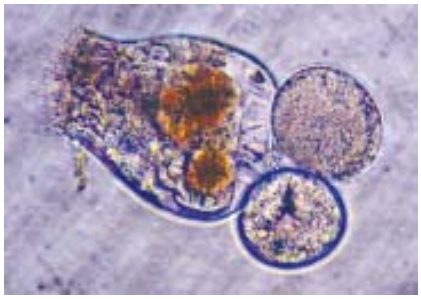


Plate 7. *B. rotundiformis*

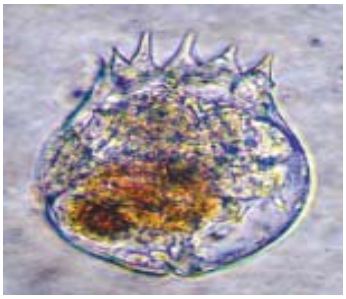


Plate 8. *B. murrayi*

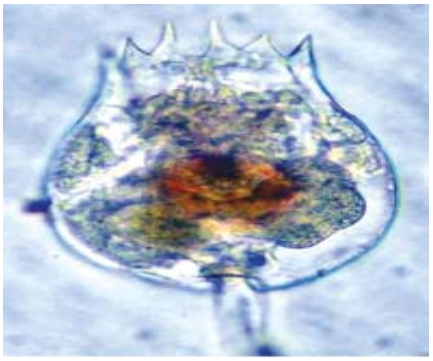


Plate 9. *B. urceolaris*

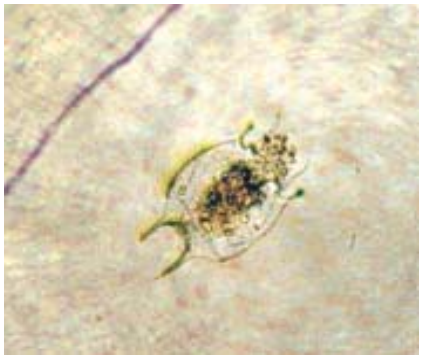


Plate 10. *B. falcatus*

Plate 11. *Kellicotia sp.*

Distribution, Abundance and Stock Assessment of Groupers and Snappers of Andaman Waters

S. Dam Roy, Kamal Sarma, Grinson George and P. Krishnan

Grouper and Snapper constitute a major group of reef fishes of Andaman under the family Serranidae. Due to increasing demand of these species for export market to the South East Asian Countries, the important of capture, especially of grouper, has increased

many folds. It is therefore very important to have proper study about different population parameters and resource availability of these two groups. With an objective to see the landing pattern and species availability of grouper and snapper in Andaman waters, several landing sites were visited on weekly basis *viz.* Wandoor, Guptapara, Chattam, Junglighat and Dugnobad. A total of 21 species of groupers and 5 species of snappers were recorded from various landing centres in and around South Andaman. From the studies it was recorded that grouper and snapper landings are quite regular and in significant quantity in Wandoor and Guptapada, though in other landing centres they are not available regularly. Among groupers, *Epinephelus malabaricus* was the predominant species in these landing centres followed by *Cephalopholis argus*, *C. miniata*, *E. faveatus*, *E. tauvina* and *L. erythropterus* while among snappers, *Lutijanus gibbus* constituted the dominant species followed by *L. decussates.* The average length and weight of *Epinephelus malabaricus* was found to be 45.36±15.54cm and 2274.44±1429.34g while that of *Lutijanus gibbus* was 35.35±10.67cm and 878.03±785.29g respectively. The length-weight relationship equation established for the predominant species is provided below :

Lutijanus gibbus : $W = 1.53\ L^{2.78}$

Epinephelus malabaricus : $W = 1.70\ L^{3.176}$

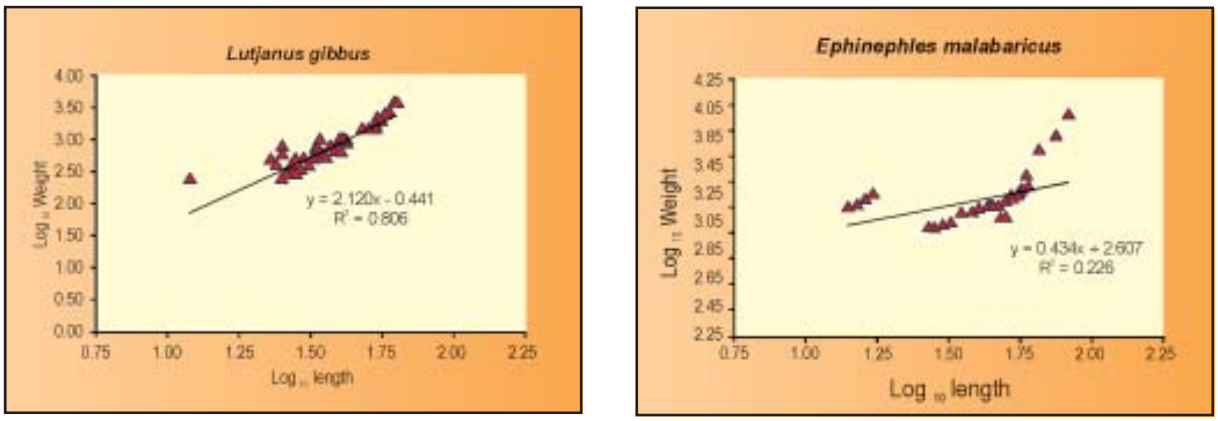


Fig. 2. Length weight relationship of the dominant species of groupers and snappers

The slope value in both the fishes was close to 3, which indicated that the fishes in the selected size groups grow symmetrically. Between the selected fishes, *Epinephelus malabaricus* was heavier for its length than *Lutijanus gibbus* as indicated by higher 'b' value. The correlation and regression coefficient of *Lutijanus gibbus* were 0.92 and 0.81 respectively which suggested that there is significant positive correlation between the length and weight and over 80% of the variations in weight are explained by that in length of the fish. However, a low regression coefficient in *Epinephelus malabaricus* (0.23) indicated that there is no significant relationship between their length and weight.

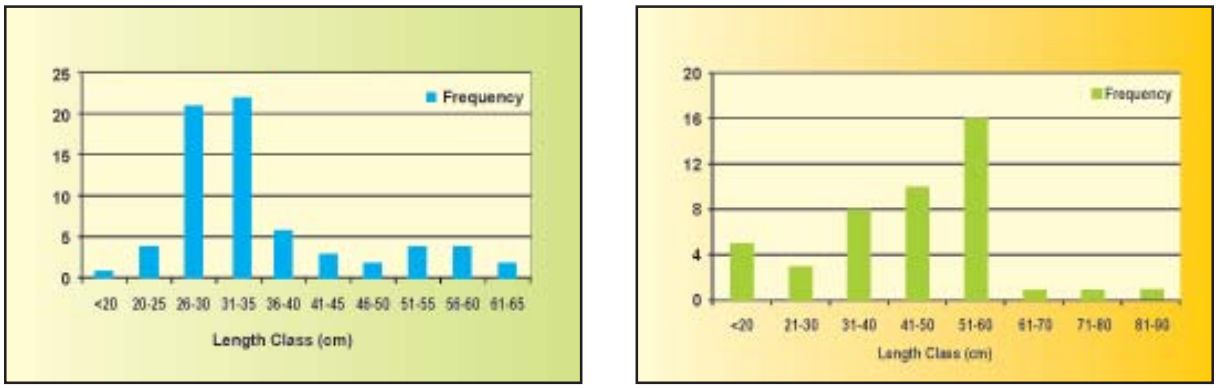


Fig. 3. Length frequency plot of dominant species of groupers and snappers

The length frequency plot of *Epinephelus malabaricus* suggested that about 75% of the catch were in the size range of 31-60cm in case of *Lutijanus gibbus* over 60% of the fishes caught ranged from 26-35cm in length. The relative condition factor of both the fishes was quite less (0.03) due to limited size classes in the fishes collected. On an average 15- 20 kg of these species are caught by hook and line and gill netting. The bait used in line fishing are *Sardinella longiceps*, *S. melanura,* etc.

Characterization of the Role of Associated Bacteria in the Bioactivity of Marine Sponges from Andaman

P. Krishnan, S. Dam Roy, Kamal Sarma, S. Murugesan and Jai Sundar

Marine sponges are the earliest metazoans, which have gained importance as a rich source of compounds, possessing novel structures and exhibiting interesting biological activities. It has been reported that as much as 40% of sponge biomass could be attributed to bacteria. Opinions are divided as to whether the sponge and/or its associated bacteria produce the bioactive molecules reported to come from sponges. A total of 486 species of sponges have been identified in India, of which about 15% are present in Andaman. Considering the paucity of studies on the sponge biodiversity in Andaman and their significance as potential producers of future drugs, the present investigation was initiated with the specific objective to assess the role of sponge surface-associated bacteria in the bioactivities of the marine sponges in Andaman. Two sponge specimens have been collected by skin diving from North Bay which were subsequently identified as *Stylissa sp and Iricinia sp*. The samples for sponge extracts were collected in methanol and those for isolation of associated bacteria in sterile seawater. Methanol extracts of the selected sponges were made following

standard protocols and concentrated in a rotary evaporator. The sponge surface associated bacteria were isolated and biochemically characterized.

Plate 12. *Iricinia sp*

Plate 13. *Stylissa sp*

In the present investigation, bacterial strains were isolated and identified based on colony morphology and biochemical tests. Out of 62 strains isolated from sponges, 30 were found as "specifically" associated with the sponges, which were subsequently screened for their antimicrobial properties against selected pathogens *viz., Aeromonas hydrophilus, Bacillus subtilis, Enterococcus durans, Streptococus lentus, Klebsiella pneumonia* and *Rolstonia solanacearum*. The antibacterial activity of the sponge extract was measured by disc diffusion method. The inhibitory zone of sponge extract and the bacterial extracts against the selected pathogens was measured. Weightage was given to the pathogens based on their pathogenicity and for each isolate, the weighted efficiency was calculated by the sum of zone of inhibition (mm) multiplied by the weightage of respective pathogens. The same was plotted against that of the sponge extract.

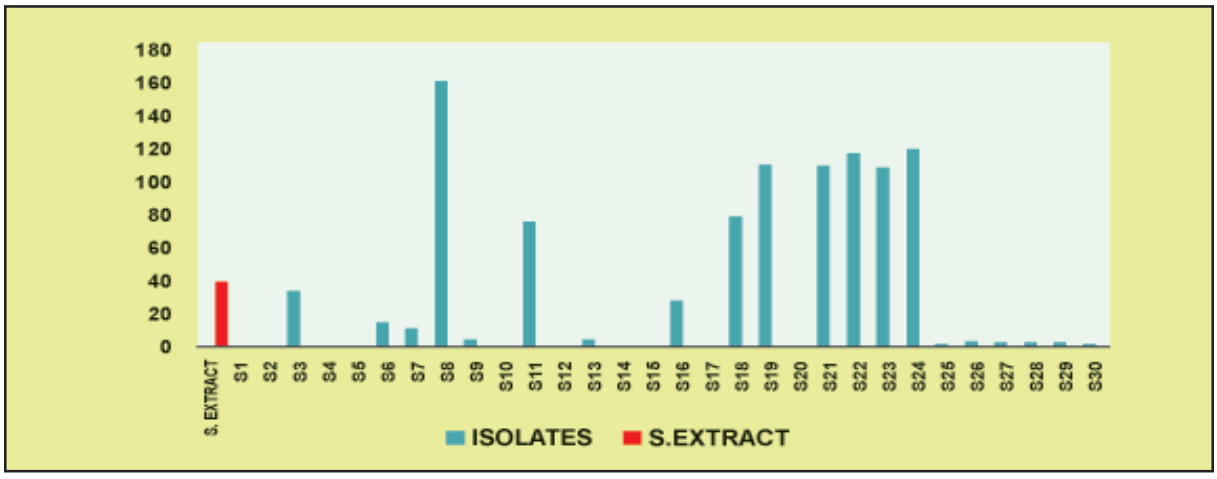


Fig. 4. Weighted inhibitory efficiency of the sponge extract and isolates from *Stylissa* spEight of the isolates from *Stylissa* sp were found to have significantly (P<0.001) higher weighted inhibitory efficiency than the sponge itself, while none of the isolates from Iricinia sp had such property. Of the bacterial isolates associated with *Stylissa* sp, 21 (70%) were found to produce antibiotics. However, the nature of inhibitory activity of the antibiotics was different among the isolates, 38% being broad spectrum antibiotics (active against >5 pathogens), 19% being narrow spectrum antibiotics (active against 2-4 pathogens) and 43% were specific to a particular pathogen. None of the isolates was effective against *Rolstonia solanacearum*, a plant pathogen. When expressed as the percentage of the inhibitory activity of selected antibiotics, it was found that the isolate SS8 could inhibit *Aeromonas hydrophilla* with about 95% of the efficiency of erythromycin and 30% of that of ciproflaxin; SI12 and SI15 were about 120% and 50% as effective as erythromycin respectively against *Klebsiella pneumonia*. Genomic DNA was isolated from the two isolates associated with *Iricinia* sp which showed significant antibacterial activity than the sponge extract. 16SrRNA gene was amplified with specific primers, PCR products were purified, sequenced and BLASTed agaisnt the GenBank database. The partial 16SrRNA sequences had 78-89% homology with *Paenibacillus* sp, *Corynebacterium* sp, *Bacillus* sp and *Firmicutes* bacterium. Studies on the biodiversity of sponges in selected islands and bioactivity of the associated bacteria are in progress.

Induction of Spawning and Larval Rearing of *Trochus Niloticus* and Subsequent Sea Ranching Programme

S. Dam Roy, Grinson George, P. Krishnan and Kamal Sarma

The top shell, *Trochus niloticus* is an ornamental shell whose stock is dwindling in the islands. A major research effort is called for to understand the distribution, biology, population dynamics and ecology of the species and the effect of fishing effort on the resources. Generation of data on these aspects is basic for suggesting any managemental measures for the conservation of these important resources.

Surveys were conducted in different islands in the Andaman *viz.*, North Bay, Jolly Buoy, Tarmugili, Wandoor, Pongi Baalu, Boat Island, Chidiyatapu and Havelock during the study period following Line Intercept Transect method. The length of the transect was 20m and observation was made upto 5m on either side, which thus encompasses an area of 200m^2. On an average, 14 individuals of the top shells were found in the survey area measuring 200 m^2. Transect study also

indicates the composition of the substrate available in the habitat of the *Trochus*. It was found that the normal habitat of top shell consisted of dead corals and algae (23.57%), dead corals (19.93), live corals (19.57%), rock and rubbles (14.28), sand (12.93), soft corals (4.01%) and other components. The algae associated with the rock forms the food of this gastropod. The algae is scrapped from the rocks for feeding by *Trochus*. The hydrographical parameters of different survey sites were recorded and were found to be within the normal ranges. An analysis on the average number of associated invertebrate fauna found in the survey area indicated that *Tridacna crocea* (40 Nos.) was the dominant species followed by *Holothuria sp*. (15 Nos), *Lambis lambis* (9 Nos), *Conus amadis* (4 Nos), *Pinctada margaritifera* (3 Nos), *Crassostrea rivularis* (2 Nos), *Sticopus variegatus* (4 Nos), and *Linkea laevigata* (1 No). The breeding trials with the wild-collected top shells are in progress.

Seed Production of Commercially Important Cat Fishes: *Clarias Batrachus* (Indian Magur) and *Heteropneustes Fossilis (Singhi)* in Andaman and Nicobar Islands

C.S. Chaturvedi, S. Dam Roy, Kamal Sarma, Grinson George and Benny Varghese

The air breathing fishes such as Indian magur *Clarias batrachus* and Singhi *Heteropneustes fossilis* can be an important component of freshwater aquaculture in the Bay Islands. These species are quite suitable for aqua farming in mono or mixed culture. It can be cultured along with Indian Major Carps. *C.batrachus* is fast growing and have good market value in Bay Island. After tsunami the availability of air breathing fishes is less due to intrusion of saline water in paddy fields. This made it imperative to produce seed of such species through captive breeding. CARI has initiated and developed the infrastructure for Cat fish Hatchery during 2008-2009.

Infrastructure facilities developed

The breeding and seed production technique of *C.batrachus* and *H.fossilis* is quite different as compared to carps. Various components of Cat fish hatchery were designed and developed. The magur hatchery so developed is indigenous, economically viable and suitable for farmers of Andaman and Nicobar Islands. In this direction, efforts have been made to control the environmental parameter like temperature, oxygen, pH, silt, water flow and proper space for hatching of the eggs. The cat fish hatchery consists of overhead tanks, air compressors, pumps, (flat bottom) hatching tubes. G.I. pipes, valves, circular concrete tanks and rearing unit etc. In the ensuing year, full fledged seed production of air-breathing fishes (especially magur & singhi) will be done, thereby creating a new avenue of earning for the fish farmers.

Raising of Brood stock in captivity

Fishes were purchased from local fish markets (Chouldhari, Diglipur, Ferrargunj villages) during the off season. They were reared in fibre glass tank or cemented tanks in hatchery. Maintenance of healthy brood fish in essential for successful breeding. During the culture period, they were fed with fish meal, prawn powder, soyabean, rice bran and oil cake @ 5% body weight. In cemented tanks, a black soil base of 3-4 thickness was provided for better survival. The condition of fishes was examined periodically. Average weight of brooders was 150-200gm, which is good for breeding experiment.

Under the research project, magur was successfully bred in captivity and a total of 1,200 seeds produced in the hatchery were distributed to fish farmers. The remaining seeds are being raised in captivity to develop as broodstock. Breeding trails using the wild-collected catfishes are also under progress.

Plate 14. Catfish Brooder (Singhi)

Plate 15. Male & Female (Magur)

Plate 16. Hatchling (Magur)

Plate 17. Supplying of catfish seed

Brackishwater Aquaculture as an Important Component in Integrated Farming System

R. C. Srivastava, S. Dam Roy, Grinson George, Kamal Sarma, S. Murugesan and Benny Varghese

The objective of the project is to develop an Integrated farming system based on brackishwater aquaculture incorporating components of horticulture medicinal plants and poultry.

After the mega earth quake of December 2004 and the consequent *tsunami*, there was subduction of land for about 1.25 m. This resulted in ingress of saline water in some coastal ponds, whereby there is a significant change of hydrographical parameters of ponds particularly with respect to salinity regime. Hence a different approach was required for efficient utilization of water bodies by stocking shrimps and other commercially important brackishwater fishes. One such *tsunami* affected pond was selected for demonstration purpose. The pond (0.06 ha) was stocked with post larvae of tiger prawn during 2007. The total production obtained was 250 kg.ha^{-1}. The average length and weight of the shrimp at the time of stocking were 1.74 cm 2.20 g and that at the time of harvest were 12.95 cm and 13.65 g respectively.

On 20.07.2008, 4000 nos. of PL_{20} of tiger prawn were stocked. Standard feeding regime was followed [1st – 40th day : starter feed (100g / day); 41st – 75th day : grower feed (200g / day); 76th day till harvest : grower feed (300 g/ day)]. They were harvested after a culture period of five months. The harvest included tiger prawn (83 kg/ha), tilapia (660 kg/ha) and mullet (33 kg/ ha). Poor yield of tiger prawn was attributed to poaching during the culture period. The introduction of tilapia and mullet was due to auto stocking.

Plate 18. A farmer's pond integrated with poultry

The harvested tiger prawn was segregated in 2 groups based on count/kg. In one group (40 nos. count/kg), the average length was 14.74 cm and average weight was 25 g. In the another group (140 nos. count/kg), the average length and average weight were 10.21cm and 7.5 g respectively.

Tilapia harvested ranged from 15.2 to 16.5 cm with an average length of 15.7 cm and average weight being 52.63 g. In addition to this horticultural crops like coconut, arecanut have already been planted in the hillock side

of the pond. As a measure to increase the income of the farmer, *Morinda citrifolia,* popularly known as Noni (50 nos. of sapling) and pepper cuttings (100 nos.) were also planted. A poultry shed has also been constructed for backyard poultry which in addition to providing egg and meat thus ensuring nutritional security, would also generate income for the beneficiary.

Potential Fishing Zone Validation in Andaman Sea

Grinson George, S. Dam Roy and Kamal Sarma

Fishes generally migrate to areas where favourable environment like temperature, salinity, dissolved oxygen and food availability exist. Among various parameters, Sea Surface Temperature (SST) and plankton (chlorophyll) availability are important parameters governing the occurrence and migration of fishes. Hence, monitoring of thermal front and chlorophyll concentration in Open Ocean with the help of satellite images can be an important tool for identifying shoaling pelagic fisheries. In this context, Indian remote sensing satellite IRS P4- OCM and National Ocean and Atmospheric Administration (NOAA)-AVHRR have been collecting data and to establish relationship between SST and Chlorophyll. By integrating these information and also taking into account of meandering pattern, eddies, upwelling areas and broadcast in terms of latitude, longitude and depth of the shelf of such locations along with direction and distance from the landing center Potential fishing zone (PFZ) can be identified. For generation and dissemination of PFZ advisories, Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, autonomous body of the Ministry of Earth Science has been set up as responsible agency.

