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वार्षिक प्रतिवेदन 2023

भाकृअनुप
ICAR

भा.कृ.अनु.प. - काजू अनुसंधान निदेशालय

(आई.एस.ओ. 9001:2008)

पुत्तूर - 574 202, कर्नाटक, भारत

ICAR-Directorate of Cashew Research

(ISO 9001:2008)

Puttur - 574 202, Karnataka, India

काअनि
DCR

Annual Cashew Day

Foundation day celebration at DCR, Puttur

ICAR sponsored Short Course on Improved Crop Production Technologies organized at ICAR-DCR, Puttur

वार्षिक प्रतिवेदन
Annual Report
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Front cover

From bottom to top: Variety Nethra Jumbo - 2 Cashew Apple, Kernels and 3 in1 moisture meter

Back cover

Images: Cashew microsatellite database and drone technology demonstration

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प्राक्कथन

मुझे आईसीएआर-काजू अनुसंधान निदेशालय (आईसीएआर-डीसीआर), पुत्तूर की वार्षिक रिपोर्ट 2023 प्रस्तुत करते हुए खुशी हो रही है। रिपोर्ट में फसल सुधार, फसल प्रबंधन, फसल सुरक्षा, फसल कटाई के बाद की प्रौद्योगिकी और प्रौद्योगिकी हस्तांतरण के साथ-साथ अन्य संस्थागत गतिविधि के क्षेत्र में इस वर्ष के दौरान की गई गतिविधियों और उपलब्धियों को शामिल किया गया है।

फसल सुधार के अंतर्गत, नेश्रा जंबो-2 - एक नया काजू संकर, बड़े आकार की बीज की किस्म के रूप में जारी किया गया है। नेश्रा जंबो-2 (एच-125), एक नया आशाजनक जंबो काजू संकर, संकरण के माध्यम से विकसित किया गया था। इस जंबो नट प्रकार (≈13 ग्राम), असामयिक और क्लस्टर बेरिंग (गुच्छों में), उच्च उपज और उच्च शेलिंग प्रतिशत (29.30) की एक अनूठी विशेशता के साथ आशाजनक पाया गया। नेश्रा जंबो-2 में एक विशेष गुण है जैसे टेस्टा को आसानी से छीला जाना, और इसका गिरी का वजन 3.4 ग्राम है जिसे 130 से बड़ी गिरी ग्रेड में वर्गीकृत किया जा सकता है। वर्ष के दौरान आठ जीनोटइप यानी वेंगुर्ला-9, जी-2, इंदिरा काजू, आरएन, टूर-1, सीएआरएस-25, जी-1, आरएफआरएस-171 को वर्णनात्मक लक्षणों के आधार पर चिह्नित और वर्गीकृत किया गया है। इसके अलावा, 41 अक्सेशनों की सीएनएसएल का आकलन किया गया और यह शून्य से 0 - 36.52 प्रतिशत तक भिन्न-भिन्न रहा।

88 InDel मार्करों का पहला सेट विकसित किया गया था और मार्करों का PIC मान 0.11 - 0.85 के भिन्न-भिन्नथा। *ए. ओथोनियानम, ए. माइक्रोकार्पम, ए. प्यूमिलम* और *एस. एनाकार्डियम* में InDel मार्करों के प्रवर्धन ने क्रमश: 84.68, 79.84, 74.19 और 58.06 प्रतिशत का सफल प्रवर्धन दिखाया। ''काजू माइक्रो सैटेलाइट डेटाबेस (सीएमडीबी)'' नामक एक वेब-आधारित डेटाबेस को उपयोगकर्ता के अनुकूल डेटाबेस के माध्यम से अनुसंधान समुदाय को सिलिको में खनन किए गए जीनोमिक एसएसआर के साथ-साथ ट्रांसक्रिप्टोम-आधारित एसएसआर तक पहुंच प्रदान करने के लिए डिज़ाइन किया गया।

20 साल पुराने काजू के बागान के लिए मिट्टी की 60 सेमी गहराई तक की ऊपरी परत में कुल कार्बन अवशोषण 99.52 से 104.61 मिलीग्राम / हेक्टेयर तक था। माइक्रोबियल बायोमास कार्बन 163.34 से 695.34 मिलीग्राम / किग्रा और माइक्रोबियल बायोमास नाइट्रोजन 15.39 से 78.86 मिलीग्राम / किग्रा तक था। कुल पौधों के बायोमास में कमी और ग्रीनहाउस स्थितियों के तहत काजू के पौधों से प्राप्त पत्तियों की आयन सामग्री में परिवर्तन के आधार पर 250 मिमी की महत्वपूर्ण नमक सांद्रता को मानकीकृत किया गया है। छोटे और सीमांत किसानों के लिए उपयुक्त काजू फल और बीज को अलग करने के लिए बैटरी चालित कटाई उपकरण विकसित किया। काजू में टी मॉस्किटो बग के लिए एचआईपीवी की पहचान करने के लिए अध्ययन किया गया, भास्कर के स्वस्थ पौधे जिनके लिए टीएमबी मादाओं ने प्रतिक्रिया दिखाई उनमें 2-मिथाइलनोने, बी-पिनीन, 3-कैरेन, टेरपिनोलीन, जी-टेरपिनीन, बी-कैरियोफिलीन आदि शामिल हैं।

काजू सेब पाउडर और वैक्यूम फ्राइड चिप्स की तैयारी के लिए एक यंत्रीकृत स्लाइसर विकसित किया गया था। स्टीम कंडीशनिंग विधि के लिए प्रसंस्करण के विभिन्न चरणों में संपूर्ण कर्नेल पुर्नप्राप्ति और मलिनकिरण को प्रभावित करने वाले महत्वपूर्ण मापदंडों की पहचान की गई। अनाजों और अनाजों ले समृद्ध काजू अंकुर आधारित न्यूट्री-बार विकसित किया गया है और इसकी गुणवत्ता विशेषताओं को ऑर्गेनोलेप्टिक रूप से बेहतर पाया गया है। काजू सेब पोमेस पाउडर का उपयोग करके कुकीज़ तैयार की गई। काजू उगाने वाले 10 राज्यों के लिए 11 भाषाओं में काजू की खेती के लिए एक विशेष एंड्रोइड अप्लिकेशन और काजू में कीटों और बीमारियों की पहचान के लिए एआई-आधारित ऐप विकसित किया गया। ''एकीकृत कीट प्रबंधन पर प्रमुख जोर के साथ काजू में बेहतर फसल उत्पादन तकनीक'' पर आईसीएआर प्रायोजित लघु पाठ्यक्रम का आयोजन किया गया। हितधारकों के बीच कृषि में ड्रोन अनुप्रयोगों के बारे में जागरूकता पैदा करने के उद्देश्य से योजना के तहत कृषि रसायनों / सूक्ष्म पोषक तत्वों / जैविक कीटनाशकों के छिड़काव के लिए पंद्रह ड्रोन प्रौद्योगिकी प्रदर्शनों का आयोजन किया गया।

निदेशालय ने हितधारकों के लिए फ्रंट लाइन प्रदर्शनों, विभिन्न मेलों में प्रदर्शनियों, एक्सपोज़र विजिट की सुविधा प्रदान की। निदेशालय ने काजू दिवस, पोषण वाटिका महाभियान, प्राकृतिक खेती, कृषि शिक्षा दिवस, अंतर्राष्ट्रीय महिला दिवस, स्थापना दिवस, हिंदी सप्ताह, सतर्कता जागरूकता सप्ताह, स्वच्छता पखवाड़ा संविधान दिवस और एआईसीआरपी की वार्षिक समूह बैठक जैसे विभिन्न कार्यक्रम आयोजित किए गये। काजू की छंटाई पर प्रशिक्षण कार्यक्रम आयोजित किया गया।

मैं, डॉ. हिमांशु पाठक, सचिव (डीएआरई) और महानिदेशक, आईसीएआर, डॉ. टी आर शर्मा, डीडीजी (बागवानी), और डॉ. बी.के. पांडे, एडीजी (बागवानी) को उनके निरंतर प्रोत्साहन, मार्गदर्शन और समर्थन के लिए आभारी हूँ। मैं, निदेशालय द्वारा की गई प्रगति में बहुमूल्य योगदान के लिए सभी वैज्ञानिकों और कर्मचारियों का आभारी हूँ। इस रिपोर्ट के प्रभारी संकलन और संपादन के लिए संपादकीय और प्रकाशन समिति के सदस्यों को धन्यवाद समर्पण करता हूँ।

(जे. दिनकर अडिग)
निदेशक

स्थान : आईसीएआर-डीसीआर, पुत्तूर
दिनांक : 31 दिसंबर, 2023

PREFACE

I am happy to present the Annual Report 2023 of ICAR-Directorate of Cashew Research (ICAR-DCR), Puttur. The report covers the activities and achievements made during the year in the areas of crop improvement, crop management, crop protection, post-harvest technology and transfer of technology along with other institutional activities.

Under the crop improvement, the Nethra Jumbo-2 - a new cashew hybrid is released as a big size nut variety. Nethra Jumbo-2 (H-125), a new promising jumbo cashew nut hybrid was developed through hybridization. It was found promising with a unique trait of jumbo nut type (≈13g), precocious and cluster bearing, higher yield and high shelling percentage (29.30). Nethra Jumbo-2 possess a special character like easy peeling of testa and kernel weight of 3.4 g which could be categorized in to the kernel grade bigger than W130. During the year, eight genotypes i.e. Vengurla-9, G-2, Indira Kaju, RN, Tour-1, CARS -25, G-1, RFRS-171 have been characterized and classified based the descriptor characters. Further, CNSL content of 41 accessions was estimated and varied from zero 0 - 36.52 per cent.

A first set of 88 InDel markers were developed and the PIC value of markers varied from 0.11 - 0.85. Amplification of InDel markers in *A. othonianum, A. microcarpum, A. pumilum* and *S. anacardium* showed successful amplification of 84.68, 79.84, 74.19, and 58.06 percent respectively. A web-based database entitled "Cashew Microsatellite Database (CMDB)," was designed to provide access to genomic SSRs mined in silico as well as transcriptome-based SSRs to the research community through a user-friendly database. Total carbon sequestration in the top layer up to 60 cm depth of soil for a 20-year-old cashew plantation ranged from 99.52 to 104.61 Mg ha^{-1}. The microbial biomass carbon ranged from 163.34 to 695.34 mg kg^{-1} and microbial biomass nitrogen from 15.39 to 78.86 mg kg^{-1}. A critical salt concentration of 250 mM has been standardized based on reduction in total plant biomass and changes in ion content of leaf obtained from cashew seedlings under greenhouse conditions. Developed the battery-operated harvesting device and tool for separation of cashew fruit and nut suitable for small and marginal farmers. The studies on identifying the HIPVs for tea mosquito bug in cashew was carried out, healthy plants of Bhaskara for which TMB females showed response include 2 - Methylnonae, b-pinene, 3 – carene, terpinolene, g-Terpinene, b-caryophyllene etc.,

A mechanized slicer for cashew apple was developed for the size reduction towards preparation of cashew apple powder and vaccum fried chips. Identified critical parameters influencing whole kernel recovery and discoloration at various stages of processing for steam conditioning method. Developed cashew sprout based nutri-bar enriched with cereals and grains and its quality characteristics observed to be organoleptically superior. Cookies were prepared using cashew apple pomace powder. Developed an exclusive android application for cashew cultivation in 11 languages for 10 cashew growing states and AI-based app for identification of pests and diseases in cashew. Organized ICAR Sponsored short course on "Improved Crop Production Technologies in Cashew with Major Emphasis on Integrated Pest Management". Conducted fifteen drone technology demonstrations for spraying of agricultural chemicals/micro nutrients/organic pesticide under the scheme with aim to create awareness about drone applications in agriculture among the stakeholders.

The Directorate facilitated front line demonstrations, exhibitions at various melas, exposure visits for stake holders. The Directorate organized different programmes such as Annual Group Meeting of AICRP on Cashew, Cashew Day, Poshan Vatika Mahabhiyan, Natural Farming, Agricultural Education day, International women's day, Foundation day, Hindi week, Vigilance awareness week, Swacchata pakhwada, Constitution day and a training programme on Cashew training and pruning.

I am grateful to Dr. Himanshu Pathak, Secretary (DARE) & D.G., ICAR; Dr. A. K. Singh, Former DDG (Hort.); Dr. T. R. Sharma, DDG (Hort.); and Dr. V. B. Patel, ADG (Hort.) for their constant encouragement, guidance and support. I am thankful to all the scientists and staff members for their valuable contribution in the progress made by the Directorate. I sincerely acknowledge the efforts made by the chairman and members of the editorial and publication committee for the effective compilation and editing of this report.

Place : ICAR-DCR, Puttur
Date : 31st December, 2023

(J. Dinakara Adiga)
Director

CONTENTS

1. कार्यकारी सारांश

आईसीएआर–काजू अनुसंधान निदेशालय, पुत्तूर काजू पर अनुसंधान और विस्तार गतिविधियों में शामिल है। वर्ष 2023 के दौरान विभिन्न वर्गें जैसे फसल सुधार, फसल प्रबंधन, फसल सुरक्षा, फसल कटाई के बाद की प्रौद्योगिकी और प्रौद्योगिकी के हस्तांतरण और अन्य पहलुओं के तहत की गई अनुसंधान गतिविधियों की प्रगति को संक्षेप में निम्नानुसार प्रस्तुत किया गया है। वर्ष 2023 के दौरान 9 बाह्य वित्त पोषित परियोजनाओं सहित कुल 45 अनुसंधान परियोजनाएं संचालित की गईं।

नेश्रा जंबो–2 (एच–125), एक नया आशाजनक जंबो काजू संकर, 'एनआरसीसी सेल–2-X भेढ़ासी' को क्रास् करके संकरण के माध्यम से विकसित किया गया था। इस जंबों नट प्रकार (≈13 ग्राम) को असामयिक और क्लस्टर बेरिंग, उच्च उपज और उच्च शेलिंग प्रतिशत (29.30) की एक अनूठी विशेषता के साथ आशाजनक पाया गया। इसे 5.76 किलोग्राम / पेड़ की औसत बीज उपज और 42.44 किलो ग्राम बीज / पेड़ की संचयी उपज के साथ लगातार उपज देने वाला आशाजनक किस्म पाया गया है। नेश्रा जंबो–2 में एक विशेष गुण है जैसे कि इसके टेस्टा को आसानी से छील सकते हैं, और बीज का वजन 3.4 ग्राम है जिस से इसे W130 से बड़ी बीजग्रेड में वर्गीकृत किया जा सकता है। गिरी शर्कर (11.16%), गिरी प्रोटीन (24.77%) और कुल फेट् (46.98%) जैसे ग्णवत्ता मानदंड तुलनात्मक रूप से बेहतर हैं। नेश्रा जंबो–2 का काजू सेब नारंगी से लाल रंग का, गोल आकार, वजन ≈102 ग्राम और 72% रस के साथ 11.0°B के TSS मान वाला होता है।

