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# वार्षिक प्रतिवेदन
# ANNUAL REPORT
## 2008 - '09

## काजू अनुसंधान निदेशालय

(पूर्वतन राष्ट्रीय काजू अनुसंधान केंद्र)
(भारतीय कृषि अनुसंधान परिषद्)
दर्बे पोस्ट, पुत्तूर 574 202, दक्षिण कन्नड, कर्नाटक

## DIRECTORATE OF CASHEW RESEARCH

*(Formerly National Research Centre for Cashew)*
*(Indian Council of Agricultural Research)*
Darbe P.O. Puttur - 574 202,
Dakshina Kannada, Karnataka

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# प्रस्तावना

यह उल्लेख करते हुए मुझे बड़ी प्रसन्नता हो रही है कि भारतीय कृषि अनुसंधान परिषद से प्राप्त अधिसूचना के अनुसार राष्ट्रीय काजू अनुसंधान केन्द्र 23 मार्च 2009 से काजू अनुसंधान निदेशालय मे उन्नत कर दिया गया है। इस निदेशालय मे अप्रैल 2008 से मार्च 2009 तक प्राप्त उपलब्धियों को प्रस्तुत करने मे मुझे खुशी हो रही है। फसल सुधार, फसल प्रबंन्धन, फसल संरक्षण, तुड़ाई उपरान्त प्रौद्योगिकी और तकनीकी हस्तांतरण क्षेत्रों को इस वार्षिक प्रतिवेदन मे सम्मिलित किया है। राष्ट्रीय काजू क्षेत्र जीन बैंक (NCHGB) में कुल 513 जनगद्रव्य एकसेशन संरक्षित है, जिनमे चार एकसेशन इस वर्ष उत्तर पूर्वी पर्वतीय प्रदेशो से एकत्रित किये थे। संकरणो H-125 और H-126 बड़ी गरी के साथ पाँचवी तुड़ाई मे उपज 7.0 और 6.0 कि.ग्रा/पेड़ तथा कुल सचय उपज 26.4 और 23.7 कि.ग्रा/पेड़ आशाजनक पाई गई है। 44 जनन द्रव्य एकसेशन को डी एन ए अगुली छाप मुद्रित विधि से जाँच किया गया जिसमे काजू के नौ बाइरी संरचना युग्म के साथ नौ SSR मार्कर की प्राइमर जोड़ियाँ मुद्रित थी। इन सभी मे NRC-97 और NRC-12 बहुत अपसारी मिले है। सामान्य पौध रोपण (200 पेड़/हे) की तुलना मे सात वर्ष बाद सघन पौध रोपण (416 से 500 पेड़/हे) क्यारी की उपज 156-158% अधिक पायी गई। पाँच साल के बाद जल एवं मृदा संरक्षण तकनीकी मे सामान्य क्यारी की उपज (1.48 ton) की तुलना मे नारियल घूसा प्रबन्धन विधि की उपज (2.04 टन/हे) सार्थक रूप से अधिक पायी गई। काजू मे दो कीट जातियाँ *एफिस सेरेना इन्डिका* और *स्यूडेफिस ऑक्सीडेन्टेलिस* परागकण वाहक के रूप मे नियमित देखी गई। चाय मच्छर के विरुध्द नये कीटनाशक का प्रयोग किया गया जिसमे फेन्प्रोपथ्रीन (0.02%) की नुकसान दर सिफारिश कीट नाशक साइलोथ्रीन (0.003%) के समान पायी गई।

काजू की 35 किस्मों के सेब चूर्ण का विश्लेषण किया, और जीवलभ्यता के आधार पर खनिज लवण और गुण सूचकांक उत्पन्न किया गया। उत्तरपूर्वी पर्वतीय प्रदेशो के लिए काजू गरी सुखाने वाले यंत्र का कल्पनक विन्यास किया गया जिसमे डिजल व बिजली संचालित उर्जा द्वारा काजू गरी की पतली परत पर हवा का बहाव किया जाता है। इस निदेशालय ने DCCD कोच्चि, SKDRDP धर्मस्थला और विविध विकास विभागो से तकनीकी हस्तांतरण कार्यकलाप हेतु अपनी सहभागिता जारी रखी है।

मै वर्ष 2008-09 मे पायी गई उपलब्धियों के संकलन करने के लिए संपादकीय समिति के सदस्यो का आभारी हूँ।

एम. गोपालकृष्ण भट्ट

स्थल : का. अ. नि., पुत्तूर
दिनांक : 8.9.2009

(एम. गोपालकृष्ण भट्ट)
निदेशक

# PREFACE

It gives me great pleasure to mention that ICAR has upgraded National Research Centre for Cashew as Directorate of Cashew Research and accordingly a notification has been issued to this effect on March 23, 2009. I am very glad to present the achievements of this Directorate for the period from April 2008 to March 2009. The progress made in the areas of Crop Improvement, Crop Management, Crop Protection, Post-Harvest Technology and Transfer of Technology is reported in this Annual Report. The germplasm accessions conserved in the National Cashew Field Gene Bank (NCFGB) has risen to 513 with the planting of four accessions collected from NEH region during the year. Hybrids, H-125 and H-126 with bold nuts continued to yield higher (7 and 6 kg/tree respectively) in the fifth harvest with a cumulative yield of 26.4 and 23.7 kg/tree for five harvests respectively. Studies on DNA finger printing advanced further and a set of 44 germplasm accessions from nine morphological clusters were fingerprinted with nine primer pairs of SSR markers of cashew. Among them, NRC 97 and NRC 12 were highly divergent. The yield in high tree density plot (416 and 500 trees/ha) was 156-158 per cent of yield realized from normal tree(200 trees/ha) density plot seven years after planting. Among the different soil and water conservation techniques tried, the highest yield was obtained in coconut husk burial treatment (2.04 t/ha) as compared to 1.48t / ha in control during the fifth year. Pollinators like *Apis cerana indica* and *Pseudapis oxybeloides* were found to visit cashew flowers regularly. Among the newer insecticides tested against tea mosquito bug in a large plot trial , the damage rating in fenpropathrin (0.02%) was on par with the recommended insecticide λ- cyhalothrin (0.003%).

Cashew apple powder of 35 varieties were analysed for the bioavailability of minerals and a quality index was developed by giving proper weightage based on the bioavailability. A conceptual design of raw cashew nut dryer for NEH regions is prepared, employing thin layer drying technique with an air supply system operated by diesel powered generator/ dual system. The Directorate continued its collaboration with DCCD,Kochi, SKDRDP, Dharmasthala and Development Departments for strengthening Transfer of Technology programmes.

I am grateful to the members of Editorial Committee for compiling the Annual Report 2008-'09.

M. Gopalakrishna Bhat

Place : Puttur
Date : 8-9-2009

**(M. GOPALAKRISHNA BHAT)**
Director

# कार्यकारी सारांश

वर्ष 2008-09 के अन्तर्गत काजू अनुसंधान निदेशालय में 28 परियोजनायें सतत प्रगति पथ पर अग्रसर है । जिसमें एक तदर्थ परियोजना, एक DBT परियोजना, एक जाँच शुल्क परीक्षण तथा चार अवलोकनार्थ परीक्षण सम्मिलित किये है । इस वर्ष उत्तर पूर्वी पर्वतीय प्रदेशों से लाये गये चार एक्सेशन को मिलाकर कुल 513 एक्सेशन को राष्ट्रीय काजू क्षेत्रीय जीन बैंक (NCFGB) में संरक्षित किया गया है । वर्ष 1998 में रोपित 29 एक्सेशनो का पाँच - छः तुड़ाई के बाद अवलोकन किया गया ।

H 43, H 66, H 68 संकरणो का क्रास कम्बिनेशन (एन.आर.सी.सी. सलेक्सन-2 और भुतनाथ II) के साथ किया तथा संकरण II - 125 और H - 126 क्रास कम्बिनेशन (NRCC - Sel-2 x पेड़ासी) के साथ किया गया जिसमें पांच साल बाद की उपज क्रमश 5.6, 4.0, 5.2, 7.0 और 6.0 कि.ग्रा / पेड़ तथा सकल उपज 25.1, 23.9, 24.0, 26.5 और 23.8 कि.ग्रा. पायी गई । अखिल भारतीय समन्वित काजू अनुसंधान परियोजना के मुदकारा केन्द्र में KGN-1 जल्दी फलन व बौनी किस्म है । परन्तु बौनेपन के लक्षण प्रदर्शित नहीं किया जैसे पौधे की उचाई, तने का व्यास, कैनॉपी फैलाव, पूर्वान्तर लम्बाई, इत्यादि/ कुल 67 काजू एक्सेशनो को चिन्हित नौ प्राइमर के साथ अगुलिका मुद्रित विधि से जाँचा गया और आनुवंशिक सम्बन्ध का निर्धारण एक्सेशन की आनुवंशिक समानता आधार मूल्य से (जेकार्ड विधि) किया जो कि 0.53 से 0.94 बीच पायी गई है । सबसे अधिक असमानता (0.53) NRC- 335 और NRC-338 में तथा सबसे अधिक समानता (0.74) NRC 338 और NRC 321 में देखी गई है । दूसरे 44 जननद्रव्य एक्सेशनो का बाइरी अकारीय संरचना गुच्छ को नौ जोड़ी SSR मार्कर के साथ अगुली मुद्रित विधि से जाँचा गया । जिसमें NRC-97, NRC-12 में अपसारी भिन्नता थी जबकि एक्सेशन NRC- 12 और NRC 67, NRC 71 और NRC- 121,NRC - 9 और NRC- 126, NRC- 111 और NRC 112 जोडिया में उच्चतम "बूटस्ट्रप" संख्या के तहत 83-100% समानता थी ।

पौध रोपण के सात वर्ष पश्चात सामान्य क्यारी की उपज (718.6 कि.ग्रा/है) परन्तु सघन पौध रोपण क्यारी की उपज (1333 से 1120 कि.ग्रा. / है जो सामान्य क्यारी से 156 से 158% अधिक सार्थक रूप से पायी गई है । उस एक सूदा प्रबन्ध तकनीकी से पांच वर्ष बाद सामान्य क्यारी उपज 1.48 टन / है, विपरित वेदिका विधि (1.94 टन / है), बलुवा गड्ढा विधि से (1.39 टन /है) परन्तु इन विधियों की तुलना में नारियल भूसा प्रबन्ध विधि से (2.04 टन / है) और परिवर्तित अर्ध चन्द्राकार बंध विधि से उपज (2.03 टन है) सार्थक रूप से अधिक पाई गई । देश की विभिन्न काजू संस्करण इकाइयों के सर्वे से भण्डारण कीट *ट्राइबोलियम कास्टेनियम* और *इफेस्टीया कौटेला* का बाधा पाया गया । इनकी रोकथाम के लिए काजू संस्करण इकाइयों कोलम, केरला तथा कन्याकुमारी, तमिलनाडु में गोदाम की दिवार, छत, कोने को LPG द्वारा प्रज्वलन आग यन्त्र से उपचारित किये जाते है । तमिलनाडु पनरुटी संस्करण इकाई में पानी और मिट्टी का तेल से भरे टोकरे के उपर बल्ब लगाकर भण्डारण कीटो को आकर्षित किया जाता है । जिससे गिरकर कीट मर जाते हैं ।

काजू में *एंफिस सरेना इन्डिका* और *स्यूडोफिस आक्सीडेन्टालाइड* परागकण वाहक मधुमक्खियाँ नियमित भ्रमण करती देखी गई । इनकी प्रति फूल भ्रमण समय 0.01 से 0.18 सेकण्ड आँकी गई *स्यूडोफिस ऑक्सीडेन्टालाइड* मुख्य रूप से नर परागकण वाहक का कार्य करती है परन्तु कभी - कभी मकरंद इकट्ठी करती हुई भी देखी गई है । चाय मच्छर के उपचार में प्रयोग की जाने वाली λ - साइलोथ्रीन और कार्बेरिल का अवशिष्ट अवशेष 15 दिन बाद 0.02 से 0.5 पाया गया । चाय मच्छर के विरुध्द नये कीटनाशक फेन्ट्रोथ्रीन (0.02%) और λ सेइलेथ्रीन (0.03%) का प्रभाव समान रूप से देखा गया ।

काजू की 35 किस्मो के सेव चूर्ण का विश्लेषण किया जिसमें Fe और Mn की जीवलभ्यता 27 और 25 किस्मो में, Zn 12 किस्मो में, Cu और Se 3-4, किस्मो में उपलब्ध नहीं था । Fe और Zn की जीवलभ्यता Cu, Se की तुलना में बहुत कम थी ।

जीवलभ्यता प्रतिशत 0.1 से 100 तक रहा, जिसे 1 से 10 तक के श्रेणी आधार पर गुण सूचकांक विकसित किया । काजू गरी को अलग - अलग समय पानी में डुबोकर पानी अवशोषण व सुखने की क्षमता का प्रयोग किया गया । उत्तर पूर्वी पर्वतीय प्रदेशो के लिए काजू गरी सुखाने वाले यंत्र का कल्पनक विन्यास किया जो डिजल व बिजली उर्जा द्वारा हवा का बहाव कर काजू की गरी को सुखाता है ।

इस साल गुटकांड कलम रोपण, नर्सरी प्रबन्धन, काजू उत्पादन तकनीको तथा काजू सेब के उत्पोग के बारे में प्रशिक्षण कार्यक्रम आयोजित किये गये । "अधिक उपज के लिय उन्नत काजू उत्पादन तकनीकों" के विषय पर वार्षिक काजू दिवस आयोजित किया गया । यह कार्यक्रम DCCD, कोच्ची की आर्थिक सहायत से आयोजित किया गया जिसमें लगभग 250 किसान और उच्च पदाधिकारि कर्नाटक, केरल और आसाम से भाग लिया था । "वैफ डवलपमेन्ट विमर्श फाउन्डेशन, पुणे के विशेष अनुरोध से वैज्ञानिको के दल ने गुजरात काजू रोपण स्थानो भ्रमण किया । तथा कम उपज के याथार्थ कारणो तथा अधिक उपज के लिए निर्दिष्ट उपाइयो की सलाह दी । इस वर्ष किसान और विस्तार विभागो में लगभग 2 लाख काजू कलमन का वितरण किया गया । इस निदेशालय में सतत प्रगति पथ पर अग्रसर अनुसंधान परियोजनाओं के परिणाम का सारांश इस वार्षिक प्रतिवेदन में प्रस्तुत है ।

# EXECUTIVE SUMMARY

A total of 28 projects including one ad - hoc project, one DBT project, one paid up trial and four observational trials were in operation at Directorate of Cashew Research during 2008-'09. A total of four collections made earlier from NEH region were planted in the National Cashew Field Gene Bank (NCFGB) bringing the total number of accessions conserved in NCFGB to 513. Observations on 29 germplasm accessions planted during 1998 were recorded after completion of six annual harvests.

The hybrids , H -43, H- 66, H -68 (cross combinations of NRCC Sel -2 x Bhotnath-II), H -125 and H -126 ( cross combinations of NRCC Sel -2 x Bhedasi ) yielded 5.6, 4.0, 5.2, 7.0 and 6.0 kg/tree, respectively with a cumulative yield of 25.1, 23.9, 24.0, 26.5 and 23.8 kg /tree, respectively after five harvests. A reported precocious dwarf, from Madakkathara Centre of AICRP Cashew, KGN 1, did not exhibit the characteristics of dwarfness with respect to plant height, stem girth, mean canopy spread and internodal length.

A total of 67 accessions of cashew, were fingerprinted using nine selected RAPD primers and the genetic relatedness of the accessions was assessed based on their genetic similarity values (Jaccard's), which varied from 0.53 to 0.94. Lowest similarity (0.53) was observed between NRC-335 and NRC-338 and highest similarity (0.94) was observed between NRC-338 and NRC-321. Another set of 44 germplasm accessions from nine morphological clusters were fingerprinted with nine primer pairs of SSR markers of cashew. Among them, NRC-97 and NRC-12 were highly divergent and pair of accessions like NRC-12 and NRC-67, NRC-71 and NRC-121, NRC-9 and NRC-126, NRC-111 and NRC-112 showed highest similarity supported by 83-100 per cent bootstrap values.

The yield in the high tree density plots (416 and 500 trees/ha) was significantly higher (1133 and 1120 kg/ha) than in normal tree density plot (718.6kg/ha) seven years after planting. This was 156-158 per cent of yield realized from normal tree density plot. Among the different soil and water conservation techniques tried, during the fifth year, the highest yield was obtained in coconut husk burial treatment (2.04 t/ha) and modified crescent bund treatment (2.03 t/ha) compared to reverse terrace (1.94 t/ha), catch pit (1.39 t/ha/year) and control (1.48 t/ha) treatments.

The cashew processing units located in Kerala, Tamilnadu, Goa and Maharashtra were surveyed for recording the incidence of storage insect pests and infestation by *Tribolium castaneum* and *Ephestia cautella* were reported from these units. The cashew processing units situated in Kollam, Kerala and Kanyakumari, Tamilnadu adopted flaming the walls and corners of the floors as well as grading equipments using a 'blow torch' operated by LPG while, processors in Panruti, Tamilnadu adopted a technique by using zero watt incandescent bulb hung on a big crate containing water and kerosene suspension to attract and kill *Tribolium castaneum*. Pollinators like *Apis cerana indica* and *Pseudapis oxybeloides* visited cashew flowers regularly and the visitation rate ranged from 0.01 to 0.18 seconds / flower. *P. oxybeloides* rapidly collects pollen grains from stamen of male flowers by scrubbing and very rarely the nectar. *A. cerana indica* collects nectar and very rarely the pollen grains from male flowers. The residues of λ- cyhalothrin and carbaryl used for the management of tea mosquito bug (TMB) in cashew apples fell below the Maximum Residue Limit (MRL) of 0.2 ppm and 0.5 ppm respectively within 15 days of treatment . Among the newer insecticides tested against TMB in large plot trial, the damage rating in fenpropathrin (0.02%) was on par with the recommended insecticide λ- cyhalothrin (0.003%).

Cashew apple powder of 35 varieties were analysed and the bioavailability of Fe and Mn was nil in 27 and 25 varieties respectively. Zn was not bioavailable in 12 varieties. Cu and Se were not bioavailable in three and four varieties respectively. Bioavailability of Fe, Mn and Zn is less compared to Cu and Se. A quality index was developed by giving weightage from 1 to 10 for per cent bioavailability varying from 0.1 to 100. Drying experiments were conducted with raw cashewnuts soaked in water for different time period to understand the drying behaviour

of water soaked nuts. A conceptual design of dryer for NEH regions is prepared, employing thin layer drying technique with air supply system operated by diesel powered generator/ dual system considering irregular electric power supply in that region.

During the year, training programmes on softwood grafting of cashew and nursery management, cashew production technology and cashew apple utilization were organized. The Annual Cashew Day was conducted with theme "Improved cashew production technologies for higher yields". The programme was sponsored by Directorate Cashew nut and Cocoa Development (DCCD), Kochi in which nearly 250 farmers and dignitaries from Karnataka, Kerala and Assam participated. A team of Scientists visited the cashew plantations in Gujarat on request from BAIF Development Research Foundation, Pune . The team studied the scientific reasons for low yield and suggested measures to increase it to the potential levels. During the year, more than two lakh cashew grafts were distributed to farmers and Development Departments.

The summary of results of the ongoing research projects of the Directorate are presented in this Annual Report.

# INTRODUCTION

Research on cashew was first initiated in the early 1950s. Indian Council of Agricultural Research (ICAR), sanctioned adhoc schemes for Research Centres located at Kottarakkara (Kerala), Ullal (Karnataka), Bapatla (Andhra Pradesh), Daregaon (Assam) and Vengurla (Maharashtra). In 1971, ICAR also sanctioned All India Coordinated Spices and Cashew Improvement Project (AICS and CIP) with its Head Quarters located at CPCRI, Kasaragod. The CPCRI Regional Station, Vittal (Karnataka) was given the mandate to carryout research work on cashew while four University Centres (Baptala, Vridhachalam, Anakkayam and Vengurla) were assigned the research component on cashew under AICS and CIP. During the V and VI plan three more centres (Bhubaneswar, Jhargram and Chintamani) came under the fold of AICS and CIP and with shifting of work of Anakkayam centre to Madakkathara. The recommendations made by the Quinquennial Review Team (QRT) constituted by ICAR in 1982, working group on Agricultural Research and Education constituted by the Planning Commission for VII Plan Proposals and the Task Force on Horticulture constituted by ICAR had resulted in the establishment of National Research Centre for Cashew at Puttur on 18th June 1986. Subsequent to the bifurcation of AICS and CIP, the headquarters of All India Coordinated Research Project on Cashew was shifted to NRC for Cashew, Puttur. At present, this Coordinated Research Project is operating in ten centres and a sub centre distributed in major cashew growing areas of the country. There are also three co-operating centres. During the XI Plan in the year 2009, ICAR approved upgradation of NRC - Cashew into Directorate. Accordingly, NRC-Cashew is renamed as **Directorate of Cashew Research (DCR).**

## MANDATE

- To conduct mission-oriented research on all aspects of cashew for improving productivity and quality with special reference to export.
- To serve as a national repository for cashew germplasm and a clearing house for research information on cashew.
- To act as centre for training in research methodologies and technology updating of cashew and to coordinate national research projects.
- To provide consultancy regarding cashew production technology.
- To generate quality planting material.
- To collaborate with national and international agencies for achieving the mandate.