Present level of exploitation of Andaman Sea is very low. The average fish production of Andaman and Nicobar Island is 26640 t (1993-2002), which is only 18% of the potential (1.48 lakh tonnes). Because of the island contour, fisherman has to scout quite a long distance in search of fish shoals which is not only time consuming but also at the cost of high fuel price. There is also uncertainty about the availability and quantity of exploitable stock. With an objective to help the fisherman to identify and locate exploitable stock, the present project has been initiated. However, proper validation with the ground data is very much important before development of the PFZ advisories for Andaman waters because of topographical variability of the ocean bottom, consistent over cast condition as well as smaller size fishing units (boats and nets).

The activities of this project have been initiated from May 2008. Initially species landing patterns has been continuously monitored from important landings centres

viz. Dignabad, Wandoor, Guptapara and Chatam of South Andaman and also once and twice from Havelock, Dundus point, Baratang and Car Nicobar Islands. Different parameters were collected from theses landing centres like species distribution, average length and weight of important species, gut content analysis, gear operated, water quality parameters etc. From the present study a total of 14 number of species were found to dominate the catch and available in the market (Table 1). With respect to the water quality parameters not much variation of temperature (27.0-29.7^{0}C) and salinity (31.1-33.7ppt) was observed. Primary productivity of water of Andaman is relatively less, ranges between 106.5 to 390mgC/m^3/h. A set of preliminary validation programme also was initiated in the month of March synchronizing with the date of the PFZ advisories from the INCOIS. However, due to several critical reasons like declaration of PFZ advisories, gear selection, depth of operation, location of the site, etc., results were not very encouraging. However, these problems will be sorted out and more systematic validation programme will be carried out to get the concurrent results.

Table 1. Commercially important species found in different landing centers

District	Landing Centers	Major catch Species
South Andaman	Junglighat	1. *Aprion virescens* 2. *Sardinella sirm* 3. *Sphyraena jello* 4. *Leiognathussplendens* 5. *Stolephorus commersonni*
	Wandoor	1. *Aprion virescens* 2. *Lutjanus gibbus* 3. *Epinephelus malabaricus* 4. *Epinephelus tauvina* 5. *Sphyraena jello* 6. *Cephalopolis miniata*
	Guptapara	1. *Spyraena jello* 2. *Epinephelus malabaricus* 3. *Aprion virescens* 4. *Cephalopholis miniata* 5. *Lutjanus decussates* 6. *Rastrelliger kanagurtha* 7. *Carangoide sexfasciatus*
	Chattam / Haddo	1. *Rasterelliger kanagurtha* 2. *Sardinella sirm* 3. *Stolephorous commersonni* 4. *Aprion virescens*
	Dignabad	1. *Sardinella sirm* 2. *Rasrelliger kanagurtha* 3. *Aprion virescens*

North & Middle Andaman	Havelock	1. *Rastrelliger kangurtha* 2. *Sadinella sirm*
	Baratang	3. *Lutjanus gibbus* 1. *Rastrelliger kanagurtha* 2. *sadinella sirm* 3. *sphyraena jello*
Nicobar	Car Nicobar	1. *Sardinella melanura* 2. *Carangiodes sexfacsiatus*

Also to make the fisherman aware about the PFZ advisories, a fishermen awareness programme was conducted on 09 February 2009, in which fisherman from Guprapara, Wandoor, Dignabad and Junlighat attended.

Plate 19. Awareness Programme for PZF validation

Costal Zone Studies

S. Dam Roy, Grinson George and P. Krishnan

Under the project survey was carried out at select sites for coastal resources like corals and mangroves. Corals were surveyed at Mahatma Gandhi Marine National Park at Wandoor, Havelock and Car Nicobar, while mangroves at Porlob Jig Creek, Guptapara, Panighat, Wandoor, Havelock, Neil Island and Kadamtala were studied.

Coral survey

Havelock

Coral survey was carried out at Havelock Island near the Radha Nagar Beach. Two transects of 224 and 202m were fixed at the site, which were separated by 50m horizontally. The water column started at 18 m and 20 m respectively from the highest tide mark and the reef area from 105m and 60m of the transects. During the survey different substrate components in transect were noted. Fishes and other invertebrate faunas were also noted on either side of the transect. The hydrographical parameters noted in the Havelock Island were well within the acceptable levels (Air temperature 32°C; surface water temperature 30°C; bottom water temperature 29.5°C; Salinity 34 ppt; pH 7.8; Dissolved oxygen 6.5 ml/lit; Alkalinity 140 ml/lit; transparency 10 m).

The analysis of LIT data indicated that live coral formed between 9.6–14 % (average (11.8%) and soft coral between 8.2% 8.3% (average 8.3%). The other major components were sand (21.8%), dead coral (53.7%), dead coral with sand (1%) and dead coral and algae on sand (4.3%). In the actual reef area (reef flat and reef slope), the live coral ranged between 15.5 and 19.9% with an average of 17.7% and the dead coral from 41.3 to 51.3% with an average of 46.3%. The soft corals constituted about 12.5 %.

Among the live coral species, *Porites solida* was found to be the largest component in the reef flat (15.4%) followed by *Porites lutea* (10.2 %), *Acropora hyacinthus* (10.1%), *Porites lobata* (8.7%), *Symphyllia recta* (7.3%), *Pocillopora eydouxi* (4.5%), *Diploastrea heliopora* (3.5%), *Acropora nasuta* (3.4%), *Acropora robusta* (3.4%), *Acropora nobilis* (2.1%), *Pocillopora damicornis* (2%), *Leptoria phrygia* (2%) and *Acropora nasuta* (2%).

Among the reef fishes, *Chromis nigrura* was the dominant species followed by *Abudefduf notatus, Lutjanus decussates, Chromis dimidiatus, Apogon hyalasoma, Acanthurus lineatus, Siganus guttatus, S. doliatus, Amphiprion ocellaris, Amphiprion akallopisos, Chromis opercularis, Dascyllus trimaculatus, Arothron nigropunctatus, Scolopsis bilineatus,, Cheatodon vagabundus, C. auriga, etc.* Among the invertebrate fauna, which occurred in the reef area, *Holothuria atra, Sticopus chlorinatus, Sticopus variegates Bohadschia graeffei, Tridacna crocea, T. squamosa,* Sea anemone, *Culcita schmideliana, Lambis lambis* and *Pinctada margaritifera* were notable.

Car Nicobar

Coral reef survey was conducted in four reef areas in Car Nicobar namely, Arong, Arong Middle, Sawai and Titapu. The hydrographical parameters were found to be in normal range but for the water temperature (28°C). Three parallel transects of about 350m length each separated by 50m were fixed (LIT) at every site upto about 10m depth. The different substrates, fishes, and invertebrate fauna along the transect were noted. The analysis of LIT data indicated that live coral formed between 44-55%, dead corals from 17-52 %, soft corals around 2% and other major components like rock, sand, algae on rock were 10%, 4%, 6% respectively in the reef.

Among the live corals, *Acropora sp.* was the dominant group represented by *A. formosa* (24-54%), *A. hyacinthus.*(4-10%), *A. youngi* (4.47%) and *A. cytheria* (3.17%). The other corals such as *Platygyra sp, Favites sp, Favia sp., Porites* sp, *Montiporas sp, Pocillophora sp* and *Millepora sp.* together accounted for 4.06% in the reef. Interestingly, *Porites* sp was not found in the sites surveyed but for that in Titapu. The reef fishes in the survey sites were very less compared to those in Andaman. In Titapu many jelly fishes and reef sharks were spotted.

Mangroves Survey

Porlob Jig: Totally nine quadrants each measuring 2500 sq. mt (50x50m) were fixed and surveyed. The major dominant species present in the quadrant were *Rhizophora apiculata* followed by *Lumnitzera littorea, Bruguiera gymnorrhiza, R. mucraonat, Ceriops tagal, Scybipora hydrophillacia, Excocaria agallocha, Heritera litaralis, Phoenix paludosa.* The percentage of Mangrove trees, dead trees and saplings were also noted.

Wandoor: Mangrove surveys carried out at Wandoor revealed that the dominant species mangrove was *Rhizophora apiculata* followed

by *Rhizophora stylosa R. mucronata, Bruguiera gymnorrhiza, Heritera litaralis, Limnizera littorea, Avicennia marina, Flegellarea indica, Phoenix paludosa, Acrosticum aureum, Nypa fruticans, Avicennia officinalis, Lumnitzera recimosa,* etc.

Guptapara: The dominant species at Guptapara was *Rhizophora apiculata* followed by *Rhizophora stylosa, Acanthus sp.Acrosticum aureum, Excoecaria agallocha, R. mucronata, Bruguiera gymnorrhiza, Limnizera littorea, Avicennia marina, Flegellarea indica, Phoenix paludosa, Heritera litaralis, Nypa fruticans,* etc.,

Panighat : Mangrove survey was carried out at Panighat. Mangrove trees were eradicated due to tsunami only *Avicennia marina* and few *Rhizopora* saplings were present in the site.

Havelock: At Havelock Island, the dominant species mangrove were *Rhizophora apiculata* followed by *Ceriops tagal, R. stylosa R. mucronata, Bruguiera gymnorrhiza, Avicennia marina, Heritera litaralis, Xylocarpus granatum Soneratia alba* etc.,

Neil Island: Mangrove surveys were carried out at Neil Island and it was found that *Limnizera racemosa* was the dominant species followed by *Rhizophora apiculata, Ceriops tagal, R. mucronata, R. stylosa, Bruguiera gymnorrhiza, Xylocarpus granatum, Excoecaria agallocha Phoenix paludosa, Soneratia alba, Acrosticum aureum, Heritera litaralis, Flegellareia indica,* etc.,

Kadamtala : The dominant species of mangroves in this region were *Rhizophora apiculata, Ceriops tagal, R. mucronata, R. stylosa, Avicennia marina, Bruguiera gymnorrhiza, Bruguiera cylindrica, Agicerus carniculatum, Excoecaria agallocha, Xylocarpus granatum, Phoenix paludosa, Soneratia alba, Limnizera littorea, Acrosticum aureum, Heritera litaralis* and *Nypa fruticans.*

Car Nicobar: At Car Nicobar the mangrove survey was carried out at Kimios Creek where *Rhizophora apiculata, Ceriops tagal, R. mucronata, Bruguiera gymnorrhiza, Xylocarpus granatum, Acrosticum aureum* and *Bruguiera cylindrical* occupied significant stretch of the creek.

Development of Mangrove Based Agro Aqua Farming for Restoration of Mangrove Ecosystem and Livelihood through Community Farming in Andaman Islands

S. Dam Roy, Alok Saxena, T. Damodaran, Grinson George and P. Krishnan

Project Co-ordinator: R.C. Srivastava

Mangroves act like a buffering zone in between terrestrial and marine ecosystem and thereby protect and reduce the impact of energy dissipated along the shore during high wave action as well as during situations like *tsunami*. The mangroves areas are also important, as they are the nursery ground for a wide range of aquatic organisms. Due to high human pressure and high demand of energy source, there is constant threat on the mangrove ecosystem. The proposed research is an initiative with an objective to explore into the mangrove ecosystem as a livelihood option for the residents of the coastal population for their social upliftment, instead of their conventional perception of cutting the

mangroves for wood and converting the lands to cultivable one, as well as an indirect method for the protection and conservation of the mangrove forest. For this propose a preliminary survey has been conducted at different places in South Andaman to identify suitable sites for the implementation of project. A final selection about the suitability of a site will be made based on physical and chemical properties of water and soil, accessibility of the site, interest of the farmers; inputs form the forest department officials, etc. For initial implementation of the project, the brackishwater fish farm at Sippighat has been selected. The water quality parameters estimated suggested that the site would be suitable for the experiment (Temperature: 29°C; pH: 6.44; Alkalinity: 36 ppm; Salinity: 29 ppt; Nitrate : 0.36 ppm; Phosphate: 0.07 ppm; Nitrite: 0.05 ppm).

Two aquaculture ponds of approximately 2,000 m^2 are being constructed adjacent to the mangrove belt. A detailed plan for the construction has been made for the construction of different components of mangrove-based aquaculture system taking in view of the topography of the land. Tiger shrimps will be cultured in the ponds and horticultural crops such as coconut, *Morinda citrifolia,* tuber crop, vegetables, etc will be planted along the bundh. It is also proposed to have a make- shift mangrove nursery adjacent to the pond site for restoration of the mangrove vegetation.

Plate 20. Farmer's field adjacent to mangroves at Manjeri being inspected by investigating team and forest officials

Division of Social Science

Socio-Economic Impact Assessment on Agriculture, Animal Husbandry & Aquaculture in the *Tsunami* hit Andaman

Subhash Chand, R. Raja, V. Jayakumar, S. Jeyakumar and S.N. Sethi

To assess the damage due to tsunami to the farming community, the data were collected from the farmers of village's viz. Chouldari (18), Mithakhari (21), Guptapara (17), Wandoor (19) and Stewartgunj (11). The study revealed that the average family size in the sample area was 6.04 with family composition of adult male (2.40), adult female (2.02), male (0. 90) and female children (0.72). The old generation was mostly involved in farming practices, while younger ones were found inclined towards service sectors. The average age of the farmers was 49.88 years with majority primary level education followed by 17.60 % secondary, 3.60 % higher secondary, 3.00% graduation, whereas 13.20% illiterate.

Land affected during pre and post tsunami: The status indicated that the land availability due to inundation after tsunami has reduced from 0.74 ha to 0.49 ha. Whereas the land affected during high tides decreased from 0.37 ha to 0.19 ha and remaining dried off. Thus, land reduced or not fit for cultivation is a serious problem to these farmers after tsunami. During post tsunami land use showing improved trend (Fig. 1).

Loss of standing crops: The loss was not only in terms of cultivable land alone but also loss of standing crops also. The study revealed (Table 1) that on an average loss of Rs. 50472/- was to the affected farmers. Maximum loss was observed in Wandoor (Rs. 79417/-) and Chouldari (Rs. 65023/-). In Stewartgunj village, the maximum damage was caused to the paddy crop (Rs. 25600/- per farmer). The crop wise maximum loss was accrued in coconut followed by paddy, arecanut, vegetable, fruits and pulses.

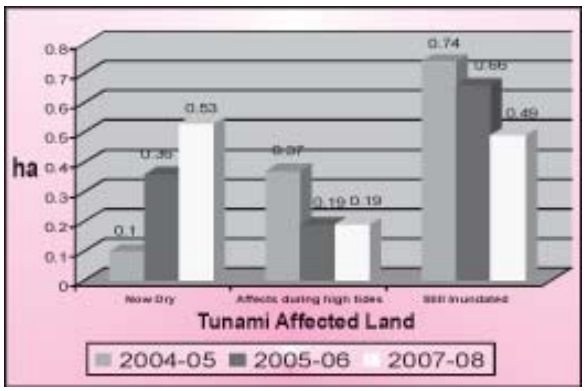


Fig. 1. Status of Tsunami affected land (In ha)

Loss of farm impacts: The study on loss of agricultural inputs indicated (Table 2) that the major loss in the form of farm implements was (Rs. 13120/-) comprising of pump sets, motors, tractors, rice mill, plough, fishing boat and fishing nets etc. followed by seeds / planting materials and fertilizer Rs. 2514/- and Rs. 142/- respectively. Village wise comparison indicates Wandoor village accrued maximum loss of Rs. 43858/- of which Rs. 36667 was from implements, fishing boats and nets. The other villages had less damage in terms of farm inputs.

Table 1. Agricultural loss due to tsunami per farmer

(In Rupees)

Villages	Paddy	Pulse	Vegetable	Coconut	Arecanut	Fruits	Total
Guptapara	1000.00	250.00	6600.00	15500.00	7200.00	0.00	30550.00
Mithakhari	18866.67	0.00	2000.00	17766.67	1200.00	333.33	40166.67
Wandoor	500.00	0.00	8166.67	59375.00	11375.00	0.00	79416.67
Stewartgunj	25600.00	0.00	0.00	1100.00	500.00	5000.00	32200.00
Chouldari	14000.00	153.85	8061.54	28153.85	12576.92	2076.92	65023.08
Overall	**12283.33**	**75.00**	**4980.00**	**25183.33**	**6583.33**	**1366.67**	**50471.66**

Table 2. Loss of agricultural inputs due to *Tsunami* per farmer

(In Rupees)

Villages	Seed/ Planting materials*	Fertilizer	Farm implements**	Total
Guptapara	420.00	250.00	18700.00	19370.00
Mithakhari	1640.00	0.00	7466.67	9106.67
Wandoor	7191.67	0.00	36666.67	43858.34
Stewartgunj	0.00	0.00	500.00	500.00
Chouldhari	2748.46	462.31	3323.08	6533.85
Overall	**2513.83**	**141.83**	**13120.00**	**15775.66**

**Indicates paddy and vegetable, **Indicates pump set, motor, Tractors / power tiller, rice mill, plough, fishing boat and fishing net.*

Affect of tsunami on animal husbandry: Based on sample survey there was considerable reduction in livestock holding due to tsunami. This was accounted for cattle 3.27 to 0.73, buffalo 0.92 to 0.25, goat 2.85 to 0.68 and for poultry birds 86.49 to 32.49 per family after tsunami. There was significant drop in the production of milk (4.48 to 0.98 liters) and egg production (from 18.20 to 7.23) per day per farmer in the study area. This was also observed that livestock sector is improving slowly.

Changes in income pattern of tsunami affected farmers: The impact of tsunami on the pattern of income revealed that, in the pre-tsunami period (2003-04) the average annual income of affected farmer was Rs. 78067/- of which farming sector was contributing about 60% but in the year of Tsunami i.e. 2004-05 the annual income was reduced to Rs. 53763/- of which the contribution from farming sector was 49 %. The 11 % reduction in income from farm sector was noticed.

However, this study has its limitation due to remoteness of the respondents, poor transport facilities, and sampling frequency and quantum. It is therefore recommended that (i) Similar type studies should be conducted in other areas, (ii) The studies on the affect of Tsunami on the change in properties of water, soil, fodder quality and human health may be conducted, and (iii) factors affecting the productivity and production in tsunami affected areas may be studied.

An Economic Analysis of Floriculture Potential in Andaman and Nicobar Islands

Subhash Chand, D.R. Singh and R. C. Srivastava

The population of these islands, as per 2001 census, is 356152 comprising 54.18 percent male and 45.82 percent male and density is at 43 persons per sq km. The population of these Islands is multi lingual and multicultural, comprising of Bengali (64706), Hindi (49469), Tamil (53536), Malayalam (26075), Telugu (32979) and others (5690). This multicultural population of these islands celebrates most of the regional festivals like in mainland. This leads to huge demand of flowers for poojas, wedding ceremony and day to day activities through out the year.

Socio economic features of flower sellers: Total six flower sellers from different parts of South Andaman were randomly selected and surveyed. It was observed that most of the flower seller were with low educational status and does this business as a subsidiary occupation. From the last two decades only flower cultivation and selling was started by the selected respondents. This was found that the major mode of flower selling was i.e. 75 percent through shops, 10 percent through door to door distribution and rest based on order or demand of individuals. This provide them part time employment for their livelihood. Number of flower shops in these islands found to be 32 and of which 19 are in Port Blair itself. In other islands flower shops are scattered and very less in numbers.

Source of flower and related materials: The local supply of flower is meager only 6 percent of the total consumption and rest of 94 percent come from mainland. The Chennai (70%) and Kolkata (24%) supply flowers to Port Blair by different means. Due to transport cost from mainland, the flowers are costlier and supply is also erratic. Many time flowers could not be sold, or stored due to various reasons. The flowers may not be useful for next sale if not properly stored.

Cost of flowers from the main land imports: The cost involved and quantity required for meeting of entire islands demand is presented in table 4. It was revealed that about 80-100 kg marigold flowers required per day at an annual cost of Rs. 48 lakhs. In the case of Chrysanthemum 50 kg and about Rs. 8.0 lakh was needed to be spent. Similarly in the case of

Jasmine, Tuberose, Crossandara, Gladiolus, Gerbera and Rose etc Rs. 10-12 lakhs is required. It can be concluded that about Rs. 86.0 to 97.0 lakhs has to be spent on flowers import. If flowers are locally cultivated, this huge amount may be saved for these islands.

Table 3. Source of Flower and related materials

Sl. No.	Major Sources	Quantity from each source (%)	Purchase Price (Rs. / kg)	Selling Price (Rs./ kg)
1	Local Growers			
a	Calicut	2	100 - 150	150 - 200
b	Muccapahar	1	100 – 150	150 – 200
c	Diglipur	3	100 - 150	150 – 200
2	Main Land			
a	Chennai	70	125 - 190	200 – 250
b	Kolkata	24	125 - 191	200 - 250

Table 4. Cost of flowers from main land

Flowers	Quantity (Kg)/Day	Quantity/ month (25 days)	Quantity/ year (300 days)	Cost (Rs/Kg)	Total amount (Rs. lakh)
Marigold	80 -100	2000 –2500	24000 - 30000	160	38.4048.00
Chrysanthemum(4 month)	50	1250	15000	160	24.00
Jasmine(8 months)	15-20	375-500	4500-6000	90	4.055.40
Crossandra	2	50	600	150	0.90
Tuberose	20	500	6000	150	9.00
Gladiolus(2 months)	100spikes	2500spikes	30000 spikes	5 /spike	1.50
Gerbera(4 months)	100spikes	2500spikes	30000spikes	5 /spike	1.50
Carnation(2 months)	50 cutflower	1250	15000	5 /spike	0.75
Rose(Loose flowers)	5 kg	125	1500	300 /spike	4.50
Rose sticks	100 spikes	2500	30000	5 /spike	1.50
				Total	***86.10***
					97.05

Area required meeting of the local demand of flowers in islands: The species wise area required for cultivation of flowers in Andaman and Nicobar Islands is presented in table 6. The findings revealed that the total area is required for cultivation of different flowers to meet the demand of these islands is about 6.0 to 7.0 ha under protected and precision cultivation. This is not much area but more efforts need to be put to create awareness to develop infrastructure.