वर्तमान में, निदेशालय में राष्ट्रीय काजू फील्ड जीन बैंक में 555 जर्मप्लाज्म अक्सेशन् हैं। वर्ष के दौरान, आठ जीनोटाइप यानी वेंगुर्ला–9, जी–2, इंदिरा काजू, आरएन, टूर–1, सीएआरएस–25, जी–1, आरएफआरएस–171 को वर्णनात्मक लक्षणों के आधार पर चिह्नित और वर्गीकृत किया गया है। इसके अलावा, 41 अक्सेशनों की सीएनएसएल (CNSL) का अनुमान किया गया और यह शून्य से 0 – 36.52 प्रतिशत तक भिन्न भिन्न मत्रा में थी। गामा किरण से उपचारित दो लोकप्रिय किस्मों यानी भास्कर और उल्लाल–3 की बीजों और सयान् स्टिक से एक सौ तेरह एम1 अंकुर और ग्राफ्ट का रखरखाव किया गया। इसके अलावा, टीएमबी के खिलाफ 38 एम1 पौधों की जांच की गई, लेकिन सभी को अतिसंवेदनशील पाया गया।

88 InDel मार्करों का पहला सेट् विकसित किया गया था और मार्करों का PIC मान 0.11 – 0.85 के बीच विभिन्न रहा। *ए. ओथोनियानम, ए. माइक्रोकार्पम, ए. प्यूमिलम* और *एस. एनाकार्डियम* में InDel मार्करों के प्रवर्धन ने क्रमश: 84.68, 79.84, 74.19 और 58.06 प्रतिशत का सफल प्रवर्धन दिखाया। ''काजू माइक्रोसैटेलाइट डेटाबेस (सीएमडीबी)'' नामक एक वेब–आधारित डेटाबेस को उपयोगकर्ता के अनुकूल डेटाबेस के माध्यम से अनुसंधान समुदाय को सिलिको में खनन किए गए जीनोमिक एसएसआर के साथ–साथ ट्रांसक्रिप्टोम–आधारित एसएसआर तक पहुंच प्रदान करने के लिए डिज़ाइन किया गया।

20 साल पुराने काजू के बागान के लिए मिट्टी की 60 सेमी गहराई तक की ऊपरी परत में कुल कार्बन अवशोषण 99.52 से 104.61 मिलीग्राम / हेक्टेयर तक था। माइक्रोबियल बायोमास कार्बन 163.34 से 695.34 मिलीग्राम / किग्रा और माइक्रोबियल बायोमास नाइट्रोजन 15.39 से 78.86 मिलीग्राम / किग्रा तक था। कुल पौधों के बायोमास में कमी और ग्रीनहाउस स्थितियों के तहत काजू के पौधों से प्राप्त पत्तियों की आयन सामग्री में परिवर्तन के आधार

पर 250 मिमी की महत्वपूर्ण नमक सांद्रता को मानकीकृत किया गया है। छोटे और सीमांत किसानों के लिए उपयुक्त काजू फल और बीज को अलग करने के लिए बैटरी चालित कटाई उपकरण और विकसित किया।

काजू में टी मॉस्किटो बग् के लिए एचआईपीवी की पहचान करने पर अध्ययन किया गया । भास्कर के स्वस्थ पौधे जिनके लिए टीएमबी मादाओं ने प्रतिक्रिया दिखाई उनमें 2-मिथाइलनोने, β-पिनीन, 3- कैरेन, टेरपिनोलीन, γ-टेरपिनीन, β-कैरियोफिलीन आदि शामिल हैं। भास्कर के जिन संक्रमित पौधों के वाष्पशील पदार्थों के लिए टीएमबी ने प्रतिक्रिया दिखाई थी, उनकी पहचान की गई, जिनमें पी-ज़ाइलीन, ओ-ज़ाइलीन, 3-कैरेन, γ-टेरपीनेन, 4-एथिलुंडेकेन, एसिटोफेनोन 4-एथिल, हेप्टाडेकेन, β गेरानियोलीन आदि शामिल हैं। काजू सेब के एन्थ्रेक्नोज रोग के कारक जीव के रूप में *कोलेटोट्राइकम सियामेंस* की पुष्टि रूपात्मक और आणविक दृष्टिकोण के माध्यम से की गई थी।

±11 प्रतिशत की सटीकता के साथ कच्चे काजू, बिना छिलके वाली और छिली हुई गुठलियों में नमी की मात्रा निर्धारित करने के लिए 3-इन-1 'नमी मीटर' विकसित किया गया। काजू सेब पाउडर और वैक्यूम फ्राइड चिप्स की तैयारी के लिए, आकार में कमी के लिए, काजू सेब के लिए एक यंत्रीकृत स्लाइसर विकसित किया गया था। स्टीम कंडीशनिंग विधि के लिए प्रसंस्करण के विभिन्न चरणों में संपूर्ण कर्नेल पुनर्प्राप्ति और मलिनकिरण को प्रभावित करने वाले महत्वपूर्ण मापदंडों की पहचान की गई। अनाजों से समृद्ध काजू अंकुर आधारित न्यूट्री-बार विकसित किया गया है और इसकी गुणवत्ता विशेषताओं को ऑर्गेनोलेप्टिक रूप से बेहतर पाया गया है। काजू सेब पोमेस पाउडर और इसके रासायनिक घटकों का उपयोग करके तैयार की गई कुकीज़ में कच्चा प्रोटीन (6.84%), कच्चा वसा (13.3%), राख (92.30%) और फाइबर (6.33%) था।

काजू उगाने वाले 10 राज्यों के लिए 11 भाषाओं में काजू की खेती के लिए एक विशेष एंड्रॉइड एप्लिकेशन और काजू में कीटों और बीमारियों की पहचान के लिए एआई-आधारित ऐप विकसित किया गया। ''एकीकृत कीट प्रबंधन पर प्रमुख जोर के साथ काजू में बेहतर फसल उत्पादन तकनीक'' पर आईसीएआर प्रायोजित लघु पाठ्यक्रम का आयोजन किया गया। हितधारकों के बीच कृषि में ड्रोन अनुप्रयोगों के बारे में जागरूकता पैदा करने के उद्देश्य से योजना के तहत कृषि रसायनों/सूक्ष्म पोषक तत्वों/जैविक कीटनाशकों के छिड़काव के लिए पंद्रह ड्रोन प्रौद्योगिकी प्रदर्शनों का आयोजन किया गया। निदेशालय ने हितधारकों के लिए फ्रंट लाइन प्रदर्शनों, विभिन्न मेलों में प्रदर्शनियों, एक्सपोज़र विजिट की सुविधा प्रदान की।

1. EXECUTIVE SUMMARY

ICAR-Directorate of Cashew Research, Puttur is involved in research and extension activities on cashew. The progress of research activities carried out during the year 2023 under different sections *viz.,* crop improvement, crop management, crop protection, post-harvest technology and transfer of technology and other aspects are summarized as follows. During the year 2023, a total of 45 research projects including 9 externally funded projects were carried out.

Nethra Jumbo-2 (H-125), a new promising jumbo cashew nut hybrid was developed through hybridization by crossing NRCC Sel-2 x Bhedasi. It was found promising with a unique trait of jumbo nut type (≈13g), precocious and cluster bearing, higher yield and high shelling percentage (29.30). It has been identified as promising and found to be consistently yielding with an average nut yield of 5.76 kg/tree and the cumulative yield of 42.44 kg nut/tree. Nethra Jumbo-2 possess a special character like easy peeling of testa and kernel weight of 3.4 g which could be categorized in to the kernel grade bigger than W130. The quality parameters like kernel sugars (11.16%), kernel protein (24.77%) and total fat (46.98%) are comparitively superior. The cashew apple of Nethra Jumbo-2 is orange to red in color, round shaped weighing ≈102 g with 72% of juice content having TSS value of 11.00B.

At present, the National Cashew Field Gene Bank at the Directorate possesses 555 germplasm accessions. During the year, eight genotypes i.e. Vengurla-9, G-2, Indira Kaju, RN, Tour-1, CARS -25, G-1, RFRS-171 have been characterized and classified based the descriptor characters**.** Further, CNSL content of 41 accessions was estimated and varied from zero 0 - 36.52 per cent. One hundred and thirteen M1 seedlings and grafts from gamma ray treated seeds and scion sticks of two popular varieties i.e., Bhaskara and Ullal-3 were maintained. In addition, 38 M1 seedlings were screened against TMB, but all were found susceptible.

A first set of 88 InDel markers were developed and the PIC value of markers varied from 0.11 - 0.85. Amplification of InDel markers in *A. othonianum, A. microcarpum, A. pumilum* and *S. anacardium* showed successful amplification of 84.68, 79.84, 74.19, and 58.06 percent respectively. A web-based database entitled "Cashew Microsatellite Database (CMDB)," was designed to provide access to genomic SSRs mined in silico as well as transcriptome-based SSRs to the research community through a user-friendly database.

Total carbon sequestration in the top layer up to 60 cm depth of soil for a 20-year-old cashew plantation ranged from 99.52 to 104.61 Mg ha^{-1}. The microbial biomass carbon ranged from 163.34 to 695.34 mg $kg^{-1}$and microbial biomass nitrogen from 15.39 to 78.86 mg kg^{-1}. A critical salt concentration of 250 mM has been standardized based on reduction in total plant biomass and changes in ion content of leaf obtained from cashew seedlings under greenhouse conditions. Developed the battery-operated harvesting device and tool for separation of cashew fruit and nut suitable for small and marginal farmers

The studies on identifying the HIPVs for tea mosquito bug in cashew was carried out, healthy plants of Bhaskara for which TMB females showed response include 2 - Methylnonae, β-pinene, 3 – carene, terpinolene, γ-Terpinene, β-caryophyllene etc., The infested plant volatiles of Bhaskara for which TMB had showed response were identified include P-xylene, o-xylene, 3- carene, γ-Terpinene,

4-Ethylundecane, Acetophenone 4'- ethyl, Heptadecane, β Geraniolene etc., *Colletotrichum siamens* as causal organism of anthracnose disease of cashew apple was confirmed through morphological and molecular approaches.

A 3-in-1 moisture meter was developed for determing the mositure content of raw cashewnut, unpeeled and peeled kernels with the accuracy of ±1 percent. A mechanized slicer for cashew apple was developed for the size reduction towards preparation of cashew apple powder and vaccum fried chips. Identified critical parameters influencing whole kernel recovery and discoloration at various stages of processing for steam conditioning method. Developed cashew sprout based nutri-bar enriched with cereals and grains and its quality characteristics observed to be organoleptically superior. Cookies prepared using cashew apple pomace powder and its chemical constituents had crude protein (6.84%), crude fat (13.3%), ash (92.30%) and fibre (6.33%).

Developed an exclusive android application for cashew cultivation in 11 languages for 10 cashew growing states and AI-based app for identification of pests and diseases in cashew. Orgainized ICAR Sponsored short course on "Improved Crop Production Technologies in Cashew with Major Emphasis on Integrated Pest Management". Conducted fifteen drone technology demonstrations for spraying of agricultural chemicals/micro nutrients/organic pesticide under the scheme with aim to create awareness about drone applications in agriculture among the stakeholders. The Directorate facilitated front line demonstrations, exhibitions at various melas, exposure visits for stake holders.

2. INTRODUCTION

2.1. History

Cashew (*Anacardium occidentale* L.) is an introduced crop to India by the Portuguese in the 16th Century which is a Native of Eastern Brazil. Cashew is a crop with high economic value and is earning considerable foreign exchange for the country. During 1950's the research on cashew initiated. *Ad hoc* schemes for cashew reserach were sanctioned by the Indian Council of Agricultural Research (ICAR), which were located at Kottarakkara (Kerala), Ullal (Karnataka), Bapatla (Andhra Pradesh) and Vengurla (Maharashtra). In 1971, ICAR also sanctioned an All India Coordinated Spices and Cashew Improvement Project (AICS & CIP) with its headquarters located at ICAR-Central Plantation Crops Research Institute (CPCRI), Kasaragod. The CPCRI Regional Station, Vittal, Karnataka was given the mandate to carry out research work on cashew while four centres under different Universities (*viz.* Bapatla, Vridhachalam, Anakkayam and Vengurla) were assigned the research component on cashew under AICS & CIP. During the Vth and VIth plan periods, three more Centres (*viz.* Bhubaneswar, Jhargram and Chintamani) came under the fold of AICS & 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, the 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 resulted in the establishment of National Research Centre for Cashew (NRCC) at Puttur on 18th June 1986. During the VIIth Plan period, AICS & CIP was bifurcated into two separate projects, one on cashew and another on spices. The headquarters of independent AICRP on Cashew was shifted to the newly established NRCC, Puttur in 1986. NRCC was upgraded and renamed as Directorate of Cashew Research (DCR) by ICAR on 23 March 2009 under XI Plan. At present, the AICRP on Cashew is operating at 14 centers which were distributed in major cahsew growing areas of the country. As per the instruction of ICAR-New Delhi, the prefix ICAR was added before the institute name since 2014.

2.2 Location

The main campus of ICAR-DCR is situated 5 kms away from Puttur town at Mottethadka village of Kemminje (12.45°N latitude, 75.15°E longitude and 90 m above MSL). The main campus has an area of 69 ha consisting of an administrative block, research laboratories and field experiment plots. Besides, the Directorate has an Experimental Station at Shantigodu, located 13 km away from the main campus which has an area of 80 ha. The institute is conducting and coordinating research on different aspects of cashew such as crop improvement, crop production, crop protection, post-harvest technology and transfer of technology.

2.3 Vision, Mission and Mandate

Vision

- Accomplishing self sufficiency in raw cashewnut production and manufacturing the premier position as the largest producer, processor and exporter at the global level.