## ORGANIZATIONAL SET UP AND INFRASTRUCTURE

- Directorate of Cashew Research is located at Puttur, Dakshina Kannada, Karnataka. The main campus is situated 5 KM away from Puttur town (at Kemminje: 12.45° N latitude, 75.4° E longitude and 90m above MSL).

  The main campus has an area of 68 ha with field experiments and Laboratory-cum-Administrative Block. Experimental Station at Shantigodu, which also forms part of this Directorate is 13 KM away from the main campus and has an area of 80 ha.

- The Directorate has got well-established library in the field of cashew research. The library is serving as an information centre on all aspects of cashew research and development in the country. The CD database viz., CABHORT, CABPEST, AGRICOLA and AGRIS, SOIL CD, CROP CD, PLANTGENE CD and TROPAG CD are also available in the library. The library also has library automation software and bar- coding facility. The library has 1143 books and 1500 back volumes of various journals. The library subscribes 33 National and 14 International journals. The library is a member of Consortium of Electronic Resources on Agriculture (CeRA), New Delhi. Tech - Focuz digital library software is also available for CD Database search.

- The Directorate has got local area network of computers with Internet connections. The Directorate has got its own website which is updated at regualr intervals.

- The headquarters of AICRP on Cashew is located at DCR Cashew, Puttur. It has ten Coordinating Centres and a Sub-Centre located in Karnataka, Kerala and Maharashtra in West Coast, Andhra Pradesh, Orissa, Tamil Nadu and West Bengal in the East Coast and in Chattisgarh, Gujarat and Jharkhand. There are three co-operating centres in Arabhavi (Karnataka), Old Goa (Goa) and Barapani(Meghalaya).

## SIGNIFICANT ACHIEVEMENTS

- The Directorate has the largest germplasm collection of cashew in the country (National Cashew Field Gene Bank) with 513 accessions. A total of 433 cashew accessions have been assigned with National Collection numbers. The conservation block of gene bank has been established with 320 evaluated accessions by planting four plants of each accession.
- It has released three selections, namely. NRCC Sel-1 , NRCC Sel-2 and Bhaskara, which are high yielding and medium nut types for cultivation in Karnataka.
- Regeneration of cashew from the seedling explants (nodal cultures) has been standardized.
- Micrografting technique for in vitro multiplication of cashew has been standardized and cashew plants raised by micro grafting have been potted.
- Protocols have been standardized for characterization of released varieties and cashew germplasm accessions using RAPD/IISR markers and isozymes.
- The Directorate has also demonstrated the advantage of growing intercrops like pineapple, turmeric, brinjal and chillies profitably in cashew gardens.
- Glyricidia grown as an intercrop during initial years contributed 5.75 t/ha of dry matter, equal to 186 kg N, 40.8 kg $P_2O_5$ and 67.8 kg $K_2O$/ha. The yield of cashew increased by 50 per cent when glyricidia and sesbania were raised as green manuring crops compared to control. However, glyricidia is recommended as best green manure crop because of its perennial nature.
- Application of 200g biofertilizer (*Azospirillum* sp.) /plant with 33 kg of compost of recyclable cashew biomass from cashew garden/plant , yielded 12 per cent higher compared to recommended doses of inorganic fertilizers. The yield increase was 38 per cent over the control plot (without biofertilizer, compost of recyclable cashew biomass and inorganic fertilizers).
- Individual tree terracing with crescent bunding is the best soil and water conservation measure in slopy lands.
- High density planting at a spacing of 4m x 4m (625 plants /ha) is better than normal spacing of 8m x 8m (156 plants/ha) resulting in an yield increase by 2.5 times over control in the initial ten years.
- Irrigating cashew at 60-80 litres of water/tree once in four days through drip after initiation of flowering till fruit set and development in combination with the application of 750: 187.5: 187.5 g of NPK/tree led to significant higher yields.
- Soil and water conservation techniques like modified crescent bund or staggered trenches with coconut husk burial treatments have helped in conserving soil moisture, reducing the annual runoff / soil loss and increasing the nut yield.
- Drip irrigation and fertigation requirements have been standardised for normal ( 200 trees/ha ) planting system. Drip irrigation at 60-80 litres of water/ tree, once in four days from December to March , totalling to 1800-2400 litres of water / tree has been found optimum.
- Softwood grafting method is feasible for the commercial multiplication.
- Rearing technique for cashew stem and root borer (CSRB) on host bark has been standardized.
- Phytosanitation reduces the level of CSRB incidence in a given location.
- Chlorpyriphos (0.2%) is effective as post-treatment prophylaxis measure against CSRB.
- Volatiles and extracts in hexane from both healthy bark and frass on testing by EAG (Electroantennogram) elicit response from adult female beetles of CSRB.
- Laboratory rearing technique for tea mosquito bug (TMB) has been standardized. λ-cyhalothrin is effective in reducing the damage of TMB under field condition.
- Residues of insecticides used for the management of pests of cashew were not detected in the kernels of the raw nuts collected from the treated plots and the samples collected from the major cashew growing areas of the country .
- Sweetened and flavoured spread could be prepared from cashew kernel baby bits. Cashew kernel baby bits could be coated with different combination of flavour and colours. Cardamom flavoured and apple green / saffron coloured and sweetened cashew kernel baby bits are most preferred. Sweetened and flavoured cashew kernel baby bits have a shelf life of 12 months at ambient temperature.

- Mineral composition of defatted cashew kernel flour, testa and cashew apple pomace of released varieties vary. Mineral composition of cashew apple pomace could be improved by blending with defatted flours of either cashew or almond.
- Cashew apple powder lipids are rich in unsaturated fatty acids and the major fatty acids are palmitoleic and oleic acids. Salt treatment of cashew apple resulted in the reduction of tannin of cashew apple powder. Antioxidant activity in the cashew apple is associated with tannin , phenols , sugars, ascorbic acid and amino acids. Cashew apple powder could be blended with cereal flour upto 20 per cent.
- Bioavailability of Fe and Zn in defatted cashew kernel flour is less compared to Cu, Mn and Se.
- Impact of transfer of technology (TOT) are assessed and strategies are suggested for refining the TOT efforts.
- Yield forecasting model for predicting cashew yield has been developed.
- The Directorate has established very good linkage with farmers and officials of State Departments and Development Agencies.

## BUDGET (2008-'09)

(Rs. in lakhs)

| Plan | Non-Plan | External | Total |
|---|---|---|---|
| 190.43 | 271.71 | 6.41 | 468.55 |

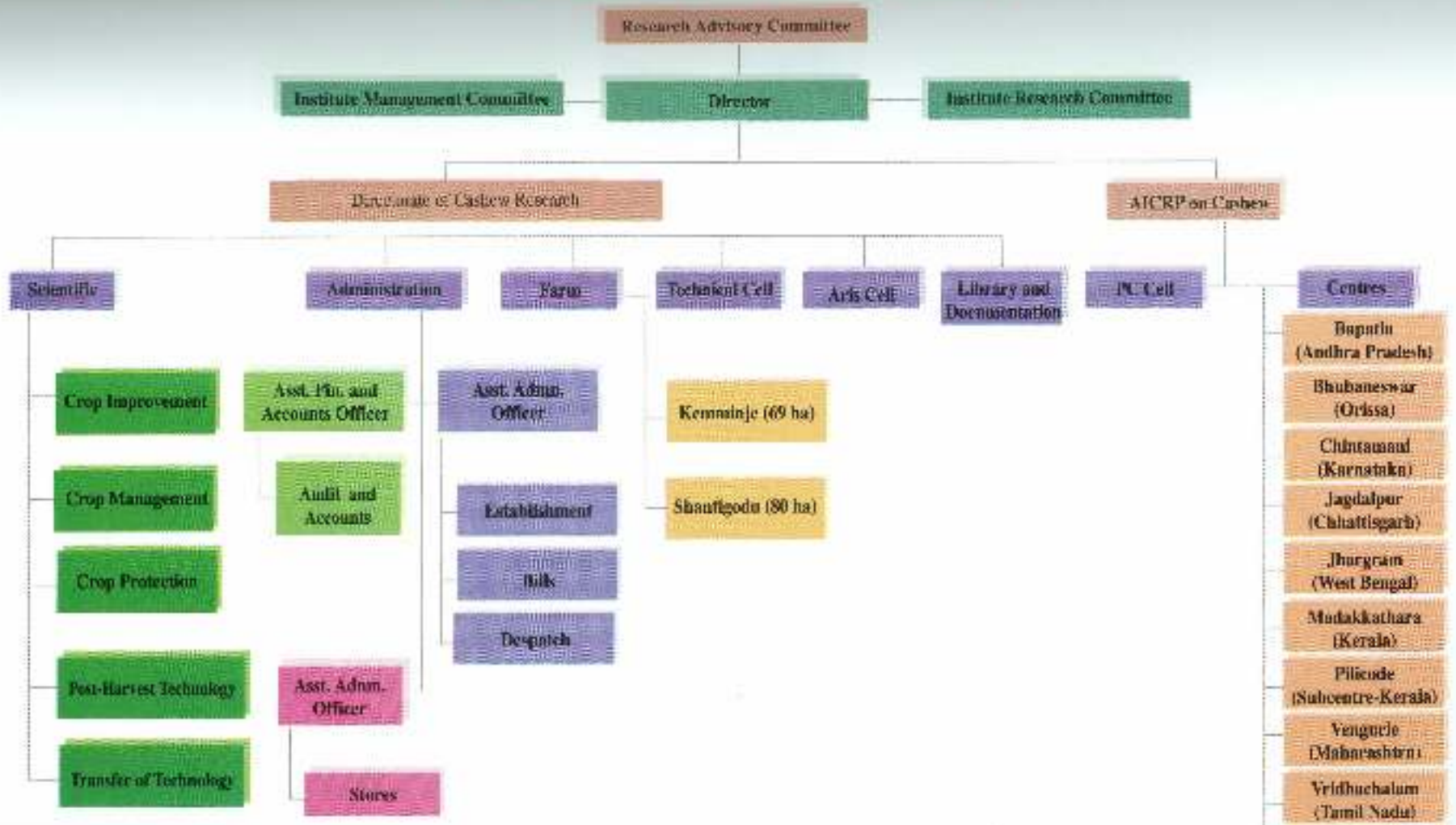
## STAFF POSITION AS ON 31.3.2009

| Category | Non-Plan | | | Plan | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sanct-ioned | Filled | Vacant | Sanct-ioned | Filled | Vacant | No. of Posts | No. filled | Vacant |
| Director (RMP) | 1 | 1 | - | - | - | - | 1 | 1 | - |
| Scientific | 18 | 12 | 6 | - | - | - | 18 | 12 | 6 |
| Technical | 19 | 17 | 2 | 4 | - | 4 | 23 | 17 | 6 |
| Administrative | 14 | 14 | - | 1 | - | 1 | 15 | 14 | 1 |
| Supporting | 41 | 36 | 5 | - | - | - | 41 | 36 | 5 |
| Canteen | 1 | 1 | - | - | - | - | 1 | 1 | - |
| **Total** | **94** | **81** | **13** | **5** | **-** | **5** | **99** | **81** | **18** |

## TOTAL MANPOWER

| | Sanctioned | Filled | Vacant |
|---|---|---|---|
| Non Plan | 94 | 81 | 13 |
| Plan | 5 | - | 5 |
| **Total** | **99** | **81** | **18** |

# ORGANISATIONAL SETUP OF DCR, PUTTUR



# RESEARCH ACHIEVEMENTS

# 1. CROP IMPROVEMENT

## 1.1 Genetic resources of cashew

### 1.1.1 Germplasm survey

A comprehensive survey was undertaken in Andaman and Nicobar islands (Havlock , Long, Baratang Lalaji, Hut bay and Comorta islands) in association with Central Agricultural Research Institute (CARI), Port Blair and Directorate of Agriculture, Andaman and Nicobar Administration , Port Blair. During the survey 10 variable cashew types and two variable types of wild cashew (related species belonging to *Semicarpus* sp) which are locally called 'jungly caju' were collected for planting in National Cashew Field Gene Bank (NCFGB).

**Fruit of wild cashew (jungly caju)**

Another survey was undertaken in NEH States particularly Moreh region of Manipur , South Garo hills of Meghalaya and South Tripura during June 2008 and three variable types were collected for planting in NCFGB.

Survey was also undertaken in Valsad, Dang and Navsari districts of Gujarat and Dadra Nagar Haveli Union Territory where few cashew trees are grown wild or by farmers. None of them were of variable type and hence no collection could be made.

### 1.1.2 Germplasm conservation

Four germplasm collections made from NEH region during 2007-08 were planted during the year under report in National Cashew Field Gene Bank (NCFGB) at 6m x 6m spacing for evaluation bringing the total number of accessions conserved to 513.

### 1.1.3 Germplasm evaluation and characterization

Germplasm accessions (29) planted during 1997-98 were evaluated and characterized as per IPGRI descriptors. Among these accessions, majority were upright growing (66%) , intensive branching types (75%), red coloured young leaves (100%), mid season flowering (86%), bold nuts(58%) , high cashew apple weight (86%), medium flowering duration types (93%), medium nut to apple ratio types (55%), high shelling percentage (75%), and medium kernel weight (72%), low cumulative yield (100%) (Table 1.1)

## 1.2 Genetic improvement of cashew for yield and quality traits

### 1.2.1 Performance of promising hybrids in unreplicated trial

Most of the promising hybrids under evaluation continued to perform better. The hybrids , H -43, H-66,H -68 (cross combinations of NRCC Sel-2 x Bhutnath-II), H-125 and H-126( cross combinations of NRCC Sel-2 x Bhedasi ) yielded 5.6, 4.0, 5.2, 7.0 and 6.0 kg/tree, respectively with a cumulative yield of 25.1, 23.9, 24.0, 26.4 and 23.8 kg /tree, respectively after five harvests ( Table 1.2 ).

### 1.2.2 Evaluation of hybrids in replicated trial

The different promising hybrids along with check varieties ( Bhaskara and NRCC Sel -2 ) planted during 2006 were compared for growth performance in a replicated trial . The hybrids did not differ significantly for growth parameters like plant height, stem girth and canopy spread.

### 1.2.3 Performance of seedling progenies

An experiment was laid out in 2007 with seedling progenies of NRCC Sel-2, Vengurla 4, VRI-3, Bhaskara, VTH-174, and VTH-30/4 to find out the variability existing in cashew cultivars raised through seedlings. Growth observations were recorded in the seedling progenies. The plant height ranged from 167.4 - 197.1 cm. The trunk girth ranged from 10 - 11 cm. The canopy spread ranged from 109 - 142.9 cm. However, the differences among the progenies for these growth parameters were not significant.

### 1.2.4 Evaluation of performance of KGN-1

A reported precocious dwarf, from Madakkathara (Trissur) Centre of AICRP Cashew, KGN-1, planted at a spacing of 4m x 4m in 2002, was evaluated alongwith NRCC Sel-2 (control) for plant growth characters from

2004-05 to 2007-08. The results revealed that KGN-1 did not exhibit the characteristics of dwarfness with respect to plant height, stem girth, mean canopy spread and internodal length over the period of observation (Table 1.3).

### 1.2.5 Crossing programme involving dwarf genotypes

Hybrid seedling (50) from nine different cross combinations involving NRCC Sel-2, Bhaskara and Ullal-3 as female parents and dwarf genotypes (Taliparamba-1, Brazil dwarf and Kodippady-2) as male parents were field planted during 2008. During 2008-09, a total of 279 hybrid nuts have been produced from five different cross combinations attempted. The per cent of fruit setting on hand pollination in different cross combinations ranged from 8 to 36 ( Table 1.4).

### 1.2.6 Evaluation of promising hybrids selected from closely planted block (coconut plot at Shantigodu)

Hybrids (13) having bold nut (8.2 g to 13 g nut weight) from closely planted block were selected and grafts were prepared during 2007-08. During 2008, a total of 180 plants comprising hybrids ( 156 plants) and check varieties like Bhaskara and NRCC Sel-2 (24 plants) have been field planted.

## 1.3 Molecular characterization of cashew germplasm

DNA was isolated from young leaves of 76 accessions of cashew following CTAB extraction procedures. The yield of DNA varied from 15-450 ug/ml with one g of tissue. Sixtyseven accessions of cashew were fingerprinted using nine selected RAPD primers which generated 60 bands, of which 44 bands were polymorphic (73.3%). The number of polymorphic markers varied from 1 - 8 with an average of 7.3 polymorphic markers/primer. Genetic relatedness of the accessions was assessed based on their genetic similarity values (Jaccard's), which varied from 0.53 to 0.94. An average similarity of 0.75 indicated low diversity existing among the accessions. However, lowest similarity (0.53) was observed between NRC-335 and NRC-338 and NRC-362 and NRC-388 accessions and highest similarity (0.84) was observed between NRC-338 and NRC-321. UPGMA diagram made, distinguished the accessions broadly into two groups and further one of the groups could be divided into several sub groups and in all 13 clusters were identified (Fig. 1.1).

Similarly 44 germplasm accessions from nine morphological clusters were fingerprinted with nine primer pairs of SSR markers of cashew described by Croxford *et al* (2005). A total of 24 bands were generated, of which 23 (95.8%) were polymorphic with number of polymorphic bands varying from 1 - 5. Genetic relatedness was assessed using Jaccard's similarity co-efficient which varied from 0.26 to 1.0. The average similarity of 0.55 indicated moderate diversity existing among the accessions. UPGMA dendrogram made distinguished the accessions broadly into two clusters and further one of the clusters was divided in to seven sub clusters. Among the accessions NRC-97 and NRC-12 were highly divergent and accessions like NRC-12 and NRC-67, NRC-71 and NRC-121, NRC-9 and NRC-126, NRC-111 and NRC-112 were highly similar.

## 1.4 Marker assisted selection in cashew

Phenotypic evaluation for nut and yield characters of $F_2$ progeny of cross VRI-2 x VTH 711/4 was carried out. Similarly, observations on 27 phenotypic characters of 177 germplasm were compiled and various parameters like mean, range and standard deviation were worked out. Germplasm were sorted for 19 economic characters based on their high and low phenotypic values. DNA was isolated from the 170 numbers of $F_2$ progeny and parents ($P_1$, $P_2$) and hybrid ($F_1$) following CTAB extraction procedure. PCR optimization for various marker systems (RAPD, ISSR, and SSR) was done with respect to various constituents of PCR mix, amplification conditions and their electrophoresis.

A total of 258 RAPD, 31 ISSR and 21 SSR primers were used for screening DNA of parents ($P_1$, P2) and $F_1$ (hybrid) and observed parental polymorphism in 86 RAPD (33.3%), 13 ISSR (39.4%) and 5 SSR (23.8%) primers respectively. DNA bulks were constituted for 11 characters in $F_2$ population and for six characters in germplasm of DCR, Puttur. Bulk Segregant Analysis (BSA) was carried out using polymorphic RAPD, ISSR and SSR primers and identified unique bands in the bulks for various characters.

In germplasm, a putative RAPD ($OPN14_{275}$) marker for small nut size was identified and validated (80%) with individuals of bulks. Similarly another RAPD marker ($UBC\ 184_{225}$) for big nut size was identified in germplasm bulks and validated (66.6%) with individuals of big nut bulk. A putative ISSR marker ($UBC\ 185_{275}$) for dwarf plant was identified in germplasm bulks and validated (66.6%) with individuals of bulks.