Marketing channels: The marketing channels involved in the flower marketing are given as below. It could be noted that there were three channels involved in flower marketing. Producer sells to the retailer and than consumer. Similarly channel II and III which was found to be long channel.

Constraints in floriculture: The major constraints faced by flower growers and the sellers in these islands were lack of cold storage and marketing facilities. This leads to huge post harvest losses and leading to higher sale price. Lack of finance and scientific knowledge also enhance the suffering to the flower seller and growers. The high rainfall force the farmers for flower cultivate in the limited open area. The other constraints viz price fluctuation, lack of good quality seed Materials and man power. Therefore if flower cultivation is to be made remunerative in these islands, minimize the constraints and provide better market facilities to the growers.

Development of Artificial Neural Networks (ANN) Based Forecasting Model for Studying Varieties Diversity, Yield and Production in Prominent Rice Cultivars of Bay Islands.

M. Balakrishnan, N. Ravisankar, Subhash Chand, R.C. Srivastava and S.K. Zamir Ahmed, Krishna Kumar and T.V.R.S. Sharma

Information was collected on various qualitative and quantitative descriptors (yield contributing components and yield) from Middle and North Andaman along with information on weather parameters was collected to develop databases and a pre-harvest forecasting model. ANN model for Phase-I and Phase II is completed and its validation is in progress.

The data collected includes the parameters such as rice varietals spectrum in the different islands, weather parameters, yield components, soil parameters and pest and disease index. Secondary data were collected from developmental departments and CARI. ANN based forecasting modeling approach though used in various fields of science but has hardly been utilized in solving agriculture related problems. Since, it is a data-driven approach and lot of data on rice can be generated, this methodology can be effectively utilized for development of pre-harvest forecasting model for predicting rice yield of prominent varieties well before harvest. The ANN Model has been developed and sample data testing of phase-I and phase-II with weather parameter is under progress.

Preliminary ANN model for phase I comprising of South Andaman is presented in Fig 1 which indicates the predicted yield coming much closer to actual values. However, the estimated ANN model needs to be tested with more data sets.

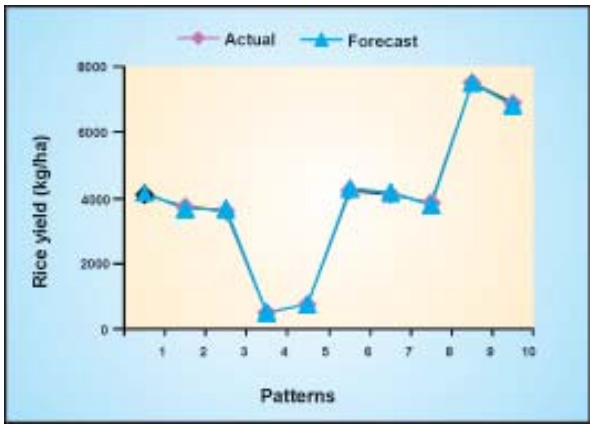


Fig. 2. ANN model for prediction of rice yield in Phase I

Development of Database on Animal Genetic Resources in Andaman & Nicobar Islands

M. Balakrishnan, S. Jeyakumar, R.C. Srivastava, T. Sujatha and A. Kundu

Majority of the world's population depend directly upon genetic, species and ecosystem biodiversity for their livelihoods. In many regions animal genetic resources are a vital component of this biodiversity. An estimated 1.96 billion people rely on livestock to supply their part or entire daily needs. Complex, diverse and risk-prone livelihood systems need animal genetic resources that are capable of performing the functions required of them in flexible, resistant and diverse manner. In order to assess the importance of animal genetic resources, there is a need to understand the functions of livestock as household assets, the need of investing resources in livestock keeping, and the genetic traits that are important for the fulfillment of these purposes. If animal genetic resources conservation is to make a contribution to improving the livelihoods of poor livestock keepers, the relative importance of animal genetic resources from the livestock keeper's perspective should be appraised. This database provides a common place to access all the data regarding animal genetic resources present in these islands.

Animal husbandry is fast emerging as one of the viable enterprises among the farming community of Andaman and Nicobar islands of late. This is mainly because of the shrinking land availability for the crop husbandry, especially after tsunami. Hence the participating scientists of this project felt it important to catalogue and develop a database of information comprising the available livestock breeds of these islands. It contains description and basic set of information on every breed, variety or line of genetic resources of cattle, goats, pigs and poultry in Andaman & Nicobar Islands is shown in the following figures 2,3 , 4 and 5 and it is entered in the tabular format preparation of schedule Created the tables using MS access is initiated. Created templates for entering the data using with the help of HTML.

Database overview and functional scope: The database is aimed at developing the website - **AGRANI** (**A**nimal **G**enetic **R**esources of **A** & **N I**slands). The website will prove to be a databank of animal genetic resources of these islands and will contain information like ready reference. The AGRANI website will provide the administrator user to create users with permissions to access the data of their respective area of work. The website is targeted to a wide range of user which includes department of Animal Husbandry and Veterinary Services, policy makers, Scientists and public.

Layout : The database in designed in Access 2003 at the backend and the interface is created using Adobe Dream weaver in HTML format. The webpage interface is interactive and is designed keeping general public in mind for easy access of their desired data. The database is very rich and up-to-date with information from latest Island wise Statistical census and other data from animal husbandry, CARI and other Veterinary Services.

The main page of the database comprises of links to Webpages of CARI, A & N Islands, Veterinary resources etc. To access the database one needs to login to the website. Once logged on the user will get access to the entire database regarding different animal genetic resources in these islands. The AGRANI database is rich in information. The databases comprises of general information about A & N Islands, fields for livestock, poultry and wild or captive animals. The databases will give a complete information regarding family, genus, species, and chromosome no, location, breed and community rearing the breed.

The database named objectives, historical development, structure, functionality, content, utility and future prospects of the Animal Genetic Resources of Andaman & Nicobar Islands (AGRANI) are described in the database. Online database is designed to cater for the needs of researchers, policy makers, development practitioners, teachers, students and farmers in developing countries for efficient access to available published and

grey literature from past and present research results on the origin, distribution, diversity, present use and status of animal genetic resources of A & N Islands. It is currently available, free of charge, on the web as well as on CD-ROM. It is argued that information on the extent of existing genetic diversity, characteristics and use of AGRANI in developing countries is the basis for their present as well as future sustainable utilization. In developing countries, neglect and lack of accurate information on the diversity and status of the animal genetic resources are believed to exacerbate the alarming rate of irreversible loss of genetic diversity. The database named as AGRANI has been developed and it was published in the CARI Website. Any one can easily access the database for retrieving the information'

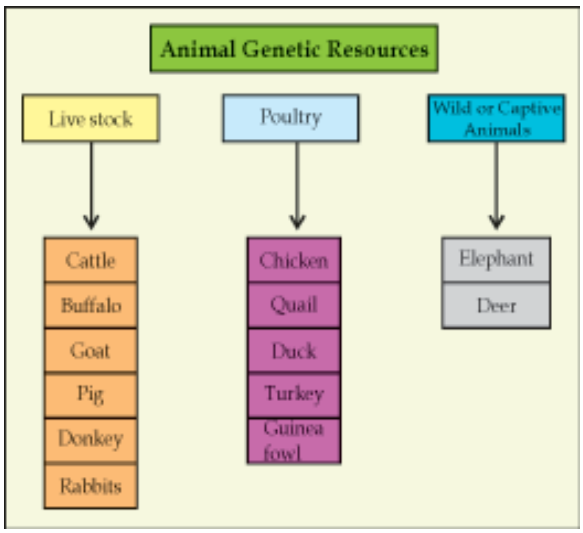


Fig. 3. Database design of AGRANI

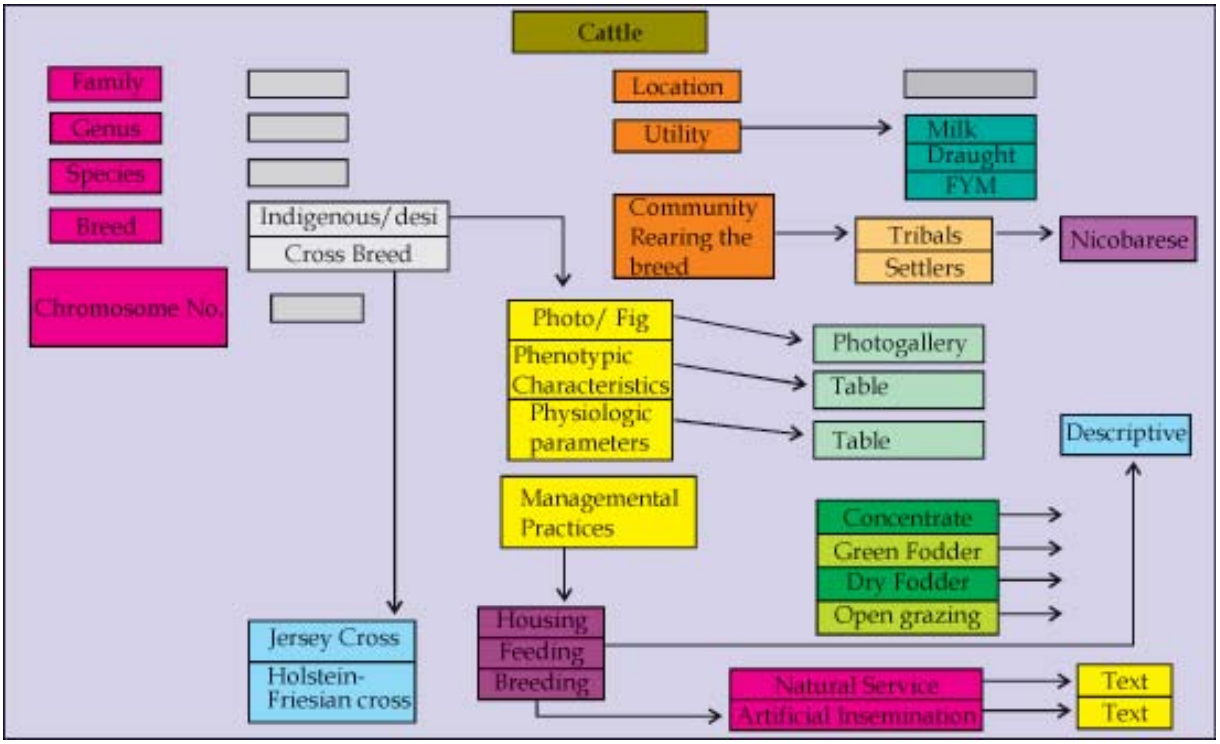


Fig. 4. Data entry form for Cattle

An Information System on Animal Genetic Resources of Andaman and Nicobar Islands (AGRANI) has been developed by using ASP at the front end and Ms-Access at the back end. All the forms have been designed in the form of a single package. The database design is such that it can store information on all aspects of animal genetics resources in an integrated form. This database has the facility to store district-wise information on animal resources w.r.t population, infrastructure, production, farms, on every breed, variety or line of genetic resources of cattle, goats, pigs and poultry in Andaman & Nicobar Islands. This system is menu driven.

Fig.5. Data base for AGRANI

Development of Database on Fodder Resources and Waste Land in Bay Islands

M. Balakrishnan, S.K. Verma, S.Jeyakumar, N. Ravisankar, A. Kundu, S.P. Yadav, Subhash Chand, S.K. Zamir Ahmed and Dr. R.C. Srivastava

In order to develop a database of information comprising the available fodder resources and waste land of these islands, all the available information on livestock population, productivity, present status of fodder resources & feeding methods, knowledge on fodder resources and their cultivation practices among the farming community were collected from primary and secondary sources. As no database on fodder resources is available for ready reference, need of the hour is to summarize all related information to facilitate both farming community & planners.

The database on fodder resources of Andaman & Nicobar Islands has been designed and data entry is in progress. The developed data base is user friendly and even a farmer can be easily access and retrieve the information in Hindi and English. The data base is shown in the following figures 6 & 7.

Fig. 6. Database design in Hindi

Fig. 7. Data base design for fodder resources

Identifying Livelihood Options and Training Needs Compatible to Self Help Groups to Fructify these Options

S.K. Zamir Ahmed, Subhash Chand, M. Balakrishnan, R.C. Srivastava

The informal credit delivery system, more precisely the Self Help Group (SHG), has come a long way since its modest beginning in the year 1992-1993. Hitherto, the status of saving and credit linkages in these islands have been studied which reflects that 1830 groups have been saving linked of which 1064 are in South Andaman, 701 in North and Middle Andaman and 65 in Nicobar District. On the other side a total of 516 groups have been credit linked of which 376 are in South Andaman comprising of 333 as women, 43 men and 26 mixed group. In North and Middle Andaman District out of 133 groups , 116 are women followed by 16 men and one mixed group and in Nicobar district only seven groups which are women only have been linked (Table 5).

Table 5: Distribution of saving and Credit Linked SHG in these Islands (upto March 2008)

District	Saving Linkage(in numbers)	Credit Linkage(in numbers)/ Type of group
South Andaman	1064	376(333 Women, 43 men)
North & Middle Andaman	701	133(116 women ,16 men and 1 mix group
Nicobar District	65	7(only women group)
Total	1830	516

The credit linkage of the SHGs accounts for only 28.20 percent which is due to the involvement of Self Help group promoting Institute (SHGPI) viz. National Cooperative Union of India (NCUI) which has mostly helped in accelerating the pace of formation of SHG followed by Association of Catholic Andaman and Nicobar Island (ACANI), A & N State Cooperative Bank, CARE India, Catholic Relief Seva (CRS), Strategic Urban Rural Advancement Banking Institute (SURABI), Unnati, Yuvasakthi, KVK etc.The Nicobar and Campbell Bay Island do not have the presence of any major NGO's other than ACANI and Unnati. Moreover the process of saving and credit linkage is undertaken by only seven banks out of 15 banks in these islands.

Randomly selected fifty SHGs from South Andaman, North & Middle Andaman District were taken as the sample and their training needs, training mode, location of the training, duration and constraints faced in practicing self employment venture were taken for study. They respondents ranked training needs on goat farming as the first followed by vegetable cultivation, floriculture, poultry, piggery, handicrafts and finally Mushroom cultivation. Maximum preferred method demonstration and field trip as the training mode and both farmers fields and CARI as the location with an option of 3 to 4 days for the training period. The major constraints identified through an open ended questionnaire were viz., lack of confidence by majority followed by lack of scientific know how and do how, no assured market, more risk involvement, non-availability of the critical inputs to the stakeholder in time and finally low level of attitude towards practicing agriculture enterprise than non-agriculture enterprises.

Economic Status and Scope of Dairy Farming in Andaman & Nicobar Islands – A Micro Level Analysis

Subhash Chand, B. Ganesh Kumar, S. Jeyakumar and Raj Vir Singh

A stratified random sampling design was used, two tehsils, Port Blair and Ferrargunj were randomly selected. Three villages were selected from each tehsil. Total 186 households were selected from the study area. The family size was 6 members in a family. The overall land holding size was found to be 1.24 ha per family. The Ferrargunj tehsil being a rural area, almost all the dairy farmers possessed land and was found to be higher as compared to Port Blair.

Practices of A.I. and N.S. followed in the study areas for dairy animals: A comparative study on the practices of Artificial Insemination (AI) and Natural Services (NS) followed by the farmers for the dairy animals was carried out. The frequency of AI (53.32%) and NS (46.68%). It was also found that there was little difference regarding the calves born using AI 50.69 percent male and 49.31percent female. In case of local

animals the percentage of adoption of AI was lower (36.42 %) than NS (63.58%) on the other hand majority of the crossbred cows AI practice was done (86.44 %). The practice of AI in buffalo was meager (1.75 %).

Investment pattern in dairy farming: The average investment on fixed assets such as milch animals, shed and stores and dairy equipment and machineries for local cows, crossbred cows and buffaloes in various categories of sample was worked out. The total investment on fixed assets per animal was Rs. 11360.59, Rs. 21176.55 and Rs. 10592.47 for local cows, crossbred cows and buffaloes respectively. In all species of animal, major part of total investment was made on animal itself.

Measurement of input output relationship: It was observed that 65.80 percent total variation in production due to four factors taken into consideration such as green fodder, dry fodder, concentrates and labour. The only factor i.e., concentrate was found to be having positive influence on milk production for all the bred and also found to be significant. Whereas green fodder and dry fodder were not influencing much to the milk yield in crossbred and similar trend was noticed in case of buffalo and local cows.

Marketed surplus function: The regression coefficient of milk yield variable was positive and significant. The regression coefficient for price of milk was also positively influencing the marketed surplus. The regression coefficient for family size, land holding size of the farmer was found to be statistically significant and negatively influencing the marketed surplus of milk. The results are in line with the findings of Siwach and Dhaka (1992), Singh and Rai (1998), Chand *et al*., (1999).

Impact Assessment of Post Tsunami Agricultural Development Programmes in Andaman and Nicobar Islands

R.C. Srivastava, Subhash Chand, M. Din and D.R. Singh

26th December 2004 was a dreadful day for these Islands when Tsunami killer waves invaded these islands. These waves caused considerable damage to human being, crops and livestock. Island wise damaged area under paddy and other field crops was worked out to be 2178.0 ha. The most severely affected area was in South Andaman (67%) followed by Campbell Bay (24%). Andaman and Nicobar island administration has formulated and initiated number of measures/intervention to bring the life to a normal level of affected people. The Government of India has approved a total package of Rs. 821.88 Cr. for A & N Islands under "Rajiv Gandhi Rehabilitation package (RGRP) for Tsunami affected areas" which includes Rs. 239.54 Cr for Agriculture Sector. The selection of site for construction works like water harvesting structure, bunding and

plantation was done after the discussion with PRIs/ Tribal representatives and PIAs. It was also observed that local labour was utilized to perform the project activities. The rehabilitation activities included horticulture plantations, power tiller distribution, pumpset distribution, distributions of farm implements, water resource development, and distribution of organic manure.

The primary data were collected through questionnaire by direct interview methods. The study indicated that survival percent of Coconut, Cashew nut, Banana, Pineapple and Pomelo was found to be comparatively higher than that of Lemon, Mango Graft, Sapota Graft and Mausambi budded. The coconut and other fruit crops got wide acceptability in all the Islands but pineapple and banana were most preferred. It was observed that farms in Diglipur, Rangat and in South Andaman areas were using power tillers not only for agriculture operations like ploughing, weeding and threshing but also for transport of input, and running paddy thresher, flour mill etc. Some beneficiaries were of opinion that it has become poor man's tractor which they use it for numerous purposes. Farmers are using the pump for pumping of water from existing water resources during wet and summer seasons. This has increased the yield of crops. One farmer reported an additional income of Rs 15,000/- due to enhanced yields. Thus although the pumps did not fulfill the objective of pumping sea water, it helped farmers in utilizing water resources to irrigate the plantation as well as field crops.

Under the package, all the farmers were given one set of hand tools which consisted 2 spades, 2 dao, 1 pickaxe, 1 crowbar, 1 fork spade, 1 sickle and 1 hand hoe. 80% farmers have reported satisfaction with the quality of hand tools distributed and their usefulness. Under the package 282 ponds (30 m X 22 m X 3 m.) and 162 ring wells to irrigate crops were constructed. Hence a total area of 331ha was brought under potential irrigation. The activity has benefited in the creation of the irrigation potential mainly for the post paddy crop, besides its use for livestock, fisheries and domestic purpose. In Diglipur area, farmers have planted vegetables and fruit trees on the embankment of ponds and are using water for multiple uses like irrigation and aquaculture purpose. The survey of ring wells showed that the 90% ring wells have the water. But in some cases the site selection is not favourable as saline water was observed. The over all impact of the use of power tiller, pump sets, water bodies and hand tools has been positive in terms of time saving, economic value and social effects, reduction in drudgery and enhancement of copping intensity. There was a significant increase availability of mechanical power per ha was (0.55) kW higher by 205.6% over pre-tsunami. The increase was mainly from the distributed power tillers and pumpsets under the package, and has helped to meet out the labour shortage and rapid recovery of the agriculture in post tsunami period. However, due to small land holding size,

some farmers were unable to use mechanization inputs efficiently. The involvement of people at all the stage of project leads towards better performance and its success. In this rehabilitation programme, people's participation at planning level was very low or negligible because the planning was done at centre level.

The records of PIA revealed that more than 753830 mandays employment were created. Sufficient amount of work was given to the people who came forward to work for the project. This has resulted in immediate relief and restored livelihood of Tsunami affected people. This is a positive indication of effective implementation of the programme.

It was found that the impact ranged from 68 percent for water resources to 38 percent for horticulture and community institution development. Since these two activities have a long gestation period, therefore the impact can be said to be good. The department of agriculture has taken a keen interest to rehabilitate the damaged area and people by providing the agricultural development package and giving them the options to improve the production and productivity. The team has also identified few constraints which can be taken care of in normal planning of development program. Recommendations have also been made for second phase of the rehabilitation programme.