Mission

- To promote overall growth through the enhancement of production and productivity in cashew

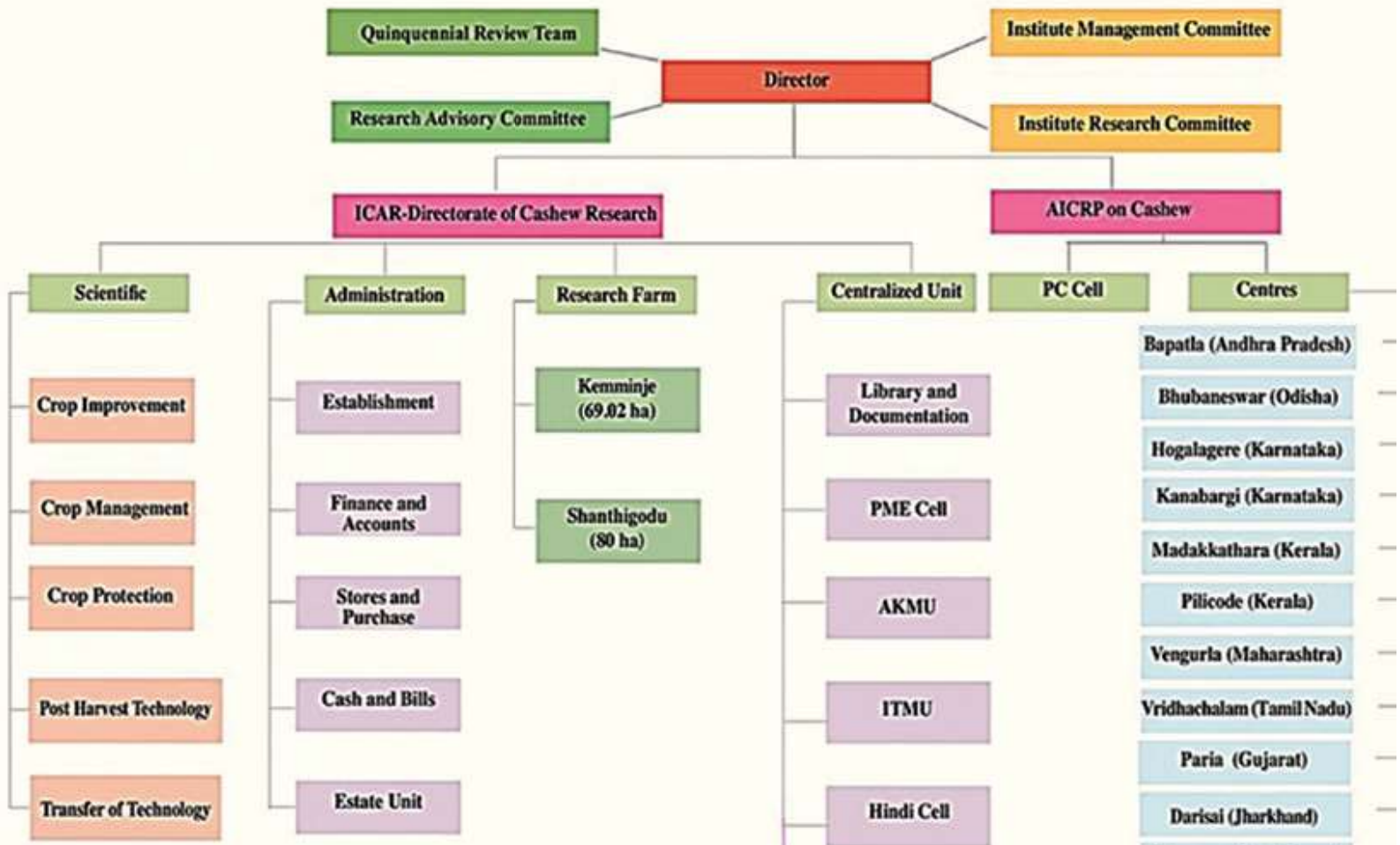
Mandate

- To undertake strategic, basic and applied research for enhancing productivity, quality, processing efficiency and value addition of cashew.
- To serve as a national repository of genetic resources and scientific information on cashew.
- To coordinate All India Coordinated Research Project on Cashew for addressing location and region-specific problems.
- To promote capacity building through the transfer of technology and consultancy services to stakeholders.

2.4 Organogram

The Director is the administrative head of the Directorate. The Institute Management Committee (IMC), Research Advisory Committee (RAC) and Institute Research Committee (IRC) assist the Director in the matters relating to the management and research activities of the Directorate respectively (Fig. 2.1). The research and extension on various aspects of cashew are conducted in five sections *viz.,* Crop improvement, Crop management, Crop protection, post-harvest technology and Transfer of technology. The institute also has different laboratories for sections of Horticulture, Soil Science, Plant Breeding, Plant Physiology, Biotechnology, Plant Protection and Post-harvest Technology. The other facilities available at the Directorate include Audio Visual Laboratory, Priority Setting, Monitoring and Evaluation Cell (PME), Institute Technology Management Unit (ITMU), Agricultural Knowledge Management Unit (AKMU), Agri-Business Incubator (ABI), Vigilance Cell, Women cell, Library and Museum. The Directorate also functions as headquarter for the All India Coordinated Research Project on Cashew.

ICAR-Directorate of Cashew Research



PME - Priority Setting, Monitoring and Evaluation
AKMU - Agricultural Knowledge Management Unit
ITMU - Institute Technology Management Unit
PC Cell - Project Coordinator Cell
ABI - Agri Business Incubation

2.5 Library/AKMU/ITMU/ABI

The Directorate has a 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* and online CAB database are also available. The library is equipped with automation software and barcoding facility. The library has 1991 books and 2255 back volumes of various journals. The library subscribes 35 national and 2 international journals. The library is a member of Consortium of Electronic Resources on Agriculture (CeRA), New Delhi.

The Agricultural Knowledge Management Unit (AKMU) was established with the responsibility of developing Information and Communications Technology (ICT) in Agricultural research, maintaining the Institute's network, the website and the webserver administration.

The Institute Technology Management Unit (ITMU) was established for intellectual property management and for commercialization of agricultural technologies. At this Directorate, ITMU takes care of commercialization of technologies developed by ICAR-DCR, Puttur.

Agri Business Incubator (ABI) operated in this institute funded by the National Agricultural Innovation Fund (NAIF) under the Division of Intellectual Property and Technology Management, Indian Council of Agricultural Research, New Delhi has the 'State-of-the-Art' processing facility for promotion of entrepreneurship and business environment in the cashew eco system.

Staff

The Institute has a sanctioned strength of 22 scientific, 19 technical, 16 administrative and 19 skilled support staff, of which 14 scientists, 5 technical staff, 5 administrative staff and 15 skilled support staff are in position and the remaining are vacant as on 31st December 2023. (Table 2.1).

Table 2.1: Staff strength at ICAR-DCR, Puttur

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	1	-
Scientific	22	14	8
Technical	19	5	14
Administrative	16	5	11
Skilled support staff	19	15	4
Total	**77**	**40**	**37**

Budget

During the financial year (FY) 2023-24, the total budget allotted to the Directorate was Rs. 1368.0 Lakhs of which Rs. 1092.16 Lakhs were utilized (Table 2.2). Under externally funded projects, the total receipts were Rs. 123.11 Lakhs, of which Rs. 50.60 Lakhs was utilized (Table 2.3). The revenue generation during FY 2023-24 was Rs. 29.87 Lakhs (Table 2.4).

Table 2.2. Budget and expenditure details of DCR from April 2023 - Jan 2024 (Rs. in Lakhs)

Particulars	Allocation	Utilization
GIA capital	52.00	24.31
GIA salary	754.00	626.18
Pension	218.00	191.67
GIA general	300.00	225.00
TSP	18.00	07.40
SCSP	26.00	17.60
Total	**1368**	**1092.16**

Table 2.3. Budget details of externally funded project/schemes at DCR for the period April 2023 - Jan 2024 (Rs. in Lakhs)

Particulars	Allocation	Utilization
RKVY-RAFTAAR, Govt. of Karnataka	96.86	36.92
PPV&FRA, New Delhi	3.45	3.29
DCCD, Cochin	10.00	1.48
DCCD (Training)	1.00	1.00
ABI	6.50	2.73
ITMU	5.30	5.18
Total	**123.11**	**50.60**

2.8 Infrastructure and assets

The major infrastructures developed during the year 2023-24, includes the instrumental facilities like Laminar air flow cabinet, Compound microscope, Volatile collection unit, HPLC, GC-MS, Drones, Multispectral sensors, Softwares, Post-hole digger, Self-propelled power weeder, Brush cutters, Sprayers, PPE kit, Telescopic tree pruners etc., These were purchased to strengthen the laboratories with modern equipment in the projects funded by RKVY-RAFTAAR, GoK.

Table 2.4. Revenue generation at ICAR-DCR from Jan, 2023 to Dec. 2023 (Rs in Lakhs)

Revenue target (2023-24)	Revenue Generated (2023-24)
81.25	29.87

2.9 Production of planting materials

ICAR-DCR has cashew nurseries at both of its campuses: Kemminje and Shantigodu, accredited by Directorate of Cashewnut and Cocoa Development (DCCD), Kochi with four-star rating to cater the need of planting material. Softwood grafts of varieties like Bhaskara, NRC Selection-2, Ullal-1, Ullal-3, Ullal-4, VRI-3, Madakkathara-2, Priyanka, Vengurla-7, Vengurla-4, H-130, Dhana etc. are produced in the two nurseries between June and August, every year for supplying to the farmers. During 2023, a total of 39,050 cashew grafts i.e., from Kemminje (25550) and Shantigodu (13500) were supplied to farmers.

3. RESEARCH ACHIEVEMENTS

3.1 CROP IMPROVEMENT

Priority area I: Management of cashew genetic resources

3.1.1 Collection, conservation, characterization, and evaluation of cashew genetic resources

Germplasm collection

At present, the National Cashew Field Gene Bank at the Directorate houses 555 germplasm accessions. Twenty-one new accessions have been procured from AICRP-Cashew; Bhubaneshwar (Table 3.1.1). This included OUAT Kalinga Cashew – 1, a recently released variety from AICRP- Cashew, Bhubaneshwar. Passport data has been prepared and sent to NBPGR for obtained IC numbers for three accessions viz., BDB-58, DB-626 and TR-8. Labelling of 826 trees has been accomplished in the gene bank during the year. Further, ten stem borer affected plants were removed in the gene bank.

Table 3.1.1: Germplasm accessions collected from AICRP- Cashew, Bhubaneshwar

Sr. No.	Collector Name	Collector No.
1	OUAT Kalinga Cashew – 1	NRC-556
2	Ransinghpur bold nut	NRC-557
3	Kalyayanpur boldnut	NRC-558
4	Lokipur - 1	NRC-559
5	Khurda - 1	NRC-560
6	Selection -8	NRC-561
7	Selection -36	NRC-562
8	Koraput cluster	NRC-563
9	Dutiya Nuapalli	NRC-564
10	Selection-25	NRC-565
11	Selection-24	NRC-566
12	Selection-21	NRC-567
13	Selection-19	NRC-568
14	Ranasinghapur-3 (RP-3)	NRC-569
15	Bhubaneswar cluster-2	NRC-570
16	Bhubaneswar cluster -1	NRC-571
17	BH-6	NRC-572
18	BH-85	NRC-573
19	Ranasinghapur-4 (RP-4)	NRC-574
20	Ranasinghapur-5 (RP-5)	NRC-575
21	Ranasinghapur-6 (RP-6)	NRC-576

Germplasm Characterisation:

During the year, eight genotypes i.e. Vengurla-9, G-2, Indira Kaju, RN, Tour-1, CARS -25, G-1, RFRS-171 have been characterised and their classification into different descriptor characters is given below in the Table 3.1.2.

Table 3.1.2: Classification of 8 accessions based on descriptor data

Field	Character		Descriptor state	Number of accessions
7	Tree Habit	3	Upright and Compact	3
		5	Upright and open	5
		7	Spreading	0
8	Internode Length of twig (cm)	3	Short (< 1.0 cm)	3
		5	Medium (1.0-2.0 cm)	5
		7	Long (> 2.0 cm)	0
9	Leaf Shape	3	Oblong	0
		5	Obovate (club - shaped)	8
		7	Oval	0
10	Tree Height (m)	3	Dwarf (<2.5 m)	0
		5	Semi tall (2.5-4.0m)	8
		7	Tall(> 4.0 m)	0
11	Tree Spread (m)	3	Low (<3.0 m)	0
		5	Intermediate (3.0-6.0m)	8
		7	High(> 6.0 m)	0
12	Cracks on Trunk Bark	0	Absent	0
		x+	Present	8
13	Crotch Angle of Main Branch	3	Acute (<90°)	8
		7	Obtuse (>90°)	0
14	Ease of Peeling Bark From Twig	3	Difficult	1
		7	Easy	8
15	Extension Growth of Twig (cm)	3	Short (<9.0 cm)	0
		5	Intermediate (9.0-19.0 cm)	1
		7	Long (19.0 cm)	7
16	Branching Pattern	1	Extensive	1
		2	Intensive	7
17	Twig Diameter (mm)	3	Thin (<4.5 mm)	0
		5	Intermediate (4.5-9.0mm)	8
		7	Thick (>9.0 mm)	0

18	Number of Leaves per Twig	3	Low (<9)	6
		5	Medium (9-19)	2
		7	High (>19)	0
19	Colour of Young Leaves	1	Red	3
		2	Yellow red	3
		3	Green yellow	1
		4	Purple	0
20	Colour of Mature Leaves	1	Light green	0
		2	Green	8
		3	Dark green	0
		4	Purple	0
21	Odour of leaves	1	Mango-like	8
		2	Turpentine-like	0
22	Leaf margin	1	Smooth	8
		2	Wavy	0
23	Leaf apex shape	1	Pointed	0
		2	Rounded	5
		3	Indented (slight notch)	3
24	Leaf Size (cm^2)	3	Small (<60 cm^2)	0
		5	Intermediate (60-120 cm^2)	3
		7	Large (>120 cm^2)	5
25	Brittleness of Leaf	3	Leathery	8
		7	Brittle	0
26	Angle of Leaf Petiole relative to stem	3	Acute (<90°)	8
		7	Obtuse (>90°)	0
27	Leaf Cross Section	1	Level	6
		2	Reflexed	2
		3	Incurved	0
		4	Twisted	0
28	Season of Flowering	3	Early (Nov-Dec)	1
		5	Mid (Dec-Jan)	6
		7	Late (Jan-Feb)	1
29	Inflorescence Shape	3	Narrowly pyramidal	0
		5	Pyramidal	6
		7	Broadly pyramidal	2
30	Flower Colour	1	White	7

		2	Cream	1
		3	Pink	0
31	Mature Cashew Apple Colour	1	Yellow	4
		2	Red	2
		3	Yellow red	2
		4	Red Purple	0
32	Cashew Apple Shape	1	Cylindrical	0
		2	Conical-obovate	8
		3	Round	0
		4	Pyriform	0
33	Colour of Mature Nutshell	1	Buff	0
		2	Grey	8
		3	Purple	0
34	Nut Shape	1	Kidney	8
		2	Oblong- ellipsoid)	0
35	Nut Weight (g)	3	Low (< 5 g)	0
		5	Intermediate (5-7 g)	4
		7	High (>7 g)	4
36	Colour of Boot Leaf	1	Light green	8
		2	Green	0
38	Compactness of Inflorescence	3	Loose	8
		7	Compact	0
39	Type of Inflorescence Branching	1	All around main axis	8
		2	Two sided	0
40	Sex Ratio	3	Low (< 0.06)	1
		5	Medium (0.06-0.13)	3
		7	High (> 0.13)	5
41	Secondary Flowering	0	Absent	8
		+	Present	0
43	Weight of Cashew Apple (g)	3	Low (<27g)	1
		5	Medium (27-52g)	0
		7	High (>52g)	7
44	Shape of Cashew Apple Base	1	Angular	3
		2	Rounded	4
		3	Flattened	0
		4	Obliquely flattened	1