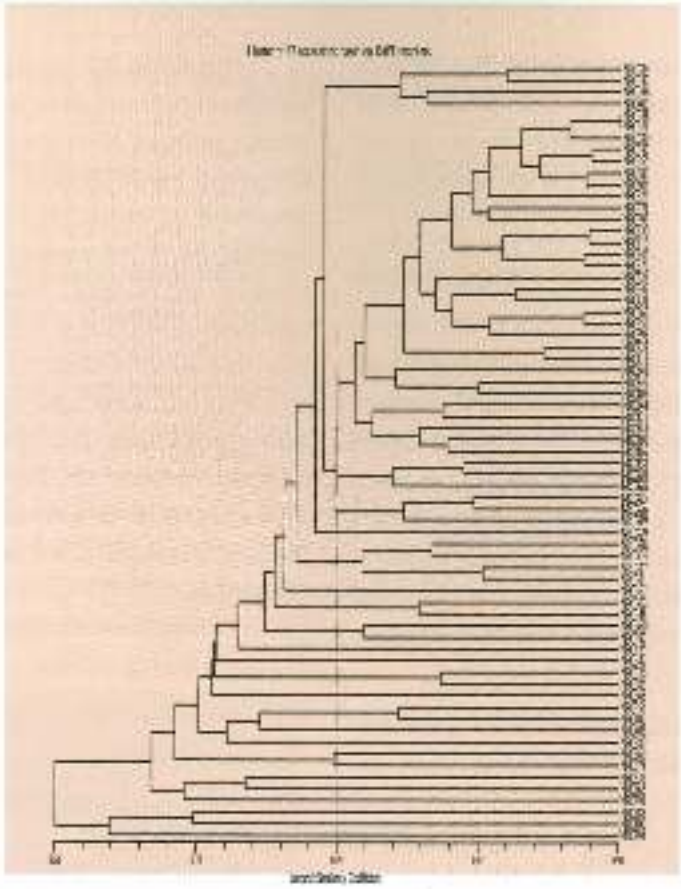


Fig 1.1: Cluster of 67 germplasm accessions of cashew based on RAPD markers

Table 1.1: Details of accessions characterized during 2008 fruiting season

| Data field | Descriptor | Descriptor state | | No.of Accessions |
|---|---|---|---|---|
| 04 | Tree habit | 3 | Upright and Compact | 19 |
| | | 5 | Upright and Open | 10 |
| | | 7 | Spreading | 0 |
| 09 | Leaf shape | 1 | Oblong | 1 |
| | | 2 | Obovate (Club shaped) | 2 |
| | | 3 | Oval | 26 |
| 16 | Branching pattern | 1 | Extensive | 7 |
| | | 2 | Intensive | 22 |
| 19 | Colour of young leaves | 1 | Red | 29 |
| | | 2 | Yellow red | 0 |
| | | 3 | Green yellow | 0 |
| | | 4 | Purple | 0 |
| 28 | Season of flowering | 3 | Early (Nov - Dec) | 2 |
| | | 5 | Mid (Dec - Jan) | 25 |
| | | 7 | Late (Jan - Feb) | 2 |
| 31 | Colour of mature apple | 1 | Yellow | 17 |
| | | 2 | Red | 3 |
| | | 3 | Yellow Red | 9 |
| | | 4 | Red Purple | 0 |

| | | | | |
|---|---|---|---|---|
| 32 | Shape of cashew apple | 1 | Cylindrical | 15 |
| | | 2 | Conical Obovate | 9 |
| | | 3 | Round | 3 |
| | | 4 | Pyriform | 2 |
| 35 | Nut weight | 3 | Low (< 5g) | 3 |
| | | 5 | Intermediate (5 – 7 g) | 9 |
| | | 7 | High (> 7g) | 17 |
| 43 | Weight of cashew apple | 3 | Low (< 27g) | 0 |
| | | 5 | Medium (27 – 52 g) | 4 |
| | | 7 | High (> 52 g) | 25 |
| 50 | Attachment of nut to apple | 3 | Loose | 5 |
| | | 5 | Intermediate | 16 |
| | | 7 | Tight | 8 |
| 57 | Shell thickness | 3 | Thin (< 2.5 mm) | 9 |
| | | 5 | Intermediate (2.5 4.0 mm) | 20 |
| | | 7 | Thick (> 4.0 mm) | 0 |
| 60 | Flowering duration | 3 | Short (< 60 days) | 2 |
| | | 5 | Medium (60 90 days) | 27 |
| | | 7 | Long (> 90 days) | 0 |
| 62 | Apple to nut ratio | 3 | Low (< 6.0) | 1 |
| | | 5 | Medium (6.0 12.0) | 16 |
| | | 7 | High (> 12.0) | 12 |
| 63 | Shelling percentage | 3 | Low (< 18.0%) | 0 |
| | | 5 | Intermediate (18.0 – 28.0%) | 7 |
| | | 7 | High (> 28.0%) | 22 |
| 64 | Kernel weight | 3 | Low (1.2 g) | 0 |
| | | 5 | Intermediate (1.2 – 2.5 g) | 21 |
| | | 7 | High (> 2.5 g) | 8 |
| 65 | Attachment of peel to kernel | 3 | Loose | 29 |
| | | 7 | Tight | 0 |
| 68 | Cumulative yield | 3 | Low (< 9 Kg) | 29 |
| | | 5 | Medium (9 18 Kg) | 0 |
| | | 7 | High (> 18 Kg) | 0 |

**Table 1.2: Performance of promising hybrids in unreplicated trial**

| Hybrid | Cross combination | Annual yield in 5th harvest(kg/tree) | Cumulative yield for 5 harvests (kg/tree) |
|---|---|---|---|
| H-43 | NRCC Sel-2 x Bhuthnath-II | 5.6 | 25.1 |
| H-66 | NRCC Sel-2 x Bhuthnath-II | 4.0 | 23.9 |
| H-68 | NRCC Sel-2 x Bhuthnath-II | 5.2 | 24.0 |
| H-125 | NRCC Sel-2 x Bhedasi | 7.0 | 26.5 |
| H-126 | NRCC Sel-2 x Bhedasi | 6.0 | 23.8 |

**Table 1.3: Performance of KGN-1 for growth characters in comparison to NRCC Sel-2**

| Character | KGN-1 | | | | NRCC Sel-2 | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2004-05 | 2005-06 | 2006-07 | 2007-08 |
| Plant height (cm) | 2.40 | 3.23 | 3.90 | 4.60 | 2.62 | 3.42 | 3.98 | 4.56 |
| Stem girth (cm) | 21.14 | 31.52 | 39.67 | 43.27 | 25.21 | 37.30 | 45.20 | 49.70 |
| Mean canopy spread (m) | 2.32 | 3.32 | 3.61 | 4.01 | 2.72 | 3.84 | 4.06 | 4.60 |
| Internodal length (cm) | 2.97 | 2.49 | 2.70 | 2.45 | 2.25 | 2.22 | 2.21 | 2.27 |

**Table 1.4: Crossing programme involving dwarf genotypes**

| Cross combination | No. of hand pollinations attempted | Initial setting (No.) | Final setting (No.) | Per cent setting |
|---|---|---|---|---|
| Ullal-3 x Brazil dwarf | 400 | 114 | 104 | 26 |
| Ullal-3 x Taliparamba-1 | 300 | 76 | 52 | 17 |
| NRCC Sel-2 x Taliparamba-1 | 110 | 14 | 09 | 08 |
| Bhaskara x Taliparamba-1 | 200 | 86 | 71 | 36 |
| Bhaskara x Brazil dwarf | 150 | 46 | 43 | 29 |

# 2. CROP MANAGEMENT

## 2.1 Fertilizer application and pruning in high density plantation

This experiment was taken up to study the nutrient requirement /unit area at three different plant densities. The experiment was laid out in 2001 with three plant densities viz., 200 (S1), 416 (S2) and 500 (S3) plants /ha as main plot treatments and three fertilizer doses viz., 75 kg N, 25 kg each of $P_2O_5$ and $K_2O$ (M1), 150 kg N, 50 kg each of $P_2O_5$ and $K_2O$ (M2), 225 kg N, 75 kg each of $P_2O_5$ and $K_2O$/ha (M3) as sub plot treatments.

### 2.1.1 Ground coverage and light interception by tree canopy

In high tree density plots (416 and 500 trees/ha), the ground coverage and light interception by the canopy was 92-98 per cent and 72-80 per cent respectively compared to 55 -60 per cent and 32-42 per cent in normal density planting system (200 trees/ha) seven years after planting (Table 2.1 and 2.2).

### 2.1.2 Yield

The yield in the high tree density plots (416 and 500 trees/ha) was significantly higher (1133 and 1120 kg/ha) than in normal tree density plot (718.6kg/ha) seven years after planting. The yield in high tree density plot was 156-158 per cent of yield realized from normal tree density plot. Among the subplots (fertilizer doses) the yield decreased significantly as fertilizer level increased from M1 (1090.6 kg/ha) to M3 (945.3 kg/ha). Interaction effect of tree density and fertilizer levels was not observed (Table 2.3). The cumulative yield for five harvests indicated that so far maintaining highest tree population of 500 /ha has given highest yield of 4735.7 kg/ha and maintaining tree population of 416 trees/ha gave next highest yield of 4338.4 kg/ha. In normal tree density plot the cumulative yield recorded was 2339.8 kg/ha which is significantly lower than the other two treatments (416 and 500 trees/ha-Table 2.4). The cumulative yield in high tree density plot were 184-202 per cent of yield realized from normal tree density plot(100 %). Among the subplot treatments the yield increased with increased application of fertilizer doses (3087.5 to 3770 kg/ha).

**Table 2.1 : Per cent ground coverage by tree canopy seven years after planting (2008)**

| Treatment (trees/ha) | M1 | M2 | M3 | Mean |
|---|---|---|---|---|
| S1-200 | 55 | 58 | 60 | 57.66 |
| S2-416 | 92 | 94 | 95 | 93.66 |
| S3-500 | 94 | 96 | 98 | 96.00 |
| Mean | 80.33 | 82.66 | 84.3 | |
| CD for density (<0.05) | | | | 3.85 |
| CD for manures (<0.05) | | | | 2.44 |

**Table 2.2 : Per cent light interception by canopy in the allotted area (2008)**

| Treatment | M1 | M2 | M3 | Mean |
|---|---|---|---|---|
| S1-200 | 32 | 38 | 42 | 37.33 |
| S2-416 | 72 | 74 | 76 | 74.00 |
| S3-500 | 78 | 79 | 80 | 79.00 |
| Mean | 60.66 | 63.66 | 66.00 | |
| CD for density (<0.05) | | | | 2.27 |
| CD for manures (<0.05) | | | | 1.49 |

**Table 2.3 : Effect of plant density and fertilizers on nut yield, kg/ha (2008)**

| Treatment (trees/ha) | MI | M2 | M3 | Mean | % of control |
|---|---|---|---|---|---|
| S1-200 | 626 | 730 | 800 | 718.6 | 100 |
| S2-416 | 1293 | 1077 | 1029 | 1133.0 | 158 |
| S3-500 | 1353 | 1000 | 1007 | 1120.0 | 156 |
| Mean | 1090.6 | 935.6 | 945.3 | | |
| CD for density (<0.05) | | | | 164.86 | |
| CD for manures (<0.05) | | | | 101.01 | |

**Table 2.4 : Effect of plant density and fertilizers on cumulative nut yield, kg/ha (Total of five harvests-2004-2008)**

| Treatment (trees/ha) | MI | M2 | M3 | Mean | % of control |
|---|---|---|---|---|---|
| S1-200 | 2182.4 | 2321.2 | 2517.0 | 2339.8 | 100 |
| S2-416 | 4396.0 | 4037.4 | 4581.7 | 4338.4 | 184 |
| S3-500 | 5084.1 | 4911.2 | 4212.4 | 4735.9 | 202 |
| Mean | 3087.4 | 3756.5 | 3770.3 | | |

## 2.2 Performance of high yielding varieties of cashew under different high density planting system

A field experiment was laid out in 2006 with fresh planting of grafts of nine varieties, each one in four different densities (spacings). The main objectives of the experiment were to determine optimum plant density for achieving highest yield and profits for the first ten years and to recommend suitable variety for achieving highest yield and profit for the first ten years under high density planting system

**Main plot : Density (No. /ha, Spacing m X m)**

S1-200 (10mx5m), S2-236 (6.5m X 6.5m), S3-384 (6.5m X 4m), S4-500 (5 m X 4m)

**Sub plot (Varieties)**

T1 - VRI-3, T2 - NRCC Sel-2, T3 - V-7, T4 - Ullal-1, T5 - Dhana, T6 - Madakkathara-2, T7 - Ullal- 3, T8 - V-4, T9 - Bhaskara

**Design**

Split plot, Replication-3, Plot size-36 plants/ main plot, 4 plants / sub plot, Border plants around treatment plants.

### 2.2.1 Initial observations on growth

Stem girth of varieties V-4 (20.0 cm), Dhana, (20.25) and Bhaskara (21.50 cm) was more compared to stem girth of other varieties (NRCC Sel 2 (15 cm), Ullal-1 (16.75cm), VRI-3 (16cm Table 2.5). The varieties Bhaskara (292.3cm), V-4 (276 cm), Dhana (260 cm) and Madakkathara-2 (260.5 cm) were taller than other varieties. The height was least in NRCC Sel-2 (219 cm), VRI-3 (225 cm) and Ullal-1 (233 cm-Table 2.6). The ground area coverage by canopy was highest (21.04 %) in the case of Bhaskara variety compared to other varieties. The least ground area covered by the canopy was observed in the case of NRCC Sel-2 (14.23 %-Table 2.7). Growth in terms of girth, height and canopy area were highest in the case of plants grown under moderate high density planting system (384 plants/ha) compared to other planting density system. The nut yield realized from the first harvest was highest in the case of Bhaskara (33 kg/ha) variety and it was the least in V-7 (4.025 kg/ha-Table-2.8). The yield realized from high plant density plots ( 384 and 500 plants /ha) was significantly higher (23.06 to 24.65 kg/ha) than low plant density (200 plants /ha) plots (10.65 to 12.19 kg/ha)

**Table 2.5 : Effect of plant density and varieties on the girth of stem at 0.75m above the ground three years after planting.**

| Varieties / Treatments (plants/ha) | VRI-3 | NRCC Sel-2 | V-7 | Ullal-1 | Dhana | Madakka-thara-2 | Ullal-3 | V-4 | Bhaskara | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| S1-200 | 15 | 13 | 19 | 15 | 19 | 22 | 21 | 19 | 21 | 16.22 |
| S2-236 | 14 | 13 | 17 | 19 | 19 | 18 | 14 | 21 | 20 | 15.11 |
| S3-384 | 18 | 17 | 20 | 20 | 23 | 19 | 18 | 21 | 25 | 20.11 |
| S4-500 | 17 | 17 | 19 | 13 | 20 | 15 | 19 | 19 | 20 | 17.66 |
| Mean | 16.0 | 15.0 | 18.75 | 16.75 | 20.25 | 18.5 | 18.25 | 20.0 | 21.5 | |
| CD(MP) | | | | | | | | | | NS |
| CD(SP) | | | | | | | | | | 3.43 |

MP- Main plot (Density), SP-Sub plot (Varieties)

**Table 2.6 : Effect of plant density and varieties on the ground coverage by canopy of the plants three years after planting (%)**

| Varieties / Treatments (plants/ha) | VRI-3 | NRCC Sel-2 | V-7 | Ullal-1 | Dhana | Madakka-thara-2 | Ullal-3 | V-4 | Bhaskara | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| S1-200 | 5.25 | 5.44 | 7.97 | 7.53 | 8.10 | 7.83 | 11.57 | 7.25 | 8.72 | 7.74 |
| S2-312 | 0.95 | 3.38 | 6.00 | 4.31 | 3.83 | 2.68 | 3.86 | 5.99 | 6.42 | 4.16 |
| S3-384 | 11.33 | 14.18 | 20.20 | 14.51 | 20.78 | 11.81 | 11.77 | 21.89 | 22.75 | 16.59 |
| S4-500 | 17.69 | 14.23 | 23.93 | 9.80 | 19.59 | 12.11 | 19.81 | 18.73 | 21.04 | 17.44 |
| Mean | 8.81 | 9.31 | 14.53 | 9.04 | 13.08 | 8.61 | 11.75 | 13.47 | 14.73 | |
| CD(MP) | | | | | | | | | | NS |
| CD(SP) | | | | | | | | | | 0.97 |

MP- Main plot (Density), SP-Sub plot (Varieties)

**Table 2.7 : Effect of plant density and varieties on the nut yield (kg/ha) three years after planting (first harvest)**

| Varieties / Treatments (plants/ha) | VRI-3 | NRCC Sel-2 | V-7 | Ullal-1 | Dhana | Madakka-thara-2 | Ullal-3 | V-4 | Bhaskara | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| S1-200 | 12.72 | 3.37 | 2.83 | 5.81 | 14.57 | 18.13 | 17.73 | 4.24 | 18.25 | 10.85 |
| S2-312 | 25.35 | 3.54 | 0.57 | 7.65 | 8.50 | 16.14 | 1.27 | 13.74 | 33.00 | 12.19 |
| S3-384 | 43.78 | 11.52 | 10.60 | 8.52 | 14.28 | 58.75 | 12.21 | 23.73 | 38.48 | 24.65 |
| S4-500 | 24.60 | 1.20 | 2.10 | 33.0 | 8.70 | 37.20 | 31.20 | 27.30 | 42.30 | 23.06 |
| Mean | 26.61 | 4.91 | 4.03 | 13.74 | 11.51 | 32.55 | 15.60 | 17.25 | 33.00 | |
| CD(MP) | | | | | | | | | | NS |
| CD(SP) | | | | | | | | | | 16.68 |

MP- Main plot (Density), SP-Sub plot (Varieties)

**Table 2.8 : Effect of plant density and varieties on the height,(cm) three years after planting**

| Varieties / Treatments (plants/ha) | VRI-3 | NRCC Sel-2 | V-7 | Ullal-1 | Dhana | Madakka-thara-2 | Ullal-3 | V-4 | Bhaskara | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| S1-200 | 233 | 217 | 254 | 253 | 250 | 283 | 308 | 288 | 288 | 263.8 |
| S2-312 | 171 | 173 | 215 | 263 | 232 | 217 | 193 | 273 | 261 | 222.0 |
| S3-384 | 243 | 256 | 273 | 233 | 303 | 325 | 277 | 283 | 332 | 280.6 |
| S4-500 | 253 | 230 | 240 | 186 | 255 | 217 | 251 | 260 | 288 | 242.2 |
| Mean | 225 | 219 | 245.5 | 233.3 | 260 | 260.5 | 257.3 | 276.0 | 292.3 | |
| CD(MP) | | | | | | | | | | NS |
| CD(SP) | | | | | | | | | | 37.38 |

MP- Main plot (Density), SP-Sub plot (Varieties)

## 2.3 Rejuvenation of trees of high density cashew orchard through canopy management

A field experiment was laid out in 2006 on 12 years old VRI-1 and seven years old Bhaskara variety. The main objectives of the experiment were standardisation of pruning techniques to be subsequently followed in limb pruned and top worked trees to maintain high yield for long period and working out cost of maintaining limb pruned and top worked trees and profits realised subsequently for recommendation to farmers.

### Treatments

1. Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working once in a year.
2. Pruning at 1 m height of the branches emerging after limb pruning or top working twice a year.
3. Pruning at 1 m height of the branches emerging after limb pruning or top working once in a year and application of pachlobutrazol @ 4ml a.i/tree/year.
4. Pruning at 1 m height of the branches emerging after limb pruning or top working once in a year and application of pachlobutrazol @ 8ml a.i/tree/ once in two years.
5. No further pruning after limb pruning –control.

Three sets of experiment were laid out with (1) limb pruned trees of 12 years old VRI-1 variety, (2) limb pruned trees of VRI-1 and subsequently top worked with scions of "Bhaskara" variety and (3) limb pruned trees of "Bhaskara" variety.

Design: RBD, Treatments-5, Replication-4, Plot size-2 plants per plot

### 2.3.1 Canopy height, spread and exposed surface area

The tree height, canopy height and spread of the trees and exposed canopy surface area (ECSA) of trees treated with paclobutrazol 4 and 8 ml a.i /tree once a year and once in two years respectively were 50 per cent less than trees receiving one or two pruning subsequent to initial limb pruning (Table 2.9) as well as control (no pruning further after initial limb pruning)

In an experiment on top worked trees the lateral shoot length ranged between 7.8 to 38.6 cm in those trees receiving different canopy management treatments. The least lateral shoot length of 7.8cm was observed in those trees receiving 4ml paclobutrazol / year and highest lateral shoot length of 38.6cm was observed in trees receiving pruning once in a year after limb pruning. In seven years old "Bhaskara" variety, the lateral shoot length was as minimum as 5.1cm in paclobutrazol applied trees. Whereas, in trees treated with pruning once or twice a year the lateral shoot length was 36.2 and 41.6 cm which were more than 5 to 8 times of that shoot treated with paclobutrazol.(5.1 cm). The number of flowering laterals in paclobutrazol treated trees was almost ten times more than (34 and 38) in trees just treated with pruning once in a year and twice in a year (3.0, 2.4) (Table-2.10).

**Table 2.9: Effect of canopy management treatments on tree height, canopy spread and ESCA**

| Treatments | Top worked on VRI1(12 years old) with "Bhaskara" | | | "Bhaskara" - Seven years | | |
|---|---|---|---|---|---|---|
| | Tree height (m) | Canopy spread ($m^2$) | ECSA ($m^2$) | Tree height (m) | Canopy spread ($m^2$) | ECSA ($m^2$) |
| Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working once in a year | 4.43 | 5.1 | 40.98 | 4.47 | 5.15 | 43.36 |
| Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working twice in a year | 4.05 | 4.45 | 34.75 | 3.90 | 4.41 | 31.38 |
| Treatment 1 and application of Paclobutrazol @ 4ml a.i / tree / year. | 2.51 | 2.55 | 11.47 | 2.08 | 1.98 | 7.26 |
| Treatment 1 and application of Paclobutrazol @ 8 ml a.i / tree one in two years. | 3.93 | 2.61 | 17.02 | 2.13 | 2.01 | 7.95 |
| No further pruning after limb pruning –control | 25.93 | 4.75 | 46.72 | 4.75 | 5.25 | 44.87 |
| CD(<0.05) | 0.67 | 0.409 | 4.95 | 0.504 | 0.511 | 7.53 |

In an experiment on top worked trees, the nut production was higher in trees receiving paclobutrazol (5.48 and 5.51kg/tree) compared to trees receiving just pruning treatments and no further pruning after limb pruning(1.508, 1.75 and 3.996 kg/tree respectively). Similar effect was noticed in case of "Bhaskara" variety trees also (Table 2.11).