Establishment of Sub- Distributed Information Centre (DBT)

M. Balakrishnan

The aim of the Bioinformatics Centre, CARI is to create the awareness about bioinformatics and its applications to the islanders and develop databases on Biodiversity of Andaman & Nicobar Islands, which would provide information to taxonomists, ecologists, biodiversity management specialists, policy makers, planners & related entrepreneurs to store, manage, and exchange electronically published scientific information in standard format. It also serves as an active site for bioinformatics research and development in the remote union territory of Andaman and Nicobar Islands.

The following activities have been carried out during the year.

- Biodiversity data has been collected from the Developmental departments and CARI records.
- Databases like Animal Genetics Resources (AGRANI), Fish Genetic resources, Mangroves and Integrated Rehabilitation of Tsunami affected village through technological Intervention in South Andaman has been developed and maintained.
- In silico analysis of different Gene expression and phylogenetic analysis of

Corynebacterium efficiems model has been developed.

- Updated and maintained the existing databases of bioinformatics centre.
- Developed a website for Bioinformatics Centre and it is updated regularly
- CARI Website has been developed with the help of Dream weaver and ASP.Net
- Organized the National workshop cum training programme on Functional and structural Genomics : An Insilco Approach
- Maintained the computers and software of the centre.
- Downloaded the freely available software's from internet
- Guided the students for project works in the discipline of M.Sc (Bioinformatics), M.Sc (Biotechnology) and B.E./B. Tech degree

Krishi Vigyan Kendra

The capacity building is an important activity of KVK and under this activity 40 training programmes were organized for practicing farmers, rural youth and extension functionaries (including 02 Nos. of sponsored training programmes under NFDB, Hyderabad) covering 956 beneficiaries (448 male and 508 female) in agriculture and allied discipline. Ten Front Line Demonstrations in agriculture and allied discipline viz., paddy, black gram, green gram, vegetables, floriculture, plantation and fruit crops, backyard poultry, duck, composite fish culture and papaya were conducted. Five On Farm Trials at farmer's field were conducted to assess and refinement of the selected technologies on agriculture and allied discipline. To improve the rural economy, generation of self employment and proper utilization of Tsunami affected land, integrated farming system has been introduced under cost effective farming system for decent livelihood. Technologies were popularized through numerous extension activities like field days, exhibitions, campaign, meet, T.V shows, Kisan mela etc. and also through popular articles and bulletins for the target groups. A summary of training achievement is presented in Table 1.

Front line demonstrations

- Ten demonstrations with two high yielding varieties of Paddy (NARDI & ADT-43) were taken up in the middle and south Andaman villages viz Urmilapur, Namunaghar and Memyo in an area of 0.4 ha each covering 10 farmers. Variety NARDI performed better and gave a yield of 5.14 t ha^{-1} followed by ADT-43 which recorded 4.8 t ha^{-1} over the local check Jaya 3.4 t ha^{1}.
- Front line demonstration on Black gram (1.6 ha) and Green gram (2.0 ha) were

Table 1. Training programmes organized during 2008 – 09

Discipline	No. of training programme	No. of Participant		
		Male	Female	Total
Practicing Farmer				
Crop Production	03	48	15	63
Horticulture	05	78	42	120
Animal Science	03	22	38	60
Fishery Science	05	86	23	109
Home Science	05	39	93	132
Agrl. Engg.	01	10	10	20
Total				
Rural Youth				
Horticulture	03	34	33	67
Animal Science	05	50	79	129
Home Science	03	-	70	70
Total				
Extension Functionaries				
Horticulture	01	09	07	16
Animal Science	01	08	07	15
Fishery Science	01	08	17	25
Home Science	02	14	66	80
Total	**38**	**406**	**500**	**906**
Sponsored Training Programme Fishery Science, (NFDB, Hyderabad)	**02**	**42**	**08**	**50**
Grand Total	**40**	**448**	**508**	**956**

conducted in the South Andaman villages viz., Guptapara, Mameyo, Badmaspahad, New Manglutan and Namunaghar village. An average yield of 0.74 t ha^{-1} and 0.76 t ha^{-1} recorded for Black gram and Green gram respectively over local check of 0.50 t ha^{-1} and 0.53 t ha^{-1} respectively.

- Three demonstrations on French bean (Arka Komal) conducted in the Namunaghar and Mameyo with an area of 0.8 ha recorded yield of 8.23 t ha^{-1} over the local check variety of white seeded which yielded 6.8 t ha^{-1}.
- Nine demonstrations on fruits were conducted at Namunaghar, Collinpur and Hatitapu covering 2.1 ha. 350 nos. of air layered seedlings were supplied from KVK to the nine farmers covering 0.5 ha. The field observation showed height of the plant 102 cm and 6.2 no. of primary branches with 0.30 cm canopy size under field condition.
- Three demonstrations on Khaki Campbell ducks were conducted in

Chouldari villages of South Andaman. The Khaki Campbell Ducks recorded a higher egg production of 242 eggs / year over the local check 180 eggs/year.

- Demonstration on large white Yorkshire were taken with 2 pigs (1male:1 female) to each farmer of Chouldari and Ferrargunj wherein large white Yorkshire recorded a body weight of 72 kg over the local check of 60 Kg in one year.
- Two demonstrations on backyard poultry birds of Vanraja variety were conducted in Chouldari and Namunaghar villages of South Andaman. The Vanraja birds recorded a higher body weight of 1.85 kg/ bird over the local desi bird of 1.4 kg/bird.
- One demonstration on quail farming was conducted at Chouldari with 100 nos one day old chicks wherein the birds attained an average body weight of 175g upto 6^{th} weeks. There was no local check against the quail.

- Five demonstrations on papaya were conducted at Namunaghar and Chouldari in each 0.01 ha area in which Andaman selection variety was demonstrated. The average yield per plant was recorded 48 nos, whereas 32 no. fruits were recorded in local check showing an increase of 50% in yield.
- Composite fish culture with four species in 5 Nos. irrigation ponds (0.08ha each) was undertaken with stocking ratio of Catla, Rohu & Mrigal were 3:4:3. The average yield was 129 Kg (1613 kg/ ha) and advantage from technological intervention was Rs 36,250/ ha.

On Farm Trials (OFT)

- OFT on validation of sweet potato varieties in farmer's field on three varieties namely Bidhan Jagnath, CARI-SP-1 and CARI SP-2.The variety CARI-SP-1 recorded highest yield of 21.64 t ha^{-1} whereas CARI SP-2 recorded 20.15 t ha^{-1}. The lowest yield was recorded in Bidhan Jagnath 17.13 t/ha.
- OFT on evaluation of growth performance of IMC was conducted and the growth rate was higher of 1280g in treatment group with feed, lime and cow dung and proper management practices over 750g under local check.
- OFT on evaluation of improved poultry strain under Backyard poultry production system with Desi, Nicorock, Vanraja and Nishibari was conducted in Chouldari and Namunaghar. The body weight recorded at 5th and 8th weeks revealed higher in Vanraja (294 .0g ± 9.09 , 565.0g ± 15.07) followed in Nicorock (264.40g ± 7.08; 547.89g ± 6.04) and lowest recorded in desi bird (189.0g ± 8.09 ; 478.0g ± 15.26).
- OFT on use of *Ipomea aquatica* as alternative feed for quail was conducted in Chouldari Village of South Andaman. The treatment with 70% poultry feed + 30% Ipomea aquatica recorded a net profit of Rs. 546 over local check poultry feed of Rs. 366. There is no adverse effect on body weight and egg laying capacity in feeding Ipomea aquatic to quail birds.
- OFT on arecanut husk based garbage management conducted in Sippighat and Chouldari Villages of South Andaman. The treatment with homestead (30 Kg)+ cow dung (5 kg)+ Gliricidea leaves (15Kg)+ local worm (1Kg) revealed a net profit of Rs.645 over the farmers practice.

Extension activities :

Krishi Vigyan Kendra undertook several extension activities round the year. The extension activities are summarized in Table 2.

Linkages & collaboration: KVK has developed effective linkage with development departments of A&N Administration and other organization. Table 3 presents a summary of linkage and collaboration.

Table 2. Summary of extension activities

Nature of extension activity	No. of activities	Farmers			Total		
		M	F	T	M	F	T
Kisan Mela	01			1600			1600
Kisan Ghosthi	02	173	67	240	173	67	240
Kisan day							
Exhibition	05						
Film Show	27						
Method Demonstrations	06	57	63	120		63	120
Farmers Seminar	01	24	16	40	24	16	40
Workshop	05	277	223	510	277	223	510
Group meetings	57	48	522	570	48	522	570
Lectures delivered	24	184	64	248	184	64	248
Newspaper coverage	11	Published in Daily Telegram, News Paper, Port Blair.					
Radio talks	06	Broadcasted in All India Radio, Port Blair					
TV talks	16	Telecasted in Doordarshan, Port Blair					
Extension Literature	03	175	175	175	175	175	175
Advisory Services	17	-	85	85	-	85	85
Scientific visit to farmers field	90	270	142	412	270	142	412
Farmers visit to KVK	48	147	187	334	147	187	334
Diagnostic visits	64	147	102	249	147	102	249
Self Help Group Conveners meetings	57	48	522	570	48	522	570
Mahila Mandals Conveners meetings	09	-	105	105	-	-	-
Celebration of important days (specify)	02	-	250	250	-	-	-
Any Other (Specify)	-	-	-	-	-	-	-
Formation of New SHG's	04	-	40	40			

Table 3. Summary of linkage and collaboration

Name of organization	Nature of linkage and Collaboration
Department of Agriculture , A & N Administration	Training and supply of seedlings
Department of AH & VS, A & N Administration	Training & Inputs distribution
Department of Fisheries A & N Administration	Training and fingerling distribution
A & N Cooperative Bank,	SHG Promotion
NABARD, Port Blair	Formation of Projects and S H G s
NRSE, Dept. of Electricity, A & N Administration	Non conventional energy resources
Lead banks	SHG promotion
CIPMC, Port Blair	IPM Management
National Cooperative Union of India	Training and field advisory
Lead NGOs	Training

Participation in seminars/symposium/meetings & training

Title	Venue and date	Name of participant attended
Training on web site design and development of LAN and WAN technologies	Gayashpur, KVK, Nadia, 16th - 30th August, 2008; Gayashpur, KVK, Nadia 1st– 19th Sept. 2008 Gayashpur, KVK, Nadia 20th - 30th Oct.,2008	Dr.Abhay Kumar Singh Shri L.B.Singh and Shri N.C. Choudhari Dr. Kanak Lata
Farmers workshop under Bharat Nirman Public Information Campaign	ATMA, Dept. of Agrl., Diglipur, A & N Islands, 22nd to 26th Nov., 2008	Dr. Kanak Lata Shri L.B.Singh and Shri N.C. Choudhari
Workshop-cum-seminar on Status and Future Strategies of Horticulture Development in A & N Islands	CARI, Port Blair, 23rd-25th Jan. 2009.	Dr. Kanak Lata Shri L.B.Singh Dr.Abhay Kumar Singh Er. Bijaya kumar Nanda Shri N. Bommayasamy Shri N.C. Choudhari Shri D. Basantia
Workshop-cum-training on Functional & Structural Genomics – An Insilico Approach	CARI, Port Blair, 26th -28th Feb. 2009	Shri Krishna Gopal Nath
Training on Mass Production and Quality Testing Methods of various Bio-pesticides/ Bio-agents	Directorate of Oilseeds Research, Hyderabad, 18th -25th March, 2009	Shri N. Bommayasamy

Technologies Assessed and Transfered

The technologies generated in agricultural and allied fields were assessed for its performance by the scientists in participatory mode and based on the location, need, preference and feed back it was transferred to the target groups through the ATIC and Krishi Vigyan Kendra of the Institute. The progressive farmers, NGO's and the line department have played a vital role in transmission of the below mentioned technologies among the target groups (both tribal and non-tribal) of the Island eco-system in South Andaman, North & Middle Andaman district and Nicobar district.

Natural Resource Management

- Integrated farming system (IFS), and Crop diversification through broad bed and furrow (BBF) system for low-lying paddy areas.
- Tank-well system and Micro irrigation system .
- Long duration rice varieties viz., Ranjit, Savitri,Varshadhan and Gayatri for low-lying areas.
- Lining materials for controlling seepage losses from farm ponds.
- Agro-technique for capsicum under protected cultivation structure.
- Small and large scale production of vermi-compost and vermi-wash.
- Self propelled mechanized paddy transplanter.
- Pedal and hand operated coconut dehusker.

Field Crops

- 4 genotypes of rice .
- *Trichoderma viride* for the management of vegetable crop diseases .
- Use of non-chemicals (pheromone traps, neem and other biopesticides) for the management of vegetable crop pests.

Horticulture & Forestry

- Development of protocol for packaging and shipment of *Morinda citrifolia* for Noni growers.
- Propagation techniques of *Morinda citrifolia* fruits for rapid seed germination.
- Production technologies of indigenous orchids, anthurium, marigold and gladiolus.

Animal Science Division

- Improved Nicobari crosses for backyard farming (WLH x WN).
- Azolla as a feed supplement for Quail and Duck.
- Ultrasonography ,a tool to characterize the ovarian follicle in poultry.

Social Science Division

- Conversion of fourteen Agricultural Technologies in Micro Business modules for taking up micro enterprise.
- Video films on technology backstopping in agriculture and allied fields for stakeholders.

Information on Other Sections

Library

The Institute has a well organized library which plays an important role as a center for literature and information related to the institute's mandate in these islands.It serves and fulfills the need of the scientists of this institute as well as research workers and students from local research and educational institutes. It has the facilities for on and off line information retrieval, networking, automation-computers and other accessories. The library has been enriched with 5271 books, 4310 other publication and 2455 bound volumes in addition to journals by subscription, gratis, on exchange basis and technical books. Extensive collection of resource materials in agriculture and allied fields, special collection of island related books and publications along with reprographic facility has given it a prime importance in these islands. Internet services via VSAT connection is also available for easy access to these informations.

Planning, Monitoring and Coordination Cell

The Planning, Monitoring & Coordination Cell (PMCC) serves as a vital link between the Institute, Council (ICAR), Government, Semi-Government, NGOs, other R & D organization and A & N Administration in addition to providing information on various research, development, extension and human resource development activities to these agencies. The cell has co-ordinated the conduct of the Institute Research Committee meeting (IRC) from 23rd to 26th July, 2008 wherein a total of 52 ongoing and 12 new projects totalling to 64 were presented by the concerned scientists. Further Mini IRC was also conducted on 14th November, 2008 to accommodate 7 new projects of the newly joined scientists, in addition 19 externally funded projects were also reviewed in the house.

Dr. R.C. Srivastava, Chairman, IRC interacts with the scientists

Beside compilation of institute reports, it also facilitates publishing of research articles, technical bulletins, folders, books, newsletter and proceedings of the workshop, symposium and seminars and coordinates the activities within the Institute and out side.

Computer Cell / ARIS Cell

The Agricultural Research Information System (ARIS) envisages providing online interconnectivity between the different Research Institutes, National Centres and State Agricultural Universities.

Activities undertaken is mentioned below:

- Database developed for the calculation of Sixth Pay Commission arrears.
- Internet and e-mail connectivity to all Scientists / Officers of CARI.
- VSAT upgraded from 256 Kbps to 512 Kbps for faster browsing and downloading information.
- Web page creation, up-dation and maintenance.
- Computer upkeep, up-gradation and training of Institute personnel.
- Data compilation and statistical analysis.
- Providing visual aids for different programmes.
- Procurement , installation , verifying quality control and maintenance of personal computer .
- Maintenance of networking, DAMA VSAT.
- Intranet maintenance and updation.
- PERMISNET - Personal Management Information System Network- Monthly and quarterly updating through online.
- Intelligent Reporting System (Quarterly up-dation of data and uploading).
- Downloading the circulars and other information from ICAR website.

Website Updated

- Institute website (http://cari.res.in) was made bilingual and is updated regularly.
- Intranet of the Institute (http://server:8080/carionline) was updated regularly.
- Krishi Vigyan Kendra website (http://kvkcari.and.nic.in) was updated.

Database developed / Updated

- Sixth Pay Commission arrear preparation database
- Cartridge maintenance

To strengthen the technical hands, ARIS Cell organised training on "Information technology and its application in Agriculture" from 12th to 27th August 2008 wherein eighteen participants attended. Introduction to computers, Microsoft Word, Microsoft Power point, Microsoft Excel, Statistical package, Email and Internet usage followed by hands on session was imparted during the training.

Dr. R.C. Srivastava, Director, distributes certificate to trainee

Sub Distributed Information Centre

Bioinformatics Centre (Sub-DIC)

The Distributed Information Sub Centre (Sub-DIC) established at CARI with the support

from DBT, Govt. of India has well equipped computer facility like hardware including computers, proxy server, mail server, database server and VSAT. It has created both off and on-line database on biodiversity of A & N Islands and serves as an active site for bioinformatics research and development in these Islands. The centre is focused on providing quality consultancy services in the field of website development, database management and manpower training. It can also assist any progressive organization / institute in developing, integrating and maintaining valuable biological data so that it can be accessible in safe and comfortable manner.

The Centre during this year has been actively indulged in the following activities viz:

- Developing databases on online fish genetic, animal genetic, mangroves and fodder resources of A & N Islands.
- Updating website of CARI, maintenance of computers and software related to bio-informatics.
- Organized National workshop cum training program
- Guided students for undertaking project works in the discipline of M.Sc (Bioinformatics) and imparted summer training in Genomics and Proteomics aspects.
- Carried out In Silico analysis of different gene expression and phylogenetic analysis of corynebacterium sp.

Official Language Cell

The cell has conducted Hindi *Pakhwada* from 15th to 30th September, 2008, wherein various programme like Essay Competition, Letter writing, Noting and drafting, Speech, Quiz, Poster, Slogan Competition and Extempore were organized for the scientists, staff, campus ladies, children and farm women to create awareness about the importance of increasing use of Hindi as official language. A seminar on "The Alternative use of Agriculture land: Problem & Solution" was also organized on 15th September, 2008.

Dr. R.C. Srivastava, Director delivers presidential address

Estate Section

The section takes up works related to infrastructure development, workshop and instrumentation which are detailed below:

Infrastructure Development

An amount of Rs. 32 lakhs (approx.) under non plan has been spent for development of new infrastructures, repairs and maintenance of the residential and non residential buildings of the Institute. The construction of drop spill way on the Kaju Nalah in the

Garacharma Farm was the challenging task for the section which was completed before the onset of the monsoon. A number of RCC wells has been constructed at Sippighat and Garacharma Farm for both domestic and irrigation purposes. Number of water reservoir has been developed at Sippighat Farm with the active support of the Farm manager. In addition polyhouses, shade net, magur hatchery, Animal Science building, Canteen, Orchidarium and Cage culture has been constructed to facilitate smooth conduct of the research activities. Beside a RCC culvert worth Rs. 1.90 lakhs was constructed in Bloomsdale farm which was a long pending demand of the Farm manager. The section acts as the liaison agency for the works executed by CPWD, Port Blair and Electricity Department of A & N Administration respectively.

Workshop

Re-scheduling of school trips , arrangement and management of vehicles during visit of

Inauguration of Poly house on 19th April, 2008 by Dr. H.P. Singh, DDG (Hort.)

Inauguration of Magur hatchery on 22nd June, 2008 by Dr. H.P. Singh, DDG (Hort.)

Inauguration of Animal Science Building on 1 9th April, 2008 by Dr. H.P. Singh, DDG (Hort.)

Inauguration of Canteen on 23rd January 2009 by Dr. H.P. Singh, DDG (Hort)

Inauguration of Orchidarium on 23rd January 2009 by Dr. H.P. Singh, DDG (Hort.)

Inauguration of Cage Culture on 24th January 2009 by Dr. H.P. Singh, DDG (Hort.)

Parliamentary Committee, Kisan Mela and other major events of the Institute was done .The works related to routine and major repairs of Staff Car, Jeep and Swaraj Mazda (bus) was also completed in stipulated time.

Instrumentation Cell

Repairs and maintenance of scientific equipments and providing uninterrupted power supply during important meetings and functions of the Institute was done.

The Estate Section has performed with its full efficiency for the smooth conduct of research works under the able guidance of the Director.

RTI, ITMU, Rajbhasha Implementation Cell (RIRIC)

RIRIC started functioning w.e.f. 1st March, 2009 at CARI, Port Blair wherein the matters related with RTI Act, Institute Technology Management Unit and Implementation of Rajbhasha Act are being dealt. During the period, seven applications received under RTI Act, 2005 were addressed. This cell undertakes timely publication of weekly issue of Agro Advisory Bulletin based on weather forecast received from Meteorological department. It also acts as the monitoring agency for implementation of Rajbhasha act.

Post Graduate Students Cell

Central Agricultural Research Institute is a premier institute engaged in research, extension, teaching and education. To facilitate use of the infrastructure by the M.Sc and Ph.D. scholars, one Post Graduate Cell has been created. Every year the institute receives large number of application from various colleges and universities for seeking permission to undergo dissertation work. This year also a total of 18 applications have been received from different universities, of which 10 students have registered for M.Sc. dissertation work in different disciplines such as Microbiology, Biotechnology, and Bioinformatics etc. The guidelines for the students have been displayed in the Institute website. The institute is also trying to

establish MoU with the Bidhan Chandra Krishi Viswavidyalaya for the Ph.D. scholars to carry out research work at this institute.