45	Ridges on Cashew Apple	0	Absent	1
		1	Broken	6
		2	Entire	1
46	Cashew Apple Apex	1	Level	8
		2	Oblique	0
47	Grooves on Apex of Cashew Apple	0	Absent	0
		3	Shallow (Notched)	8
		7	Deep (Furrowed)	0
48	Cavity at Apex of Cashew Apple	0	Absent	2
		3	Shallow	6
		7	Deep	0
49	Skin of Cashew Apple	1	Smooth and glossy	0
		2	Rough and dull	8
50	Attachment of Nut to Apple	3	Loose	3
		5	Intermediate	3
		7	Tight	2
51	Shape of Nut Base	1	Round	8
		2	Flattened	0
		3	Obliquely flattened	0
		4	Angular	0
52	Suture of Nut	1	Round	1
		2	Angular	7
53	Flanks of Nut	3	Flattened	3
		5	Round	5
		7	Bulging	0
54	Stylar Scar on Nut	3	Small (Narrow)	5
		7	Large (Wide)	3
55	Shape of Nut Apex	1	Round	6
		2	Intermediate	2
		3	Pointed	0
56	Relative Position of Suture and Apex	1	Suture projection in front of apex	5
		2	Suture projection in line with apex	3
		3	Suture projection behind apex	0

57	Shell Thickness (mm)	3	Thin (<2.5 mm)	0
		5	Intermediate (2.5-4.0mm)	6
		7	Thick (>4.0mm)	2
58	Uniformity of Shell Thickness	0	Not uniform	3
		+	Uniform	5
60	Flowering Duration (days)	3	Short (<60 days)	1
		5	Medium (60-90 days)	7
		7	Long (>90 days)	0
61	Flowering Intensity (%)	3	Low (<40 %)	0
		5	Medium (40-70%)	8
		7	High (>70%)	0
62	Apple to Nut Ratio	3	Low (<6.0)	0
		5	Medium (6.0-12.0)	8
		7	High (>12.0)	0
63	Shelling Percentage	3	Low (<18.0 %)	0
		5	Intermediate (18.0-28.0 %)	1
		7	High (>28.0%)	7
64	Kernel Weight (g)	3	Low (1.2 g)	0
		5	Intermediate (1.2-2.5 g)	8
		7	High (>2.5 g)	0
65	Attachment of Peel to Kernel	3	Loose	5
		7	Tight	3
67	Cotyledonary Grooves	3	Shallow	6
		7	Deep	2
68	Yield (kg/tree)	3	Low (< 9 kg)	8
		5	Medium (9-18 kg)	0
		7	High (>18 kg)	0




Germplasm maintenance:

Thirteen unique types (dwarf and wild species etc.,) were maintained during the year. Further, 512 germplasm accessions and 61 core collections were maintained in conservation block (Fig 3.1.1).

Fig 3.1.1: View of the core collection block

Germplasm database maintenance

The cashew germplasm database (https://cashew.icar.gov.in/dcr/) was maintained during the year and it was visited 5180 times by different users.

Estimation of Cashew Shell Nut Liquid (CNSL) in germplasm accessions

The CNSL content of 41 accessions was estimated during the year 2023. Among the 431 accessions, the CNSL content was varied from 0.00 to 36.52 per cent. The frequency distribution pattern revealed that the symmetric distribution of the trait with skewness of 0.032. Though the correlations of CNSL content with many characters such as nut weight, shell thickness etc. were significant, linear regressions patterns revealed no substantial relationship (very less R2 value) with these characters. (Table 3.1.3 and Fig 3.1.2)

Table 3.1.3: Estimation of CSNL content in cashew accessions

Sl. No.	Variety	CNSL %	Sl. No.	Variety	CNSL %
1	H-130	24.81	20	DB-626	20.50
2	175	25.14	21	NRC-141	15.79
3	301	19.77	22	NRC-137	21.41
4	T No. 160	29.56	23	NRC-410	14.79
5	T No. 183	20.9	24	NRC-415	20.67
6	T No. 130	29.52	25	NRC-416	15.02
7	T No. 480	26.74	26	NRC-463	11.70
8	Nethra vaaman	30.60	27	NRC-470	7.48
9	H-126	30.98	28	NRC-478	13.09
10	BDB-58	23.94	29	Taliparamba	20.93
11	H-125	23.77	30	BPP-3	11.33
12	V-9	19.79	31	Bhubaneshwar-1	17.68
13	G2	29.49	32	OUAT Kalinga Cashew-1	13.7
14	RN	18.72	33	Balabhadra	18.75
15	IK	24.47	34	Jagannath	20.95
16	Tour (565)	26.17	35	Bidhan bonsai kaju	16.86
17	Cars 25	26.73	36	Vengurla-8	19.89
18	G1	26.50	37	Jhargram-2	23.24
19	RFRS-171	25.70	38	Vengurla-9	30.17
			39	Indira Caju	18.6
			40	Goa-2	20.4
			41	Chintamani-2	21.21

CNSL %	
N	400
Minimum	36.52
Maximum	0
Mean	18.425
Std. error of mean	0.275
Std. deviation	0.275
Variance	30.349
Skewness	0.032
Kurtosis	0.916

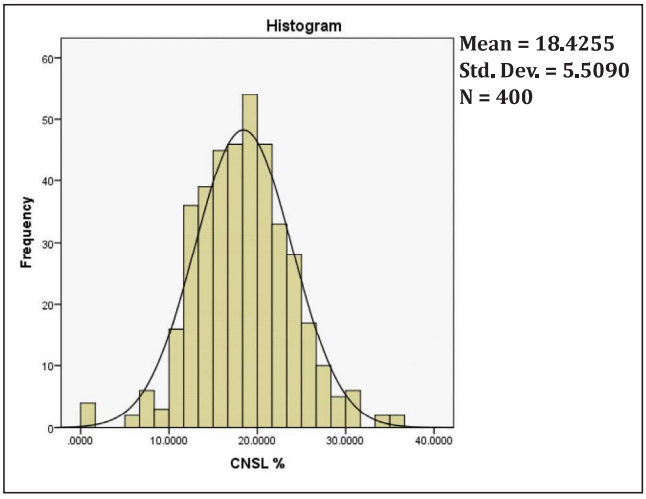


Fig 3.1.2 Descriptive Statistics and Frequency distribution of CNSL content in germplasm accessions

Priority area II: Genetic improvement of cashew for yield and quality traits

3.1.2 Genetic improvement of cashew through hybridization and seedling selection approaches [1986 -Long Term]

Identification of new promising hybrid, Nethra Jumbo-2 (H-125)

In cashew, more than 80% of varieties belongs to medium (7g) to small nut (5-6 g) category. Very few bold nut types are available among the commercially cultivated varieties. The bold nut types ease the process of harvesting and separation of nuts and also save the labor cost. The bold nut types fetch premium price in the market.

Fig 3.1.3: Cluster bearing habit and cashew apples of Nethra Jumbo-2

Nethra Jumbo-2 was developed through hybridization process by crossing NRCC Sel-2 x Bhedasi. It was found promising with a unique trait of jumbo nut type (12-13g), precocious and cluster bearing, higher yield and shelling percentage (29.30%).

Under ICAR ad-hoc scheme on "Network Programme on Hybridization in Cashew", a large number of hybrids were generated at ICAR-DCR. The main objective of this scheme was to evolve bold nut cashew hybrids which fetch premium price in export market. The hybrids were generated by

using cross combinations among the parents, NRCC Sel-2, Bhedasi and Bhuthnath-II and planted at 7m x 7m spacing in un-replicated manner for initial evaluation at ICAR-DCR Experimental Station, Shantigodu in the year 2000. Among the hybrids generated from various cross combinations, five hybrids showed promising results.

During evaluation, NRCC Sel-2 was also considered as check. Among different hybrids, Nethra Jumbo-2 (cross combination of NRCC Sel-2 x Bhedasi) has been identified as a promising and found to be consistently yielding with an average nut yield of 5.76 kg/tree (over eight years of harvest). At 8th harvest, 8.0 kg nut/tree and over eight harvests cumulative yield of 42.44 kg nut/tree was recorded. The nut yield/tree of these hybrids were better over check (NRCC Sel-2). Moreover, the average nut yield of other hybrids was also good but the mean nut weight and shelling percentage was better in Nethra Jumbo-2 (29.30%) over other hybrids.

Under replicated trial also, Nethra Jumbo-2 performed well with an average nut yield of 3.01 kg/tree after 5th harvest (2.74 kg/tree). At 5th harvest, the nut yield was (4.68 kg/tree), whereas, in all other hybrids the yield was less than 3 kg/tree. The yield of check varieties was further low under replicated trial. On cumulative basis and on per hectare basis, the yield of Nethra Jumbo-2 was the highest (15.03 kg/tree and 1.65 t/ha respectively) among all hybrids and checks (Table 3.1.4; Table 3.1.5; Table 3.1.6).

The distinguished morphological characteristics of Nethra Jumbo-2 are i) upright and open tree habit; ii) the plant height is around 5.3 m (9-year age plant), with extensive branching pattern; iii) large size leaf of obovate shape and rounded apex (Fig. 3.1.3 and Table 3.1.7). The canopy spread is around 5.4m. the inflorescence is broadly pyramidal type with high sex ratio of 0.37. The season of flowering is December to Mach and season of harvest is January to April.

The nut characters of Nethra Jumbo-2 are; i) the weight of the nut is 12-13 g; ii) high shelling percentage of 29.30; iii) the nut weight of Netha Jumbo-2 is on par with Nethra Jumbo-1. Nethra Jumbo-2 kernels (Fig. 3.1.4) were analyzed for quality parameters like kernel sugars (11.16%), Kernel Protein (24.77%). And total fat (46.98%) and whole kernels of 130 lb^{-1} grade with high shelling percentage (29.30%), Kernel weight varies from 3-3.5 g. The cashew apple of Nethra Jumbo-2 is orange to red in color, round shaped weighs around 102 g, with 72% of juice content of TSS 11.0 0B.

The Hybrid Nethra Jumbo-2 is recommended on account of jumbo nuts (13.50 g nut weight), with premium grade kernel (W130), higher yield over the standard variety Bhaskara and NRCC Selection-2 (Table 3.1.8), and cluster bearing nature (Fig. 3.1.6) with 5- 6 fruits per panicle with uniform nut size. The DNA finger printing with SSR (CS-17) marker of Nethra Jumbo-2 is depicted in Fig. 3.1.5.

Table 3.1.4: Performance of Nethra Jumbo-2 under un replicated trial (Shantigodu farm) in comparison to parents

Hybrid	Cross combination	Ann. Yld. in 8th Harvest (kg/tree)	Cum. Yld. for 8 Harvest (kg/tree)	Av. Yld. of eight harvests (kg/tree)	Mean nut Wt. (g)	Mean kernel Wt. (g)	Shelling (%)
H-125	NRCC Sel-2 x Bhedasi	8.00	42.44	5.31	12.00	3.40	30.76
NRCC Sel-2 (check)	-	1.97	25.14	3.14	9.2	2.63	28.60
Bhedasi (parent)	-	-	5.21 (over six harvests)	0.87	10.00	3.0	30.00

Table 3.1.5: Yield performance of Nethra Jumbo-2 in comparison with NRCC Selection-2 and Bhaskara at Kemminje campus of DCR (replicated trial)

Hybrid/ Variety	1st Harvest (2011)	2nd Harvest (2012)	3rd Harvest (2013)	4th Harvest (2014)	5th Harvest (2015)	6th Harvest (2016)	7th Harvest (2017)	Cumulative yield of 7 harvests	Avg. yield per tree (Kg)
H-125	0.63	2.79	2.83	2.79	4.68	2.74	8.00	28.33	2.74
NRC-Sel-2 (Check)	0.24	2.17	2.99	1.69	0.53	1.00	3.50	12.12	1.73
Bhaskara (Check)	0.37	3.35	2.76	2.72	1.49	0.82	4.40	15.91	2.30
CD @ 5%	NS	NS	NS	0.15	1.75	1.75	1.95		

Fig 3.1.4: Bold Kernels of Nethra Jumbo-2

Table 3.1.6: Per cent increase/ decrease in nut & kernel weight of Nethra Jumbo-2 over Bhaskara and NRCC Sel-2

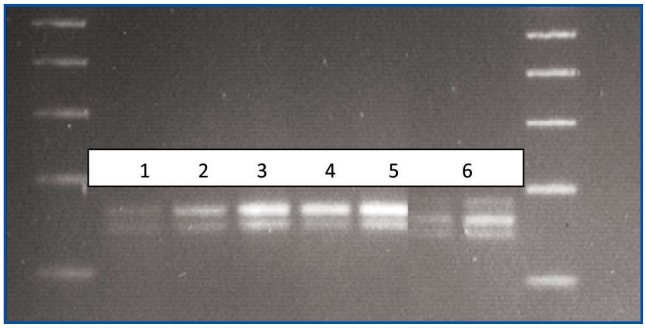
Hybrid/ variety	Cross combination	Nut weight(g) over Bhaskara	Nut weight(g) over NRCC Sel-2	Kernel weight(g) over Bhaskara	Kernel weight(g) over NRCC Sel-2
H-125	NRCC Sel-2 x Bhedasi	91.53	45.87	79.52	35.61
NRCC Sel-2 (check)	Check	31.30	-	32.38	-
Bhaskara (check)	Check	-	23.84	-	24.46

Table 3.1.7: Morphological characteristics of Nethra Jumbo-2

Plant and leaf Characters	
Tree	Upright, open
Plant height	5.3 m (9 yr. age)
Branching pattern	Extensive
Leaf size	Large
Leaf shape	Obovate, green, smooth margin, brittle, rounded apex
Canopy Spread	5.4 m
Flowering and fruiting characters	
Number of flowering laterals/m^2 canopy	12-14
Panicle shape	Broadly Pyramid
Sex ratio (male to female)	High (0.37)
Season of flowering	Dec-March
Duration of flowering	64 days
Season of harvest	Jan-April
Apple Juice content	72%
TSS of juice (0B)	11.00B
Vitamin C (mg/100g)	158.55
Nut and Kernel characteristics of Nethra Jumbo-2	
Nut weight (g)	10-12 g
Number of nuts kg^{-1}	80-83 nuts
Shelling (%)	High (29.1)
CNSL content	23.77
Shelling percentage	29.30
Kernel weight	3.4 g
Whole kernel count lb^{-1}	W130 $lb.^{-1}$
Kernel sugars (%)	11.16
Kernel protein (%)	24.77
Total fat (%)	46.98 - 47

Table 3.1.8: Large scale demonstration yield data

Year	Average yield (kg/plant)
2018	10.15
2019	9.90
2020	10.05
2021	10.20
2022	11.07



1-Ullal-3, 2-Bhaskara, 3-Selection-2, 4-Bhedasi, 5-H-125, 6-H-126

Fig 3.1.5: DNA finger printing with SSR (CS-17) marker of Nethra Jumbo-2

Fig 3.1.6: Nethra Jumbo-2 tree and cluster bearing habit

Evaluation of promising cashew varieties and bold nut hybrids in bulk trial

The seedling selection, T. No. 480 (Fig. 3.1.7) continued to perform as best promising type recording highest cumulative nut yield of 14.79 kg per tree from 4 harvests. It was found to be superior over other promising bold and medium nut types likes H 32/4, NRC 493, H1616 and Bhaskara (check) for yield. The highest shelling percentage (31.62), protein (30.07), total antioxidant activity (245.21 mg/100g) and total phenols (265.99 mg GAE/100g) were recorded in T. No. 480 followed by H-126 and H-125. The total sugar content was maximum in H-126 (12.9) followed by H-125 (11.16).