**Table 2.10: Effect of canopy management treatments on lateral shoot length, number of flowering and non flowering laterals**

| Treatment | Top worked on "VRI-1"(12 years old) with "Bhaskara" | | | "Bhaskara" - Seven years | | |
|---|---|---|---|---|---|---|
| | Lateral shoot length (cm) | No. of flowering laterals ($m^2$) | Non flowering laterals ($m^2$) | Lateral shoot length (cm) | No. of flowering laterals ($m^2$) | Non flowering laterals ($m^2$) |
| Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working once in a year | 38.6 | 6.6 | 9.4 | 41.6 | 3.0 | 6.2 |
| Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working twice in a year | 36.2 | 9.4 | 9.0 | 36.2 | 2.4 | 6.0 |
| Treatment 1 and application of Paclobutrazol @ 4ml a.i / tree / year. | 7.8 | 28.2 | 8.6 | 5.1 | 38.0 | 10.0 |
| Treatment 1 and application of Paclobutrazol @ 8 ml a.i / tree one in two years. | 9.32 | 28.0 | 7.8 | 5.27 | 34.0 | 6.4 |
| No further pruning after limb pruning – control | 33.8 | 12.8 | 7.2 | 38.5 | 4.8 | 7.0 |
| CD(<0.05) | 5.4 | 3.28 | 2.5 | 5.8 | 5.22 | 2.17 |

**Table 2.11: Effect of canopy management treatments on nut yield/tree (kg/tree)**

| Treatments | Top worked on "VRI-1" (12 years old) with "Bhaskara" | "Bhaskara" Seven years |
|---|---|---|
| Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working once in a year | 1.508 | 1.009 |
| Pruning at 1 m height of the branches emerging after limb pruning (decrowning) or top working twice in a year | 1.750 | 1.025 |
| Treatment 1 and application of paclobutrazol @ 4ml a.i / tree / year. | 5.476 | 1.946 |
| Treatment1 and application of paclobutrazol @ 8 ml a.i / tree one in two years. | 5.513 | 1.850 |
| No further pruning after limb pruning – control | 3.996 | 2.750 |

Trees treated with paclobutrazol

Effect of paclobutrazol on plant growth and flowering habit

Control plant with vigorous vegetative growth but poor flowering

## 2.4 Development of INM package for commercially important plantation crops - Microbial inoculant based nutrient management in cashew (DBT)

### 2.4.1 Nursery trial

Nursery trial was initiated to study the effect of biofertilizers during the first growth phase of cashew seedlings and grafts. Cashew seedlings were raised in the nursery bags and different biofertilizers and combinations of biofertilizers were applied to soil media of nursery bags while sowing seeds.

In another batch initially seedlings were raised in nursery bags as explained above and when seedlings were 1.5 month old scion "Bhaskara" variety was grafted on seedlings and maintained for another one month. Subsequently, they were treated with different biofertilizers as per the details given below. The surface soil was removed and the microbial cultures were applied as per the treatment and were covered with the removed soil.

#### 2.4.1.1 Treatments:

T1 - control, T2 - Arbuscular Mycorrhizal Fungi, T3 - *Azospirillum*, T4 - P-Solubilizer, T5 - *Pseudomonas*, T6- AMF+ *Azospirillum*+ P-Solubilizer+ *Pseudomonas*.

Germination of seeds started in all the treatments 15-20 days after sowing. Growth observation of both seedlings and grafts were taken during the 4-5 month stage after sowing and after imposing biofertilizer treatments respectively (Table 2.12 and 2.13).

Different biofertilizers did not affect stem girth, plant height and number of leaves . However, *Azospirillum* (T-3) and combination of all the biofertilizers including AMF (T6) increased the number of leaves but reduced individual leaf area.

In general number of leaves produced in grafts was less compared to seedlings.

### 2.4.2 Field trial

The microbial cultures were applied as per the treatment, to an existing seven year old "Bhaskara" variety to study the effect of biofertilizers on mature plantation.

#### 2.4.2.1 Treatments

T1 - Conventional

T2 - Conventional + Biofertilizers*

T3 - 50% N and P, 100%K + Biofertilizers*

T4 - 75% N and P, 100%K + Biofertilizers*

* 50 g each of *Azospirillum*, P-Solubilizers and *Pseudomonas*+ 1% AMF

** 5 kg cattle manure was applied to all the treatment plants.

Variation in growth was not observed in trees before imposing treatments (Table-2.14).

**Table 2.12: Effect of treatments on biometric parameters of cashew seedlings**

| Treatments | Plant height (cm) | Stem girth (cm) | No. of leaves | Leaf area( $cm^2$) |
|---|---|---|---|---|
| T1 | 37.87 | 4.47 | 11.67 | 52.25 |
| T2 | 38.58 | 4.81 | 11.85 | 64.49 |
| T3 | 33.92 | 4.46 | 14.25 | 49.99 |
| T4 | 35.36 | 4.46 | 11.43 | 53.55 |
| T5 | 37.61 | 4.53 | 11.00 | 52.16 |
| T6 | 34.83 | 4.67 | 13.75 | 51.09 |

**Table 2.13: Effect of treatments on biometric parameters of cashew grafts**

| Treatments | Plant height (cm) | Stem girth (cm) | No. of leaves | Leaf area ($cm^2$) |
|---|---|---|---|---|
| T1 | 38.73 | 4.57 | 7.47 | 60.17 |
| T2 | 39.40 | 4.27 | 8.73 | 56.71 |
| T3 | 35.93 | 4.30 | 7.27 | 49.56 |
| T4 | 37.73 | 4.27 | 7.53 | 58.33 |
| T5 | 38.53 | 4.57 | 7.87 | 56.15 |
| T6 | 38.80 | 4.57 | 7.53 | 63.90 |

**Table 2.14: Preliminary growth observations under field trial**

| Treatment | Plant height (cm) | Stem girth (cm) | Canopy height (cm) | Canopy spread (cm) |
|---|---|---|---|---|
| T1 – Conventional | 355.0 | 50.1 | 103.6 | 307.8 |
| T2-Conventional + Biofertilizers | 356.3 | 55.3 | 97.5 | 323.4 |
| T3-50 % N & P ,100% K+ Boifertilizers | 383.8 | 52.9 | 92.3 | 371.6 |
| T4-75 % N & P ,100% K+ Boifertilizers | 396.3 | 57.4 | 97.6 | 303.8 |

Soil samples were also collected from the field before treatment at 0-60cm depth one metre away from the base of the tree and analyzed for nutrient contents (Table 2.15) and microbial population status was assessed (Table 2.16 and 2.17).

The initial nutrient status showed that soil is low in organic C content and medium to high in P content and medium in K contents

Enumeration of microbial population in soil before and after imposing treatments indicated that it was higher in those soils receiving 50 and 75 per cent N and P and 100 per cent K + biofertilizers compared to soil receiving fertilizers through conventional method where biofertilizers was not applied.

**Table 2.15: Pretreatment Nutrient status of the field**

| Treatment | OC% | $P_2O_5$ (kg/ha) | $K_2O$ (kg/ha) | Ca (ppm) | Mg (ppm) | Cu (ppm) | Zn (ppm) | Fe (ppm) | Mn (ppm) |
|---|---|---|---|---|---|---|---|---|---|
| T1—Conventional | 0.78 | 69.05 | 381.35 | 14.17 | 0.63 | 1.265 | 16.90 | 93.30 | 12.47 |
| T2-Conventional + Biofertilizers | 0.79 | 78.20 | 269.28 | 13.695 | 0.58 | 0.9 | 22.50 | 75.77 | 10.28 |
| T3-50 % N & P, 100% K+ Boifert | 0.71 | 65.79 | 272.99 | 10.445 | 0.52 | 0.89 | 21.60 | 91.19 | 11.88 |
| T4-75 % N & P, 100% K+ Boifert | 0.83 | 24.72 | 247.61 | 8.42 | 0.53 | 0.69 | 22.16 | 95.77 | 11.01 |

**Table 2.16: Microbial population in soil before and after imposing treatments (cfu/g dry soil)**

| Treatments | Bacteria | | Fungi | | P-solubilizers | |
|---|---|---|---|---|---|---|
| T1-Conventional | Before | After | Before | After | Before | After |
| | $10^5$ | $10^6$ | $10^4$ | $10^4$ | $10^5$ | $10^5$ |
| T2- Conventional + BF | 39.45 | 10.6 | 3.92 | 8.72 | 12.14 | 17.42 |
| T3-50% N & P, 100% K+BF. | 30.74 | 65.67 | 2.70 | 31.06 | 4.85 | 65.15 |
| T4-75 % N & P, 100% K+BF. | 22.00 | 37.08 | 1.38 | 11.99 | 3.78 | 62.92 |

**Table 2.17: Microbial population *(N-fixers* and *Actinomycetes)* in soil before and after imposing treatments (cfu/g dry soil)**

| Treatments | N-fixers | | *Actinomycetes* | |
|---|---|---|---|---|
| | Before | After | Before | After |
| T1-Conventional | $10^3$ | $10^4$ | $10^5$ | $10^5$ |
| T2- Conventional + BF | 18.4 | 24.63 | 19.27 | 70.83 |
| T3-50% N & P, 100% K+BF. | 23.30 | 34.09 | 14.19 | 410.6 |
| T4-75 % N & P, 100% K+BF. | 22.68 | 11.99 | 8.60 | 249.07 |

## 2.5 Efficacy of soil and water conservation techniques coupled with organic and inorganic manuring in cashew garden grown in slope areas

### Expt B: Evaluation of different soil and water conservation measures in relation to soil moisture availability and yield of cashew plantations grown in steep slopes

In order to evaluate various soil and water conservation measures in relation to soil moisture, yield and economics, this experiment was laid out with five treatments namely, modified crescent bund (at 2 m radius having a crescent shaped bund of 6 m length, 1m width and 0.5 m height) (T1), staggered trenches with coconut husk burial between two rows of cashew (trenches of size five m length, 1m width and 0.5 m depth in the middle of four plants with coconut husk buried) (T2), reverse terraces (2 m length, 2 m width and 0.7 m depth of cut) (T3), catch pits (3 m length, 0.5 m width and 0.5 m depth) (T4) and control plot without any soil and water conservation measure (T5). It was laid out in RBD with four replications having 25 grafts of "Madakkathara-2" variety planted along the contour in the year 2003. Two treatments of mulching for cashew plants using locally available plant materials (T6) and fodder *Stylosanthes* (T7) was imposed for five plants each in the soil and water conservation experiment. The soil moisture content, cashew nut yield and growth data were recorded during 2008-09.

### 2.5.1 Soil moisture content and nutrient content

Soil samples at 0-30 cm, 30-60 cm and 60-90 cm depths were collected from 1 m radius of the plant from December 2008 to May 2009 and at soil moisture content (SMC) was determined under the different treatments. During December 2008, mean soil moisture content (0-90 cm) of 18.8 to 21.2 per cent dry basis was observed in modified crescent bund treatment, coconut husk burial treatment, reverse terrace and mulch treatments compared to soil moisture content of 16.7 per cent dry basis in control. During January 2008, the soil moisture content in the upper layer of soil (0-30 cm) was similar in all the treatments except catchpit treatment and control. At the lower layers (31-90 cm) of soil, the SMC was highest in coconut husk burial, modified crescent bund, reverse terrace and mulch treatments (16.8 to 18.5 per cent db in January) compared to control (11.6 to 12.95 %db in January) (Table 2.18). Similar trend was observed during February and March also. The available soil moisture ranged between 12 and 22 per cent dry basis. During April 2009, a rainfall of 26.9 mm received. This pre monsoon rainfall was effectively harvested by the soil and water conservation treatments and increased soil moisture. The soil moisture content at the lower layers of soil in the best treatment plots were 20.4 to 21.1 per cent dry basis compared to 17.1 to 17.5 per cent dry basis in control.

Before application of fertilizer and manure, soil samples from different treatments were analyzed for organic carbon, $P_2O_5$, $K_2O$, Ca, Mg, Zn, Mn, Cu and Fe (Table 2.19). The organic carbon content and $P_2O_5$ content of the soil at a depth of 0 to 60 cm was highest in coconut husk burial, modified crescent bund and mulch treatments (organic carbon content - 0.57 to 0.66% compared to 0.44% in control, $P_2O_5$ content - 5.8 to 6.9 kg/ha compared to 1.3 kg/ha in control). Soil $K_2O$ content was highest in mulch treatments (144 to 155 kg/ha compared to 63 kg/ha in control). The minor nutrients and micronutrients were on par in different treatments.

**Table 2.18. Mean soil moisture content (% dry basis) in January 2009**

| Treatment | Depth (cm) | | | Mean |
|---|---|---|---|---|
| Modified crescent bund | 15.6 | 16.8 | 18.5 | 16.9 |
| Staggered trenches with coconut husk burial between 2 rows of cashew | 15.8 | 17.8 | 18.6 | 17.4 |
| Reverse terraces | 12.9 | 16.5 | 18.5 | 15.9 |
| Catch pits | 11.7 | 13.5 | 12.8 | 12.6 |
| Control plot without any soil and water conservation measure | 10.8 | 11.6 | 12.9 | 11.7 |
| Mean | 13.3 | 15.2 | 16.2 | |
| CD (5%) - Treatment | | | | 1.73 |
| CD (5%) - Depth | | | | 0.68 |

### 2.5.2 Growth and nut yield

Among the different soil and water conservation structures tried, no significant difference in plant height was observed. Stem girth (61.3 cm) and canopy spread (6.2 m) was highest in modified crescent bund treatment followed by coconut husk burial and reverse terrace treatments (stem girth – 53.8 and 53.5 cm and canopy spread – 5.4 and 5.2 m) and lowest in control (stem girth – 52.3 cm and canopy spread – 5.0 m) (Table 2.20).

During the 5th year, the highest yield was obtained in coconut husk burial treatment (2.04 t/ha) and modified crescent bund treatment (2.03 t/ha/year) compared to reverse terrace (1.94 t/ha/year), catch pit (1.39 t/ha/year) and control (1.48 t/ha/year) treatments. In the treatment of mulching using *Stylosanthes*, the yield was 1.75 t/ha/year and in local mulch treatment, it was 1.68 t/ha/year. The *insitu* soil and water conservation structures effectively harvested the pre monsoon rainfall and increased the cashew yield significantly.

**Table 2.19. Nutrient status of the soil in different treatment plots (July 2008)**

| Treatments | OC (%) | P (kg/ha) | K kg/ha | Ca (ppm) | Mg (ppm) | Cu (ppm) | Zn (ppm) | Mn (ppm) |
|---|---|---|---|---|---|---|---|---|
| Modified crescent bund | 0.60 | 6.9 | 96.2 | 2.29 | 0.51 | 2.34 | 7.28 | 41.48 |
| Staggered trenches with coconut husk burial | 0.66 | 5.8 | 101.1 | 0.42 | 0.47 | 2.16 | 5.27 | 20.37 |
| Mulching with *Stylosanthes* | 0.64 | 6.6 | 155 | 3.46 | 0.81 | 1.99 | 1.15 | 26.56 |
| Local mulch application | 0.57 | 6.0 | 144 | 3.32 | 0.81 | 2.45 | 5.6 | 42.2 |
| Control | 0.44 | 1.3 | 63.3 | 0.30 | 0.15 | 1.79 | 1.01 | 6.53 |

**Table 2.20: Growth observations (2003 and 2008)**

| Treatment | Tree height (m) | | Canopy spread (m) | | Stem girth (cm) | | Yield (t/ha) |
|---|---|---|---|---|---|---|---|
| | 2003 | 2008 | 2003 | 2008 | 2003 | 2008 | 2008-09 |
| Modified crescent bund | 0.55 | 5.00 | 0.22 | 6.20 | 2.78 | 61.30 | 2.03 |
| Staggered trenches with coconut husk burial between 2 rows of cashew | 0.52 | 4.50 | 0.24 | 5.20 | 2.69 | 53.50 | 2.04 |
| Reverse terraces | 0.50 | 4.70 | 0.24 | 5.40 | 2.66 | 53.80 | 1.94 |
| Catch pits | 0.29 | 4.20 | 0.14 | 4.80 | 2.22 | 52.80 | 1.39 |
| Control plot without any soil and water conservation measure | 0.58 | 4.70 | 0.23 | 5.00 | 2.88 | 52.30 | 1.48 |
| CD (5%) Treatment | | NS | | 0.88 | | 4.35 | 0.224 |

## 2.6 Geographical Information System (GIS) and Remote Sensing (RS) technologies to develop a spatial database and to identify suitable area for expanding cashew cultivation – A study at farm level

For the preparation of spatial data base, soil samples at two different depths (0-60 cm) from 16 different plots were analyzed for major, minor and micro nutrients before and after application of fertilizer and manure. Before the application, the organic carbon content of the soil was highest in two plots (0.80 to 0.81%), medium in four plots (0.55 to 0.68%) and low in 10 plots (0.19 to 0.48%). The $P_2O_5$ content of the soil was medium in five plots (13.3 to 22.2 kg/ha) and low in 11 plots (2 to 10.8 ppm). The $K_2O$ content was high in two plots (285 to 290 kg/ha), medium in four plots (155 to 270 kg/ha) and low in 10 plots (0 to 144 kg/ha).

After application of fertilizer and manure, the OC content of the soil (0 to 60 cm depth) was highest in 10 plots (0.75 to 0.93%), medium in four plots (0.50 to 0.59%) and low in two plots with more sandy soil (0.3 to 0.46%). The $P_2O_5$ content of the soil was high in six plots (25 to 29 kg/ha), medium in two plots (12.5 to 24.9 kg/ha) and low in eight plots (2.8 to 12.49 kg/ha). The $K_2O$ content was high in 14 plots and medium in two plots. Digitization of the map of individual plots completed and spatial database preparation initiated with GIS package (Fig. 2.1 and 2.2). Classification of images and field surveys for identifying area under cashew and barren area also initiated. Spatial data base (elevation) of soil and water conservation plot is prepared for estimating the runoff and soil loss from different treatments (Fig. 2.3). The common drainage point where the runoff from the whole field occurs (green area). This spatial data is essential for identifying the locations where different soil and water conservation structures are to be constructed.