Employee Welfare Association (CARIEWA)

CARIEWA is actively engaged in carrying out activities pertaining to the welfare of the employees of CARI, wherein almost all the employees of the CARI are members. The association has been associated with various welfare programmes like extending personal loan to the members based on the exigency like sudden demise, wedding and farewell of staff. A canteen has been constructed having all the modern facilities beside children park and construction of a shed for recreational activities in the campus is under consideration. Under the able guidance of Patron CARIEWA, the association has also extended help to conduct Independence and Republic Day

AWARDS AND RECOGNITION

Scientist	Award / Recognition	Awarding Agency/ Organization society
D.R. Singh,	Appreciation certificate	In recognition of his work on Biological Diversity by C.P. Ramaswamy Aiyar Foundation, Eldams Road, Chennai on 22nd May, 2008.
S. Dam Roy	Appreciation certificate	In recognition of his work on Mangrove and Coral biodiversity by C.P. Ramaswamy Aiyar Foundation, Eldams Road, Chennai on 22nd May, 2008.
C.B. Pandey, S. Ghoshal Chaudhuri, and M. Din	Fakhruddin Ali Ahmed Award	In recognition for Agricultural Research in Tribal Areas of A&N Islands, ICAR, New Delhi on 16th July, 2008.
S. Dam Roy	Lieutenant Governor's Commendation Certificate	In recognition of his excellent professional skills and meritorious services to these Islands on the Independence Day.
	Member Selection Committee	In Pondicherry University for UGC Fellowship in Meritorious studies on 5th March 2009.
S.K. Zamir Ahmed	Jury member	To judge Rank & Bolt Award for UT of A & N Islands and AIR India on 30th & 31st August, 2008, Port Blair.
	Member Task force	Govt. of India, Ministry of Science & Technology, Dept. of Bio-Technology, New Delhi.
D.R.Singh, R.C. Srivastava, R. Raja and S. Manju	Best poster paper award	Noni Search 2008 organized by the World Noni Research Foundation at New Delhi from 18th -19th, Oct. 2008.
V. Damodaran, R. Sudha, T. Damodaran D.R. Singh, M.Sankaran and I.Jaisankar	Best Paper	National Workshop cum Seminar on "Status , and future strategies of Horticulture Development in A&N Islands", CARI, Port Blair from 23rd to 25th January, 2009
Chaudhary N.C., Singh L.B., Singh, A.K., Damroy S., Srivastava R.C., Subhash Chand, Lata K. and Damodaran V.	Best paper presentation award	National workshop cum seminar on "Status and future strategies of Horticulture Development in A&N Islands", CARI, from 23rd to 25th January, 2009.

Banu Saira., Subhash Chand, Damodaran, T. and Srivastava, R.C	Best paper presentation award	National workshop cum seminar on "Status and future strategies of Horticulture Development in A&N Islands", CARI from 23rd to 25th January, 2008.
Natural Resource Management Division	Theme Prize	Kisan Mela, CARI during 24th -25th, February, 2009.
M.S. Kundu	Best oral presentation award	National Symposium on Organic Livestock Farming - Global Issues, Trends and Challenges at WBUAFS, Kolkata from 26th to 28th February 2009.
S. Jeyakumar	Best Paper (Poster) Presentation Award	International Summit on Advancing Veterinary Medical Care : Challenges and Strategies, Madras Veterinery College, Chhenai, from 19th to 21st February, 2009.
Subhash Chand, A.K. Sikka, R.C. Srivasstava, & P. Sundrambal	Best paper presentation award	Society of Extension Education during 5th National Extension Education Congress – 2009 at C.S.A. University of Agriculture Technology, Kanpur (U.P.), from 5th to 7th March, 2009.
S.K. Zamir Ahmed & R.C. Srivastava	Best paper presentation award	Society of Extension Education during 5th National Extension Education Congress – 2009 at C.S.A. University of Agriculture & Technology, Kanpur (U.P.) held on 5th to 7th March, 2009.
S.K. Zamir Ahmed	Best Extension Professional Award -2009	Society of Extension Education during 5th National Extension Education Congress – 2009 at C.S.A. University of Agriculture & Technology, Kanpur (U.P.) from 5th to 7th March, 2009.
P. Krishnan	Young Scientist Award	For development of DNA-based vaccine for control of WSSV in tiger shrimps. Asian Fisheries Society (Indian Branch)
M. Sankaran	BOYSCAST Fellowship	DST, Govt. of India for undergoing Post the year 2009-2010 Doctoral Research at CIAT, Colombia, South America.

ON GOING RESEARCH PROJECTS

Externally Funded

Project Title	Principal Investigator	Budget (lakhs)	Date of Start/ Completion	
AP Cess Fund, ICAR				
Adoption of improved implements for rice based farming in Andaman and Nicobar Islands	Dr. M. Din	21.02	04/2005	06/2008
Biochemical and molecular characterization of soils of mangrove forests of Andaman	Dr. S. Ghoshal Chaudhuri	21.03	04/2005	06/2008
Crop diversification through Broad Bed and Furrow (BBF) based farming system in valley areas of Bay Islands	Dr. N. Ravisankar	24.06	07/2005	10/2008
Economic Status and Scope of Dairy Farming in Andaman & Nicobar Islands – A Microlevel Analysis	Dr. Subash Chand	11.75	07/2005	06/2008
Impact assessment of agriculture development programmes	Dr. R.C. Srivastava	5.42	02/2007	07/2007
Central Sector Scheme-NHM				
Centrally Sponsored scheme for Integrated development of spices – NHM	Mr. I. Jaisankar	5.79	04/2004	03/2010
Department of Biotechnology				
Digital database on plant resources of Andaman & Nicobar Islands	Dr. T.V.R.S. Sharma	19.91	03/2006	08/2009
Conservation and phenotypic and molecular characterization of indigenous goat of Andaman and Nicobar Islands	Dr. S.P.Yadav/ Dr. S. Jeyakumar (w.e.f. March, 2009)	34.07	04/06	06/2009
Development of Mangrove based fin/shellfish culture for livelihood restoration through employment generation in Andaman Islands	Dr. S. Dam Roy	36.00	2008	2011
Establishment of Distributed Information Centre	Dr. M. Balakrishnan	60.00	04/2005	03/2012

NMPB, New Delhi				
Technological innovations for commercial exploitation of *Morinda citrifolia* as livelihood option for island farmers.	Dr. D.R.Singh	246.00	2008	2011
MoWR				
Farmer participatory action research programme (FPARP) on water management	Dr. R.C. Srivastava /Dr. S.K. Ambast	24.00	03/2008	12/2009
A&N Admn.				
Soil and crop mapping of Andaman Islands using remote sensing and geographical information system	Dr. S.K. Ambast	12.97	02/2008	06/2009
MoES				
Integrated agro-meteorological advisory services	Dr. R.C. Srivastava /Dr.S.K. Ambast	60.00	04/2008	04/2012
ICAR				
Seed production in agricultural crops & fisheries Mega Seed project (Shrimp seed production)	Dr. S. Dam Roy	45.00	2006-07	2008-09
All India Network Project on Rodent Control (Coordinating Scientist	Dr. Ajanta Birah	8.31	02/2009	03/2012
Improvement and management of tuber crops in the Bay Islands under AlCRP-Tuber Crops	Dr. M. Sankaran	Not received	2008	To be continued
National Network Project on underutilized fruits	Ms. R. Sudha	Not received	2008	2011
AICRP on Vegetable Crops	Dr. Shrawan Singh	Not received	2008	To be continued
Mega seed Project	Dr. S. Dam Roy	45	2006	2009
SAC, Ahmadabad				
Coastal zone studies	Dr. S. Dam Roy	17	2007	2009
NBAIM-ICAR				
Application of Microorganisms in Agriculture and Allied Sectors	Dr. Krishna Kumar	4.82	10/2006	03/2012

WNRF, Chennai				
Collection, conservation, characterization and identification of superior clones of *Morinda citrifolia*	Dr. D.R. Singh	9.24	03/2008	2011
INCOIS, Hyderabad				
Potential Fishing Validation in Andaman sea	Mr. Grinson George	21.00	2008	2011
NOVOD				
Germplasm collection, evaluation and identification of some high yielding genotypes of Jatropha and Karanja and their multiplication in Bay Islands	Dr. T.V.R.S. Sharma	20.00	2008	2011
IIRS, Derhadun				
Spatial assessment of soil carbon pool for A&N Islands	Dr. S. Ghoshal Chaudhuri	66.50	03/2009	02/2011
NABARD, Port Blair				
Establishment of Out Reach Centre (ORC) for North-Middle Andaman, District	Dr. R.C. Srivastava/ Dr. S.K. Zamir Ahmed	79.80	2009	2013

Institute Funded

Project Title	Principal Investigator
Natural Resource Management	
Development on fresh and brackish water based Integrated Farming System (IFS) in bay Islands	Dr. R.C. Srivastava
Planning, augmentation and efficient utilization of water resources in Kaju Nallah watershed	Dr. S.K. Ambast
Assessment of spatial and temporal variability in soil physico-chemical and biological properties of tsunami affected agricultural lands of Andamans	Dr. S. Ghoshal Chaudhuri
Evaluation of soil management techniques in problem soils of South Andaman	Dr. T.P. Swarnam / Dr. S. Ghoshal Chaudhuri
Impact of integrated nutrient management on soil quality under rice-maize cropping system in Andaman	Mr. B.L. Meena/ Dr. S. Ghoshal Chaudhuri
Natural resources degradation and socio economic impact of leased farming in Andaman	Dr. S. Ghoshal Chaudhuri

Standardization of package of practices for table purpose (HPS) groundnut in Andaman	Dr. N. Ravisankar
Effect of supplemental irrigation on crop yield and water use efficiency in rice based cropping system of A&N Islands	Dr. R. Raja / Mr. T. Subramani
Studies on effective storage of water in ponds	Er. P.S. Deshmukh / Dr. M. Din/ Dr. R.C. Srivastava
Value addition to horticultural crops and fisheries products through application of renewable and non renewable energy sources	Dr. M. Din / Dr. R.C. Srivastava
Performance evaluation of different structures of protected cultivation in the humid tropics of Bay Islands	Dr. M. Din/ Dr. R.C. Srivastava
Field Crops	
Improving the productivity and quality of rice and other crops in rice based cropping system in A & N Islands.	Dr. T.V.R.S. Sharma
Assessment of crop losses and epidemiology of major vegetable diseases of South Andaman.	Dr. Krishna Kumar
Standardization of production and protection technology of tropical mushrooms.	Dr. Krishna Kumar
Development of eco-friendly IPM module for Okra and cucurbits in Andaman.	Dr. Ajanta Birah
Integrated Pest and disease management of Black pepper	Dr. Someshwar Bhagat
Development of integrated disease management modules for tomato crop	
Molecular characterization of economically important flora and microbes of Andaman and Nicobar Islands	Mr. Israr Ahmad
Horticulture & Forestry	
Collection, conservation, evaluation and documentation of indigenous vegetables from Andaman & Nicobar Islands	Dr. Shrawan Singh
Standardization of technologies for protected cultivation of vegetable crops under Bay Island conditions	
Standardization of technology for production of quality flowers under Island ecosystem	Ms. R. Sudha
Studies on effect of plant growth promoting biocontrol agents on growth and yield of papaya	

Value addition to horticultural crops and fisheries products through application of renewable and non renewable sources	Ms. R. Sudha
Standardization of Micropropagation techniques for potential orchids and ferns of A & N islands	Dr. D.R. Singh
Collection, characterization and conservation of open pollinated early flowering mango clones of Bay Islands	Dr. M. Sankaran
Improvement of coconut and areca nut	
Silvipastural system: Effect of Fertilizer and Cutting on net primary production (Herbage production) in Humid Tropical Climate of Bay Islands	Mr.I. Jaisankar
Standardization of agro technique for organic Black pepper cultivation in Andaman and Nicobar Islands	
Identification, evaluation and development of Silvipastoral system for Bay Island condition	
Role of Alley cropping system in nutrient conservation (nutrient build up + protection of fine soil particles from erosion), and selection of suitable crop sequence for the cropping system for the Andaman Islands	
Fisheries Science	
Cage culture of commercially important marine and brackis water fishes in protected bays and creeks of Andamans	Dr. S. Dam Roy
Induction of spawning and larval rearing of Trochus niloticus and subsequent sea ranching programme	
Stock assessment of Grouper and Snapper	
Temporal and spatial variability of water quality parameters and mineral profile of waters of Andaman and their impact on shell fishes and fin fishes.	Dr. Kamal Sarma
Brood stock development and breeding of damsel fishes	Mr. Grinson George
Breeding and Seed Production technology of Commercially important Cat fishes: *Clarius batrachus* (Indian Magur) and *Heteropneustus fossilis* (Singhi) in A & N Islands	Dr. C. S. Chaturvedi
Characterization of the role of associated bacteria in the bioactivity of Marine sponges from Andaman	Dr. P. Krishnan

Animal Science	
Improvement, Evaluation & Propagation of Indigenous Nicobari fowl and Ducks and Dissemination of Technology in Tsunami Affected Areas.	Dr. A. Kundu
Productivity Enhancement of Pigs under Island Ecosystem	Dr. M.S.Kundu
Study the feasibility and convergence on subsistence Pig rearing to commercial Pig farming inclusive of its process.	
Evaluation of therapeutic and immunomodulatory properties of *Morinda citrifolia* in poultry.	Dr. Jai Sunder
Characterization of livestock production sub system and assessment of critical nutritional gap in bay Islands.	Dr. S.K.Verma
Evaluation and utilization of Azolla as feed supplement for backyard poultry in Bay island.	Dr. T. Sujatha
Productivity enhancement and sustainable dairy cattle and Buffalo production in Bay Islands.	Dr. S. Jeyakumar
Productivity enhancement of goats in bay islands.	
Social Science Section	
Economic Status and Scope of Dairy Farming in Andaman & Nicobar Islands – A Micro level Analysis	Dr. Subash Chand
Development of Artificial Neural Networks (ANN) based forecasting model for studying Varieties Diversity, Yield and production in prominent rice cultivars of bay islands	Dr. M. Balakrishnan
Development of Database on Animal Genetic Resources in Andaman & Nicobar Islands	Dr. M. Balakrishnan
Development of Database on Fodder Resources and Waste Land in Bay Islands	Dr. M. Balakrishnan
Identifying livelihood options and training needs compatible to self help groups to fructify these options	Dr. S.K. Zamir Ahmed

PUBLICATION

Research Article

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Sankaran, M., N.P. Singh, Jai Prakash, Chander Datt, S.P. Das and S.V. Ngachan (2008). Under Utilized Vegetable Crops in Tripura: Their Documentation and Nutritional Characteristics. In : Regional Conference on Food Security and Sustainable Agriculture Development at Tripura University, West Tripura, 24th to 25th November.

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Sankaran, M., T. Damodarn, V. Damodaran, R.Sudha, D.R. Singh and R.C.Srivastava (2009). CARI-SP1 and CARI-SP2: High Yielding Sweet Potato Varieties of CARI. In: National Workshop cum Seminar on Status and Future Strategies of Horticulture Development in A&N Islands at CARI, Port Blair, 23rd to 25th January, p:173.

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Singh, D.R., R. Sudha, Abhay K. Srivastava, Amit srivastava, R.C. Srivastava (2009). Potential Biodiversity of Under Utilized Fruits in Andaman and Nicobar Islands. In: National symposium on Recent Advances in Biodiversity of Indian Subcontinent at ZSI, Port Blair, 11th to13th March.

Singh, D.R., R.C. Srivastava, Jai Sunder and Z. George (2009). A Review Research of *Morinda citrifolia* L. on Animals. In: National Workshop cum Seminar on Status and Future Strategies of Horticulture Development in Andaman & Nicobar Islands at CARI, 23rd to 25th January, p: 202.

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Singh, D.R., R.C. Srivastava, Saira Banu, R. Sudha and S. Manju (2009). Tapping biodiversity of medicinal plants for livelihood improvement in islands. In: National Workshop cum Seminar on Status and Future Strategies of Horticulture Development in A&N Islands at CARI, Port Blair, 23rd to 25th January, p: 203.

Singh, D.R., R.C. Srivastava, Z. George and Subhash Chand (2008). Development of Protocol for Packaging and Shipment of *Morinda citrifolia.* In*:* Third National Symposium on Noni Research, 18th to 19th October, p:68.

Singh, D.R., R.C.Srivastava, R. Raja and S. Manju (2008). Salt tolerance of *Morinda citrifolia* by Using Sodium Chloride as Irrigation Water during Seedling Growth. In : Third National Symposium on Noni Research, 18th to 19th October, p: 81.

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Singh, R.S., D. R. Singh, R.K. Mall and Indrasen Singh (2008). Emergence and Growth of

Noni (*Morinda citiroflia* L.) Seedlings under Sub – Tropical and Dry Sub – Humid Climate of Varanasi (UP) in India. In : Third Indian Horticultural Congress.

Singh, Shrawan, C.B. Pandey, V.B. Pandey and, V. Dadomaran (2008). Rare Legume vegetables in Andaman and Nicobar Islands: Present and Future Prospects. In: Proceedings of Brainstorming Session on Rare Legumes, IIVR, Varanasi.

Sudha, R., D.R. Singh and R.C. Srivastava (2009). Protected Cultivation of Flower Crops in Andaman and Nicobar Islands. In: National Conference on Floriculture for Livelihood and Profitability at IARI, New Delhi,16th to 19th March, p: 128.

Sudha, R., T.Damodaran, D.R. Singh, Krishna Kumar, V.Damodaran and Saira Banu, (2009). Effect of Plant Growth Promoting Bio Control Agents on Growth and Yield of Papaya under Island Ecosystem. In : National Workshop cum Seminar on Status and Future Strategies of Horticulture Development in A&N Islands at CARI, Port Blair, 23rd to 25th January, p:155.

Databases Developed

Balakrishnan, M., S.Jeyakumar R.C.Srivastava (2008). Database for Animal Genetics Resources of Andaman and Nicobar Islands. C.A.R.I., Port Blair.

Balakrishnan, M., R.Elanchezhian and R.C.Srivastava (2008). Database for Fish Genetics resources of Andaman & Nicobar Islands. C.A.R.I., Port Blair.

Balakrishnan, M., and R.C.Srivastava (2008). Database for Mangroves of Andaman and Nicobar Islands. C.A.R.I., Port Blair.

Balakrishnan, M., S.K.Verma, N.Ravisankar, S.Jeyakumar R.C.Srivastava, Subhash Chand and S.K.Zamir Ahmed (2009). Database for Fodder resources and waste lands of Andaman and Nicobar Islands. C.A.R.I., Port Blair.

Balakrishnan, M., R.C. Srivastava, T.Damodaran, N.Ravisankar, S.Jeyakumar, Prasanth Deshmuk, S.K.Zamir Ahmed and S.Chaturvedi (2009). Database for Integrated Rehabilitation of Tsunami affected village through technological Intervention in South Andaman. C.A.R.I., Port Blair.

Students Guided By Scientists

Name of the student	Degree/ Course	Duration (Month)	Title of Project work / Thesis	College/ University
Dr. Jai Sunder				
Mr. Esath Natheer	M.Sc (Micro.)	04	Evaluation of antibacterial activity of indigenous medicinal plants of Andmans	Jamal Mohamed College
Mr. Riyas. K	M.Sc (Micro.)	04	Studies on antifungal effects of some indigenous medicinal plants of Andamans	Jamal Mohamed College
Mr. M.Fizzu	M.Sc (Micro.)	03	In-vitro antifungal activity of M.citrifolia extracts	Thanthai Hans College
Mr. Pritam Chakraborty	M.Sc (Micro.)	04	Antibacterial activity study of M.citrioflia seed extracts	Thanthai Hans College
Dr. S. Dam Roy				
Mr. Bipul C. Roy	M.F.Sc.,	12	Present status of reef fish assemblages in the North Bay site of A&N Islands and culture possibilities of a reef species of ornamental importance in the Island conditions.	West Bengal University of Animal and Fishery Sciences
Ms. Malathi Subramaniyan	B.Tech (Biotech)	03	Inhibitory activity of surface-associated bacteria from Stylissa sp, a marine sponge from Andaman against selected pathogens	P.R.Engineering College, Anna University, Chennai
Dr. C.S. Chaturvedi				
Mr. Meharoz Ali	M.Sc., (Biotech)	03	Studies of the microbial flora associated with catfishes raised on animal wastes	Univ., Salem K.S.R. College of Arts & Science, Periyar
Dr. Kamal Sharma				
Mr. S. Veeramani	B. Tech (Biotech)	03	Antimicrobial properties of Iricinia sp, a marine sponge from Andaman and their associated bacteria	P.R. Engineering College Anna University, Chennai
Mr. Israr Ahmed	M.Sc. (Biotech)	03	-	Annamalai University

Ms. A.M/ Sahitya	M.Sc. (Biotech)	03	-	-do-
Dr. P. Krishnan				
Mr. Abdul Farook	M.Sc., (Micro.)	03	Characterization of the bacteria associated with marine sponges of Andaman and their inhibitory activity against selected pathogens	Jamal Mohamed College, Bharathidhasan University, Trichy
Mr. S. Saravanan	B.Tech (Biotech)	03	Biochemical and molecular characterization of bacteria associated with white band disease in Acropora formosa, a branching coral from Andaman	P.R. Engineering College Anna University, Chennai
Dr. M. Balakrishnan				
Mr. Saravanakumar	M.Sc (Bio-Informatics)	03	In Silico Analysis of Different Gene Expression and Phylogenetic Analysis of Corynebacterium Efficiency	Kongu Nadu Arts And Science College, Coimbatore
Ms. Bibiyana Kumari	M.Sc (Biotech & Bio-Informatics)	03	Sequence Analysis of Gene and Protein using Bioinformatics Tools	Karpagam Arts & Science College, Coimbatore.
Ms. Farhat	-do-	03	Sequence Analysis of Gene and Protein using Bioinformatics Tools	S.R.M University, Tamil Nadu

PEER RECOGNITION TO DIRECTOR, DR. R.C. SRIVASTAVA

Award

- Elected as Fellow of Indian Society of Agriculture Engineers.