Fig 3.1.7: Cashew apples and fruit bearing habit of T. No. 480

Evaluation of half-sibs of HYVs

This work was initiated in the year 2022 to utilize the variability among half-sibs of high yielding varieties. Seedlings of Nethra Ganga, Nethra Vaaman, Nethra Jumbo-1 are being maintained in the field at Shantigodu farm. Observations on growth and dwarfing traits such as seedling height, length from cotyledon to first leaf, stem girth, intermodal length, stomatal density and total chlorophyll content were recorded. The descriptive statistics of these traits in seedlings of these varieties is presented below (Table 3.1.9; Table 3.1.10; Table 3.1.11).

Table 3.1.9: Descriptive Statistics Half-Sibs of Nethra Ganga (N=138)

Trait	Mean	SE	SD	Min	Max	Skewness	Kurtosis
LCFL (cm)	6.28	0.15	1.73	2	11	0.02	0.11
SG (cm)	11.31	0.20	2.39	6	25	1.14	7.31
HT (cm)	32.91	0.61	7.10	15	46	-0.32	-0.23
INL (cm)	3.19	0.18	2.14	0.5	9	0.68	-0.29
Total chlorophyll (mg/g Fresh wt.)	2.76	0.14	1.61	0.60	7.20	0.82	-0.24
Stomatal density (number per microscopic area)	79.26	1.25	14.65	44.67	130.33	0.54	0.21

Table 3.1.10: Descriptive Statistics Half-Sibs of Nethra Vaaman (N=168)

Trait	Mean	SE	SD	Min	Max	Skewness	Kurtosis
LCFL (cm)	4.70	0.08	1.10	2	7	-0.16	-0.14
SG (cm)	10.87	0.13	1.70	4.3	14.59	-0.85	1.60
HT (cm)	40.10	0.51	6.71	17	61	-0.84	1.93
INL (cm)	2.68	0.11	1.38	0.5	6	0.11	-0.73
Total chlorophyll (mg/g Fresh wt.)	2.94	0.15	1.45	0.5	6.63	0.26	-0.54
Stomatal density (number per microscopic area)	77.22	0.99	12.93	54.66	109.66	0.23	-0.81

Table 3.1.11: Descriptive Statistics Half-Sibs of Nethra Jumbo-1 (N=9)

Trait	Mean	SE	SD	Min	Max	Skewness	Kurtosis
LCFL (cm)	5.11	0.53	1.62	3	8	0.69	-0.35
SG (cm)	12.55	1.50	4.51	8.97	22.86	1.81	3.16
HT (cm)	34.89	5.58	16.75	20	71	1.45	1.86
INL (cm)	3.44	0.52	1.57	2	6.5	0.94	0.15
Total chlorophyll (mg/g Fresh wt.)	3.79	0.36	1.02	2.40	5.74	0.69	1.24
Stomatal density (number per microscopic area)	74.85	2.67	8.02	61.33	83.66	-0.54	-1.06

3.1.3 Development of polyclonal hybrids from core collections

At the Directorate, a core collection of cashews consisting of 61 accessions was made during the year 2016-17 following a relatively new technique i.e. Advanced Maximization Strategy with Heuristic Approach. These accessions were field planted during the year 2017. These core collections inherently possess maximum diversity with minimum number of accessions. One of the important uses of this diversity is that these collections can be profitably utilized to develop novel populations to realize enhanced genetic gains.

Hence, it is planned to develop polyclonal hybrids from the core accessions. In quantitative genetics, it is a well-known fact that polygenic/ oligogenic trait will follow normal distribution if the sample size is 30 and hence, it is planned to collect seeds arising out of random mating among core accessions i.e., 10 each from 61 accessions for continuous three years to capture the diverse progeny possible with the core accessions.

During October 2023, a total of 645 nuts were collected from accessions in the core and out of these, 529 were germinated. These plants along with the 281 plants of the previous year were planted in Augmented Block Design (12 blocks) with checks viz., Bhaskara and Vengurla-4 at a spacing of 6 m x 6m. (Fig 3.1.8 and Fig 3.1.9)

The list of 59 accessions from which nuts were collected during the year 2023 are NRC18, NRC 20, NRC38, NRC 41, NRC 63, NRC 96, NRC101, NRC 111, NRC 126, NRC140 NRC145, NRC 160, NRC211, NRC 278, NRC 275, NRC 283, NRC 306, NRC 308, NRC 319, NRC342 NRC 349, NRC388, NRC385, NRC388, NRC 383, NRC 385, NRC 470, NRC 01, NRC 11, NRC 20 NRC 40, NRC 43, NRC 121, NRC 126, NRC 138, NRC 140, NRC 143

Fig 3.1.8: Seedlings of the polyclonal hybrid seeds

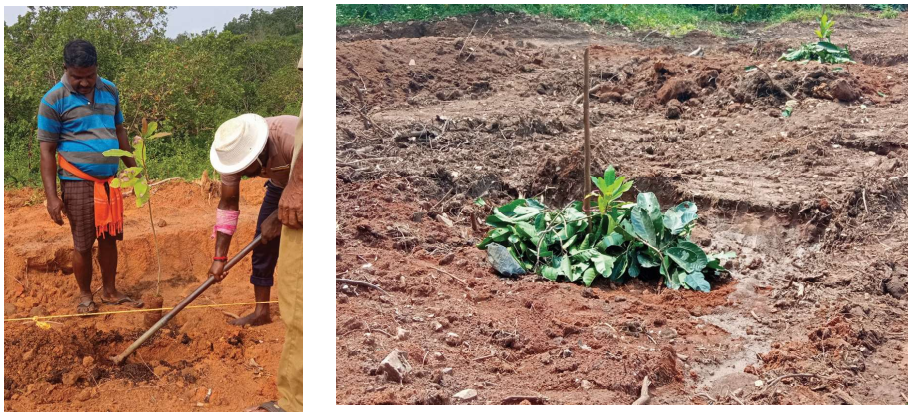


Fig 3.1.9 Planting of polyclonal hybrids in Shantigodu farm

3.1.4 Breeding approaches for developing TMB tolerance

One hundred and thirteen M1 seedlings and grafts from gamma ray treated seeds and scion sticks of two popular varieties viz., Bhaskara and Ullal-3 were maintained. In these seedlings, variations such as puckering of leaves, dwarfness, excessive branching was observed. During the year, 57 M2 seeds from 19 trees were collected and sown in the nursery. Out of which, 38 seedlings were screened for TMB resistance, however, all were found susceptible (Table 3.1.12 and Fig. 3.1.10).

Table 3.1.12: TMB score of M_2 seedlings

Treatment details	Number of plants	TMB damage grade
Bhaskara 20 KR	11	4
Bhaskara 30 KR	5	4
Bhaskara 50 KR	5	4
Ullal-3 20 KR	8	4
Ullal-3 40 KR	3	4
Ullal-3 50 KR	6	4

Fig 3.1.10. No choice screening for TMB

Further, to uncover the variations in mutagen treated seedlings, geitonogamy was attempted. Accordingly, 400 geitonogamy crosses were made in 40 trees of Ullal-3 and Bhaskara varieties with 10 crosses in each tree. Out of the crosses made, only 25 seeds were set (6.25 %) and out of these, only 20% germination was observed. (Fig. 3.1.11)

Fig 3.1.11: Geitonogamous seedlings

3.1.5 Polyploidy breeding in cashew

Cashew is a diploid (2n=42). So far, polyploids have not been induced in cashew. Using Colchicine ($C_{22}H_{25}NO_6$) it is intended to develop polyploids in 2 selected varieties of cashew i.e. Bhaskara, a vigorous and high yielding variety and Nethra Vaaman, a dwarf variety. This work basically aims at creating novel variations and hence opportunistic selection for useful variations is also possible. Seeds and seedlings of these two varieties are subjected to Colchicine treatment. It was observed that the concentration and duration of the colchicine was not significant in both the varieties. Only varieties differed in their germination percentage levels (Table 3.1.13 – 3.1.18 and Fig. 3.1.12 – 3.1.15).

Table 3.1.13: Germination percentage of treated seeds

Variety	Concentration	Duration (hrs.)				
		12	24	36	48	Mean
Nethra Vaaman	0.40 %	80	80	80	80	80
	0.80%	90	90	40	90	77.5
	1%	100	70	90	100	90

	Mean	90	80	70	90	82.5
	Control	100	70	60	60	72.5
	0.40%	100	100	80	80	90
	0.80%	90	100	90	100	95
Bhaskara	1%	90	100	100	100	97.5
	Mean	93.33	100	90	93.33	94.16
	Control	100	90	100	70	90

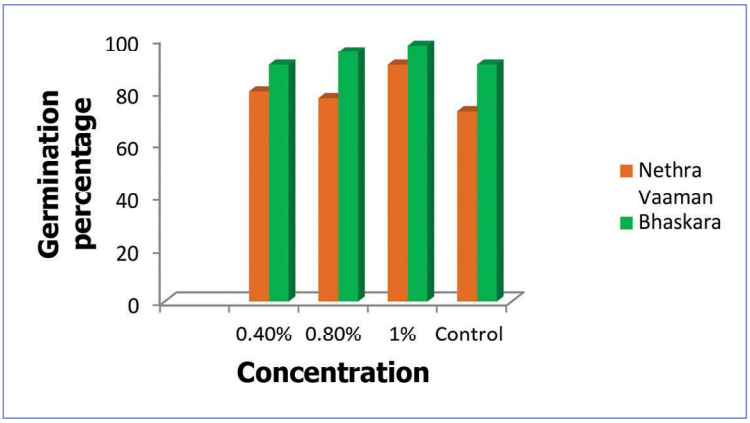


Fig 3.1.12. Germination percentage at different concentrations

Table 3.1.14 Three factor CRD for germination percentage of treated plants

Source of Variation	df	Sum of Squares	Mean Squares	F-Calc.	Significance
Factor A (Variety)	1	0.714	0.714	9.77	0.00376*
Factor B (Concentration)	3	0.433	0.144	1.976	0.13741
Int A X B	3	0.147	0.049	0.672	0.57539
Factor C (Duration)	3	0.338	0.113	1.54	0.22318
Int A X C	3	0.237	0.079	1.083	0.37032
Int B X C	9	1.222	0.136	1.858	0.09566
Int A X B X C	9	0.566	0.063	0.861	0.56817
Error	32	2.339	0.073		
Total	63	5.997		CV = 13.24 %	

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.138	0.068	0.048
Factor(B)	N/A	0.096	0.068
Interaction A X B	N/A	0.135	0.096
Factor(C)	N/A	0.096	0.068
Interaction A X C	N/A	0.135	0.096
Interaction B X C	N/A	0.191	0.135
Interaction A X B X C	N/A	0.27	0.191

(A: Variety; B: Concentration; C: Duration)

Table 3.1.15: Seedling Height (cm) of treated seeds

	Nethra Vaaman					Bhaskara				
Days/Concentration	0.40%	0.80%	1%	Control	Mean	0.40%	0.80%	1%	Control	Mean
12	32.20	33.12	35.26	40.61	35.30	44.52	39.32	42.97	44.01	42.71
24	39.79	37.69	36.85	39.30	38.41	41.42	42.42	41.93	45.35	42.78
36	38.46	33.01	34.78	42.47	37.18	38.74	41.43	41.90	43.33	41.35
48	39.28	40.59	36.32	43.30	39.87	36.48	33.04	39.90	32.72	35.54
Mean	37.43	36.10	35.80	41.42		40.29	39.05	41.68	41.35	

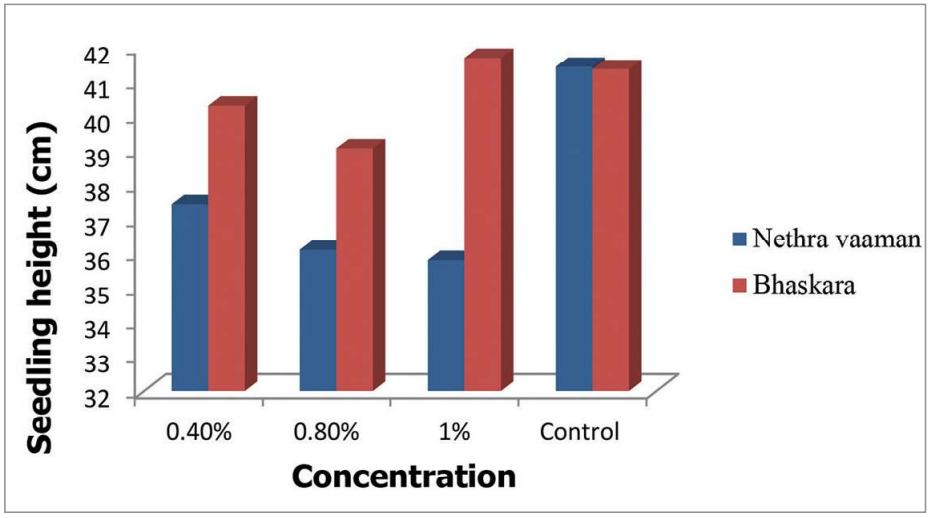


Fig 3.1.13 Seedling height at different concentrations

Table 3.1.16 Seedlings from treated Seeds – Height

Source of sVariation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	1	134.686	134.686	26.042	0.00001**
Factor B	3	123.523	41.174	7.961	0.00042**
Int A X B	3	70.602	23.534	4.55	0.00914**
Factor C	3	67.344	22.448	4.34	0.01126*
Int A X C	3	305.807	101.936	19.71	0
Int B X C	9	50.883	5.654	1.093	0.39493
Int A X B X C	9	149.373	16.597	3.209	0.00702**
Error	32	165.5	5.172		
Total	63	1,067.72		CV: 5.81% %	

Factors	C.D.	SE(d)	SE(m)
Factor(A)	1.158	0.569	0.402
Factor(B)	1.638	0.804	0.569
Interaction A X B	2.317	1.137	0.804
Factor(C)	1.638	0.804	0.569
Interaction A X C	2.317	1.137	0.804
Interaction B X C	N/A	1.608	1.137
Interaction A X B X C	4.634	2.274	1.608