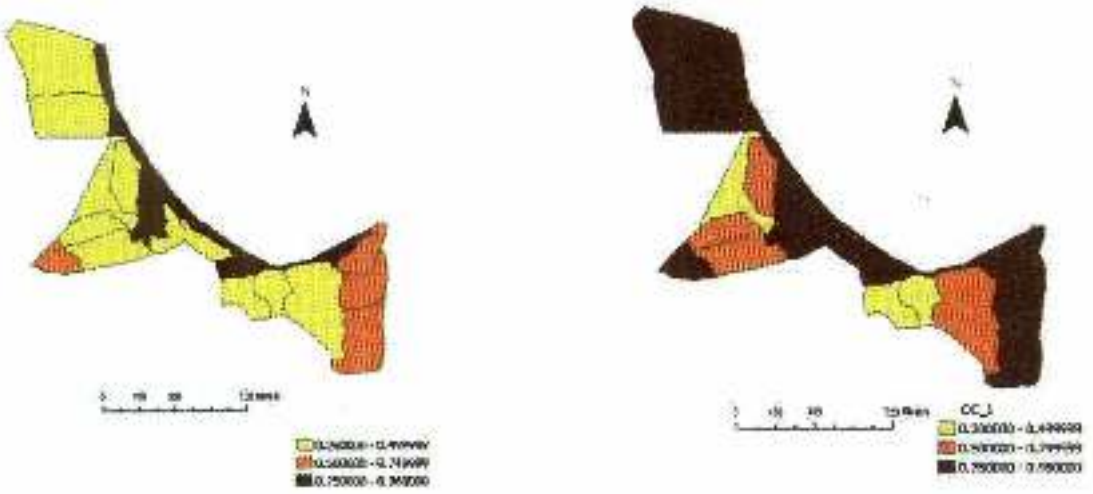


Fig.2.1. Organic carbon (OC %) in the soil before and after application of fertilizer and manure

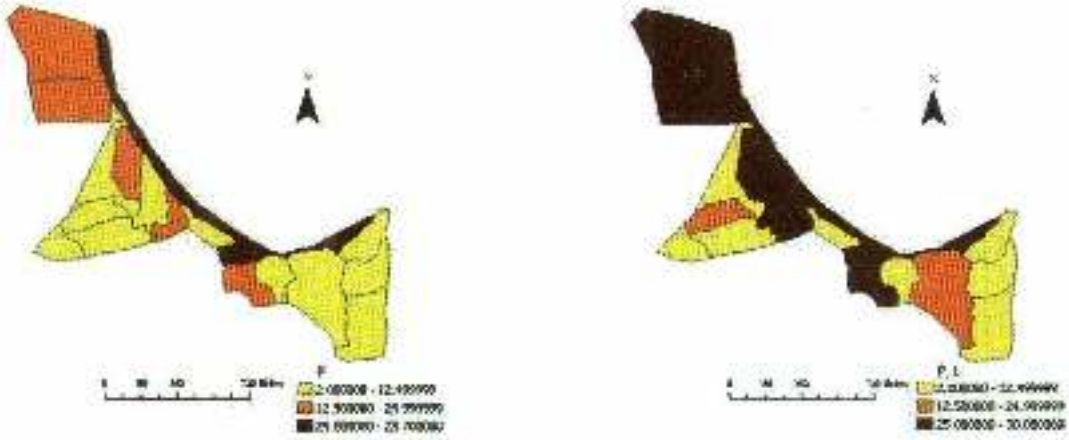


Fig.2.2. $P_2O_5$ content (kg/ha) in the soil before and after application of fertilizer and manure

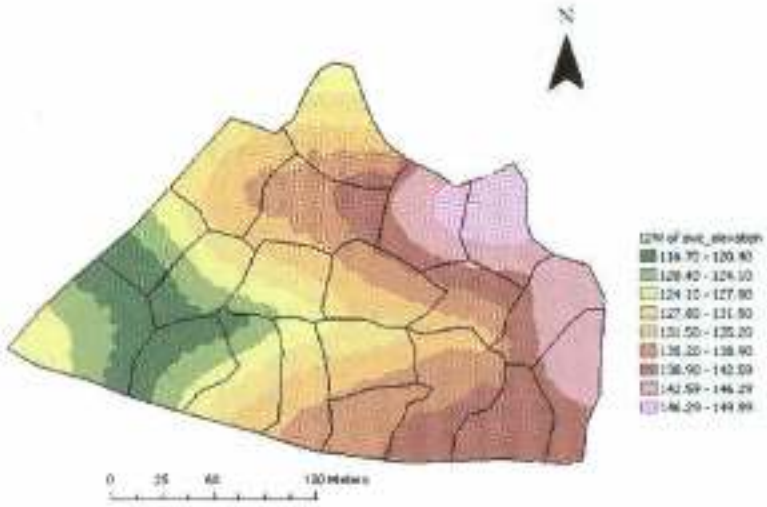


Fig.2.3. The elevation data of the soil and water conservation plot

## 2.7 Root stock studies

All the stionic combinations, excepting the ones involving 'Taliparamba-1' as rootstock, recorded nearly cent per cent grafting success. The stionic combinations involving "Taliparamba-1" as rootstock recorded around 50 per cent grafting success (Table 2.21). About 210 successful grafts obtained from 12 different stionic combinations have been field planted in a replicated trial.

Table 2.21. Graft success in various stionic combinations

| Stionic combination (scion on rootstock ) | Graft success (%) |
|---|---|
| VRI-3 / Brazil dwarf (VRI-3 scion on Brazil dwarf rootstock) | 98.7 |
| NRCC Sel-2/ Brazil dwarf | 98.7 |
| V-4/ Brazil dwarf | 100 |
| Ullal-3/ Brazil dwarf | 97.3 |
| VRI-3/ V-4 | 100 |
| NRCC Sel-2/ V-4 | 100 |
| V-4/ V-4 | 100 |
| Ullal-3/ V-4 | 98.7 |
| VRI-3/Taliparamba-1 | 48.0 |
| NRCC Sel-2/ Taliparamba-1 | 48.0 |
| V-4/ Taliparamba-1 | 50 |
| Ullal-3/ Taliparamba-1 | 50 |
| SEd | 1.9 |
| CD (1%) | 3.9 |

# 3. CROP PROTECTION

## 3.1 Storage insect pests

### 3.1.1 Survey for storage insect pests infesting cashewnuts / kernels

The cashew processing units located at Kollam in Kerala; Panruti and Kanyakumari in Tamilnadu; Digha, Ramnagar and Contai in West Bengal; Goa; Vengurle, Kudal and (Sangameshwar) Ratnagiri in Maharastra were surveyed. Two insect pests viz., *Tribolium castaneum* and *Ephestia cautella* were common in these units.

The cashew processors in Kollam (Kerala) and Kanyakumari (Tamilnadu) adopted flaming the walls and corners of the floors as well as grading equipments using a "blow torch" operated by LPG. The processors in Panruti ( Tamilnadu) adopted a technique of using zero watt incandescent bulb hung on a big crate containing water and kerosene suspension to attract and kill *Tribolium castaneum*.

All the processing units surveyed in Goa as well as Vengurle, Malwaan and Kudal (Maharashtra) had a secure and regular market for their produce either in the Panaji or Mumbai market. The regular movement of kernels did not give any scope for long duration stock holding, which would have prevented them from storage pest multiplication.

### 3.1.2 Assessing the level of damage caused by *Ephestia cautella* under laboratory

The damage caused by the major pest viz., *Ephestia cautella* was assessed under laboratory conditions by exposing whole cashew kernels (100 g) for egg laying by two pairs of adults of *E.cautella* for 24 h. It was noticed that *E.cautella* could damage upto 19.8 per cent of the kernels in 75 days leading to a weight loss of 19.22 per cent (Table 3.1)

## 3.2 Cashew stem and root borer (CSRB)

### 3.2.1 Standardizing semi synthetic diet (SSD) and mass rearing techniques

The CSRB grubs reared on SSD and on host bark had similar body weight up to 90 days.Later on, body weight was higher in case of SSD reared CSRB grubs. The older grubs reared on SSD fed voraciously, while the CSRB grubs reared on host cashew bark experienced gradual drying of host bark provided as feed (Table 3.2).

**Table 3.1: Estimation of damage by *E.cautella* on stored cashew kernels**

| Parameters | Days after allowing the *E.cautella* moths | | | | |
|---|---|---|---|---|---|
| | 15 | 30 | 45 | 60 | 75 |
| Mean no. of cashew kernels damaged | 6.0 | 8.5 | 9.8 | 11.7 | 14.3 |
| % of kernels damaged | 9.67 | 12.6 | 13.2 | 17.2 | 19.8 |
| Weight loss, % | Negligible | 1.45 | 3.03 | 9.55 | 19.22 |

**Table 3.2: Comparative body weight of the CSRB grubs reared on host bark and SSD**

| Age of the CSRB grubs (days) | Mean body weight of CSRB grubs (g) | |
|---|---|---|
| | Host bark | SSD |
| 30 - 45 | 0.64 | 0.67 |
| 46 – 60 | 1.04 | 1.03 |
| 61 - 75 | 2.69 | 2.70 |
| 76 - 90 | 3.52 | 3.71 |
| 91 -105 | 5.23 | 6.16 |
| 106 -120 | 5.95 | 6.31 |

## 3.3 Studies on black spots in kernels

### 3.3.1 Assessment of intensity of black spots in kernels obtained from imported nuts

During the survey for incidence of storage insect pests in various cashew processing units located in Maharashtra, Goa, Karnataka, Kerala, Tamilnadu, Andhra Pradesh, Orissa and West Bengal, information on the severity of black spot occurrence in the cashew nuts imported from Tanzania, Mozambique, Madagascar, Papau New Guinea, Guinea Bissau, Ivory Coast, Benin, Ghana and Indonesia was also recorded. It was reported that the intensity of black spot ranged from 0.5 2.5 per cent in the processed kernels (Table 3.3)

### 3.3.2 Estimation of black spots in nuts collected from insect protected and unprotected panicles

The panicles were caged using thin muslin cage from nut set stage till full maturity to avoid any insect infestation. Nuts collected from such protected panicles and unprotected normal panicles were processed to assess the intensity of black spots, if any. It was observed that black spot occurred both in caged and uncaged nuts. However, the percentage of black spot kernels in caged nuts was considerably lesser than in the uncaged nuts. (Table 3.4)

**Table 3.3. Incidence black spot kernel of in imported nuts**

| Country of import | % |
|---|---|
| Tanzania | 0.5 - 1.5 |
| Mozambique | 0.5 - 2.0 |
| Madagascar | 1.5 - 2.5 |
| Papau New Guinea | 0.5 - 2.0 |
| Guinea Bissau | 0.5 - 1.5 |
| Ivory Coast | 1.0 - 1.5 |
| Benin | 0.5 - 1.0 |
| Ghana | 1.0 - 1.5 |
| Indonesia | 1.0 - 2.5 |

**Table 3.4:. Incidence of black spots in nuts obtained from caged and uncaged panicles**

| Variety | % kernels having black spot (on weight basis) | |
|---|---|---|
| | Caged | Uncaged |
| V-7 | 0.52 | 0.95 |
| V-4 | 0.30 | 0.51 |
| VRI-3 | 0.32 | 0.82 |
| Ullal-4 | 0.41 | 0.75 |
| Chintamani-1 | 0.57 | 0.98 |
| NRCC Sel-2 | 0.26 | 0.83 |

### 3.4. Role of pollinators in cashew

#### 3.4.1 Honey bee colony establishment and monitoring

Colonies of *Apis cerana* (honey bee) established in both Kemminje and Shanthigodu [illegible] are observed critically. When the colonies of *A. cerana* (honey bee) and *Trigona irridipennis* (sting less bee) were maintained side by side, the honey bee colony deserted due to nuisance activities of sting less bees. Therefore, colonies of sting less bees were shifted from the premises of bee hive.

#### 3.4.2 Recording visitation of bees (pollinators)

The cashew panicles were observed constantly through video recording. By replaying, the visitation rate of *A. cerana indica* and *Pseudapis oxybeloides* could be assessed accurately and it ranged from 0.01 to 0.18 seconds/flower (Table 3.5). *P. oxybeloides* rapidly collected pollen grains from stamen of male flowers by scrubbing and very rarely the nectar whereas, *A. cerana indica* collected nectar and very rarely the pollen grains from male flowers.

#### 3.4.3 Estimation of pollen load on stigma

During the forenoon hours (11.00-12.00 h), the new bisexual flowers (before anthesis) of VRI-1 visited by honey bees were collected individually and examined under stereomicroscope to estimate the pollen load. Similarly, the new bisexual flowers after anthesis (12.00-13.30 h) were observed. Finally, in the evening (5.00 PM), that day morning flowered bisexual flowers were collected at random and examined to estimate the pollen load. The new bisexual flowers before anthesis had pollen load on 46.8 per cent of flowers whereas, the bisexual flowers after anthesis had pollen load on 40.7 per cent of flowers and finally evening randomly collected bisexual flowers had pollen deposit on 54.6 per cent of flowers (Table 3.6). As the visit of *P. oxybeloides* was also observed on new bisexual flowers before anthesis, the high level of pollination observed might be due to cumulative effect of visit by both species of bees. In spite of visit of honey bees, maximum of 46.8 per cent of flowers only ensured with pollination. At the same time, the morning blossomed bisexual flowers when collected at random at the evening, highest pollination of 54.6 per cent was observed.

While observing the pollen deposit, the total number of pollen grains deposited and the pattern of pollen deposit either as individual, clumped as two grains or more than two were counted under microscope and tabulated (Table 3.7). The results indicated that 57.4 - 65.2 per cent of pollen grains were deposited in the form of single pollen grains. Even though, on dehision of anther lobe, most of pollen grains were seen as sticky and clumped, its deposit on stigma was found to be in the form of single pollen grain. It may be possible that the pollen grains might spilled out (dusted) from the body of bees during flight activities when the bees are repeatedly visiting near cashew flowers. That may be a reason even in the newly opened flower

**Table 3.5: Visitation of bees to cashew flowers observed through video recording**

| Name of the bees | No. of bees visited on 15 panicles (in 20 minutes) | | | Visitation rate / flower (seconds) | |
|---|---|---|---|---|---|
| | Day-1 | Day-2 | Day-3 | Mean± S.D. | Range |
| *Apis cerana indica* | 3 | 2 | 2 | 0.036±0.010 | 0.02-0.05 |
| *Pseudapis oxybeloides* | 1 | 4 | 4 | 0.041±0.039 | 0.01-0.18 |

**Table 3.6: Estimation of pollen load on stigma**

| Stage | % of stigma with pollen load | Mean± S.E (pollens/ stigma) | Range (pollens/ stigma) |
|---|---|---|---|
| Before anthesis (11.00-12.00 h)* | 46.8 | 2.14±0.39 | 1-7 |
| After anthesis (12.00-13.00 h)* | 40.7 | 4.00±1.42 | 1-17 |
| Evening collected (17.00h)** | 54.6 | 3.48±0.47 | 1-15 |

*Flowers visited by *Apis cerana indica*

**Flowers collected at random

**Table 3.7: Pattern of pollen grain deposit on stigma**

| Flower types | % of pollen grain deposited as | | |
|---|---|---|---|
| | Single | Double | > 2 (clump) |
| Before anthesis (11.00-12.00 h)* | 65.2 | 17.4 | 17.4 |
| After anthesis (12.00-13.00 h)* | 57.4 | 16.2 | 32.4 |
| Evening collected (17.00 h)** | 62.8 | 13.2 | 24.0 |

*Flowers visited by *Apis cerana indica*; **Flowers collected at random

without any anthesis, deposit of pollen grain was observed (Table 3.6). This provides an indication that by enhancing the activities of bees (pollinators), highest level of pollination can be achieved. Thus productivity could be enhanced.

### 3.4.4 Management and conservation of pollinators through floral and faunal biodiversity

The floral biodiversity of pollinators observed during off season of cashew (rainy season) at coastal Karnataka was identified with the help of Botanical Survey of India, Southern Regional Station, Coimbatore and it consisted of *Lindernia antipoda* , *L. crustacea* and *L. ciliata* (Scrophulariaceae) and *Spermacoce ocymoides* (Rubiaceae). Similarly, floral biodiversity of pollinators observed during off-season and flowering season of cashew at southern Tamil Nadu was identified. It was *Ocimum adscendens* (Lamiaceae).

The seed of *Blumea lacera*, annual weed which supports the non-*Apis* species viz., *P.oxybeloides*, *Losioglossum* sp. and *Braunsapis* sp. was introduced during rainy season at Karnataka Cashew Development Corporation cashew plantation, Bajathur and the establishment was poor. But when seedlings of same was uprooted from DCR Experimental Station, Shanthigodu and directly planted, it established sparingly. It gave an indication that in future, it should be established as potted seedling instead of direct transplanting during rainy season. However, on the established plants of *B. lacera*, activities of above mentioned non-*Apis* species were also confirmed and therefore, the plants of the species can be introduced in cashew plantations of west coast where it does not exist.

## 3.5 Studies on the determination of insecticide residues in cashew apples

The cashew apple samples were collected at regular intervals from the trees treated with λ-cyhalothrin (0.003%) during cashew apple development stage. The cashew apple samples collected on 0,1,3,7, 15, 21 and 28 days after treatment were analyzed for the residues of the insecticide for studying the dissipation pattern. The residues level fell below the Maximum Residue Limit of 0.2 ppm within 15 days of treatment.

Similarly, samples were collected at regular intervals from the trees treated with carbaryl (0.2%) and were got analyzed for studying the dissipation pattern. The samples collected on 0,1,3,7, 14, 21 and 28 days after treatment were analyzed for the residues of the insecticides. The level of residues of carbaryl also fell below the Maximum Residue limit of 0.5 ppm within 15 days of treatment.

## 3.6 Evaluation of newer insecticides against tea mosquito bug (TMB)

### 3.6.1 Efficacy of fenpropathrin against TMB under field condition

Fenpropathrin (Meothrin 30 EC) supplied by M/S Sumitomo Chemical, India, Mumbai was evaluated against TMB under field condition in larger plots. Sprays were given at flushing, flowering and fruiting stages. Damage on shoots was assessed after one month

of third spray in 0 - 4 scale. The damage grade was recorded in 52 shoots in each tree and the mean damage was worked out. The damage rating in fenpropathrin (0.02%) was on par with the recommended insecticide λ- cyhalothrin (0.003%). The damage rating was 0.47 for fenpropathrin and 0.24 for λ- cyhalothrin. In untreated check, the damage rating was 1.72. There was no significant difference in the natural enemy complex in the treated plots and untreated control. The average number of predators/panicle ranged from 0.91 - 0.98 in the fenpropathrin treated plots compared to 1.06 in the untreated control. Fenpropathrin was found effective under field condition in the trials undertaken during 2007- 08 and 2008-09 flushing - fruiting season. In laboratory studies, the adults and nymphs allowed to feed on the shoots treated with this insecticide but could not survive confirming the efficacy of the insecticide.

### 3.7 Evaluation of synthetic fungicides against flower drying diseases of cashew

Spraying of synthetic fungicides viz., mancozeb, carbendazim and propiconazole was taken up in cashew variety NRCC Sel-2 during flowering season of 2008. The unopened flowers due to the disease were estimated in the spayed trees. The incidence of disease was lower in mancozeb (8.9%) treated trees followed by propiconazole (13%). The damage rating in untreated control was 29.4 per cent.

# 4. POST-HARVEST TECHNOLOGY

## 4.1 Bioavailability of minerals in cashew

Cashew apple powder of released varieties was prepared by autoclaving at 16 psi for 10 min followed by drying at 70°C for two days in a cabinet airflow dryer. The dried cashew apple was powdered and sieved through 60 mesh sieve. The sieved material was soxhelt extracted for 3 h with methanol and methanol extracted cashew apple powder was digested by both diacid and proteolytic enzymes separately and mineral composition was determined by AAS. Results are presented in Table 4.1. Significant varietal variation was noticed for mineral composition both after acid and enzyme digestion. Mineral content in the enzyme digest of cashew apple powder of released varieties is presented in Table 4.2. Per cent bioavailability of minerals of cashew apple powder of released varieties is presented in Table 4.3. Out of 35 varieties analysed, bioavailability of Fe and Mn was nil in 27 and 25 varieties respectively. Zn was not bioavailable in 12 varieties. Cu and Se were not bioavailable in three and four varieties respectively. Se was not detected in 14 varieties namely VRI-3, V-1, V-2, V-3, V-4, V-5, V-6, BPP-1, BPP-2, BPP-5, BPP-6, Akshaya, Dhana and Jhargram-1. Bioavailability of Fe, Mn and Zn is less compared to Cu and Se. It was observed that all the minerals were not bioavailable in none of the varieties analysed. A quality index was developed by giving weightage from 1 to 10 for % bioavailability varying from 0.1 to 100. Accordingly the cumulative index for different varieties is furnished in Table 4.4. The cumulative index for different varieties varied from 3 to 23. Variety V-7 had highest index of 23 while varieties Ullal-4, V1, V5, BPP-6 had lowest index of 3.

## 4.2 Design development of artificial dryer for raw cashewnut

Drying experiments were conducted with raw cashewnuts soaked in water for different time periods i.e., 3 to 72 h to understand the drying behaviour of water soaked nuts. Moisture diffusion through different layers viz., whole nut, shell and kernel during drying period was found out. A conceptual design of dryer, employing thin layer drying technique with air supply system operated by diesel powered generator/ dual system considering non-availability / erratic electric power supply in cashew growing NEH regions is prepared.

## 4.3 Studies on alternate energy utilization of cashew shell cake

A thermo-gravimetric analyzer was used to determine the weight loss of cashew shell and its cake at different temperature. Preliminary trials were conducted to generate producer gas using gasifier developed by Central Institute of Agricultural Engineering, Bhopal. It was observed that producer gas generated from cashew shell cake burnt for about 1 h 42 min for the given feed stock (6 kg).

## 4.4 Design development and evaluation of solar tunnel dryer for cashew apple

Studies on generation of heat inside solar dryers viz., cabinet and tunnel type dryer are continuing due to interruption of long spell of rain in this region. Results revealed that air temperature inside dryer could be increased to 65°C during bright sunshine days i.e., an increase of 20 to 27°C between 12 noon and 2 PM.

It was observed that cashew apple slices (1- 2mm thick- horizontally sliced) and cashew apple segments (sliced vertically from stem to nut end) require 14 h and 18 h duration to reduce its moisture partially i.e., from 81.23 per cent to 14.56 per cent (w.b), a moisture reduction of 82.08 per cent is achieved in solar drying technique.

Electrically operated convective air oven drying of partially dried apple slices required 3 to 4 h to bring down the moisture level to 5.62 per cent (air temperature maintained at 70?C inside convective air dryer).

### 4.5 Development of compact type drum roasting machine for raw cashewnuts

Cashewnut processing industries and cashew machinery manufacturers in Kerala (Quilon), Tamil Nadu (Kuzhithura) and Andhra Pradesh (Palasa and Vetapalam) were visited to understand the problems related to drum roasting process. Environmental pollution (air) due to smoke emanating from burning shell with CNSL during roasting process, health hazard to operators, optimization of processing parameters, roasting quality for better whole kernel recovery are the major problems of cashew processing units following drum roasting (DR) process. Drawing of drum roasting machine has been prepared. Accounting quality assurance factors like residence time, rotational speed of drum and feed rate after roasting and nut cracking process a conceptual design for mechanized continuous roasting process is developed.