Special Deliberations

- New Year Message on the topic "CARI in the services of Island Farmers: Achievements in 2008 and Projections for 2009" narrowcasted on 1st January 2009 by All India Radio, Port Blair.
- Radio talk for Vigyan Bharti Science Magazine on the theme "Effect of Changing Climate on Agriculture" broadcasted at 10 PM on 28th January 2009 by National Channel of All India Radio, New Delhi.
- TV talk on "Water Day" on the theme "Andaman Dweep Samuh Me Varsha Jal Ke Upyog Se Jal Sansadhano Ka Vikas" telecasted on 20th March 2009 by Door Darshan Kendra, Port Blair.
- Radio talk on "Water Day" on the theme "Andaman Dweep Samuh Me Varsha Jal Ke Upyog Se Jal Sansadhano Ka Vikas" narrowcasted on 22nd March 2009 by All India Radio, Port Blair.
- Radio talk on "World Meteorology Day" on the theme "Role of CARI in providing Weather based Agro Advisory Services in Andaman Nicobar Islands" narrowcasted on 23rd March 2009 by All India Radio, Port Blair.
- Foundation Day Lecture on "3rd Foundation Day Seminar on the theme "Climate Change & its effect on Islands" held at IGNOU, Regional Centre, Port Blair" on 27th March 2009.

Lead Papers presented in Symposium/ Seminars

Srivastava, R.C. (2008). Recent Trend in Development of Fisheries and Horticulture in Andaman and Nicobar Islands. 2008, National Seminar on Recent Trend in Development of Fisheries and Horticulture. Institution of Engineers, Kolkata.

Srivastava, R.C. (2008). Water resource development and management for plantation crops. XVIII Convention of Indian Society of Plantation Crops, Puttur.

Srivastava, R.C. (2009). Climate Change and Water Resources – Challenges and Approaches. Indian Science Congress, Shillong.

Srivastava, R.C. (2009). Horticulture Scenario in Andaman & Nicobar islands. National Workshop cum Seminar on Status and Future Strategies for Horticulture Development in A & N Islands.

Srivastava, R.C. (2009). Water Management for Horticultural Crops.. National Workshop cum Seminar on Status and Future Strategies for Horticulture Development in A & N Islands.

Srivastava, R.C. (2009). Integrated Water Resource Development and Management in A & N Islands –Vision for future. National Seminar on Water for Island Eco System.

Srivastava, R.C. (2009). Technological innovation and extension approach for

Island ecosystem. 5th National Extension Education Congress at C.S. Azad University of Agriculture & Technology, Kanpur.

Peer Recognition

- Member of Organizing Committee of Indian Fisheries Forum held at Kolkata from 26th to 29th November, 2008.
- Member of Advisory Committee for organizing World Noni Congress held at New Delhi from 17th-18th October, 2008.
- Member, State Board for Wild life, A & N Islands
- Member, Governing Body & Coconut Mission, A & N Administration
- Member, UT Varietal Release Committee, A & N Administration.
- Member, State Level Sanction Committee for RKVY, A & N Administration.
- Member, UT Coordination Committee, A&N Administration, Port Blair.
- Member, Society for Science Centre, A&N Islands, Port Blair.
- Member, Executive Committee of SOC, Andaman Nature Club, Port Blair.
- Member, State Level Advisory Committee for Narrowcasting Project under the scheme "Mass Media Support for Agril. Extension" A&N Islands.
- Member, State Seed Sub-Committee for Agricultural & Horticultural Crops, A&N Islands.
- Member, Inter Departmental working group to monitor and oversee the functioning of "KISAN CALL CENTRE" of A&N Islands.
- UT level Monitoring Committee to Monitor the implementation of programme relating to rehabilitation of Animal Husbandry.
- Member, State Level Watershed Development Committee under Watershed Development Project for rainfed areas in A&N Islands.
- Member, Governing Council, High Value Agriculture Development Agency for the UT of A&N Islands.
- Member, UT level Task Force Committee for A&N Islands.
- Member, Governing Council, Agriculture Technology Management Agency Governing Board of A&N Islands.
- Member, State Level Environment Council, A&N Islands.
- Member, State Level Committee for Identification of Critical Wildlife Habitat for A&N Islands.
- Member, National Development Council to review the progress of Agricultural & Allied Sectors.
- Chairman, Rashtriya Krishi Vikas Yojana, A&N Islands.
- Member, Plant Protection and Quarantine & Storage State Level Committee for A&N Islands.
- Member, Steering Committee, Coconut Mission, A & N Islands.

Participation in important meeting, symposium and workshop

- Chaired the meeting and finalized the technical programme of 'Network Project on *Morinda* citrifolia' on 28th and 29th April, 2008 at Bhubaneshwar.

- National Seminar on 'Grass roots Level Informatics Development Programmes for Sustainable Development and Growth' on 9th May, 2008 at New Delhi.
- SFC meeting at ICAR, New Delhi, on 26th May, 2008.
- Mega Seed Project meeting with Project Director, DSR and Network Project on Microorganisms with NBAIM, on 5th June, 2008 at Mau.
- National Seminar on "Production, Marketing and Export of Litchi for Economic Prosperity" on 8th to 11th June, 2008 at Muzaffarpur.
- ICAR Foundation Day on 16th July, 2008 at New Delhi.
- Workshop on "Women in Agriculture in South Asia" from 12th to 14th August, 2008 at New Delhi.
- Brainstorming Session on "Impact Assessment of Climate Changes for Research Priority Planning in Horticultural Crops on 6th - 7th September 2008 at Shimla.
- XIXth Regional Committee No. II meeting from 26th & 27th September 2008 at OUAT, Bhubaneshwar.
- Expert Group Meeting held at National Institute of Communicable Disease, Delhi on 7th October 2008.
- Noni Search Third National Symposium held at Delhi on 18th to 19th October 2008.
- National Symposium on Indian Agriculture & Environment held at Patna on 6th to 7th November 2008.
- 8th Fisheries Forum held at Kolkata on 22nd November 2008.
- 18th Plantation Crop Symposium held at NRC, Puttur on 10th to 13th December 2008.
- All India Seminar on "Recent Trends in Processing & Marketing of Fishery & Horticultural Products" held at Kolkata on 19th to 20th December 2008.
- Review Meeting of ICAR Seed Project held at Delhi on 5th to 6th January 2009.
- Seminar on Climate Change & Water Resources at Indian Science Congress held at Shillong on 7th January 2009.
- Divisional Meeting of Horticulture at Delhi on 14th January 2009.
- Director's Conference of ICAR Institutes held at Delhi on 15th to 16th January 2009.
- Annual Convention of Indian Society of Agril. Engineering held at BAU, Ranchi on 15th to 16th February, 2009.
- Workshop on Novel Sheet Materials for Conservation & Control of Water at IIT, New Delhi on 14th February 2009.
- Meeting of National Monitoring Committee of NMPB project on *Morinda Citrifolia* held at Delhi on 13th March 2009.
- National Conference on Floriculture for Livelihood and Profitability held at IARI, New Delhi on 16th March 2009

Management & Guidance of Research, Development and Extension (RDE)

Research:

During the IRC meeting held on 25th to 28th July, 2008 research programs were reviewed in the light of recommendations of RAC. Another meeting of IRC was held on 14th

November, 2008 to review the new projects of new scientists and sponsored projects. Guided smooth execution of ongoing institute projects (43 nos.) and sponsored projects (17 nos.) by making periodic reviews of the projects .

Summary of the institute funded and sponsored projects for the period under report is given below alongwith their significant achievement:

Summary

a) Number of institute funded research projects continuing : **43**

b) Number of institute funded research projects concluded : **10**

c) Number of new institute funded research projects initiated : **13**

d) Number of externally funded projects continuing : **17**

e) Number of externally funded projects concluded : **NIL**

f) Number of new externally funded projects initiated : **3**

Significant achievements

- Eleven varieties viz., four varieties of rice, four varieties of coconut, one variety of arecanut and two varieties of sweet potato are ready for release by UT varietal release committee which has been constituted by the efforts of the institute.
- Tomato varieties viz.Arka Vikash (250 q/ha) & Laxmi (234q/ha) in Cowpea, varieties viz. VRCP-5 (59.20 q/ha) , VRCP-6 (38.8 q/ha), Arka Anoop (94.5q/ha), Swarna Lata (89.3 q/ha) and DWFB F-1 (76.53q/ha) of French Bean and in Dolichus bean var. Gomuchi Green (68.9q/ha were found to be better for Island conditions.
- Fourty five genotypes of paddy, (5) black gram (12) green gram, were collected from N & M Andaman District. 26 improved lines of sesamum were also evaluated for improvement.
- Variety Arka Saurav showed resistance against wilt and 10 entries against tomato leaf curl disease.
- Foot rot (24.5%) and Pollu beetle(11.6%) were the major disease and pest recorded in black pepper in South Andaman.
- Seed treatment (ThrAN-5 and TvAN-3) + seedling dip before transplanting + soil drenching in the main field after transplanting in tomato were found very effective in reducing Fusarium wilt disease incidence. The lone isolates of *Ps. fluorescens* in combination with neem cake were found to reduce bacterial wilt incidence.
- In nursery alternate spray of neem oil and Metasystox at weekly intervals significantly reduced the whitefly population leading to less leaf curl incidence in tomato.
- *Amomum aculeatum* was proved as a strong repellent and tranquilizing agent against housefly (*Musca domestica*) under controlled laboratory conditions. It has also been tested in a fish selling shop and same results have been obtained.
- During preliminary survey at North Bay, six species of sponge have been observed , two of which have been collected and identified as *Iricinia sp* and *Stylisa sp*.
- Single strand conformation polymorphism (PCR-SSCP) studies

revealed monomorphic pattern in the Teresa goat exon-3 of FSH-beta gene.

- Nicobari fowl (Black, Brown, White), crosses of Chara-Chemballi, Pekin and Teresa goat is being conserved at Institute farm.
- The ethanol extract of *Morinda citrifolia, Vitex trifoliate, Eupatorium odoratum* and *Gliricia sepium* plants showed best antibacterial and antifungal activity.
- Standardized ultrasonographic method for sex identification and to study the ovarian status in Guinea fowl. Developed a new method to study and characterize ovarian follicular status in chickens.
- In plantation based fodder farming, Hybrid Napier performed better than guinea and para grass as an intercrop in coconut plantation.
- Water resource development through tank cum well system has been found very effective for mid hill situation.
- 48 demonstrations in participatory mode, wherein 12 technologies of each have been taken up in South Andaman, Neil, Havelock and Little Andaman.
- Protocol for packaging and storage for Morinda has been developed.
- The genetic diversity in between *Morinda citrifolia* and *Morinda trimera* was 55% whereas between *Morinda citrifolia* and *Morinda trimera* was 61%

Two sponsored research programs have been initiated viz.

- Germplasm collection, Evaluation and Identification of some high yielding genotypes of Jatropha and Karanja and their multiplication in Bay Islands. Funding Agency: NOVOD; Budget: Rs. 20 Lakhs.
- Enhancement & Sustainable Dairy Production through Reproductive Health Care. Sponsored by DST under Women Scientist Scheme. Budget : Rs. 13 lakhs.

In addition six projects (as detailed below) have been approved at concept stage by DBT

- Conservation & Molecular Profiling in Nicobari Fowl – an engangered poultry Germplasm of Andaman & Nicobar Islands. PI : A Kundu ; Duration: 3 year; Budget: Rs. 99.871 Lakhs.
- Characterization & Conservation of Indigenous Pig of Bay Islands through Participatory Mode. PI: MS Kundu; Duration: 3 year; Budget: Rs. 99.407 Lakhs.
- Molecular characterisation of geminivirus diversity of vegetable crops. PI: Krishna Kumar; Duration: 3 years; Budget: Rs. 83.72 Lakhs.
- Habitat enrichment by conserving endangered plant species in Bay Islands. PI: Israr Ahmad, Duration 3 years; Budget: Rs. 38.12 Lakhs.
- Collection, Documentation, Molecular Characterization & Exploration of some under utilized Gingiberaceae Plants having Ornamental Value in A&N Islands. Project Coordinator: R.C. Srivastava; PI: M Shankaran; Duration: 3 years; Budget: Rs. 55.94 Lakhs.
- Cataloguing & Conservation of Marine Sponges of Andaman through DNA Bar

Coding. PI: P Krishnan; Duration: 3 years; Budget: Rs. 55.02 Lakhs.

The institute has also become cooperating centre of AICRP on Rodent Control, Vegetables (breeding, pathology and entomology) and Tuber Crops. Beside two consultancy projects from Andaman & Nicobar Administration and NGO have been completed and two more consultancy projects are in pipeline for approval.

Management and maintenance of Institute resources

- Bloomsdale farm of the institute which is 12 Km. away from the main campus was having irregular size plots with poor drainage facility hindering proper layout of the experiments. The farm has been

Development of Research Infrastructure

New constructions/renovations	Equipments
Ponds & Wells at Sipighat Farm	Bomb Calorimeter
Renovation of cattle, quail & poultry shed completed	CCTV
New Building at Marine Hill	Compacters
Reorientation at Bloomsdale Farm	DG Set
New terraces for pathology block, floriculture & morinda	Electronic Stage Level Recorder
Renovation of canteen	Fodder reaper
Farm road at Sipighat farm	Hatchery Unit (15000 eggs capacity)
Cage culture unit at Mini Bay	High-tech Podium
Magur hatchery	Interactive White Board
Renovation of Orchidarium	Optical Fibre Connectivity
Vermicomposting Unit	PCR
Establishment of banana and minor fruit blocks	Percussion Drill
Establishment of RO system for drinking water supply	Portable projector
Replacement of three vehicles	Power Chaff Cutter
	Pressure Plate Apparatus
	Self Propelled Paddy Transplanter
	Time Domain Refrectrometer
	Total Survey Solution
	UV Water Filtration System
	Visualizer
	Water Quality Analyser

reoriented to develop into new large plots of regular size. The drainage nala has also been straightened which has resulted in reclamation of more land.

- Separate block has been developed for planting minor fruits.
- All the three farms which are rainfed, a comprehensive plan for development of water resources has been chalked out and implementation is being done in stages. Two ponds, one 5 m diameter open dug wells, three 2 m dia open dug wells have been constructed. Design of drip and sprinkler system is almost complete which will be procured and installed shortly.
- All the genetic material related to livestock, fisheries, crops, fruits are being maintained.
- The World Coconut Germplasm is being maintained.

Infrastructure development for staff welfare

Although water scarcity was alleviated, the problem of providing good quality drinking water remained. To overcome this, a RO system has been installed which provides very good quality drinking water for guest house and residential colony. The old canteen has been renovated to a neat and hygienic canteen for the staff members.

Extension activities

Transfer of developed technology to farmers, functionaries of line departments, PRI functionaries and NGOs were undertaken in different modes viz:

Develop & conduct of customized training programs for stakeholders on various technologies funded by NGOs and State agencies

- Brackish water Fish Farming
- Cat Fish Breeding and Culture
- Poultry-cum-Fish Farming
- Value Added Fish Product Development
- Brackish water farming in Andaman
- Vermicompost making and utilization
- Mushroom production
- Mushroom spawn production

Organizing Workshops / Seminars / Conferences

- Launching ceremony of Network Research project on *Morinda citrifolia* (Funded by NMPB) on 18th April, 2008 by Ms. Anita Das, Secretary, AYUSH, Government of India.
- Brainstorming Session on "Development of Island fisheries" held on 21st & 22nd June, 2008.
- Celebration of 30th Foundation Day of the Institute on 23rd June, 2008.
- Noni Kisan Sammelan and Launching of Procurement of Noni fruits on 5th December, 2008.
- Brain Storming Session on "Biodiversity Conservation, Environmental Bio-technology and Climate Change" was conducted on 21st January 2009, wherein 20 projects submitted by the scientists of RMRC, Department of Ocean Studies & Marine Biology, Pondicherry University, Department of Agriculture & CARI were presented.

- National Level Workshop cum Seminar on Horticulture on 23rd to 25th January, 2009.
- National Water Seminar on 29th and 30th January, 2009.
- National Level Seminar on Novel Sheets for Water Conservation jointly by IIT, Delhi and CARI, Port Blair at IIT, Delhi on 14th February, 2009.
- National Workshop-cum-Training on Functional and Structural Genomics: An In-silico Approach organized from 26th to 28th February 2009 under the DBT funded project on Bioinformatics.

Other Extension Activities

- Establishment of **Out Reach Centre (ORC)** at Diglipur, North Andaman supported by NABARD, at the cost of Rs. 79.80 lakhs for four years (2009-2013), with an objective to disseminate technologies in agriculture and allied fields to far flung areas of North Andaman Islands.
- To provide advice to the farmers on weather**, Agro Advisory Bulletin** is being narrowcast by the AIR and DDK, Port Blair on every Tuesday. The bulletin is also sent to all Rural Knowledge Centres on the same day and simultaneously printed by the local Newspapers for wider coverage. This service was launched on 23rd June 2008, the 30th Foundation day of the institute when Dr. H.P. Singh, DDG (H) handed over the first edition of bulletin to Officials of Press Information Bureau, AIR and Doordarshan. A campaign for popularizing it was launched during the Kisan Mela.
- An Agricultural Column was launched on 23rd June 2008, in the Echo of India an English daily published simultaneously from Kolkata and Port Blair for wider dissemination on Technological innovations in agriculture an allied fields to the Islands stakeholders. The newspaper publishes the column on weekly basis.
- Kisan Mela on the theme "Jal Sanrakshan Evam Prabandhan Dwara Adhik Krishi Utpadan" was organized on 24th and 25th February, 2009. A total of 20 stalls representing different divisions of CARI, line departments of Administration like Agriculture, Animal Husbandry, Fisheries, State Bank of India, NGOs, private entrepreneurs and Self Help Groups were put up showcasing their activities for the benefit of the stakeholders *viz*., farmers, farmwomen, youths and urban dwellers. The attraction of the Kisan Mela was the organization of "Kisan Sangoshti" on 24th February 2009 and "Khulla Munch" on 25th February 2009 wherein farmers in large number interacted with the scientists and got their problem addressed.
- KVK imparts regular training programs both on and off campus for farmers in addition to conduct of On Farm Trials and Front Line Demonstrations.
- To provide technical backstopping to the Department officials and the farmers, Scientists and Technical Officers participated in various programmes viz, Kharif 2008 Workshop cum Exhibition (at S / Andaman), Farmers Exhibition cum workshop (at Nicobar), Bharat

Nirman Public Information Campaign and Scientist Farmers Interaction at Diglipur.

- Training cum Awareness program on *Morinda citrifolia* was imparted at Campbell Bay, the Southernmost part of archipelago.

Further, the review team headed by Dr. (Mrs) Manju Sharma visited the project site of 'Integrated Rehabilitation of Tsunami affected people through Technological Interventions in Andaman Islands and appreciated its inclusive and participatory approach. The project site was visited by RAC members also and it was highly acclaimed. The chief Secretary of A & N Administration has also showed interest in the models developed

Resource generation/Consultancy

- Institutional charges worth Rs 70,000/- have been collected from 7 sponsored training programs
- Four consultancy projects sponsored by A & N Administration, and NGOs, have been processed, while approval of two have been received, for others it is in progress.
- New sponsored research projects have been sanctioned from which institutional charges will be collected.
- Six concept papers with DBT and two from CDB have been approved and detailed projects are under consideration. This will add to the institute infrastructure as well add additional revenue in terms of institutional charges.

Administration

Changes in the functioning of the administration have been done for smooth and fast disposal of administrative process. Promotion cases of all categories of staff has been cleared. Implementation of sixth pay commission was done within the stipulated time. Four scientists posts have been filled up in response to our requisition of filling of vacant posts of scientists. No major issue have been raised in IJSC meetings.

A new section 'Post Graduate Cell' has been created to take care of students coming to the institute for their Post Garduate/Graduate dissertation work under supervision of the institute' scientists. In 2008-09, 18 students carried out their M.Sc. dissertation in different disciplines such as Microbiology, Biotechnology and Bioinformatics etc. The institute is in process of establishing MoU with the Bidhan Chandra Krishi Viswavidyalaya for the Ph.D. scholars who wants to carry out their research work at this institute.

Another section 'Right of Information, IPR, and Rajbhasha Act Implementation Cell has been created headed by a scientist to supervise the implementation of these acts. This cell also looks after ITMU.