Table 3.1.17: Seedling girth (cm) of treated seeds

	Nethra Vaaman					Bhaskara				
D/C	0.40%	0.80%	1%	Control	Mean	0.40%	0.80%	1%	Control	Mean
12	9.02	9.17	8.64	8.71	8.89	8.59	8.83	8.57	8.62	8.65
24	8.97	8.96	8.17	8.22	8.58	8.39	8.52	8.38	9.04	8.58
36	9.73	7.90	8.91	9.05	8.90	8.86	8.92	8.06	8.21	8.51
48	8.34	8.02	8.60	8.74	8.43	8.24	8.59	8.28	9.07	8.55
	9.02	8.51	8.58	8.68		8.52	8.72	8.32	8.74	

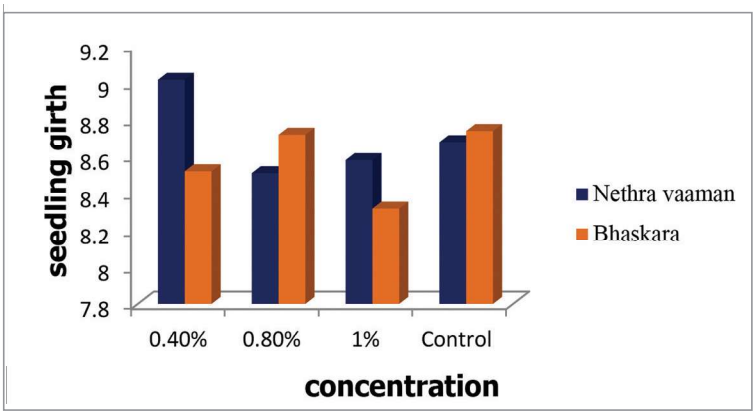


Fig 3.1.14 Seedling girth at different concentrations

Table 3.1.18 Analysis of variance for colchicine treatment

Source of Variation	df	Sum of Squares	Mean Squares	F-Calc.	Significance
Factor A	1	0.245	0.245	0.858	0.36122
Factor B	3	0.914	0.305	1.066	0.37735
Int A X B	3	1.184	0.395	1.38	0.26671
Factor C	3	0.767	0.256	0.894	0.45478
Int A X C	3	0.626	0.209	0.729	0.54205
Int B X C	9	2.938	0.326	1.141	0.36397
Int A X B X C	9	3.3	0.367	1.282	0.28423
Error	32	9.151	0.286		
Total	63	19.125		CV: 6.19%	

Factors	CD	SE(d)	SE(m)
Factor(A)	N/A	0.134	0.095
Factor(B)	N/A	0.189	0.134
Interaction A X B	N/A	0.267	0.189
Factor(C)	N/A	0.189	0.134
Interaction A X C	N/A	0.267	0.189
Interaction B X C	N/A	0.378	0.267
Interaction A X B X C	N/A	0.535	0.378

Since variable responses were seen in concentrations 0.4 to 3.0 %, high concentration of colchicine was also tried (5%) for treating the seeds (10 each) in Bhaskara and Nethra Vaaman varieties. The germination percentages are presented in Table 3.1.19. No clear-cut trends were seen with respect to duration of treatment.

Table 3.1.19: Germination percentage in seeds of Bhaskara and Nethra Vaaman varieties with 5% Colchicine concentration

Bhaskara	Germination Percentage (%)
24 hours	60
48	80
72	60
96	30
Control	100
Nethra Vaaman	100*
24 hours	70
48	100
72	80
96	90
Control	100

Fig 3.1.15. Germination and growth in seedlings with 5% colchicine treatment

Planting of colchicine treated plants: A total of 404 colchicine treated plants and 54 plants of the check varieties (Bhaskara, Nethra Vaaman, Vengurla-4, Nethra Ganga) were planted in an augmented block design with six blocks (Fig. 3.1.16).

Fig 3.1.16: Planting of colchicine treated plants in the main field.

3.1.6 Evaluation of dwarf and semi dwarf accessions and their seedling progenies for high density planting system

Plants of 16 dwarf and semi-dwarf accessions collated from different parts of the country are planted in the field in split plot design with three replications for evaluation. Spacing as the main plot (Three spacings – 3 m x 3 m, 4 m x 4 m and 5 m x 5 m) and varieties as the sub plot were taken (Fig. 3.1.17). The trial included a total of 576 plants. Surrounding the trial, the plants of high yielding varieties such as V-7, H-126, H-130 and Bhaskara were planted for introgressions of genes to dwarf and semi-dwarf accessions. Plants in the trial maintained during the year. In addition to per se evaluation, Seedling selection will be done from these accessions for identification of dwarf types with high yield.

Fig 3.1.17. View of the plants in the dwarf and semi-dwarf variety trial

Genetics of traits: Purple coloration

Purple cashew whose leaves and fruits are purple in colour, is a mutant. This was used as male to cross with popular cashew varieties Bhaskara and Nethra Ganga (Table 3.1.20 & Fig. 3.1.18). The seedlings are generated (71 seedlings) and planted along with checks in the main field for further observations during the year.

Table 3.1.20 Different cross combinations for purple coloration

Cross	Total number of crosses made	Seed set (%)	Germination (%)
Bhaskara x purple mutant	300	11.67	88.57
Nethra Ganga x purple mutant	500	13	61.53

Purple mutant

Bhaskara variety

Nethra Ganga variety

Bhaskara × Purple mutant

Nethra Ganga x Purple mutant

Fig 3.1.18: Progenies of crosses between popular varieties and purple mutant

3.1.7 Development of morphological descriptors and DUS test guidelines for cashew (Externally funded project)

Earlier, thirty reference varieties were planted for the purpose of DUS testing at a spacing of 6 m x 6 m with four plants/variety and these were maintained in the field. Planting of Nethra Jumbo -1 (H-126) and Vengurla-9 in the DUS testing block has been accomplished for characterization during the year. Also facilitated the registration of Poornima variety from Cashew Research Station, Madakkathara and the process of applying to PPV FRA is under progress. Nethra Vaaman (2nd year) and H- 130 (third year) varieties have been maintained in the DUS testing block for characterization. (Fig. 3.1.19 and Fig. 3.1.20)

Fig. 3.1.19: Nethra Ganga under testing

Fig. 3.1.20: Nethra Jumbo under testing

3.1.8 Breeding in Cashew for Special Traits

Experiment 1: Development of dwarf and compact cashew hybrids

This experiment involves two approaches viz., 1. direct and reciprocal crosses and 2. backcrosses

Direct and reciprocal crosses

This work was started in the year 2013 in which direct and reciprocal crosses were attempted between dwarf/compact with low yielding germplasm accessions and tall high yielding varieties. Then nearly 800 F1 seedlings of 15 direct and reciprocal crosses were planted at Shantigodu in the year 2013. Among them, 10 trees were selected based on cumulative nut yield of six years and dwarf nature. A total of 157 plants including grafts of selections, parents and checks were planted in the field during August 2022 for evaluation in randomized block design with two replications and are maintained in the field (Fig.3.1.21). During the year, 153 selected plants were maintained in the field. The list of selections, parents and checks planted is given in the Table 3.1.21.

Table 3.1.21: List of selections, parents and checks planted in the replicated trial

Selections	Vengurle-4 x NRC-492 (2No), Vengurle-4 x Taliparamba-1, Priyanka x NRC 492, Madakkathara-2 x NRC 492, NRC 492 x Madakkathara-2, NRC 492 x Dhana (2No), Madakkathara-2 x NRC 492 (2No)
Parents	Vengurle-4, NRC 492, Priyanka, Madakkathara-2, Dhana
Checks	Bhaskara, Nethra Ganga, Nethra Jumbo-1, Vengurla-7

Fig. 3.1.21. Field view of replicated trial with direct and reciprocal crosses selections, parents and checks

Backcrosses

This work was started in the year 2014 wherein 471 back cross progenies were developed by back crossing Bhaskara/Ullal-3 with semi-dwarf F_1 tree (T.No.626) selected from cross between Bhaskara x NRC 492. They were planted during October 2014 at Shantigodu and evaluated for six harvests. Among them, 6 trees were selected based on cumulative nut yield of six years and dwarf nature. A total of 112 plants including grafts of selections, parents and checks were planted in the field in randomized block design during August 2022 with two replications (Fig. 3.1.22). At present 107 plants are maintained in the field. The list of selections, parents and checks planted is given in the Table 3.1.22.

Fig 3.1.22. Field view of replicated trial with backcross selections, parents, and checks

Table 3.1.22: List of selections, parents and checks planted in the replicated trial

Selections	BDB-626 -97, BDB-626-58, BDB-372 -60, BDB-372 -84, BDB-372 -23, BDB-626 -113
Parents	Bhaskara, NRC 492, BDB-626
Checks	Nethra Ganga, Nethra Jumbo-1, Vengurla-4, Vengurla-7

Experiment 2: Breeding for improvement of nut size in cluster bearing genotypes

This experiment was initiated in the year 2017 with the objective to improve nut weight of high yielding and cluster bearing varieties which have medium and small nuts by crossing them with bold nut genotypes. A total of 435 seedlings of 15 crosses were planted in the year 2018 in augmented block design at Kemminje farm. This year growth observations such as stem girth (cm), tree height (m), tree spread in E-W and N-W directions and nut yield in parents, checks and hybrids were recorded (Fig. 3.1.23) and analyzed. The analysis of variance for growth characters and nut yield revealed that test entries (hybrids) and test versus checks were significantly different for height, stem girth, tree spread, nut weight but did not differ significantly for nut yield (Table 3.1.23). Nut weight among the hybrids ranged from 4.5 to 18.0 g while nut yield per tree was up to 2.61 kg (Table 3.1.24).

Fig 3.1.23. A field view of small nut x bold nut types

Table 3.1.23: Analysis of variance for growth characters and yield

Source	Df	Height	Nut weight	Stem girth	Tree spread	Nut yield
Block (ignoring Treatments)	3	4.87 **	21.41 *	899.39 **	5.21 **	0.95 **
Treatment (eliminating Blocks)	442	1.08 **	12.59 **	78.19 **	0.8 **	0.16 ns
Treatment: Check	7	2.39 **	32.81 **	212.64 **	2.88 **	0.65 **
Treatment: Test and Test vs. Check	435	1.06 **	12.26 **	76.02 **	0.76 **	0.15 ns
Residuals	53	0.38	6.93	35.34	0.42	0.11
	Mean	4.63	6.91	40.28	3.76	0.35
	SE	0.73	3.12	7.05	0.77	0.4
	CD	1.46	6.26	14.14	1.55	0.8
	CV	13.55	38	15.14	17.68	96.55

Table 3.1.24: Range of nut weight and nut yield in various crosses

Cross	Nut weight (g)		Nut yield (kg/tree)	
	Min	Max	Min	Max
Nethra Ganga x Ullal-2 (N=33)	5.0	13.8	0.00	2.61
Ullal-2 x Nethra Ganga (N=34)	5.0	10.0	0.00	2.07
NRC 493 x Ullal-2(N=34)	5.9	8.3	0.00	1.18
Ullal-2 x NRC 493(N=23)	5.0	8.2	0.00	1.06
Bhaskara x NRC 493(N=10)	5.7	8.4	0.00	0.94
NRCC Sel-2 x Bhaskara (N=51)	4.5	9.8	0.00	1.78
Ullal-3 x Nethra Ganga (N=22)	6.8	12.7	0.00	1.22
Madakkathara-2 x Nethra Ganga (N=23)	6.0	10.0	0.00	1.41
V-4 x Nethra Ganga (N=40)	6.5	11.5	0.00	1.33
Nethra Ganga x NRC 493(N=31)	8.7	12.8	0.00	1.27
NRC 493 x Nethra Ganga (N=22)	8.0	11.8	0.00	0.86
Nethra Ganga x Ullal 4 (N=46)	4.9	18.0	0.00	0.87
Vengurla 7 x Nethra Ganga (N=28)	5.8	14.8	0.00	0.69
Priyanka x NRC 493 (N=23)	6.6	9.3	0.00	0.17
VRI 3 x Nethra Ganga (N=33)	6.5	14.0	0.00	0.85

Experiment 3: Breeding for reduced tannin content in cashew apples of popular cultivars

This experiment was started in the year 2019 with the objective to reduce tannin content in cashew apples of popular cultivars by crossing them with trees of interspecific hybrids (*A.microcarpum* and cultivars of *A.occidentale* varieties Ullal-1, Ullal-3, Bhaskara, Vengurle-4) with low tannin content. In 2022, tannin content in cashew apples of 59 trees of interspecific hybrids was estimated and identified two hybrids trees T.No. 81, T.No.81 with low tannin content (0.02%). They were used as male parents and crossed with Bhaskara and Vengurla-4. Total 225 F1 nuts were obtained from four crosses and planted 225 plants including checks and parents in the augmented block design during October 2023 at Shantigodu farm (Table 3.1.25).

Table 3.1.25: Crosses and number of plants planted

Cross	Nuts sown	Seeds germinated	Germination (%)	Number of plants planted
Bhaskara x T.No. 81	58	41	70.69	40
Bhaskara x T.No. 83	39	32	79.49	32
Vengurla 4 x T.No. 81	63	57	90.48	56
Vengurla 4 x T.No. 83	64	56	87.50	56
Checks and parents				41
Total				184

Experiment 4: Breeding for improving shelling percentage in HYVs

A germplasm accession (NRC 393) with high shelling percentage (40.5) was selected for hybridization with high yielding varieties having low shelling percentage. NRC 393 was used as male parent and crossed with high yielding varieties Madakkathara-2 and Vengurla-3 having shelling percentage of 26 and 27 respectively. A total of 128 F1 nuts were obtained from two crosses made and planted (151 nos.) including checks and parents in the augmented block design during October 2023 at Shantigodu farm (Table 3.1.26).

Table 3.1.26: Cross combinations and planting of progenies during the year 2023

Cross combinations	No. of seed sown	No. of Seeds germinated	Germination (%)	No. of progenies planted
Vengurla 3 x NRC 393	52	46	86.54	46
Madakathara 2 x NRC 393	82	77	93.90	77
Checks and parents				28
Total				151

Experiment 5: Breeding for improving nut weight in HYVs

Three genotypes with high nut weight viz., NRC 183 (13.41g), NRC 111 (12.50g), Nethra Jumbo-1 (12.00g) were used for hybridization with high yielding varieties viz. Ullal-2, Ullal-3, Nethra Vaaman, Bhaskara having low nut weight. A total of 510 F1 nuts were obtained from eight crosses and planted 500 plants including checks and parents in the augmented block design during October 2023 at Shantigodu farm (Table 3.1.27).