### 4.6 Design, development and performance of online detection of spoiled in-shell cashewnuts

Information collected from cashewnut processing units in Karnataka (4), Kerala (6 units), Tamilnadu (6) and Andhra Pradesh (11) on extent of spoiled kernels (proportion) at various stages of processing revealed that it ranged from 0.75 to 5 per cent irrespective of origin of nuts. As the imported nuts are either undried or partially dried, spoiled / rejects proportion in the whole lot is higher than domestic nuts.

### 4.7 Value chain in cashew

A project on "Value chain in cashew" has been approved under NAIP Component-2 with an outlay of 1025.54 lakhs. Directorate of Cashew Research is one of the consortium members with Cashew Export Promotion Council of India (CEPC), Kollam as consortium leader. University of Agricultural Sciences, Bengaluru and Kerala State Cashew Development Corporation (KSCDC), Kollam are also associated in this project. Various tasks to be accomplished by DCR are developing standards for raw cashewnut (RCN), water activity studies on RCN, modernization of drum roasting process, Studies on kernel drying process, development of grader for RCN, refinement of grade standards for cashew kernel (colour and size based), storage and package studies on kernels etc., in collaboration with consortium partners.

Table 4.1: Mineral content (μg/100 mg) in acid digest of methanol extracted cashew apple powder prepared from autoclaved and dried cashew apple (n=3)

| Variety | Fe | Cu | Mn | Zn | Se |
|---|---|---|---|---|---|
| Ullal-1 | 7.76 | 1.19 | 2.72 | 1.88 | 2.86 |
| Ullal-2 | 6.76 | 2.43 | 1.55 | 1.96 | 2.14 |
| Ullal-3 | 2.61 | 1.01 | 1.56 | 1.41 | 4.50 |
| Ullal-4 | 2.76 | 1.35 | 1.90 | 2.00 | 2.19 |
| UN-50 | 13.07 | 1.37 | 3.24 | 1.56 | 1.75 |
| Chintamani-1 | 4.92 | 0.63 | 1.56 | 1.64 | 4.31 |
| V-1 | 2.6 | 0.55 | 0.83 | 0.71 | ND |
| V-2 | 7.21 | 1.50 | 0.89 | 0.86 | ND |
| V-3 | 5.42 | 0.98 | 1.21 | 0.82 | ND |
| V-4 | 4.99 | 1.97 | 1.03 | 0.99 | ND |
| V-5 | 7.87 | 2.16 | 1.00 | 0.57 | ND |
| V-6 | 8.98 | 1.70 | 0.79 | ND | ND |
| V-7 | 5.88 | 1.97 | 0.62 | 2.23 | 2.69 |
| NRCC Sel-1 | 3.58 | 2.54 | 1.84 | 1.75 | 9.57 |
| NRCC Sel-2 | 6.83 | 1.34 | 1.52 | 0.76 | 4.56 |
| Bhaskara | 7.70 | 0.96 | 0.64 | 1.29 | 3.26 |
| VRI-1 | 3.55 | 1.38 | 3.58 | 2.85 | 3.81 |
| VRI-2 | 5.64 | 1.04 | 0.71 | 1.30 | 1.48 |
| VRI-3 | 4.18 | 1.53 | 1.77 | 1.58 | ND |
| BPP-1 | 6.21 | 1.82 | 2.27 | 2.78 | ND |
| BPP-2 | 6.15 | 1.40 | 1.82 | 1.61 | ND |
| BPP-5 | 7.73 | 1.92 | 1.88 | 1.8 | ND |
| BPP-6 | 21.63 | 3.73 | 2.59 | 6.03 | ND |
| Jhargram-1 | 17.78 | 4.84 | 1.39 | 4.14 | ND |
| BLA-39-4 | 10.25 | 0.96 | 2.56 | 1.43 | 32.88 |
| Kanaka | 6.98 | 1.02 | 2.26 | 1.98 | 20.67 |
| Dhana | 12.34 | 1.09 | 1.66 | 2.31 | ND |
| Akshaya | 7.89 | 2.51 | 2.09 | 2.32 | ND |
| Dharasri | 11.01 | 2.41 | 2.24 | 0.92 | 1.98 |
| Bhubaneswar-1 | 60.91 | 1.73 | 3.08 | 2.89 | 19.5 |
| Amrutha | 8.38 | 2.84 | 1.88 | 1.91 | 5.45 |
| Sulabha | 15.95 | 2.66 | 1.87 | 2.96 | 1.20 |
| Anagha | 8.63 | 2.80 | 1.25 | 1.36 | 1.21 |
| Priyanka | 7.31 | 1.44 | 2.01 | 2.46 | 25.06 |
| NDR-2-1 | 126.43 | 1.47 | 5.01 | 2.65 | 9.63 |
| CD (5%) | 5.77 | 0.47 | 0.67 | 0.45 | 5.14 |

ND – Not detected

Table 4.2: Mineral content of enzyme digest of cashew apple powder (µg/100 mg) (n=4)

| Variety | Fe | Cu | Zn | Mn | Se |
|---|---|---|---|---|---|
| Ullal-1 | 0 | 0.065 | 0 | 0 | 1.66 |
| Ullal-2 | 0 | 0.265 | 0 | 0 | 1.55 |
| Ullal-3 | 0 | 0.102 | 0 | 0 | 4.02 |
| Ullal-4 | 0 | 0.158 | 0.119 | 0 | 0 |
| UN-50 | 0.474 | 0.033 | 0.20 | 0 | 0.474 |
| Chintamani-1 | 0 | 0.134 | 0.317 | 0 | 4.56 |
| V-1 | 0 | 0.103 | 0 | 0.082 | 0 |
| V-2 | 0.272 | 0.262 | 0 | 0.195 | 0 |
| V-3 | 0 | 0.191 | 0 | 0.149 | 0 |
| V-4 | 0 | 0.252 | 0.08 | 0.225 | 0 |
| V-5 | 0 | 0.456 | 0 | 0 | 0 |
| V-6 | 0 | 0.439 | 0 | 0.145 | 0 |
| V-7 | 0 | 0.378 | 0.108 | 0 | 3.137 |
| NRCC Sel-1 | 0 | 0.41 | 0.128 | 0.433 | 1.923 |
| NRCC Sel-2 | 0 | 0.309 | 0.019 | 0 | 6.711 |
| Bhaskara | 0 | 0 | 0.094 | 0.637 | 5.549 |
| VRI-1 | 0 | 0.343 | 0.259 | 0 | 5.495 |
| VRI-2 | 0 | 0.456 | 0.141 | 0 | 0 |
| VRI-3 | 0.331 | 0.057 | 0.386 | 0 | 0 |
| BPP-1 | 0.594 | 0.76 | 0.12 | 0 | 0 |
| BPP-2 | 0.239 | 0.691 | 0 | 0 | 0 |
| BPP-5 | 0.206 | 0.159 | 0.692 | 0 | 0 |
| BPP-6 | 0.625 | 0.318 | 0.094 | 0 | 0 |
| Jhargram-1 | 0.887 | 0.259 | 0.014 | 0 | 0 |
| Bla-39-4 | 0 | 2.509 | 0.805 | 0.805 | 8.39 |
| Kanaka | 0 | 0 | 0.054 | 0.275 | 17.02 |
| Dhana | 0 | 2.025 | 0.166 | 0 | 0 |
| Akshaya | 0 | 1.471 | 0.526 | 0 | 2.2 |
| Dharashri | 0 | 1.015 | 0 | 0 | 1.76 |
| Amrutha | 0 | 1.959 | 0.381 | 0 | 0 |
| Sulabha | 0 | 0.731 | 0.211 | 0 | 2.50 |
| Anagha | 0 | 0 | 0.267 | 0 | 139 |
| Priyanka | 0 | 1.665 | 0.369 | 0 | 19.24 |
| NDR-2-1 | 0 | 0.38 | 0 | 0.609 | 0 |
| Bhubaneswar-1 | 0 | 1.374 | 1.517 | 0 | 13.72 |
| CD (5%) | 0.819 | 0.206 | 0.682 | 0.329 | - |

Table 4.3 : Bioavallability of minerals of cashew apple powder (%)

| Variety | Fe | Cu | Zn | Mn | Se |
|---|---|---|---|---|---|
| Ullal-1 | 0 | 5.5 | 0 | 0 | 58.0 |
| Ullal-2 | 0 | 10.9 | 0 | 0 | 72.4 |
| Ullal-3 | 0 | 10.1 | 0 | 0 | 89.3 |
| Ullal-4 | 0 | 11.6 | 5.9 | 0 | 0 |
| UN-50 | 3.6 | 2.4 | 12.8 | 0 | 27.1 |
| Chintamani-1 | 0 | 21.3 | 19.4 | 0 | 100.0 |
| V-1 | 0 | 19.8 | 0 | 9.8 | ND |
| V 2 | 3.8 | 17.4 | 0 | 21.8 | ND |
| V-3 | 0 | 19.6 | 0 | 12.3 | ND |
| V-4 | 0 | 12.7 | 8.0 | 21.8 | ND |
| V-5 | 0 | 21.1 | 0 | 0 | ND |
| V-6 | 0 | 25.8 | ND | 18.4 | ND |
| V-7 | 0 | 19.2 | 4.8 | 100.0 | 100.0 |
| NRCC Sel-1 | 0 | 16.1 | 7.3 | 23.7 | 20.1 |
| NRCC Sel-2 | 0 | 23.1 | 2.5 | 0 | 100.0 |
| Bhaskara | 0 | 0 | 7.3 | 100.0 | 100.0 |
| VRI-1 | 0 | 24.8 | 9.1 | 0 | 100.0 |
| VRI-2 | 0 | 43.7 | 10.8 | 0 | 0 |
| VRI-3 | 7.9 | 3.7 | 24.4 | 0 | ND |
| BPP-1 | 9.6 | 41.7 | 4.3 | 0 | ND |
| BPP-2 | 3.9 | 49.3 | 0 | 0 | ND |
| BPP-5 | 2.7 | 8.3 | 37.5 | 0 | ND |
| BPP-6 | 2.9 | 8.5 | 1.6 | 0 | ND |
| Jhargram-1 | 4.9 | 5.3 | 0.3 | 0 | ND |
| Bla-39-4 | 0 | 100.0 | 56.4 | 0 | 8.4 |
| Kanaka | 0 | 0 | 2.7 | 12.1 | 17.4 |
| Dhana | 0 | 100.0 | 72.0 | 0 | ND |
| Akshaya | 0 | 58.5 | 22.7 | 0 | ND |
| Dharashri | 0 | 42.1 | 0 | 0 | 88.9 |
| Amrutha | 0 | 68.9 | 19.1 | 0 | 0 |
| Sulabha | 0 | 27.5 | 7.1 | 0 | 100.0 |
| Anagha | 0 | 0 | 0 | 0 | 100.0 |
| Priyanka | 0 | 100.0 | 15.0 | 0 | 19.2 |
| NDR-2-1 | 0 | 41.8 | 0 | 12.2 | 0 |
| Bhubaneswar-1 | 0 | 79.5 | 52.5 | 0 | 13.7 |

ND – Not detected in acid digest

**Table 4.4: Cumulative index for bioavailability of minerals in cashew apple powder**

| Variety | Fe | Cu | Mn | Zn | Se | Cumulative Index |
|---|---|---|---|---|---|---|
| Ullal-1 | 0 | 1 | 0 | 0 | 6 | 7 |
| Ullal-2 | 0 | 2 | 0 | 0 | 8 | 10 |
| Ullal-3 | 0 | 2 | 0 | 0 | 9 | 11 |
| Ullal-4 | 0 | 2 | 0 | 1 | 0 | 3 |
| UN-50 | 1 | 1 | 0 | 2 | 3 | 7 |
| Chintamani-1 | 0 | 3 | 0 | 2 | 0 | 5 |
| V-1 | 0 | 2 | 1 | 0 | - | 3 |
| V-2 | 1 | 2 | 3 | 0 | - | 6 |
| V-3 | 0 | 2 | 2 | 0 | - | 4 |
| V-4 | 0 | 2 | 3 | 1 | - | 6 |
| V-5 | 0 | 3 | 0 | 0 | - | 3 |
| V-6 | 0 | 3 | 2 | - | - | 5 |
| V-7 | 0 | 2 | 10 | 1 | 10 | 23 |
| NRCC Sel-1 | 0 | 2 | 3 | 1 | 3 | 9 |
| NRCC Sel-2 | 0 | 3 | 0 | 1 | 10 | 14 |
| Bhaskara | 0 | 0 | 10 | 1 | 10 | 21 |
| VRI-1 | 0 | 1 | 0 | 1 | 10 | 12 |
| VRI-2 | 0 | 5 | 0 | 2 | 0 | 7 |
| VRI-3 | 1 | 1 | 0 | 3 | - | 5 |
| BPP-1 | 1 | 5 | 0 | 1 | - | 7 |
| BPP-2 | 1 | 5 | 0 | 0 | - | 6 |
| BPP-5 | 1 | 1 | 0 | 4 | - | 6 |
| BPP-6 | 1 | 1 | 0 | 1 | - | 3 |
| Jhargram-1 | 1 | 1 | 0 | 1 | - | 3 |
| BLA-39-4 | 0 | 10 | 0 | 6 | 1 | 17 |
| Kanaka | 0 | 0 | 2 | 1 | 2 | 5 |
| Dhana | 0 | 10 | 0 | 8 | - | 18 |
| Akshaya | 0 | 6 | 0 | 3 | - | 9 |
| Dharasri | 0 | 5 | 0 | 0 | 9 | 14 |
| Bhubaneswar-1 | 0 | 8 | 0 | 6 | 2 | 16 |
| Amrutha | 0 | 7 | 0 | 2 | 0 | 9 |
| Sulabha | 0 | 3 | 0 | 1 | 10 | 14 |
| Anagha | 0 | 0 | 0 | 0 | 10 | 10 |
| Priyanka | 0 | 10 | 0 | 2 | 2 | 14 |
| NDR-2-1 | 0 | 5 | 2 | 0 | 0 | 7 |

# 5. TRANSFER OF TECHNOLOGY

## 5.1 Training on softwood grafting technique in cashew (SGTC)

A training programme on "Softwood grafting technique in cashew (SGTC)" was organized at this Directorate during 19-20 September 2008. Participants from the Department of Agriculture, Andaman and Nicobar island attended the programme.

## 5.2 Special training on cashew production technology

A special training programme on cashew production technology was organized at this Directorate during 22-26 September 2008 for the officials of Department of Agriculture, Andaman and Nicobar Islands. The latest developments in the production technology on cashew were explained to the trainees, which comprised of lectures, visit to experiment plots, visit to demonstration plots and processing factories.

Another two days training programme specially arranged for the benefit of farmers of North Kachar Hill Council, Assam during 20-21 February 2009 on cashew production technology and utilization of cashew apple.

## 5.3 Annual Cashew Day

The Annual Cashew Day was held on 21st February 2009 at Experimental Station, Shantigodu. The theme of the programme was "Improved cashew production technologies for higher yields". The programme was sponsored by Directorate Cashew nut and Cocoa Development (DCCD), Kochi. About 250 farmers and other dignitaries from Karnataka, Kerala and Assam attended the programme.

Progressive farmer sharing experience during annual cashew day

In the seminar organized in connection with the Annual Cashew Day, Mr. Ramamoorthy, a progressive cashew farmer, explained his experience on high density system of planting. He also explained about "Bhaskara" and "Ullal-3" varieties grown in his plot. He opined that pepper can also be taken up as an intercrop profitably along with cashew without affecting cashew yield.

Mr. M.S. Bhat another progressive farmer, explained about the utilization of fallow land existed nearby his residence for taking up cashew cultivation. He opined that by following suitable soil and water conservation measures, entire quantity of rain water can be made to percolate into the soil and thus conserved in the cashew garden itself. Dr. N. Yadukumar, Principal Scientist (Agronomy) compared the economics of establishment of cashew and rubber plantations.

Sri. Srihari, Director, Sri Kshetra Dharmasthala Rural Development Programme (SKDRDP) the Chief Guest on the occasion said that the farmers should think and make use of the available technologies at DCR, Puttur, so that they can get maximum profit from cashew.

## 5.4 Consultancy

A team of Scientists visited the cashew plantations in Gujarat during 12-16 January, 2009 on request from BAIF Development Research Foundation, Pune. The team studied the scientific reasons for low yield in the project areas and suggested measures to increase yield to the potential levels.

## 5.5 Production and supply of planting material

During the year more than two lakh cashew grafts produced in two nurseries of Directorate under Mega Seed Project, DCCD Revolving Fund and Institute revenue generation activity and distributed to farmers and Development Departments.

# 6. CONCLUDED PROJECT

## 6.1: Evaluation of cashew hybrids for the improvement of nut size in released varieties (XII C)

**(Two experiments concluded under Project 1.2: Genetic improvement of cashew for yield and quality traits)**

| | | |
|---|---|---|
| Project Leader | Dr. M. G. Bhat | (1994- 2005 ) |
| | Dr. M. G. Nayak | ( 2005- 2007 ) |
| | Dr. J. D. Adiga | ( 2007- 2008) |
| Project Number | 1.2 | |
| Project Duration | 1995 - 2008 | |

### 6.1.1 Introduction

In cashew, nut size enhances the export potential of a given variety. One of the approaches to improve the nut size of released varieties is through hybridization. Since most of the released varieties had lower nut weight ( < 7g ) an attempt was made to improve the nut size in such types by crossing with bold nut types.

### 6.1.2 Objectives

i) Improvement of the nut size in released varieties

ii) Studying the consequences of hybridization on yield and yield related parameters (nut weight, kernel weight and shelling percentage).

### 6.1.3 Treatments

Treatments

| | | |
|---|---|---|
| No. of crosses/entries | : | 5 + 1 |
| Year of planting | : | 1995 |
| Location | : | Kemminje |
| Design | : | Unreplicated |
| Plot size | : | Individual trees |
| No. of experimental plants | : | 110 |
| No. of border plants | : | 2 (VRI-2 and VTH 174 ) |
| Total no. of plants | : | 110 +2 |

### 6.1.4 Results and discussion

Among the different cross combinations , the tree no. 2452 and 2473 of the cross combination BLA139 –1 (18) x VTH 711/4 performed better over the years with respect to yield and yield related parameters (Table 6.1). The performance of all the other cross combination was poor with respect to nut size and yield.

### 6.1.5 Conclusion

The tree no. 2452 and 2473 with better performance were carried forward for further evaluation in a replicated trial.

**Table 6.1: Evaluation of cashew hybrids for the improvement of nut size in released varieties**

| Cross combination | Tree no. | Annual yield 2007 (kg/tree) | Cumulative yield (kg/tree) | No. of harvests | Mean cumulative yield (kg/tree) | Mean nut weight (g) | Kernel weight (g) | Shelling (%) |
|---|---|---|---|---|---|---|---|---|
| BLA139 -1 (18) x | 2452 | 2.6 | 32.4 | 8 | 4.1 | 8.5 | 2.5 | 33.9 |
| VTH 711/4 | 2473 | 1.0 | 21.3 | 9 | 2.4 | 10.0 | 3.2 | 30.2 |
| BLA139 -1 (19) x | 2445 | 3.5 | 10.1 | 5 | 2.0 | 9.5 | 2.2 | 23.2 |
| VTH 711/4 | 2465 | 2.1 | 14.5 | 7 | 2.1 | 10.0 | 2.6 | 26.0 |
| BLA139 -1 (264) x VTH 711/4 | 2404 | - | 4.7 | 3 | 1.6 | 10.0 | 2.2 | 22.0 |
| V-2 x VTH 711/4 | 2455 | 3.3 | 7.7 | 5 | 1.5 | 12.5 | 3.0 | 24.0 |
| | 2487 | 1.0 | 4.9 | 6 | 0.8 | 8.1 | 2.4 | 28.9 |
| VTH 711/4 x BLA 139-1(18) | 2447 | 2.0 | 16.4 | 5 | 3.3 | 6.3 | 1.6 | 25.3 |
| VTH 711/4 ( OP ) | 2480 | 1.5 | 6.2 | 5 | 1.2 | 8.3 | 2.3 | 28.0 |
| NRCC Sel-1 | 2397 | - | 2.6 | 4 | 0.6 | 7.0 | 2.2 | 34.1 |
| NRCC Sel-2 | 2488 | 1.6 | 6.3 | 4 | 1.6 | 9.0 | 2.2 | 31.4 |

# EDUCATION
# TRAINING
# GENERAL
# MISCELLANEOUS
# INFORMATION

# 7. EDUCATION AND TRAINING

- A training programme on 'Softwood grafting technique in cashew (SGTC)" was organized at this Directorate during 19-20 September 2008. Participants from the Department of Agriculture, Andaman and Nicobar island attended the meeting. The trainees were given the practical training on softwood grafting techniques in cashew and nursery management practices.
- A special training programme on "Cashew Production Technology" was organized at this Directorate during 22-26 September 2008 for the officials of Department of Agriculture, Andaman and Nicobar Island. The latest developments in the production technology on cashew were explained to the trainees, which comprised of lectures, visit to experiment plots, visit to demonstration plots and processing factories.
- A training programme on "Cashew Production Technology and Processing" was organized at this Directorate during 12-14 February, 2009 for the benefit of farmers and officials from North Kachar Hill council, Assam. The participants were given the training on cashew cultivation and processing. The trainees were taken to various experiment plots, demonstration plots and processing factories. The participants also had an opportunity of participating in the Annual cashew day of DCR on 14th February, 2009.
- The National Science Day was celebrated as 'Open Day' on 28th February, 2009 at DCR, Puttur. About 300 High School students visited this Directorate. The students were taken to the cashew museum, various laboratories and experimental plots of this Directorate. The information regarding mandate of the institute, the research accomplishments were briefed to the visitors. The options of utilizing the inter space between cashew plants by growing crops like pineapple and elephant foot yam were explained. High density planting system employing canopy architectural practices was also shown.