PARTICIPATION OF SCIENTISTS IN CONFERENCES / SEMINARS/ SYMPOSIA / MEETINGS

Scientists	Programme	Venue	Date / Duration
Jai Sunder	Meeting on Rabies in A& N Islands organized by the Rabies in Asia Foundation	RMRC of ICMR, Port Blair	9th - 12th April 2008.
Krishna Kumar	43rd Annual Rice Group Meeting	IGKV, Raipur	11th - 14th April, 08
S.K. Ambast	RPC and Cost Committee Meet of NAIP for project on Enhancing productivity of the degraded land and water in coastal regions	New Delhi	15th - 21st April, 08
S.K. Zamir Ahmed	Farmer Development cum Exhibition (Kharif 2008) meeting of DOA	Port Blair	14th May, 2008
	Attended 5th, 8th, 11th and 12th Project Implementing Monitoring Committee Meeting of CARE India	Port Blair	13th May, 23rd September, 31st October, 2008 and 15th February, 2009
	Site visit for Biotechnology based programme for women at Periyar Nagar, Vallam, Thanjavur Dist., Tamil Nadu.	Thanjavur, Tamil Nadu	21st & 22nd May, 2008
S.K. Ambast	PMC Meet of NAIP for project on Enhancing productivity of the degraded land and water in coastal regions	New Delhi	19th May, 08
S. Dam Roy	Brainstorming Meet on "Aquaculture 2025 Challenges and opportunities".	CIFA, Bhubaneswar	7th - 8th June, 2008.
S.K. Ambast & Subhash Chand	Brainstorming session on Development of Fisheries in Islands	CARI, Port Blair	21st - 22nd June, 08
T. Subramani	Foundation Course for Agricultural Research Scientists	NAARM, Hyderabad.	26th June - 24th Oct., 08
S.K. Ambast	Management Development Programme on Priority Setting, Monitoring and Evaluation for Agricultural Research and Innovation	IIM, Lucknow	7th - 11th July, 08

Kamal Sarma	Training programme on "Seabass breeding and culture".	Central Institute of Brackishwater Aquaculture, Chennai.	20th - 29th August, 2008
S.K. Zamir Ahmed	13th meeting of Task Force on "Biotechnology based programme for women"	New Delhi	21st & 22nd August, 2008.
P. Krishnan	National Conference on Coral Reef Ecosystem MACCRE 2008	College of Fisheries, Tuticorin	18th - 19th Sep., 08.
Subhash Chand	International Seminar on Strategies for improving livelihood security of rural poor	International Society of Extension Education Society of Nagpur, India	24th - 27th Sept. 08
N. Ravisankar	28th biennial workshop of All India Co ordinated research project on Cropping Systems	Vivekananda Kendra, Kanyakumari	3rd - 5th Oct., 08
S.K. Zamir Ahmed & S. Jeyakumar, M. Sankaran & V. Jeyakumar	Training cum workshop on IP and Technology Management (Theme; Copyright Protection) organized by ICAR	NIRJAFT, Kolkata	16th to 18th, October 2008
Subhash Chand	Price trend and Market integration	IASRI, New Delhi	16th - 25th Oct. 2008
D.R. Singh, Jai Sunder & Subhash Chand	National Symposium: Noni search	New Delhi	18th - 20th Oct., 2008.
A. Kundu, M.S.Kundu & S. K. Verma.	Seminar on Intellectual Property Rights on Health Sciences	RMRC of ICMR, Port Blair	23rd Oct., 2008
S.K. Ambast & Subhash Chand	National Seminar and 2nd Annual Review Meeting on Integrated Agromet Advisory Services for Farmers	Anand	11th - 14th Nov., 08
S. Dam Roy, Kamal Sarma, P. Krishnan	Asian Fisheries Society, Indian Branch	8th Indian Fisheries Forum Kolkata	22nd - 26th Nov., 08.
S. Dam Roy	World Aqua Congress	II World Aqua Congress at India Habitat Centre	26th - 28th Nov. 08.
Subhash Chand	Zonal workshop of KVK	ZC office, Kolkota and Nimpith KVK	27th - 30th Nov. 2008

T.V.R.S. Sharma	National conference on eco-friendly approaches in sustainable agriculture and horticulture production	Lucknow	28th - 30th Nov., 2008
A. Kundu	National Symposium of Indian Poultry Science Association	Anand Agri. Univ. Anand, Gujarat	10th - 12th Dec., 2008.
Subhash Chand	Annual Seminar of KVK	GB, Pant University Pantnagar	27th - 29th Dec. 2008
N. Ravisankar	Environment and Disaster	National Institute of Disaster Management (NIDM), New Delhi	12th - 16th Jan., 09
T.V.R.S. Sharma & M. Balakrishnan	Participated in the deliberations of the 7th Taskforce Meeting on Application of Biotechnology for Biodiversity Conservation and Environment	CARI, Port Blair	19th - 20th Jan., 2009.
S. Dam Roy, T.V.R.S. Sharma, A. Kundu, M.S. Kundu, C.S. Chaturvedi, S. K. Verma, Kamal Sarma, M. Balakrishnan & P. Krishnan.	Biodiversity Conservation Environmental Biotechnology and Climate Change	CARI, Port Blair	21st Jan., 09.
S. K. Ambast ,TVRS Sharma, S. Ghoshal Chaudhuri, Krishna Kumar, Ajanta Birah, N. Ravisankar, Someshwar Bhagat, P. K. Singh, Israr Ahmad, M.S.Kundu, S. K Verma, S. Dam Roy C.S. Chaturvedi, Kamal Sarma, M. Balakrishnan, P. Krishnan & T. Subramani	National level workshop cum seminar on Status and future strategies of Horticulture development in A & N Islands.	Port Blair	23rd - 25th Jan., 2009

S.K. Ambast, S. Ghoshal Choudhuri, A.Kundu, S.K. Zamir Ahmed, N. Ravisankar, S.Jeyakumar, S.K. Verma & T. Subramani	National Seminar on Challenges of Providing Potable Water to the Islands.	CARI, Port Blair	29th - 30th Jan., 09
Subhash Chand	Attended Zonal Workshop of sports	ICAR, Res. Comp. Pant, Bihar	29th Jan., - 2nd Feb. 2009
S. Ghoshal Chaudhuri	Workshop on "Agroforestry practices in degraded land caused by Tsunami in Joint Forest Management, South Andaman area of A&N Islands	Jadavpur University, Kolkata	1st Feb, 2009.
M. Balakrishnan	XX All India BTISnet Coordinators Meeting	DBT, Ministry of Science and Technology at NEHU, Shillong, Megalaya	3rd - 4th February, 2009
S.K. Zamir Ahmed	4th World Congress on Conservation Agriculture.	New Delhi	4th to 7th February, 2009
Krishna Kumar	27th AIVRP VC Group Meeting	TNAU, Coimbatore	12th to 15th Feb.,2009
S.K. Ambast	Regional Workshop on Ground Water Related Issues in West Bengal, Andaman and Sikkim	Central Ground Water Board (Eastern Region), Kolkata	13th - 14th Feb., 09
	National Workshop on Novel Sheet Materials for Conservation and Control of Water	IIT, New Delhi	14th Feb., 2009
S. Jeyakumar	International Summit on Advancing Veterinary Medical Care: Challenges and Strategies,	Madras Veterinary College, Chennai	19th - 21st Feb., 2009
M.S.Kundu	National Symposium on Organic Livestock Farming Issues, Trends and Challenges	Department of Animal Prouction and Management, WBUAFS	26th- 28th February 2009

Krishna Kumar, Ajanta Birah, P. K. Singh and Israr Ahmad & P. Krishnan	National Workshop cum Training Programme on Functional and Structural Genomics: An Insilico Approach	CARI, Port Blair	26th - 28th Feb., 2009
T. Subramani	Winter School on "Micro Irrigation"	WTC, IARI, New Delhi	04th - 24th March, 09
Subhash Chand & S.K. Zamir Ahmed	5th National Extension Education Congress on Extension Perspective in Changing Agri-Rural Environment	C.S Azad University of Agriculture & Technology, Kanpur	5th to 7th March, 2009
S. Dam Roy	Tuna Project by Department of Fisheries A & N Administration.	A & N Administration	9th March, 2009
S. Dam Roy & T.V.R.S. Sharma	National Symposium on Recent Advances in Biodiversity of Indian Subcontinent	ZSI, Port Blair	11th -13th March, 2009
S. Dam Roy, C.S. Chaturvedi	Seminar on Water Resources Management: Demand Assessment and Management.	Bureau of water standards, New Delhi	20th March, 2009
V. Jayakumar	Training programme on Molecular characterization of disease causing organisms.	National Research Centre for Banana	
S. Dam Roy C.S. Chaturvedi Kamal Sarma	Stakeholders meeting to discussion shrimp farming by local farmer's vs specific pathogen free brood stock development by MPEDA.	Department of Fisheries, A&N Administration	2008
P. Krishnan	Review Meeting of the NFDB's Network Project on Fish Marketing.	National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.	2008
	The Closing Workshop of the NFDB's Network Project on Fish Marketing.	-do-	2009

HUMAN RESOURCE DEVELOPMENT

Training to Stakeholders

Title	Period	Partici-pants (Nos.)	Type of Participants	Venue	Collaborating/ Sponsoring Agency
Mushroom Cultivation	8th - 12th April, 2008	30	SHG Women	CARI	ANNET , Port Blair
Mushroom Spawn Production	16th -19th June, 2008	5	SHG Women	CARI	Don Bosco, Port Blair
IT& its application in Agriculture	12th -27th August, 2008	18	Technical Staff	CARI	CARI
PoP of Fodder Cultivation.	12th - 14th August, 2008	20	Farmers	Indira Nagar	KVK & ASD
Vermicomposting	23rd -29th September, 2008	17	Progressive Farmer	CARI	HVADA
Brackish water fish farming	15th -17th October, 2008	19	Farmer	KVK	KVK & FS D
Japanese Quail Farming	22nd - 24th October, 2008	20	Progressive farmers	Sippighat	KVK & ASD
Importance of Catfish and their culture techniques in A & N Islands.	16th - 18th December, 2008.	20	Farmers	KVK	KVK & FSD
Backyard poultry Farming	22nd -24th December, 2008	15	SHG Women	Bhatubasti	KVK & ASD
Scientific Cattle Management Practices	7th - 9th January, 2009	11	Farmers	Sippighat	KVK & ASD
Scientific Dairy Farming	7th - 13th January, 2009	170	Farmers & youth	Car Nicobar	CARI
Poultry Cum Fish Farming.	16th -19th January, 2009	20	Farmers	KVK	KVK& ASD
Value added fish products	16th -18th February, 2009	20	Farm women	KVK	KVK & FSD
Brackishwater Farming	25th Feb. - 5th March, 2009	25	Practicing farmers	KVK	KVK& FSD

Brackishwater fish farming	27th February - 8th March 2009	19	Farmers & youth	KVK	KVK& FSD
Breeding, Rearing and management of Indian Major Carps, air breathing fishes and freshwater prawns (NFDB Training programme).	17th - 27th March, 2009	25	Progressive Farmers	KVK	KVK & FSD
Planning and Development of Farm Water Resources	25th - 27th March, 2009.	27	Farmers	CARI	KVK & NRM
Scientific Cattle Management Practices	26th - 28th March, 2009	15	In service personnel	KVK	KVK& ASD

Extension Activities

Title	Period	Partici-pants (Nos.)	Type of Participants	Venue	Collaborating/ Sponsoring Agency
Workshop/ Seminar					
Kharif 2008 Workshop cum Exhibition	17th -21st June, 2008	Many	PRI members & Farmers	Ferrargunj	ATMA
National level workshop on Horticulture	23rd - 25th January, 2009	Many	Experts, Scientists & Farmers	CARI	CARI, HVDA & Deptt. Of Agril. A & N Admn.
National Seminar on Challenges of providing potable water to the islands	29th - 30th January, 2009	80	Scientists/ Staff of NGO's	CARI, Port Blair	EHA and CARI
National Workshop on Novel sheet materials for conservation and control of water	14th February, 2009	60	Scientists/ Professors	IIT-Delhi New Delhi	Jointly by IIT-Delhi, and CARI, Port Blair
Workshop Cum Training	26th - 28th February, 2009	24	Scientists & Scholars	CARI	Sub-DIC

Exhibition					
Exhibition at 8th Indian Fisheries Forum	22nd - 24th Nov., 2008	Many	Scientists & Stakeholders	Kolkata	IIF & CARI
Bharat Nirman Public Information Campaign	22nd - 26th December, 2008	Many	Farmer, Youth & PRI members	Diglipur	PIB, Port Blair
Kisan Mela in the theme " Jal Sanrakshan evam prabandhan dwara adhik krishi utpadan"	24th - 26th February, 2009	1087	Farmer, Youth, PRI, Students & Urban women	CARI	CARI
Farmers Exhibition cum workshop	2nd - 5th Sept, 2008	Many	Farmers & PRI members	Car Nicobar	ATMA
Other Extension Activities					
Brainstorming Session on Development of Island Fisheries	21st & 22nd June, 2008	60	Development Department, PRIs & Progressive farmers	CARI	FSD
Scientist Farmer Interaction under FPARP	22nd June, 2008	15	Farmers	KVK	KVK & NRM
Press Conference	23rd June, 2008	15	Media personnel	CARI	CARI
30th Foundation Day	23rd July, 2008	Many	Representative of A & N Admn. & ICAR	CARI	CARI
Awareness Campaign on *Morinda citrifolia*	3rd & 4th September, 2008	800	Youth & School Children	Car Nicobar	CARI
Training cum Awareness on *Morinda citrifolia*	5th - 8th September, 2008	132	Official & Farmers	Campbell Bay	CARI
Scientist Farmers - Interaction(02)	23rd - 25th November, 2008	76	Farmers & Farm Women	Diglipur	CARI
Launching ceremony of purchase of Noni fruits from farmers & Noni kisan Sammelan	5th December, 2008	600	Farmers & Farm Women	CARI	CARI & HIL
Fishermen Awareness on PFZ validation in Andaman	9th February, 2009	50	Fishermen of South Andaman	Fisheries Training Centre	FSD-CARI & Department of Fisheries A & N Administration
Kisan Call Centre	107 call received from target group in agriculture allied fields and answered				

Radio Talks

Pashuon mein aantrik va bahya parjeeviya	21.11.2008	Jai Sunder
Kharif Ke Dauran KVK Ki Gatividhiya	29.07.2008	M.S. Kundu
Murgipalan me aahar ki vyavastha	26.03.2009	
Abortion in Cattle	2009	S. Jeyakumar
Artificial Insemination in Goats	2009	
Intensive Poultry farming - Important Hints.	4.07.2008	A. Kundu
Bachit -Murgi palan , tikakaran ahmiyat.	21.02.2009	
Dweepon Ke Liye Upayaukt Chara Ghanse Aur Vriksha	5.04.2008	S.K.Verma
Navjaat Bachhdon Ka Bharan Posahan	20.08.2008	
Dudharu Pashuon Ke Poshan Me Khanij Tatvon Ka Mahattva evam Paripurti.	7.02.2009	
Kaddu vargiya sabzio me beemariya	21.02.2009	Krishna Kumar
Sabzio me uktha rog prabandhan	04.04.2008	
SRI technique of paddy cultivation (Hindi)	19.06.2008	N. Ravisankar
Adhik fasal utpadan ke liye jal prabandhan (Hindi)	29.07.2008	
Global warming ka krishi par prabhav (Hindi)	-	S. K. Ambast
Tikavu krishi ke liye jal va mrida samrakshan (Hindi)	18.11.2008	S. Ghoshal Chaudhuri
Krishi khentre kencho sarer bhumika (Bengali)	21.01.2009	
Machali Palan Me Talabo ka Prabardhan	10.05.08	
Magur Machili palan vaigyanik vidhi Se	12.11.08	C. S. Chathurvedi
Fish disease of Air breathing fishes & their treatment	10.02.09	
Garmiyo me matsya palan Talabo ka dekhbal	11.02.09	S.Dam Roy
Machali palan me aahar vyavastha	26.02.09	Kamal Sarma
Machali Beej Utpadan ki Takneek	17.05.08	
Economics of noni cultivation.	18.09.2008	Subhash Chand
Deepo main phoolo ki kheti ki sambhavnai	05.08.2008	
Mat nursery	04.07.2008	S.K. Zamir Ahmed
Storage grain prevention - few tips	17.11.2008	

Doordarshan Interview

Title	Date of Broadcast	Expert
Profitable Dairy Farming	2008	S.Jeyakumar
Nicobari Fowl and its importance in Bay Island	19.09.08	A.Kundu
Groundnut harvesting, drying and storage	02.05.2008	N. Ravisankar
Intercultural operations for sugarcane	12.06.2008	N. Ravisankar
Mausam Aadharit Krishi Paramarsh Patrika	04.07.2008	S. K. Ambast
Intercultural operations for paddy	07.08.2008	N. Ravisankar
Nursery techniques for cole crop vegetables in BBF system	07.11.2008	N. Ravisankar
Intercultural operations for Table purpose groundnut	23.01.2009	N. Ravisankar
Aftercare and Field management for pulses	20.02.2009	N. Ravisankar
Thirsty Paradise: A Documentary About the Andaman Islands' Water Crisis by Andaman Water Project, EHA	22.10.2008	S.K.Ambast

ROUND UP OF INSTITUTE ACTIVITIES

Sl.No	Events	Date
1.	RAC Meeting	4th – 5th April,2008
2.	Customized training on Mushroom Cultivation	8th – 12th April, 2008
3.	Launching of Network Research Project on Morinda citrifolia	18th April, 08
4.	Customized training on Mushroom Spawn Production	16th – 19th June, 2008
5.	Kharif 2008 Workshop cum Exhibition	17th – 21st June, 2008
6.	Brain Storming Session on Development of Island Fisheries	21st – 22nd June, 2008
7.	Press Conference	23rd June, 2008
8.	30 Foundation Day celebration	23rd June, 2008
9.	DBT Review Team Visit	9th -10th July, 2008
10.	IRC – Meeting	23rd – 26th July, 2008
11.	Training on IT& its application in Agriculture	12th – 27th August,2008
12.	Farmers Exhibition cum workshop (At Nicobar)	2nd – 5th September,20 08
13.	Awareness Campaign on *Morinda citrifolia* (At Nicobar)	4th September,2008
14.	Training cum Awareness on *Morinda citrifolia* (At Campbell Bay)	5th – 8th September, 2008
15.	Customized training on vermicomposting	23rd – 29th Sep., 2008
16.	Hindi Pakwada	15th – 30th Sep., 2008
17.	Bharat Nirman Public Information campaign (At Diglipur)	22nd – 26th Nov., 2008
18.	Scientist Farmers Interaction(2) at Diglipur	23rd and 25th November, 2008
19.	Mini IRC Meeting	14th November,2008
20.	Launching of Purchasing Noni Fruits and Noni Kisan Samelanam	5th December, 2008
21.	Task force meeting of DBT	19th – 20th January, 2009
22.	Brain Storming Session on Biodiversity Conservation	21st January, 2009
23.	National level Workshop cum Seminar on Horticulture	23rd – 25th January, 2009
24.	National Water Seminar	29th – 30th January, 2009
25.	Visit of Parliamentary Committee on Official Language	4th February, 2009
26.	National Level seminar on Novel sheets for water conservation jointly by IIT Delhi & CARI	14th February, 2009

27.	IMC Meeting	23rd February, 2009
28.	Visit of Site selection committee for new KVK	23rd -25th February,2009
29.	Kisan Mela	24th – 25th February, 2009
30.	Workshop Cum Training on Functional and structural Genomics : An In-silico Approach	26th – 28th February,2009
31.	Training on Brackishwater Aquaculture in Andaman	28th Feb. - 9th March, 2009
32.	Training on Breeding, rearing and management of Indian Major Carps, Air breathing Fishes and Freshwater Prawns	17th - 27th March, 2009
33.	Review meeting of FPARP and Noni project	21st - 22nd March, 2009

Ms. Anita Das, Secretary, AYUSH releases publications brought out by the Institute during "Launching ceremony of Network Research project on *Morinda citrifolia*

Dr. A.K. Bandyopadhyay, Ex-Director, CARI, the Chief Guest cuts the Foundation Day cake jointly with senior most persons from Scientist, Technical, Administrative and Supporting staff

Shri Vivek Rae, Chief Secretary, A & N Adm. addressing the participants

Dr. R.C. Srivastava, Director CARI Addressing during inaugural function of Kisan Mela

Students Visiting the Stall during Kisan Mela

Aerial view of Kisan Mela

LINKAGES AND COLLABORATION

Natural Resource Management

- Indian Meteorological Department, New Delhi (Ministry of Earth Sciences).
- Central Ground Water Board, CWC, New Delhi (Ministry of Water Resources).
- Indian Institute of Remote Sensing, Dehradun, (Department of Space).
- Project Directorate of Cropping System Research (PDCSR), Modipuram.
- Central Soil Salinity Research Institute (CSSRI), Karnal.
- National Institute of Disaster Management, New Delhi.
- High Value Agricultural Development Agency, Directorate of Agriculture (A&N Administration), Port Blair

Field Crops

- Directorate of Rice Research, Hyderabad.
- Indian Institute of Pulse Research, Kanpur.
- Indian Institute of Vegetable Research, Varanasi.
- National Research Centre for Mushroom, Solan.