Table 3.1.27 Cross combinations and planting of progenies during the year 2023

Cross combinations	No. of seed sown	No. of Seeds germinated	Germination (%)	No. of progenies planted
Ullal-3 x Nethra Jumbo 1	60	55	91.67	55
Ullal-3 x NRC 183	41	40	97.56	40
Ullal-3 x NRC 111	17	15	88.24	15
Ullal-2 x Nethra Jumbo 1	93	89	95.70	89
Ullal-2 x NRC 183	51	45	88.24	43
Ullal-2 x NRC 111	25	24	96.00	23
Nethra Vamana x Nethra Jumbo 1	80	52	65.00	49
Bhaskara x Nethra Jumbo 1	143	95	66.43	92
Checks and parents				94
Total				500

Experiment 6: Breeding for dwarf types through interspecific hybridization between *A.occidentale and A.pumilum*

Three varieties (Nethra Jumbo-1, Bhaskara, Vengurla-7) were crossed with *A. pumilum* to incorporate dwarfing nature of wild species *A. pumilum* at Shantigodu farm. A total of 89 nuts were sown at Shantigodu farm nursery in June 2023 and obtained 68 seedlings. A total of 93 plants including the checks and parents were planted in the augmented block design during October 2023 at Shantigodu farm (Table 3.1.28).

Table 3.1.28: Cross combinations and planting of progenies during the year 2023

Cross combinations	No. of seed sown	No. of Seeds germinated	Germination (%)	No. of progenies planted
A. o. var Bhaskara x *A. pumilum*	79	61	77.22	61
A. o. var Nethra Jumbo 1 x *A. pumilum*	6	4	66.67	4
A. o. var Vengurla 7 x *A. pumilum*	3	2	66.67	2
A. pumilum x *A. o. var* Bhaskara	1	1	100.00	1
Checks and parents				25
Total				93

3.1.9 Genetics of traits in cashew

This project was initiated in the year 2019 to estimate the nature of gene action for important traits in cashew employing generation mean analysis technique with six generations *viz.,* P_1, P_2, F_1, F_2, BC_1, BC_2. Total 206 plants of all the six generations were planted in August 2022 in the field at Kemminje. This year few plants were dead in some generations and the remaining plants are maintained. (Table 3.1.29 and Fig. 3.1.24)

Fig. 3.1.24. Field view of six generations

Table 3.1.29 Number of plants planted in six generations with parentage

Sl. No.	Generation	Parentage	# plants
1	P_1	Bhaskara	9
2	P_2	NRC-492	9
3	F_1	Bhaskara x NRC-492	9
4	F_2	Selfing of F_1	66
5	B_1	F_1 x Bhaskara	68
6	B_2	F_1 x NRC-492	33
		Total	194

Priority area III. Development, refinement and use of biotechnological approaches in cashew

3.1.10 Genetic dissection of QTLs governing nut yield and cashew nut shell liquid (CNSL) content in cashew

Morphological characterization of F_1s

The F_1 progenies of tree species are derived from the hybridization between two heterozygous clones. In 2019, 327 cashew seedlings of Vengurla-7 x NRC116 (139), Vengurla-7 x NRC492 (12) and Bhaskara x NRC188 (176) planted with 5m x 5m spacing; 352 cashew seedlings Bhaskara x NRC188 (154), NRC492 x H-130 (UV) (18), Bhaskara x H-130 (UV) (21), Bhaskara x NRC492 (59), NRC492 x Bhaskara (35), NRC492 x Thaliparamba (51), and NRC492 x H-130 (16) were planted with a 3 m x 3 m spacing and two crosses of NRC492 x Vengurla-7 (60) and Vengurla-7 Population (92) of total 152 seedlings were transplanted at 4m x 4m spacing, all 11 crosses were planted in square cropping pattern. The four-year-old plants of F_1 mapping populations were evaluated for the flowering, panicle size, nut set and nut characteristics. A total of 112 plants flowered and of it 68 plants set nuts. With respect to size of panicles, 89 of 112, F_1 lines showed larger and long panicles. Further, shell oil and kernel oils were checked in the plants with good nut sets (Fig. 3.1.25a and Fig. 3.1.25 b).

Fig. 3.1.25 a: Comparison of F1 progeny (3-12-11) with parent Nethra Ganga for nut size

Fig. 3.1.25 b: Cluster bearing nature of the F1 Progeny (3-17-13) of Nethra Vaaman x Bhaskara progeny

In 2021, NRC492 x H-130 (75), EMS treated (seed treatment) 20 seedlings of NRC492 xx H-130 and 33 Bhaskara seedlings were transplanted at 6m x 6m spacing; 168 seedlings of NRC392 x Bhaskara (71), NRC153 x NRC142 (22), Bhaskara x NRC142 (14), Bhaskara x NRC153 (3) and NRC492 (self) (10) were transplanted at 3mx3m spacing; 106 grafts of NRC285 (16), NRC189 (16), NRC270 (18), NRC281 (19), NRC385 (18), NRC110 (19) and seedlings of NRC153 x Bhaskara(24), NRC189 x NRC285 (4) and NRC492 x Bhaskara (4), H-130 x NRC110 (15), NRC142 x NRC153 (4), EMS treated (seed treatment) NRC492 (BLB) (43), Bhaskara (18), NRC492 (63) and 8 seedlings of Benin were transplanted at 3x3m spacing, all the above seedlings and grafts were planted in square cropping pattern. Among these three plants derived from open pollinated and EMS treated NRC 492 nuts showed precocious flowering i.e., flowered within two years of planting.

Mapping populations development

During 2023, NRC492 x NRC 385 (109), NRC492 x NRC577 (48), NRC385 x H-130 (29), NRC577 x 385 (11), NRC577 x H-130 (19), NRC392 x NRC577 (20), NRC392 x NRC385 (58), and NRC492 x H-130 (36) were planted at 3m x 3m spacing. The gap filling has done by NRC392 x H-130 (36), NRC392 x Bhaskara (48) at 3m x 3m spacing and 56 seedlings of NRC492 x H-130 at 6m x 6m spacing.

Clonal evaluation of promising exotic germplasm and F_1s

Promising accessions from the exotic seedling germplasm block [Puttur Col No. 9 (NRC577), Puttur Col No. 10 (NRC578), Puttur Col No. 12 (NRC 580), Puttur Col No. 13 (NRC581)] and F1s (3-17-3, 5-18-10, 3-12-11, 3-7-8, 5-28-1, 5-18-3) from the mapping populations having high nut yield and related characters (medium to large nut size, high sex ratio, cluster bearing) and unique traits (heavy and precocious bearing and compactness) were multiplied by softwood grafting and planted at 6 ? 6 m spacing for clonal evaluation in random block design (RBD) along with check varieties and parents. In the seedling evaluation phase, nut yield performance is observed on single trees. Therefore, more reliable data on yields can be collected from evaluation of clones of the promising seedlings selected in the seedling trials. The secondary evaluation trials are usually the first source of larger quantities of fruit for market testing and postharvest evaluation of fruit.

Germplasm Characterization (IC number) and NBPGR genetic stock registration

A total of 7 accessions, five from the exotic seedling block [Puttur Col No. 9 (NRC577), Puttur Col No. 10 (NRC578), Puttur Col No. 11 (NRC 579), Puttur Col No. 12 (NRC 580), Puttur Col No. 13 (NRC581)] and two [SS-1-Compact (NRC 582), SS-2- Cluster (NRC 583)] from the mapping populations with novel traits were identified and applied for IC numbers from NBPGR, New Delhi after submitting 10 clones of each accession to the National Active Germplasm Site (NAGS) at ICAR-DCR, Puttur. Further, one accessions with unique cashew apple type NRC-385 i.e. having similarity with fruits of Malus ? domestica sp. has been submitted for genetic stock registration at NBPGR, New Delhi (Fig. 3.1.26a and Fig. 3.1.26b).

Fig. 3.1.26a. Cashew apple and nut comparison between Bhaskara and NRC 581

Fig. 3.1.26b. Cluster bearing nature of NRC578 accessions and comparison of Cashew apple, nut and kernel between NRC578 and Bhaskara

Morphological and Biochemical Characterization of a CNSL free germplasm NRC 116

The study was carried out to characterize CNSL free germplasm NRC 116 in comparison the reference variety, Bhaskara to understand the morphological and biochemical differences between the CNSL free mutant (NRC-116) and CNSL containing (Bhaskara) genotype. Morphologically, NRC-116 differed from Bhaskara in leaf shape and dimensions, and reproductive characteristics like sex ratio and yield-related traits. The nutshell thickness of NRC-116 was significantly less compared to Bhaskara. Biochemical analysis showed that NRC-116 is free of CNSL and significantly differed from Bhaskara in kernel Fatty acids, proteins, oils and phenolics. Thus, the CNSL free nature of NRC-116 presents it as a unique genetic material for understanding CNSL biosynthetic pathway.

Parental polymorphism with genomic SSRs and genotyping of Bhaskara x NRC 188

A total of 244 SSR markers were used testing the parental polymorphism in the four parents viz. Bhaskara, NRC-188, Vengurla-7 and NRC-116 and 73 of the 244 markers screened were polymorphic (Fig. 3.1.27).

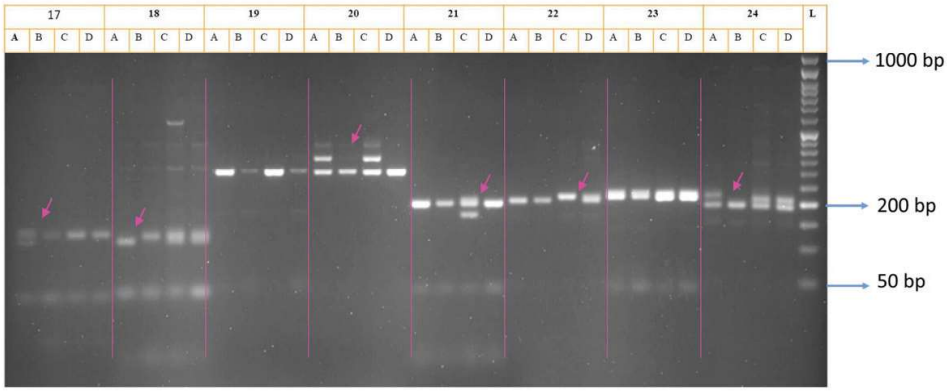


Fig. 3.1.27 Parental polymorphism with genomic SSRs of Bhaskara x NRC 188

Genetic variants identification and INDELs markers development

Genetic variants *viz.,* single nucleotide polymorphisms (SNPs) and insertions/deletions (InDels) are the most abundant and genome wide genetic variations. SNP and InDel markers are valuable tools for genetics and genomic research in crops. To identify genome wide genetic variants in cashew genomes, the whole genome of Nethra Vaman, a dwarf clone of cashew was resequenced and characterized their genome-wide variants (GVs) A total of 420,560 SNPs and 26,987 InDels were identified by aligning with the draft genome of cashew cv. Bhaskara. The density of SNPs was 2,867 per Mb of the genome while the density of InDels was 184 per Mb. Metabolic pathway analysis using KEGG database of the genes with GVs showed that plant hormone signal transduction and Mitogen-activated protein kinase (MAPK) pathways were enriched. Further, a first set of 88 InDel markers were developed and the PIC value of markers varied from 0.11 - 0.85. Amplification of InDel markers in *A. othonianum, A. microcarpum, A. pumilum* and *S. anacardium* showed successful amplification of 84.68%, 79.84%, 74.19%, and 58.06%, respectively. The genomic resources, identification and annotation of GVs, and the development of new class of markers is valuable for genetics, and molecular breeding in cashew and its closely related species.

Development of novel SSR markers and database

Important traits can be studied genetically using DNA marker markers and among the various

DNA markers, microsatellites or SSRs are highly informative and widely used in genetic studies and breeding. In cashew, SSR markers are scarce for comprehensive genetic studies and molecular breeding. A comprehensive genome-wide survey and characterization microsatellites/SSRs in cashew and resulted in identification of 54526 SSRs. Further, the validation of the in silico-mined genome-wide SSRs by PCR screening in cashew genotypes resulted in the development of 59 polymorphic SSR markers, PIC values of the SSR markers varied from 0.19 to 0.84. A web-based database named "Cashew Microsatellite Database (CMDB)," was designed to provide access to genomic SSRs mined in silico as well as transcriptome-based SSRs to the research community through a user-friendly database (Fig. 3.1.28).

Fig. 3.1.28: View of cashew microsatellite database

3.1.11 Deciphering the molecular basis of Cashew-Tea Mosquito Bug (TMB) interactions to understand host response and TMB effectors

The work on molecular basis of Cashew-TMB interactions have been initiated. The objectives of this project are to assemble whole genome of TMB and then study the cashew TMB interactions with the transcriptomes and proteomes studies in the infested plants. In the de novo assembly of draft genome of TMB, a total of about 630 million filtered reads (99.02%) were produced using the Illumina sequencing technology. The long Nanopore reads are being generated for the hybrid de novo assembly of TMB. The sampling has been done for the study of transcriptome and proteome analysis during Cashew-TMB interaction and analysis has been initiated (Fig. 3.1.29).

Fig. 3.1.29 Sampling of control and treatments in cashew _TMB interactions

3.2 CROP MANAGEMENT

Priority area IV: Enhancing input use efficiency and productivity

3.2.1 Developing nutrient management strategies for cashew based on soil and leaf status

In order to standardise the fertiliser recommendation under high density planting in cashew, the treatments were imposed during the year 2022-23. The cashewnut yield ranged from 1.30 to 3.47 kg/tree. The nitrogen content in leaf samples ranged from 0.74 to 1.48%, phosphorus from 0.11 to 0.28%, potassium from 0.35 to 0.63%, calcium from 0.15 to 0.36%, and magnesium from 0.15 to 0.24%. The contents of micronutrients such as iron ranged from 30.05 to 100.96 ppm, Mn from 17.33 to 57.56 ppm, zinc from 9.06 to 29.04 ppm, and copper from 4.78 to 21.72 ppm.

3.2.2 Carbon cycling, sequestration and nutrient dynamics in cashew orchards

A 20-year-old plantation of cashew on a highly weathered lateritic soil can sequester biomass carbon in the range of 42.93 to 50.41 Mg C ha^{-1} which is equivalent to 157.56 to 184.99 Mg ha^{-1} of CO2 equivalents. The total sequestration of carbon in the top 60 cm layer of soil of a 20-year-old cashew plantation ranged from 99.52 to 104.61 Mg ha^{-1}. The soil biological activities under the plantations were also studied. The microbial biomass carbon ranged from 163.34 to 695.34 mg kg^{-1} and microbial biomass nitrogen from 15.39 to 78.86 mg kg^{-1}

Priority area V: Physiological and basic studies

3.2.3 *In vitro* pollen germination and pollen tube growth of cashew varieties in response to high temperature stress

The pollens of five cashew varieties comprising three early (VRI-3, Vengurla-4 and Ullal-3), one mid (Bhaskara) and one late (Madakkathara-2) were screened in field (in vivo) as well as at controlled temperatures (in vitro) from 5 to 50°C. Pollen germination under in vivo was high for early types with optimum temperature (T_{opt}) of 25°C while it was low in mid and late types with T_{opt} of 30°C. The in vitro study further confirmed this finding, pollen germination at 25°C was 75% in early types while it was 57.8 and 50.5% for mid and late types respectively at 30°C. However, mid and late varieties exhibited better tolerance to high temperature beyond 40°C suggesting their wider adaptability to high temperature. The in vitro temperature screening technique is further used to screen large number of cashew varieties where 12 cashew varieties were screened at controlled temperatures (5 to 50°C) and cardinal temperatures (minimum, optimum and maximum) were worked out (Table 3.2.1 and Fig. 3.2.1).