# 8. LINKAGES / COLLABORATION

| Name of the organization | Type of collaboration |
|---|---|
| Central Food Technological Research Institute, Mysorem | DBT sponsored project on nutraceuticals |
| SKDRDP, Dharmasthala<br>Manaje Vyavasaya Sahakari Seva Society, Kamalashile<br>Nagarika Seva Trust, Guruvayanakere | Maintenance of demonstration plots, trainings, distribution of planting materials and Annual Cashew Day |
| Directorate of Cocoa and Cashew Development, Kochi | Farmers training programme, Annual Cashew Day |
| Cashew Export Promotion Council of India, Kollam. | Insecticide residue analysis |
| Department of Horticulture, Karnataka<br>Karnataka Cashew Manufacturers' Association, Mangalore.<br>Agricultural Research Station, Ullal, Mangalore. | Farmers training programmes |

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# 10. PUBLICATIONS

## 10.1 Research Publication

Abdul Salam , M. Jacob John,P., Megale Joseph, Mini Podval, Prasanna Kumar, Yadukumar , N. and Bhat, M.G. 2008. Quantitative estimation of soil fertility and fertilizer recommendations (QUEFC) for cashew *Anacardium occidentale* *J. Plantation Crops* **36** (2): 86-94.

Balasubramanian, D. 2008. Osmotic dehydration characteristics of coconut cubes. *J. Plantation Crops* **36** (3):486-490.

Balasubramanian,D. 2007. Optimisation of processing parameters using farm level cashewnut processing. *Agricultural Engineering Today* 31(2):35-41.

Bhat, M.G., Nagaraja, K.V., Yadukumar, N. and M.G. Nayak. (2008). Cashew Research and Technology Status in India. In: Souvenir of PLACROSYM XVIII (Ed. By Dr. K.V. Nagaraja and Dr. P.S. Bhat) NRCC, Puttur, pp.55-70.

Bhat, P.S. and Raviprasad, T.N. 2008. Studies on lindane and chlorpyriphos residues in cashew kernels. *J. of Plantation Crops* **36** (2): 142-144.

Bhat, P.S. and Raviprasad, T.N. 2008. Sex pheromone of tea mosquito bug *Helopeltis antonii* Signoret (Miridae Heteroptera). *J. of Plantation Crops* **36** (3):451-453.

Nayak, M. G ., Swamy, K. R. M. , Yadukumar , N. and Raviprasad , T. N. 2008 . Effect of limb pruning on growth and yield of four cashew ( *Anacardium occidentale L.* ) varieties . *J. Plantation Crops*: 36(3): 300-303.

Raviprasad ,T.N. and Nagaraja ,K.V. 2008. Responses of cashew stem and root borers (*Plocaederus* spp) to host plant derivatives under olfactometer and electroantennogram (EAG) evaluations. *J. Plantation Crops* **36** (3):382-387.

Yadukumar, Rejani ,R.and Nadan, S.L. 2008. Studies on green manuring in high density cashew orchards. *J. Plantation Crops:* 36(3): 265-269.

Yadukumar, N. Rejani, R. and Prabhakar,B. 2008. Fertigation for efficient water and nutrient management in high density cashew plantation. *J. Plantation Crops*. 37(2): 102-110.

## 10.2 Papers presented in Symposia / Workshop / Seminar

Balasubramanian, D. 2009. Researchable areas in Post harvest Technology to Address Cashew Industry related Problems. **In:** Interactive meeting on 'Cashew Processing related Problems and Probable Solutions' conducted at Directorate of Cashew Research, Puttur, Karnataka on 6th March, 2009.

Balasubramanian, 2009. Cashewnut processing – Opportunities and challenges. **In:** Techno week program – Issues related to export of cashew and mango, conducted at Konkan Krishi Vidya Peeth, Dapoli, Maharashtra during 1-5 January, 2009.

Bhat, M G, K V Nagaraja and D. Balasubramanian. 2008. Post Harvest Technology of Cashew. **In:** Interactive meeting on post harvest technology of horticultural crops held Indian Institute of Horticultural research, Bangalore, India during 23 - 24 August, 2008.

Bhat, P.S. and Raviprasad, T.N. 2008. Sex pheromone of tea mosquito bug *Helopeltis antonii* Signoret (Miridae:Heteroptera). In: Plantation Crops Symposium –XVIII (PLACROSYM-XVIII) held at Directorate of Cashew Research, Puttur during 10-13 December 2008.

Nayak M.G. 2009 . Implementation of Mega Seed Project at DCR, Puttur and position of Revolving Fund. **In:** The review meeting of Mega Seed Project held at NASC Complex, New Delhi on 6th January 2009.

Nayak ,M.G. 2009. Status on cashew germplasm collection in Andaman and Nicobar islands **In:** seminar cum workshop on status and strategies for horticultural Development in Andaman and Nicobar islands held at CARI, Port Blair during 23-25 January 2009.

Sundararaju, D., Bhat P.S. and Raviprasad T.N. 2008. Evaluation of organic pest management techniques against tea mosquito bug in cashew. **In**: National Conference on organic farming in Horticultural Crops held at Central Plantation Crops Research Institute, Kasaragod, 15-18 October 2008.

Yadukumar, N. 2008. Nutrient Dynamics in cashew In: Interactive meeting on Nutrient Dynamics in Horticultural Crops held at Indian Institute of Horticultural Research , Hessaraghata, Bangalore -560089 during 14-15 June, 2008.

Yadukumar, N., Nayak, M.G. and Bhat, M.G. 2008. Technological intervention for organic production of cashew. **In**: National conference on organic farming in horticultural crops with special reference to Plantation crops at CPCRI, Kasaragod, Kerala, during , 15-18 October, 2008. Programme and abstracts pp: 21-22.

Yadukumar, N. , Raviprasad T.N., Bhat, M. G. 2008. Status of the effect of climatic change on yield and insect pest incidence in cashew. **In**: Brain storming session on Impact Assessment of Climate Change for Research Priority Planning in Horticultural Crops ,Central Potato Research Institute, Shimla-171001, HP, India: pp.100-104 during 6-7 September 2008.(Edited by S.S.Lal and others).

N Yadukumar, R Rejani and Bhat, M.G. 2008. Scope for adoption of soil and water management techniques to increase cashew yields in Andaman and Nicobar Islands. **In**: National Level Workshop cum Seminar On Status and Future Strategies for Horticulture Development in Andaman and Nicobar Islands held at Central Agriculture Research Institute, Portblair 744101 Andaman and Nicobar Islands during 23-25 January,2009.

## 10.3 Technical Reports / Bulletins / Compendia

Directorate of Cashew Research , 2008. Annual Report 2007-08, Puttur, Karnataka, 72 pp.

Directorate of Cashew Research , 2008. Research Highlights 2007-08, 20pp

Directorate of Cashew Research, 2008. Cashew News, Newsletter. Vol. 13 (1), Jan-Jun 2008, Puttur, Karnataka. 8 pp.

Directorate of Cashew Research, 2008. Cashew News, Newsletter. Vol. 13 (2), Jul - Dec 2008, Puttur, Karnataka. 8 pp.

## 10.4 Extension bulletins / pamphlets

Nayak M.G., Bhat P.S. and Raviprasad T.N. 2009 Top working in cashew (Kannada): Directorate of Cashew Research Extension Handout No.10 (Revised) , 6pp.

Yadukumar N. Nayak M.G. and Bhat P.S. 2009 Cashew Cultivation Practices (Kannada): Directorate of Cashew Research Extension Handout No.1 (Revised), 6pp.

## 10.5 Technical bulletin

Yadukumar,N. and Rejani,R. 2008. Soil and Water Management in Cashew Plantations. Technical Bulletin No.10. Directorate of Cashew Research. 12 pp.

# 11. LIST OF ONGOING RESEARCH PROJECTS

| | Project No. | Title |
|---|---|---|
| **I** | **CROP IMPROVEMENT** | |
| | 1.1 | Collection, conservation, ...ing and evaluation of cashew germplasm (M.G. Nayak, M.G .Bhat,Ramkesh ... and P.S. Bhat). |
| | 1.2 | Genetic improvement ... ashew for yield and quality traits (J.D.Adiga ,M. G. Nayak, Ramkesh Meena and ... Bhat). |
| | Ad hoc | Molecular characterization of cashew using RAPD and isozyme markers (Thimmappaiah). |
| | DBT | Identification of molecular markers linked to economic characters in cashew (Thimmappaiah). |
| | 1.7 | Molecular characterization of cashew germplasm (Thimmappaiah) |
| **II** | **CROP MANAGEMENT** | |
| | 2.2(h) | Fertilizer application and pruning trials in high density plantations (N .Yadukumar). |
| | 2.8 | Efficacy of soil and water conservation with organic and inorganic manuring in cashew garden grown in slope areas (R. Rejani and N. Yadukumar). |
| | 2.11 | Performance of high yielding varieties of cashew in different high density planting (N.Yadukumar and J.D.Adiga). |
| | 2.12 | Rejuvenation of trees of high density cashew orchards through canopy management (N.Yadukumar and M. G. Nayak). |
| | 2.13 | Green manuring in cashew to increase productivity of cashew (N. Yadukumar and R .Rejani). |
| | 2.14 | Geographical information system (GIS) and remote sensing (RS) technologies to develop a spatial database and to identify suitable areas for expanding cashew cultivation - A study at farm level (R. Rejani and N. Yadukumar). |
| | 2.15 | Root stock studies in cashew (J.D.Adiga and M.G.Nayak). |
| | Obser. Trial | Effect of foliar application of nutrients on growth, fruit set, yield and nut quality of cashew. |
| **III** | **CROP PROTECTION** | |
| | 3.11 | Investigations on insect fauna associate with cashewnut /kernels(TN Raviprasad and P.S. Bhat). |
| | 3.12 | Role of pollinators in improving productivity of cashew (D.Sundararaju). |
| | 3.13 | Studies on sex pheromone of shoot tip caterpillar *Hypatima haligramma* M. (Gelichiidae: Lepidoptera) (D.Sundararaju and T.N. Raviprasad). |
| | 3.14 | Studies on the determination of insecticide residue on cashew apples (P.S.Bhat and T.N. Raviprasad). |
| | 3.15 | Evaluation of alternate techniques for the management of cashew stem and Root Borer (T.N .Raviprasad and P.S. Bhat). |
| Paid up Trial | | Evaluation of newer insecticides against tea mosquito bug *Helopeltis antonii* Sig (P.S.Bhat). |
| Obsv. trial | | Evaluation of synthetic fungicides against flowering diseases of cashew (D.Sundararaju and P.S.Bhat) |
| Obsv. trial | | Studies on causes of black spot formation on cashew kernel ( T.N . Raviprasad) |
| **IV** | **POST HARVEST TECHNOLOGY** | |
| | 4.10 | Assessment of bio availability of minerals in cashew (K.V. Nagaraja). |
| | 4.11 | Design, development of artificial dryer for raw cashew nuts (D. Balasubramanian). |
| | 4.12 | Studies on alternate energy utilization of cashew nut shell cake (D. Balasubramanian). |
| | 4.13 | Design ,development and evaluation of solar tunnel dryer for cashew apple (D. Balasubramanian). |
| | 4.14 | Development of compact type drum roasting machine for raw cashew nuts (D. Balasubramanian). |
| Obsv. trial | | Design , development and performance of online detection of spoiled in ñshell cashew nuts (D. Balasubramanian). |
| **V** | **TRANSFER OF TECHNOLOGY** | |
| | 5.1 | Transfer of technology programme in cashew (M.G. Nayak ,P.S. Bhat, N.Yadukumar, J.D.Adiga and Ramkesh Meena). |

# 12. IMPORTANT MEETINGS AND SIGNIFICANT DECISIONS

## 12.1 Research Advisory Committee

| | |
|---|---|
| Prof. D.P.Ray, Vice Chancellor<br>Orissa University of Agriculture and Technology<br>Bhubaneshwar 751 003,Orissa | Chairman |
| Dr. I. Irulappan, Former Dean (Horticulture)<br>28. Abhirami Nagar. Narayanapuram Ist Main Road.<br>Narayanapuram West, Madurai 625 014<br>Tamil Nadu | Member |
| Dr. M.N.Khare, Ex-Dean. JNKVV.Jabalpur (MP)<br>24, Ravindranagar, Adhartal. Jabalpur 482 004. M.P | Member |
| Dr. Narendra Kumar, Former Director<br>Directorate of Personnel, DRDO Bhawan, Rajaji Marg.<br>New Delhi 110 011 | Member |
| Dr. P.M. Salimath, Director of Research<br>UAS, Dharwad 580 005, Karnataka | Member |
| Dr. S. Rajan, Asstt. Director General (Hort.I)<br>Indian Council of Agricultural Research<br>Krishi Anusandhan Bhavan II, Pusa<br>New Delhi ñ 110 012 | Member |
| Mr. Cyriac John,TC-25/2057,<br>KMR Residency Kunnukuzhi, Thiruvananthapuram,<br>Kerala | Non Official Member |
| Dr. P.M. Haldankar, Professor and Head<br>Department of Horticulture, College of Agriculture<br>Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth<br>Dapoli - 415 712, Ratnagiri district. Maharashtra | Non Official Member |
| Dr. M.G. Bhat. Director<br>Directorate of Cashew Research<br>Puttur, Karnataka-574 202 | Member |
| Dr. M.G. Nayak<br>Principal Scientist (Horticulture)<br>Directorate of Cashew Research,<br>Puttur 574 202 | Member-Secretary |

Composition of V RAC is w.e.f. 8.12.2008 as per the Office order F.NO. 7-1/2008-IA-V dated 17th December 2008 for three years.

The first meeting of the fifth RAC (13th meeting) of this Directorate was held on 8th June 2009 under the Chairmanship of Prof. D.P.Ray,Vice Chancellor,Orissa University of Agriculture and Technology,Bhubaneshwar 751 003,Orissa. Dr. S. Rajan,Dr. M.N.Khare, Dr. Narendra Kumar and Dr. P.M. Haldankar participated in the meeting. The progress made under the research projects was discussed in the meeting.

### 12.2. Institute Management Committee

| Name and Address | Status |
|---|---|
| Dr. MG Bhat. Director, DCR, Puttur, - 574202, DK District, Karnataka. Ph: 08251-231530, 230902 (O), 230992 (R) | Chairman |
| Dr. S. Rajan, Assistant Director General (Hort-I, ICAR, Krishi Anusandhan Bhavan-II, New Delhi-110 012, 011-25842467 (O) | Member |
| The Joint Director of Horticulture,(Plantation Crops & Plant Protection), Lalbagh, Bangalore-560 004, Karnataka | Member |
| Dr. J. Venkatesha, Director of Instruction (Hort), Horticulture College, Mudigere -577 132, Chickmagalore, District. Karnataka 08263-228022 (O); 08263-228014 (R), Mobile: 9449866912 | Member |
| Senior Finance & Accounts Officer, Central Plantation Crops Research Institute, Kudlu, Kasaragodu- 671 124 , Kerala | Member |
| Dr. D. Balasimha, Head, CPCRI Regional Station, Vittal-574243, DK district, Karnataka. 08255-265289 (O); 08255-239244 (R) | Member |
| Dr. K.V.Nagaraja, Principal Scientist (Biochemistry), DCR, Puttur - 574202, DK District, Karnataka , Ph: 08251-230902 | Member |
| Dr. Thimmappiah, Principal Scientist ( Genetics & Cytogenties), DCR, Puttur - 574202, DK District, Karnataka. Ph: 08251-230902 | Member |
| Dr. (Mrs.) R. Rejani Scientist (Soil & Water conservation Engineering), DCR, Puttur- 574202. DK District. Karnataka, Ph: 08251-230902 | Member |
| Dr.P .M. Haldankar, Professor and Head Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth. Dapoli 415 712, Ratnagiri District, Maharashtra. Mobile: 09421809721 / 09423295550 | Member |
| Cyriac John. TC-25/2057, KMR Residency, Kunnukuzhi Thiruvananthapuram, Kerala | Member |
| Asst. Administrative Officer, DCR, Puttur- 574202, DK District, Karnataka Ph: 08251 230902,236490 | Member |

The Institute Management Committee met twice on 22.11.2008 and 16.3.2009 and reviewed the progress of research project and ad-hoc projects. The equipments to be purchased and the works to be undertaken during the current year of XI Plan period were finalized during the meetings. The IMC's tenure is for three years from 28-11-2006.

### 12.3 Institute Research Committee (IRC) Meeting

The 21st Institute Research Committee (IRC) meeting was held on 29-30 May 2008. In the introductory remarks, Dr. M.G. Bhat, Director, DCR, Puttur and Chairman of the IRC meeting briefed about the progress made in different research projects. Dr. M. Abdul Salam, KAU., Vellayani released 'Research Highlights' 2007-08 of the Directorate. There were technical sessions on 'Crop Management' chaired by Dr. M. Abdul Salam : 'Crop Improvement' chaired by Dr. M.G.Bhat ;'Crop Protection' chaired by Dr. R. Chandramohanan, CPCRI, Kasaragod ; 'Post-Harvest Technology' chaired Dr. Anil Kumar Dubey, CIAE, Bhopal and 'Transfer of Technology' chaired by Dr.M.G.Bhat. The scientists of the Directorate presented progress made under various projects.