Fisheries Science

- B.C.K.V.; Mohanpura Nadia
- Pondichery University
- O.U. A T. Bhubaneswar
- West Bengal University of Animal & Fishery Sciences
- Tamil Nadu Agricultural University and Annamalai University
- Space Application Centre, Ahmadabad.
- INCOIS, Hyderabad
- DBT, New Delhi.

Animal Science

- DBT, New Delhi
- RMRC, ICMR, Port Blair
- ICAR Institutes; IVRI, PD_ADMAS, CIRG, IGFRI, PDP, CARI, Izatnagar.
- DAHVS, A&N Admn.
- TANUVAS
- TNAU
- KLDB

Social Science Section

- A & N Administration
- CARE India International
- AP Cess, ICAR, New Delhi
- Tribal Council, CARNIC
- CIPMC, Port Blair
- Asha Sagar Project
- Andaman & Nicobar Island Environmental Team Centre for Island Ecology (ANNET)
- Don Bosco Non formal Technical Training Institute
- NABARD
- IGNOU
- CIPMC
- Lead Bank

DISTINGUISHED DIGNITARIES

- Dr. V.S. Bhatia / Dr. O.P Joshi, Pr. Scientist, Crop Production, National Research Centre for Soybean, Khandwa Road, Indore on 7th April, 2008.
- Dr. B.C. Deopura, Indian Institute of Technology, New Delhi – 110 016 on 11th April, 2008.
- Ms. Anita Das, Secretary, AYUSH, Ministry of Health, GOI on 18th April, 2008.
- Shri Cherring Targay, Chief Secretary, A & N Administration on 18th April, 2008.
- Shri B.S. Sajwan, CE, National Medicinal Plant Board on 18th April, 2008.
- Dr. S. Ayyappan, DDG (Fy.), ICAR, New Delhi on 21st June, 2008.
- Dr. H.P. Singh, DDG (Hort.), ICAR, New Delhi on 22nd & 23rd June, 2008 and 23rd January, 2009.
- Shri S.S. Choudhury, Secretary, Environment & Forest & PCCF, A & N Administration on 23rd June, 2008.
- Dr. A.K. Bandyopadhyay, Ex-Director, CARI, Port Blair on 23rd June, 2008.
- Dr. (Mrs.) Manju Sharma, Ex-secretary, DBT, GOI on 9th & 10th July, 2008.
- Dr. Hamida Abdi, Advisor, DBT, GOI on 9th & 10th July, 2008.
- Smt. Tipti Das, Training School, DHS Office on 28th July, 2008
- Shri Durga Prasad Parihar, CGM, BSNL, Port Blair on 15th September, 2008
- Mr. Rita Srivastava, AFWWA President (R) on 18th October, 2008.
- Hon'ble Lt. Gen. (Rtd.) Bhopinder Singh, PVSM, AVSM, Lt. Governor on 5th December, 2008.
- Mr. Tapan Mandal, Development Commissioner, A & N Admn, on 5th December, 2008.
- Prof. P.I. Peter, Chairman, HIL, Chenai on 5th December, 2008.
- Dr. Kirti Singh, Chairman Person, World Noni Research Foundation on 5th December, 2008.
- Prof. I. Dasgupta, University of Delhi South Campus, New Delhi on 3rd January, 2009.
- Dr. A. Ashok Reddy, Pr. Scientist, NRC Sorghum, Hyderabad on 13th January, 09.
- Mr. Chintan Kumar, New Delhi on 3rd January, 2009
- Dr. S.P. Tiwari, DDG (Education), New Delhi on 5th January, 2009
- Mrs. Girija Shankar, Command House, Port Blair on 15th January, 2009
- Mrs. Renu Chaturvedi, W/o Maj Gen. A.K. Chaturvedi, COS, Port Blair on 15th January, 2009.
- Mrs. Awijavanthi Bharadwaj, W/O Commodore V. Bharadwaj, CSY, NSRY, Port Blair on 15th January, 2009.

- Dr. Ashwani Kumar, Acting Director, Indian Institute of Toxicology Research (CSTR), Lucknow on 19th January, 2009.
- Dr. S.K. Apte, Assoc. Biomedical Group, Research Centre on 19th January, 2009.
- Dr. K.L. Tiwari, Prof. & Head, Biotech. Dr. Ravishankar University, Raipur on 20th January, 2009.
- Dr. Govindwar, Advisor, DBT, New Delhi on 21st January, 2009.
- Dr. S. Shivaji, CCMB, Hyderabad on 21st January, 2009.
- Mr. V.B. Mayret & Group on 22nd January, 2009
- Shri Vivek Rae, Chief Secretary, A & N Administration on 23rd January, 2009.
- Dr. Alok Saxena, MD, A & N Islands Forest & Plantation Development Coorporation Ltd. On 30th January, 2009.
- Col. N. Raj Kumar, on 5th February, 09
- Dr. Balmiki Prasad on 18th February, 09
- Mr. Dinesh Kumar on 18th Feb., 09
- Mr. Sivaji Rao, M/o Defence on 18th February, 09
- Mr. Yogesh Diwedi, Asstt. Director, ISTM, DOP & T, JNU (Old) Campus, New Delhi on 18th February, 2009
- Dr. Balmiki Prasad, Dy Director (Admn.), Safdajung Hospital, New Delhi – 110 029 on 18th February, 2009.
- Dr. A.K. Singh, Zonal Coordinator, Zone-II, Kolkata on 24th & 25th February, 2009.
- Dr. K. Meena, Principal & Director, Department of Computer Application, Srimati Indira Gandhi College, Trichy on 26th February, 2009.
- Dr. Laxmi Narayana Paladi, Dy. Director of Agriculture (Retd.), Hyderabad on 25th March, 2009

PERSONNEL

Director	Dr. R.C. Srivastava
Head / Incharge Divisions / Section	
Head, Division of Fish & Fishery Sciences	Dr. S. Dam Roy
Head, Division of Natural Resource Management	Dr. S.K. Ambast
Head i/c Division of Field Crops	Dr. T.V.R.S. Sharma
Head i/c Division of Animal Science	Dr. A. Kundu
Head i/c, Division of Horticulture & Forestry	Dr. D.R. Singh
Incharge, Social Science Section	Dr. Subhash Chand
Incharge, Planning, Monitoring & Coordination Cell	Dr. S.K. Zamir Ahmed
Incharge, Computer Cell	Dr. M. Balakrishnan
Incharge, Library	Sh. Gangopadhyay
Incharge, Central Instrumentation Facility	Dr. Jai Sunder
Incharge, Legal Cell	Dr. S.K.Zamir Ahmed
Incharge, Garacharma Farm	Dr. T.V.R.S. Sharma
Incharge, Sippigaht Farm	Mr. I. Jaisankar
Incharge, Bloomsdale Farm	Dr. S. Ghoshal Chaudhuri
Estate Officer, Estate Section	Er. S.L.Paik
Incharge, Guest House	Dr. V.B. Pandey
Administrative Officer	Shri. Abhishek Srivastava
Finance & Accounts Officer I/c	Shri Joseph George
Assistant Director, Official Language	Smt. Sulochana
Security Officer	Sh. N.K. Pushp
Controlling Officer, Krishi Vigyan Kendra	Dr. Subhash Chand
Co-ordinator, Bio-Informatics Centre	Dr. M. Balakrishnan
Incharge, RIRIC	Dr. S.K. Verma
Incharge PG Cell	Dr. Jai Sunder

List of Scientific Staff

Division of Natural Resource Management

Dr. S.K. Ambast, Head

Dr. S. Ghoshal Chaudhuri, Principal Scientist (Soil Science: SP&WC)

Dr. N. Ravisankar, Senior Scientist (Agronomy)

Mr. T. Subramani, Scientist Agronomy)

Division Of Field Crops

Dr. T.V.R.S. Sharma, Principal Scientist & Head i/c

Dr. Krishna Kumar, Senior Scientist (Plant Pathology)

Dr. Ajanta Birha, Senior Scientist (Agrl. Entomology)

Dr. Pankaj Kumar Singh, Senior Scientist (Plant Breeding)

Dr. Someshwar Bhagat, Scientist (Plant Pathology)

Shri Israr Ahmed, Scientist (Biotechnology)

Division Of Horticulture

Dr. D.R. Singh, Pr. Scientist & Head I/c

Dr. M. Sankaran, Senior Scientist (Horticulture)

Miss R. Sudha, Scientist (Horticulture)

Shri I. Jaisankar, Scientist (Forestry)

Dr. Shrawan Singh, Scientist (Vegetables)

Division Of Fish & Fisheries Science

Dr. S. Dam Roy, Head

Dr. Chandra Shekhar Chaturvedi, Senior Scientist (Fish & Fisheries)

Dr. Kamal Sarma, Senior Scientist (Fish & Fisheries)

Dr. P. Krishnan, Scientist (Fish & Fishery)

Shri. Grinson George, Scientist (Fish & Fishery Science)

Division Of Animal Science

Dr. A. Kundu, Senior Scientist (Livestock Production & Management) & I/c Head

Dr. Madhu Sudan Kundu, Sr. Scientist (Animal Nutrition)

Dr. Satyapal Yadav, Scientist (Animal Biotechnology)

Dr. S. Jeyakumar, Scientist Sr. Scale (Animal Reproduction)

Dr. Jaisunder, Scientist Sr. Scale (Veterinary Microbiology)

Dr. S.K. Verma, Scientist Sr. Scale (Animal Nutrition)

Dr. T. Sujatha, Scientist (Poultry Science) on study leave

Social Science Section

Dr. Subhash Chand, Sr. Scientist, (Agriculture Economics) & Incharge.

Dr. S.K. Zamir Ahmed, Sr. Scientist (Agriculture Extension)

Dr. M. Balakrishnan, Scientist Sr. Scale (Computer Applications)

Krishi Vigyan Kendra

Dr. Subhash Chand, Controlling Officer

Sh. Nagesh Ram, Subject Matter Specialist (Fisheries) – on study leave

Dr. Kanak Lata, Subject Matter Specialist (Home Science)

Mr. L.B. Singh, Subject Matter Specialist (Horticulture)

Dr. Abhay Kr. Singh, Subject Matter Specialist (Animal Science)

Mr. Bijaya Kr. Nanda, Subject Matter Specialist (Agrl. Engineering)

Mr. N.C. Choudhuri, T-6 (Animal Science)

COMMITTEES OF THE INSTITUTE

Research Advisory Committee

Dr. S.S. Magar	-	Chairmanship
Dr. P.N. Jha	-	Member
Dr. R.P. Awasthi	-	Member
Dr. A.N. Maurya	-	Member
Dr. D.D. Nambudiri	-	Member
Dr. Arun Varma	-	Member
Dr. Umesh Srivastava	-	Member
Dr. R.C. Srivastava	-	Member
Dr. S. Dam Roy	-	Member Secretary

Institute Joint Staff Council

Technical Staff

Shri K. Babu Rao, T-2

Shri Kishore Tete, T-3

Administrative Staff

Shri P.K. Roy, Sr. Clerk

Smt. Florence Toppo, Jr. Steno

Supporting Staff

Shri K. Ali, S.S. Gr.II

Shri Dominic Ekka, S.S. Gr.

Official Side (Nominated by Director)

Dr. S.K. Ambast, HOD, NRM

Dr. S. Dam Roy, HOD, Fisheries Science

Dr. T.V.R.S. Sharma, HOD I/c Field crops

Administrative Officer

Finance & Accounts Officer

Estate Officer

Institute Management Committee

Dr. R.C. Srivastava	-	Chairman
Dr. G.S. Prakash	-	Member
Dr. S. Dam Roy	-	Member
Dr. S.K. Naskar	-	Member
Dr. D. Nag	-	Member
Director of Agriculture	-	Member
Director of Horticulture (A & N Admn.)	-	Member
Director of Horticulture (Govt. of Orrisa, Bhubaneswar)	-	Member
Director of Research BCKV, West Bengal	-	Member
Mrs. R.S. Uma Bharathi	-	Member
Shri Mohammed Azimuddin	-	Member
Finance & Accounts Officer, CRIJAF,Barrackpur, -West Bengal	-	Member
Administrative Officer	-	Member Secretary

Official Language Implementation Committee

Dr. R.C. Srivastava	-	Chairman
Dr. N. Ravisankar	-	Member
Dr. Kanak Lata	-	Member
Shri A.K. Tripathi	-	Member
Mr. Abhishek Srivastava, Administrative Officer	-	Member
Mr. Joseph George, Finance & Accounts Officer	-	Member

Mrs. Sulochana	-	Member secretary

Purchase Advisory Committee

Dr. T.V.R.S. Sharma	-	Chairman
Dr. N. Ravisankar	-	Member
Dr. M. Sankaran	-	Member
Dr. S. Jeyakumar	-	Member
Dr. P. Krishnan	-	Member
Finance & Accounts Officer	-	Member
Administrative Officer	-	Member secretary

Works Committee

Dr. A. Kundu	-	Chairman
Finance & Accounts Officer	-	Member
Administrative Officer	-	Member
Er. S.L.Paik	-	Member Secretary

Price Fixation Committee

Dr. A. Kundu	-	Chairman
Administrative Officer	-	Member
Finance & Accounts Officer	-	Member
Mr. A.K. Tripathi	-	Member Secretary

House Allotment Committee

Dr. A. Kundu	-	Chairman
Finance & Accounts Officer	-	Member
Administrative Officer	-	Member
Mr. K. Babu Rao, IJSC	-	Member
Estate Officer	-	Member Secretary

Employee Welfare Association (CARIEWA)

Dr. S. Dam Roy	-	Chairman
Dr. Subhash Chand	-	Secretary
Dr. Kamal Sarma	-	Joint Secretary
Shri D. Mohan Rao	-	Treasurer
Shri S.P. Narayan	-	Canteen Secretary
Shri Babuswamy	-	Sports Secretary
Shri Ali Akbar	-	Member
Shri A.K. Tripati	-	Member
Shri M.S.R.C. Murthy	-	Member

Sports Committee

Dr. A.Kundu	-	Chairman
Dr. Subhash Chand	-	Vice Chairman
Dr. Jai Sunder	-	Secretary
Dr. M.Shankaran	-	Jt. Secretary (Out door games)
Dr. I. Jaishankar	-	Jt. Secretary (Gym)
Sh. N.K. Pushp	-	Jt. Secretary (In door games)
Dr. Kanak Lata	-	Member
Shri. N.David	-	Member
Shri. A. Babuswamy	-	Member
Shri. Akbar Ali	-	Member

NEW ENTRANTS / TRANSER / PROMOTION

New Entrants

- Shri I. Jaisankar, Scientist joined on 16th May, 2008.
- Dr. Shrawan Singh, Scientist joined on 21st May, 2008.
- Shri Israr Ahmed, Scientist joined on 3rd July, 2008.
- Dr. M. Sankaran, Senior Scientist joined on 1st September, 2008.
- Dr. Ajanta Birha, Senior Scientist joined on 8th September, 2008.
- Dr. Pankaj Kumar Singh, Senior Scientist (Plant Breeding) joined on 21st November 2008 in the Field Crops Division.
- Mr. T. Subramani, Scientist (Agronomy) joined on 3rd November 2008 in the Natural Resource Management Division.
- Shri Joseph George, F&AO joined on18th December 2008 upon his transfer from NDRI, Southern Campus, Bangaluru.
- Shri Krishna Gopal Nath, Computer programmer joined on 19th December 2008 at KVK, CARI, Port Blair.
- Shri Bijaya Kumar Nanda, SMS (Agril. Engg.) joined on 12th January 2009 at KVK, CARI, Port Blair.
- Shri Debabrata Basantia, Farm Manager joined on 12th January 2009 at KVK, CARI, Port Blair.
- Shri N. Bommayasamy, SMS (Agronomy) joined on 23rd January 2009 at KVK, CARI, Port Blair.

Transfer

- Er. Deshmukh P.S. Rao, Scientist transferred to CIRCOT, Mumbai on 30th June, 2008.
- Dr. T. Damodaran, Scientist (Senior Scale) transferred to CSSRI, RR Station, Lucknow on selection as Senior Scientist on 18th August, 2008.
- Dr. R. Raja, Scientist transferred to CRRI, Cuttack on selection as Senior Scientist on 20th August, 2008.
- Dr. B.R. Singh, HOD (Animal Science) transferred on 26th September, 2008.
- Dr. M. Din, Sr. Scientist (Farm Mach.) transferred to CRRI, Cuttack, Orissa upon his selection as Pr. Scientist on 15th October 2008.
- Dr. C.B. Pandey, Sr. Scientist (Agro forestry) transferred to CSSRI, Karnal, Haryana upon his selection as Pr. Scientist on 21st December 2008.
- Dr. (Mrs.) Simmi Tomar, Sr. Scientist (Poultry Science) transferred to CARI, Izatnagar, on 23rd December 2008.
- Dr. S.P. Yadav, Scientist (Sr. Scale) Animal Biotechnology transferred to CIRB, Hissar on 31st January 2009.
- Dr. V. Jeyakumar, Scientist (Sr. Scale) Plant Pathology transferred to CICR, Regional Station, Coimbatore on 31st January 2009.
- Dr. T.P. Swarnam, Scientist (Sr. Scale) Soil Science transferred to CICRB, Regional Station, Coimbatore on 31st January 2009.

Promotion

- Dr. N. Ravisankar, Scientist (Sr. Scale) got promoted to Senior Scientist w.e.f. 5th October, 2007.

- Dr. T.P. Swarnam, Scientist got promoted to Scientist (Sr. Scale) w.e.f. 14th November, 2007.
- Dr. V. Jaya Kumar, Scientist got promoted to Scientist (Sr. Scale) w.e.f. 29th November, 2007.
- Shri V. Damodaran, T-5 got promoted to T-6 w.e.f. 25th July, 2007.
- Shri Arul Selvam, T-4 got promoted to T-5 w.e.f. 1st November, 2004.
- Shri S. Murugesan, T-4 got promoted to T-5 w.e.f. 4th November, 2004.
- Shri M. Alagar, T-4 got promoted to T-5 w.e.f. 14th March, 2005.
- Shri Ambika Singh, T-4 got promoted to T-5 w.e.f. 2nd July, 2006.
- Smt. Ani Dath, T-4 got promoted to T-5 w.e.f. 3rd October, 2006.
- Shri A.K. Tripathi, T-4 got promoted to T-5 w.e.f. 1st May, 2008.
- Shri N.K.D. Pillai, T-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Late N. Veeran Kutty, T-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri A.K. Betal, T-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri R. Kondaiah, T-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri S. Alvi, T-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri P. Gopalan Nair, T-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri Anjan Sengupta, T- 3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri Abdul Majeed, T-II-3 got promoted to T-4 w.e.f. 3rd February, 2005.
- Shri Derrick, T-2 got promoted to T-3 w.e.f. 5th September, 2003.
- Shri David, T-2 got promoted to T-3 w.e.f. 5th September, 2003.
- Shri Harishankar Prasad T-2 got promoted to T-3 w.e.f. 5th September, 2003.
- Shri R.C. Das, T-2 got promoted to T-3 w.e.f. 20th January, 2005.
- Shri Theophil Gidh, T-2 got promoted to T-3 w.e.f. 15th March, 2005.
- Shri T. Ravi, T-1 got promoted to T-2 w.e.f. 29th June, 2001.
- Shri Kishore Tete, T-1 got promoted to T-2 w.e.f. 1st May, 2003.
- Shri Ram Chander, T-1 got promoted to T-2 w.e.f. 2nd September, 2008.
- Dr. D.R. Singh got selected as Principal Scientist and joined at CARI, Port Blair on 7th November 2008.
- Mr. P. Sanyal got promoted as T6 w.e.f. 1st July 2003
- Dr. N.C. Choudhuri got promoted as T6 w.e.f. 17th October 2004
- Mr. Benny Varghese got promoted as T6 w.e.f. 15th October 2006
- Shri Nehru Ram got promoted to Jr. Clerk w.e.f. 4th February 2009.
- Shri Emil Lakra got promoted to Jr. Clerk w.e.f. 9th February 2009.

Retirement

- Shri D. Bandopadhyay retired on 31st August, 2008
- Shri T.V. Madhvan took voluntary retirement on 31st January 2009.

WEATHER PARAMETERS (2008-09)

at CARI, Port Blair

(110.36'.51.7" N, 92.42'.59.8" E, 48 m A-MSL)

Month & Year	Rainfall (mm)	Rainy days	Maximum T (°C)	Minimum T (°C)	RH (%)	Wind speed (KMPH)
April '08	380.4	11	33.7	21.8	84	2.8
May '08	778.7	19	31.9	21.2	87	7.2
June '08	355.2	18	31.6	22.8	86	7.0
July '08	298.4	15	30.7	23.3	89	3.4
Aug '08	446.4	18	31.2	21.8	89	5.6
Sept '08	442.6	16	31.1	22.4	89	5.4
Oct '08	244.2	12	31.8	22.4	89	1.9
Nov '08	455.2	12	31.3	22.4	88	4.6
Dec '08	2.0	0	30.6	18.6	77	5.6
Jan '09	3.6	1	31.2	18.1	74	5.7
Feb '09	1.8	0	34.9	17.0	77	2.6
Mar '09	27.2	4	33.2	18.5	81	4.5