### 12.5 Institute Joint Staff Council (IJSC)

| | VII IJC |
|---|---|
| **Official Side** | |
| Dr. M.G. Bhat | Chairman |
| Dr.D. Sundararaju | Member (Upto18.2.2009) |
| Dr. J.D.Adiga | Member |
| Shri. K. Sanjeeva | Member |
| Shri. H. Ganesha | Member |
| Dr.(Mrs) R.Rejani | Member Secretary |
| **Staff Side** | |
| Shri. R.Mutharaju | Member-Secretary |
| Shri. K.V. Ramesh Babu | Member (CJSC) |
| Shri. K.M. Lingaraju | Member |
| Shri. K. Balappa Gowda | Member |
| Shri.H.Veerappa gowda | Member |
| Shri. K.Umanatha Shetty | Member |

The IJC met four times at quarterly intervals during the year to discuss about staff welfare activities

## 12.6 RAJBASHA

राजभाषा कार्यान्वयन एवं प्रगती

### राजभाषा कार्यान्वयन समिति

| | | |
|---|---|---|
| 1. | डॉ. एम. जी. भट् | अध्यक्ष |
| 2. | डॉ. टी. एन. रविप्रसाद | सदस्य |
| 3. | श्री रामकेश मीणा | सदस्य |
| 4. | श्री लक्ष्मीपती | सदस्य |
| 5. | श्री प्रकाश जी. भट् | सदस्य |
| 6. | श्री के. एम. जयराम नायक | सदस्य |
| 7. | श्री के. सीताराम | सदस्य |
| 8. | श्री उमाशंकर | सदस्य |
| 9. | कुमारी विशी लोबो | सदस्य |
| 10. | श्री रविशंकर प्रसाद | सदस्य |
| 11. | श्री के. सजीव | सदस्य सचिव |

वर्ष 2008-09 में राजभाषा कार्यान्वयन समिति की चार बैठकें आयोजित हुई । हर बैठक में निदेशालय में हो रही हिन्दी कार्यान्वयन के संबंध में चर्चा किया गया । जरूरी विचारों पर केन्द्र से आए पत्रों एवं सूचना के बारे में भी चर्चा किया गया । जैसा कि हमें वार्षिक कार्यक्रम के अनुसार निश्चित लक्ष्य दिया गया था उन लक्ष्यों के प्राप्ती के लिए की जा रही कार्रवायी के बारे में भी चर्चा किया गया । अनेक निर्णय भी लिए गए ।

हिन्दी में कार्यालयीन कार्य करनेवालों को प्रोत्साह देने की दृष्टी से पुरस्कार योजना जारी किया गया है । इनके कारण हिन्दी में काम भी ज्यादा हो रहा है । इस निदेशालय के बहुतेक कर्मचारी हिन्दी में कार्यसाधक ज्ञान प्राप्त कर चुके हैं । अन्य कर्मचारियों की प्रशिक्षण के लिए कोशिश जारी है ।

कार्यालय में सभी नामफलक, प्रपत्र, मोहरे आदियों को द्विभाषी में बनवाया गया है । कर्मचारियों को हिन्दी में काम करने की झिझक दूर करने के लिए समय समय पर हिन्दी कार्यशाला का आयोजन किया जा रहा है । सितंबर में आयोजित हुई हिन्दी पखवाडा में हमेशा की तरह कर्मचारी बडे उत्साह से भाग लिये हैं ।

### पुत्तूर नगर राजभाषा कार्यान्वयन समिति (नराकास)

काजू अनुसंधान निदेशालय, पुत्तूर नगर राजभाषा कार्यान्वयन समिति (नराकास) की संयोजक कार्यालय है । यह निदेशालय पुत्तूर नराकास की 23 सदस्य कार्यालयों में की जा रही राजभाषा गतिविधियों की समीक्षा करती है और उनको बढ़ावा देने के लिए जरूरी कार्यक्रमों को संयोजन करती है ।

इस वर्ष, जुलाई और जनेवरी में, पुत्तूर नराकास की दो अर्धवार्षिक बैठक आयोजित हुई । इन बैठकों में पुत्तूर और विट्ल के सभी केन्द्र सरकारी कार्यालयों से कार्यालय प्रधान / अधिकारी भाग लिए । इन में क्षेत्रीय कार्यान्वयन कार्यालय से आए अधिकारी भाग लिए और मार्गदर्शन किए । हर कार्यालय में हो रही गतिविधियों की समीक्षा करना और उन्हे आगे बढ़ाने के लिए जरूरी सूचना, मार्गदर्शन देना इन बैठकों का उद्देश था । इसी दृष्टी से अनेक विचारों पर चर्चा भी किया गया और निर्णय भी लिया गया ।

सभी सदस्य संघटनों की कर्मचारियों की सुविधा के लिए जुलाई महिने में एक दिन की हिन्दी कार्यशाला आयोजन किया गया था । उनेक विद्वानों ने मार्गदर्शन किया ।

सितंबर 14-28 तक बहुत उत्साहपूर्ण वातावरण में हिन्दी पखवाडा मनाया गया । इस अवसर कर्मचारियों और विद्यार्थियों केलिए अनेक प्रतियोगिताओं का आयोजन किया गया । विद्यार्थियों को, हिन्दी सीखने की प्रति प्रेरणा देने के लिए, हिन्दी परीक्षाओं में उत्तम अंक प्राप्त करने केलिए नगद पुरस्कार से सम्मानित किया गया । हिन्दी की प्रसारण को विस्तृत रूप देने की दृष्टी से हिन्दी अध्यापकों को, पोषकों को भी कार्यक्रम में शामिल किया गया । संयोजक कार्यालय में, सदस्य कार्यालय के कोई भी कर्मचारियों को हिन्दी सीखने के लिए जरूरी सुविधा दिया जा रहा है ।

## 13. PARTICIPATION IN SYMPOSIA / CONFERENCES / SEMINARS / MEETINGS

| | | |
|---|---|---|
| Bhat, M.G.<br>Yadukumar, N. | Interactive meeting on Nutrient Dynamics in Horticultural Crops held at Indian Institute of Horticultural Research , Hessaraghatta, Bangalore. | 14-15 June. 2008 |
| Bhat, M.G. | 139th Board Meeting of Karnataka Cashew Development Corporation (KCDC), Mangalore at Mangalore | 21 June ,2008. |
| Nayak, M.G. | Meeting on Innovative Extension methodologies held at IIHR, Bangalore. | 24 June, 2008. |
| Nayak, M.G. | Annual day celebration of Jana Jagruthi. Rural development, dividend sharing and de - addiction programme of SKDRDP at Putur. | 26 June,2008. |
| Bhat, M.G. | Third meeting of 'Steering Committee on Cashew' in Krishi Bhawan, New Delhi. | 8 July, 2008. |
| Bhat, M.G.<br>Nagaraja K.V. | Interactive Meeting on Post Harvest Technology in Horticultural Crops at Indian Institute of Horticultural Research, Bangalore. | 23-24 August, 2008. |
| Bhat, M.G.<br>Yadukumar, N.<br>Raviprasad , T.N. | Brain Storing session on 'Impact Assessment of Climate Change for Research Priority Planning in Horticultural Crops' at Central Potato Research Institute, Shimla-171001. HP. | 6-7 September, 2008. |
| Bhat, M.G. | 140th Board Meeting of Karnataka Cashew Development Corporation (KCDC), Mangalore and 30th Annual General Meeting at Mangalore | 4 October ,2008. |
| Nayak, M.G. | Review meeting of cashew Research Programme of ICAR Research Complex, Goa. Held at Ela farm, Old Goa. | 7 October, 2008. |
| Bhat, M.G.<br>Yadukumar, N.<br>Sundararaju,D. | National Conference on Organic Farming in Horticultural Crops with Special Reference to Plantation Crops held at Central Plantation Crops Research Institute , Kasaragod 671124, Kerala | 15-18 October, 2008. |

| | | |
|---|---|---|
| Yadukumar, N.<br>Balasubramanian D. | Training Cum Workshop on Intellectual Property and Technology Management held at Central Tuber Crops Research Institute, Sreekariam, Thiruvananthapuram, Kerala | 30 October -1 November ,2008. |
| Bhat, M.G. | National Seminar on Piperaceae at Indian Institute of Spices Research, Calicut. | 21-22 November, 2008. |
| Rupa, T. R. | National Seminar on Developments in Soil Science 2008 : 73rd Annual Convention of Indian Society of Soil Science held at University of Agricultural Sciences , Bangalore. | 27-30 November, 2008. |
| Director and all Scientists | Plantation Crops Symposium - XVIII (PLACROSYM XVIII) held at Directorate of Cashew Research, Puttur 574 202, Karnataka. | 10-13 December, 2008. |
| Bhat, M.G.<br>Nayak, M.G. | Review meeting of Mega Seed Project' Seed Production in Agricultural Crops and Fisheries ' at NASC Complex, ICAR, New Delhi. | 5-6 January, 2009. |
| Bhat ,M.G. | ICAR Directoris conference at NASC Complex, ICAR, New Delhi. | 15-16 January, 2009. |
| Yadukumar, N.<br>Nayak, M.G. | National Level Workshop cum Seminar On Status and Future Strategies for Horticulture Development in Andaman and Nicobar Islands held at Central Agriculture Research Institute, Portblair 744101 Andaman and Nicobar Islands. | 23 - 25 January, 2009. |
| Director and all Scientists | Interactive meeting on "Cashew Processing related Problems and Probable Solutions" jointly conducted by DCR, Puttur, CEPC, Kochi and KCMA, Mangalore at Directorate of Cashew Research, Puttur, Karnataka. | 6 March, 2009. |
| Bhat M.G. | 142nd Board Meeting of Karnataka Cashew Development Corporation (KCDC), Mangalore and 30th Annual General Meeting at Mangalore | 23 March ,2009. |

# 14. FARMER'S DAY/KRISHIMELA/EXHIBITION/ CAMPAIGNS/CONSULTANCY

| | | |
|---|---|---|
| Nayak, M.G. | Krishi Mela Programme organised by SKDRDP and Self Help Group of Bellippadi near Puttur, Karnataka. | 20 December, 2008. |
| Nayak, M.G. | Krishi Mela programme of SKDRP held at Mundoor, Puttur, Karnataka. | 28 January, 2009. |
| Nayak, M.G.<br>Bhat, P.S. | Consultancy visit to Gujarat (Navsari, Valsad and Dang districts) for guidance on cashew cultivation to the beneficiaries of BAIF Development Research Foundation, Pune. | 12-16 February, 2009. |
| Director, all Scientists, technical and administrative staff | Annual Cashew Day at DCR, Puttur. | 21 February, 2009. |
| All Scientists | National Science Day 2009 | 28 February, 2009. |

# 15. DELEGATION / TRAINING

| | | |
|---|---|---|
| Nayak, M.G. | Training programme on General Management Programme at Administrative Staff College of India, Hyderabad | 21 July - 8 August, 2008 |
| Yadukumar, N. | Training Cum Workshop on Intellectual Property and Technology Management held at Central Tuber Crops Research Institute, Sreekariam, Thiruvananthapuram, Kerala | 30 October - 1 November, 2008 |
| Rejani, R. | Short Course on 'Application of GIS in Plant Biodiversity and Horticulture' | 25 February to 6 March, 2009. |

# 16. DISTINGUISHED VISITORS

| | |
|---|---|
| Sri. Anthony De Sa , IAS<br>Director<br>UNIDO Centre for South South Industrial co-operation (UCSSIC), New Delhi | 30 April, 2008. |
| Sri. K.P.Lall<br>National Programme Officer<br>UNIDO Centre for South South Industrial co-operation (UCSSIC), New Delhi | 30 April, 2008. |
| Dr. H.P. Singh<br>Deputy Director General (Hort)<br>ICAR, New Delhi | 13 December 2009 |
| Sri. A.K.Upadhyay<br>Additional Secretary, DARE<br>and Secretary ICAR ,<br>Government of India<br>New Delhi. | 24 December, 2008. |
| Dr.Thrilok Chandra<br>Assistant Commissioner<br>Puttur, Karnataka. | 6 February, 2009. |

# 17. PERSONNEL

## Managerial

Director Dr. M.G. Bhat

## 17.1 Scientific

| Discipline | Scientist | Scientist (Sr.Scale) | Sr.Scientist | Pr.Scientist | Total (Incl. vacant posts) |
|---|---|---|---|---|---|
| Agricultural Engg. (ASPE) | | | D. Balasubramanian | — | 1 |
| Agricultural Entomology | — | — | P.S. Bhat<br>T.N. Raviprasad | D.Sundararaju (Upto 18.2.09) | 3(1) |
| Agril.Extension | Vacant | - | — | — | 1(1) |
| Biochemistry (Pl.Sci.) | — | — | | KV Nagaraja | 1 |
| Biotechnology | — | — | — | Thimmappaiah (Gen.& Cyto.) | 1 |
| Computer Application | PD.Sreekanth * | — | — | — | 1 |
| Genetics and Cytogenetics | Vacant | | Vacant | — | 2(2) |
| Horticulture | Ramkesh Meena (w.e.f.15.5.08) | — | J.D. Adiga<br>Vacant 1 post | M.G. Nayak | 4 (1) |
| Plant Physiology | Vacant | — | — | — | 1 (1) |
| Soil Science | — | — | — | N Yadukumar (Agr.) | 1 |
| Soil and Water Cons. Engg. | — | R. Rejani | — | — | 1 |
| Soil Science - Soil Physics and water conservation | — | — | — | T.R.Rupa(w.e.f.30.10.08) | 1 |
| Total | 5(3) | 1 | 6(2) | 6(1) | 18 (6) |

* On study leave for Ph.D.

Figures in the parantheses indicate no. of vacant posts.

### 17.2. Technical

| | |
|---|---|
| Sri. K.Muralikrishna | Farm Superintendent 'I'(7-8) |
| Sri. P. Adbulla | Farm Superintendent 'I' (7-8) |
| Sri. A.Padmanabha Hebbar | Tech. Officer (Elec.) (T 5) |
| Sri. R.Anilmony | Tech. Officer (lib.) (T-6 ) |
| Sri. Prakash G Bhat | Tech. Officer (T-6) |
| Sri. N.Manikandan | Technical Officer (T-5) |
| Sri. R. Muthuraju | Technical Officer (Computer) (T-5) |
| Sri. K. Seetharama | Technical Officer (T-5) (Farm) |
| Sri. Lakshmipathi | Technical Officer (T-5) |
| Sri. R. Lakshmisha | Technical Officer (T-5) |
| Sri. K.V. Ramesh Babu | Technical Officer (T-5) |

A. Poovappa Gowda (**T4**) Ravishankar Prasad, K. Babu Poojary, Sri. Bejmi Veigas, Sri. K.K. Madhavan(upto 20.1.09) and Sri. K. Umanath (**T2**).

### 17.3. Administration

| | |
|---|---|
| Sri Ganesha | Assistant Finance and Accounts Officer |
| Sri.K.Sanjeeva | Assistant Administrative Officer |
| Sri. K. Jayarama Naik | Assistant Administrative Officer (Stores) |

Ms. B. Jayashree and Sri. O.G. Varghese (Personal Assistants); Ms. K. Reshma (Jr. Stenographer); Sri. K.M. Lingaraju and Ms. M. Ratna Ranjani (Assistants) Ms. Winne Lobo, Sri. Rosario Mascarenhas and Ms. Leela (UDCs); Sri.Uma Shankar and Ms Padmini Kutty (LDCs); Sri. K. Balappa Gowda (Gestetner Operator)

# 18. MISCELLANEOUS

### 18.1 Posting nursery information on DCR , Website

Information on availability of about 25 lakh cashew grafts produced in cashew nurseries of five cashew growing states were posted in DCR, website for the benefit of cashew growers all over the country.

### 18.2 Visitors

About 1500 visitors viz., farmers, development department officials were provided knowledge about the research and development activities of DCR, Puttur.

### 18.3 Consultancies

A consultancy trip was made to Gujarat (Navsari, Valsad and Dang districts) during first week of February, 2009 to offer expert advice on cashew cultivation to the tribal farmers who are the beneficiaries of BAIF Development Research Foundation, Pune. The farmers were given advice mainly on cashew cultivation aspects such as manuring, training and pruning and plant protection. The team of scientists from DCR, suggested the organization to try different cashew varieties in the region to know the suitability of the varieties and also to overcome the flower drying problem.

### 18.4 PLACROSYM XVIII

Plantation Crops Symposium (PLACROSYM) is held biennially at different Research Institutes engaged on Research and Development of Plantation Crops in the country. The crops include arecanut, cashew, cocoa, coconut, coffee, oil palm, rubber, spices and tea. PLACROSYM was initiated with an objective to bring the scientists working on these crops to a common platform for interaction and exchange of ideas and technologies developed in various member institutions and to formulate strategies to solve the problems in plantation sector. PLACROSYM - XVIII (eighteenth in the series) was held at Directorate of Cashew

Research, Puttur during 10-13 December 2008. The theme of the symposium was "Achieving competitiveness through improvement of productivity and quality in plantation crops". Dr. M.G. Bhat, Director, DCR, Puttur was the General Chairman and Dr. K.V. Nagaraja, Principal Scientist (Biochemistry), DCR, Puttur was General Convener for this national level symposium. Dr. P.Rethinam, Former Executive Director, Asian and Pacific Coconut Community (APCC), Jakarta, Indonesia inaugurated the symposium on 10 December, 2008. Dr. K.V.Ahamed Bavappa , FAO Expert and Founder President Indian Society of Plantation Crops (ISPC), Kasaragod presided over the inaugural function. Dr. M.K. Nair former Director, Central Plantation Crops Research Institute (CPCRI), Kasaragod was the Guest of Hounor. A Souvenir containing articles contributed by all the organizing institutions, the special issue of Journal of Plantation Crops containing accepted papers for PLACROSYM - XVIII, technical bulletins viz.,' Soil and water management in cashew plantations " published by DCR, Puttur ; " Bunch analysis of oil palm" and "Estimation of mesocarp oil from oil palm fruits" published by Directorate of Oil Palm Research Pedavegi, Andhra Pradesh and " Coconut nursery management " published by CPCRI, Kasaragod were released. On 10th December 2008, Dr. P.Rethinum presented the theme paper "Achieving competitiveness through improvement of productivity and quality in plantation crops". On 11th December 2008 , Dr. Ahmed Bavappa delivered a special talk on "Plantation Crops Industry in the 21st Century .

There were six technical sessions viz., 1) Breeding Strategies in Plantation Crops; 2) Biotechnology Approaches for Improvement of Productivity and Quality; 3) Production Technology for Plantation Crops; 4) Protection Technology for Plantation Crops; 5) Product Diversification and Value Addition in Plantation Crops and 6) Technology Transfer and Market Analysis of Plantation Crops. In each session, there were presentation of lead papers and oral/poster presentation of research articles.

On 13th December, 2008, Dr. H.P. Singh, Deputy Director General (Hort.), ICAR, New Delhi Chaired the plenary session. Dr. V.A. Parthasarathy, Director, IISR, Calicut and Dr. M.G. Bhat, co-chaired the session. Dr. M.G. Bhat, welcomed the dignitaries and delegates. Dr. K.V. Nagaraja, presented the proceedings and recommendations of various technical sessions. The following recommendations emanated after the deliberations.

- There should be a session in the future PLACROSYMs for the farmers to discuss their field problems and to interact with the scientists. This can be in the form of an open forum.
- A committee is to be constituted to review the status of the plantation crop scenario in India and to make recommendations for planning strategies for improvement of plantation crops industry in India and also to provide policy recommendations on research and development aspects.
- Indigenous farm machineries are to be developed for specific requirements. Governmental initiatives should be made in this regard. There should be a separate session on Farm Mechanization and more papers should also be presented in that session during future PLACROSYMs. 'Mechanization of harvesting' and 'Post harvest management' also may be covered in this session on Farm Mechanization.

On 13th December 2008, Dr. H.P. Singh, DDG (Hort.) delivered the key note address on "Enhancing research competitiveness in plantation crops". In his address, he highlighted the research achievements made in plantation crops. He emphasized that the science and technology should be brought together to tackle the problems faced by the plantation crops sector. PLACROSYM should act as a catalyst for conducting high quality R&D in Plantation Crops and should have clear cut objectives. There should be rethinking on continuation of PLACROSYM in the present form or need for modification due to the changed situation as compared to the period when PLACROSYM was started in 1978. The outcome of last PLACROSYMs should be analysed to evaluate the fulfillment of the purpose of organizing such symposia. Various awards and honours sponsored by ISPC were distributed to the concerned by Dr. H.P. Singh, DDG (Hort.) during the Plenary Session. The session ended with a vote of thanks by Dr. P.S. Bhat, Member of Working Committee (DCR,Puttur).

## 18.5 Average weather data (2008-' 09)

| Month | Maximum Temperature (°C) | Humidity (%) FN | AN | Rainy days | Rainfall (mm) | Sunshine hours | Evaporation |
|---|---|---|---|---|---|---|---|
| Apr.08 | 35.1 | 91 | 54 | 3 | 27.9 | 7.8 | 5.3 |
| May 08 | 35.0 | 92 | 58 | 4 | 62.6 | 6.8 | 4.4 |
| Jun. 08 | 29.6 | 96 | 87 | 24 | 879.8 | 1.4 | 2.2 |
| Jul. 08 | 31.1 | 94 | 78 | 26 | 715.3 | 1.9 | 2.5 |
| Aug. 08 | 31.0 | 94 | 73 | 17 | 464.6 | 2.7 | 2.9 |
| Sept. 08 | 32.1 | 94 | 72 | 10 | 263.4 | 3.9 | 3.2 |
| Oct. 08 | 34.7 | 93 | 57 | 12 | 211.9 | 6.2 | 3.5 |
| Nov. 08 | 35.4 | 90 | 56 | 4 | 48.9 | 8.0 | 3.7 |
| Dec. 08 | 34.8 | 91 | 56 | 1 | 16.8 | 9.2 | 3.9 |
| Jan. 09 | 35.4 | 92 | 52 | 0 | 0.0 | 9.7 | 4.6 |
| Feb. 09 | 37.3 | 92 | 46 | 0 | 0.0 | 9.4 | 5.4 |
| Mar.09 | 38.0 | 90 | 44 | 1 | 5.8 | 8.2 | 5.1 |

## 18.6. LIST OF DCR PUBLICATIONS

| Sl. No. | Publication | Price (Rs) |
|---|---|---|
| 1 | Cashew Production Technology (Revised) | 50.00 |
| 2 | Softwood grafting and nursery management in cashew | 35.00 |
| 3 | Annotated Bibiliography on Cashew | 75.00 |
| 4 | Catalogue of Minimum Descriptors of Cashew | |
| | Germplasm accessions - I | 165.00 |
| | Germplasm accessions - II | 125.00 |
| | Germplasm accessions - III | 128.00 |
| 5 | Question and Answers regarding Cashew Cultivation (English) | 31.00 |
| 6 | Status of Cashew Germplasm Collection in India (Booklet) | |
| 7 | High Density Planting of Cashew (Booklet) | |
| 8 | Compendium of Concluded Research Projects (1986- 2001) | |
| 9 | Indigenous Technical Knowledge in Cashew | |
| 10 | Sudharitha geru besaya kramagalu (Booklet in Kannada) | 15.00 |
| 11 | Cashew Nutritive Value Revised (Brochure) | |
| 12 | Database on cashew nut processing in India (2003) | 100.00 |
| 13 | Directory of cashew nut processing industries in India (2003) | 100.00 |
| 14 | Process catalogue on development of economically viable on-farm cashew nut processing | 45.00 |
| 15 | Cashew cultivation practices (Pamphlet) | |
| 16 | Annotated bibliography on cashew 1995-2007 | 205.00 |
| 17 | Soil and water management in cashew plantations | 30.00 |

Price indicated above does not include postage.

Address your enquiries to the Director, DCR, Puttur - 574 202, D.K., Karnataka.

Besides, leaf and soil analysis are undertaken on payment basis.