Table 3.2.1: Determination of cardinal (minimum, optimum and maximum) temperatures for maximum pollen germination in cashew varieties

		Equation constants				Cardinal temperature		
Varieties	Maximum pollen g ermination (%)	a	b_1	b_2	R_2	T_{opt}	T_{min}	T_{max}
V-1	69.8±0.80	65.73	0.62	-3.95	0.97	24.4	10.0	44.1
Kanaka	75.5±1.11	75.20	0.96	-4.55	0.97	23.3	9.7	44.3
V-7	80.3±2.08	83.68	1.15	-5.03	0.98	22.9	9.4	44.5

VTH 30/4	81.9±0.64	90.33	1.28	-5.29	0.99	22.7	8.9	45.2
VTH-174	81.9±5.86	87.86	1.26	-5.18	0.99	22.6	9.0	45.0
Ullal-1	70.1±2.055	66.35	0.72	-4.02	0.95	23.8	9.8	43.9
H-130	84.7±0.70	92.93	1.33	-5.38	0.99	22.6	8.8	45.5
M-1	72.5±0.91	66.11	0.77	-4.11	0.91	24.0	10.4	43.8
Dhana	49.9±1.30	48.35	-0.21	-2.63	0.94	31.1	11.1	48.2
Priyanka	60.2±1.98	68.54	-0.64	-3.69	0.95	32.6	10.1	48.4
Bhaskara	57.9±1.62	61.98	-0.45	-3.33	0.93	32.1	10.6	48.5
M-2	34.3±1.04	38.31	-0.34	-2.10	0.93	32.5	10.7	48.2

Note: Tmin: Minimum; Topt: Optimum and Tmax: maximum

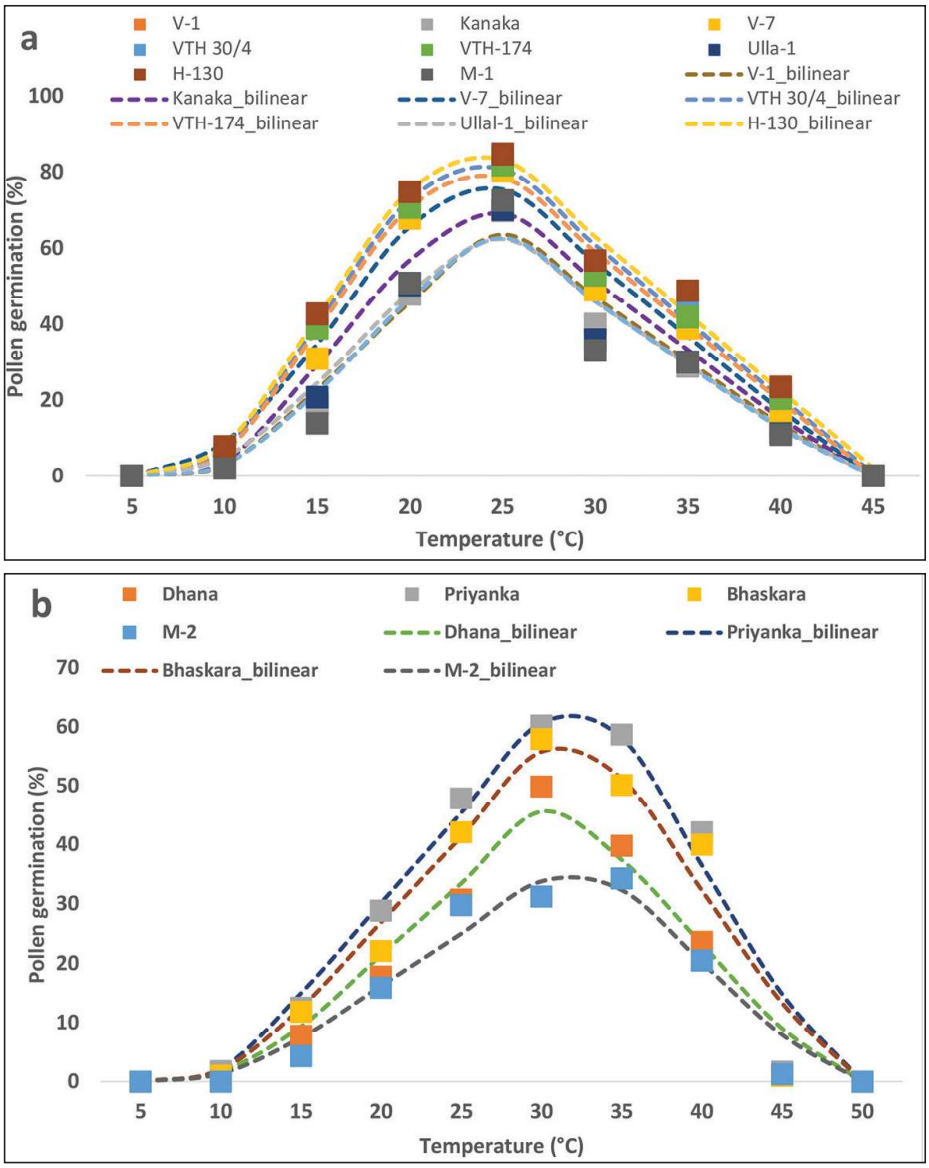


Fig: 3.2.1: Pollen germination in response to temperature and their fitted lines based on modified bilinear model for cardinal temperatures. (a) in early varieties and (b) in mid and late varieties

3.2.4: Physiological and biochemical basis of salinity tolerance in cashew

A critical salt concentration of 250 mM has been standardized based on reduction in total plant biomass and changes in ion content in leaf in cashew seedlings under greenhouse conditions. The plant biomass reduction corresponded to 13%, 23%, 37.9% and 46.4% at 100 mM, 150 mM, 200 mM and 250mM over control. The increase in Na+ content in leaf corresponded to 73.4%, 90.3%, 95.2% and 95.6% at 100 mM, 150 mM, 200 mM and 250mM over control. The leaf K+ content was reduced to the extent of 20.79%, 24.81%, 30.71% and 43.71% at 100 mM, 150 mM, 200 mM and 250mM over control. The reduction in K+/Na+ ratio in leaf corresponded to 78.79%, 92.73%, 96.66% and 97.51% at 100 mM, 150 mM, 200 mM and 250mM over control. Based on standardization of critical salt concentration, a pot culture experiment has been initiated where seedlings of twenty-two cashew varieties (both DCR and AICRP varieties) have been raised in 10 kg capacity plastic bags to screen at 250 mM for salt tolerance under greenhouse conditions (Fig. 3.2.2 and Table 3.2.2; Table 3.2.3 & Table 3.2.4)

Fig. 3.2.2: Leaf toxicity symptoms after different days of salinity treatments (250 mM). a. after 25 days of treatments and b. after 35 days of salinity treatments.

Table 3.2.2: Effect of salinity stress on leaf Na^+ content in cashew varieties

NaCl (mM)	Leaf Na+ content (%)							
	VTH-175	Dhana	Ullal-1	VRI-3	Vengurla-4	M-2	Bhaskara	Ullal-3
0	0.1±0.0091e	0.06±0.009e	0.08±0.009e	0.1±0.0091e	0.06±0.007d	0.1175±0.02e	0.09±0.02e	0.08±0.009d
100	0.23±0.012d	0.32±0.009d	0.29±0.009d	0.33±0.012d	0.36±0.01c	0.45±0.007d	0.31±0.009d	0.33±0.01c
150	0.89±0.012c	0.78±0.018c	0.87±0.012c	0.93±0.007c	0.93±0.01b	0.95±0.012c	0.78±0.009c	0.77±0.01b
200	1.56±0.014b	1.67±0.014b	1.77±0.020b	1.89±0.015b	1.88±0.03a	1.89±0.019b	1.67±0.01b	1.73±0.01a
250	1.87±0.015a	1.930.012a	1.9±0.044a	1.94±0.015a	1.92±0.02a	1.96±0.009a	1.77±0.02a	1.8±0.05a

Table 3.2.3: Effect of salinity stress on leaf K^+ content in cashew varieties

NaCl (mM)	Leaf K^+ content (%)							
	VTH-175	Dhana	Ullal-1	VRI-3	Vengurla-4	M-2	Bhaskara	Ullal-3
0	1.14±0.009a	1.02±0.02a	1.05±0.009a	1.11±0.043a	1.05±0.012a	0.99±0.020a	1.08±0.009a	1.08±0.015a
100	1.09±0.009b	0.91±0.03b	0.83±0.033b	0.57±0.009b	0.94±0.016b	0.67±0.015b	0.88±0.014b	0.86±0.008b
150	1.07±0.015b	0.84±0.01c	0.8±0.0091bc	0.55±0.012b	0.89±0.009c	0.65±0.031bc	0.87±0.012b	0.75±0.009c
200	1.05±0.009b	0.65±0.01	0.75±0.009c	0.53±0.012b	0.8±0.015d	0.58±0.012cd	0.75±0.019c	0.81±0.024d
250	0.61±0.020c	0.6±0.01d	0.62±0.041d	0.51±0.031b	0.59±0.009e	0.51±0.031d	0.7±0.027c	0.66±0.015e

Table 3.2.4: Effect of different levels of salinity on leaf K^+/Na^+ in cashew varieties

NaCl (mM)	Leaf K^+/Na^+ content							
	VTH-175	Dhana	Ullal-1	VRI-3	Vengurla-4	M-2	Bhaskara	Ullal-3
0	11.38±0.33a	15.89±0.96a	13.72±0.91a	11.1±0.62a	16.26±0.81a	9.9±0.94a	12±0.53a	14.44±0.84a
100	4.83±0.64b	2.86±0.96b	2.87±0.23b	1.73±0.14b	2.6±0.05b	1.48±0.03b	2.84±0.041b	2.61±0.06b
150	1.2±0.0298c	1.07±0.01bc	1.1525±0.2c	0.59±0.05c	0.96±0.03c	0.69±0.03b	1.11±0.039c	0.98±0.061c
200	0.67±0.06c	0.39±0.01c	0.43±0.04c	0.28±0.01c	0.43±0.02c	0.31±0.009b	0.45±0.03c	0.47±0.024c
250	0.33±0.02c	0.31±0.03c	0.33±0.03c	0.26±0.04c	0.31±0.03c	0.26±0.01b	0.4±0.04c	0.37±0.012c

Priority area VI: Horticulture production technologies

3.2.5 Effect of growth regulator in combination with flower and fruit-set enhancing chemicals on cashew (*Anacardium occidentale* L.)

The different plant growth hormone combinations were sprayed to the trees of VRI-3, Vengurla-4 and Priyanka to evaluate the influence of plant growth regulators on flowering, fruit set and yield. Observations on flowering panicle, male flower, female flower and number of fruit set were recorded after foliar application of different plant growth hormones.

3.2.6 Cryopreservation and in vitro pollen germination studies in Cashew

Cryo preserved *Semekarpus kurzii* and other cashew genotypes. The pollen morphology, and flower of *Semekarpus kurzii* was studied through scanning electron microscope. The cryopreserved pollen of *Semekarpus kurzii* was utilized for further in vitro germination studies and *in vivo* pollination (Fig. 3.2.3).

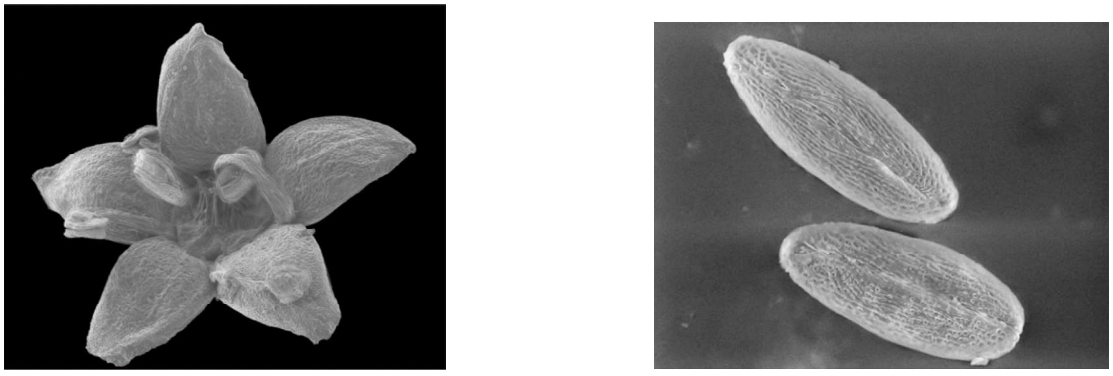


Fig. 3.2.3: Scanning electron microscopic images of *Semekarpus kurzii* flower and pollen

3.2.7 Biochemical and mineral composition studies in relation to phenology of fruit development and maturity in cashew

The main aim of the study is to understand the biosynthesis of some of the important bioactive components in different phenological growth stages of cashew. Important bioactive components like total phenols, flavonoids, total antioxidant activity, tannins, vitamin C, the protein, and CNSL content in five fruit development and fruit maturity stages of cashew, was recorded. The analysis was done in three different varieties Viz., VRI-3, CNSL free type, and NRC selection-2. The total phenols showed a decreasing trend throughout the fruit maturity period as like in other fruit crops, because of the oxidation of phenols by the enzyme polyphenol oxidase. Similar trend was noticed with respect to antioxidants activity and total phenols, the tannin. Vitamin C concentration increases with increasing fruit maturity stages in both the varieties VRI-3 and NRC Selection -2. whereas in case of CNSL free type with respect to tannin concentration starting from the first stage to last phenological stages it remained zero as there was no synthesis of CNSL. In other varieties after flavonoids synthesis through condensation and polymerization phases the condensed tannins are formed but these hydrolysable tannins are the derivatives of gallic acids which was completely absent in CNSL free types.

3.2.8 Establishment of Centre of Excellence for profiling of bioactive components in cashew apple and nut (Externally funded project)

A central laboratory for profiling of bioactive components was established with advanced facilities like High pressure liquid chromatography, Gas chromatography Mass spectrometry, UV-Visible spectrophotometer along with that two air conditioners and laboratory island and working tables were procured and installed (Fig. 3.2.4a; 4b & 4c).

Fig. 3.2.4a. High Pressure Liquid Chromatogrpahy (HPLC)

Fig. 3.2.4b. UPS for HPLC

Fig. 3.2.4c.Gas Chromatography Mass spectrometry Laboratory

3.2.9 Effect of inter-stocks in Cashew (*Anacardium occidentale*)

Inter-stock grafting experiment was conducted at nursery with different dwarf and vigorous inter-stock with VTH-174 as root stock to know the success of inter-stock grafting and to induce the dwarf character in grafts in 3 replications and 30 grafts /replications and Different inter-stock viz. V-4 (I1), Bhaskara(I2), Anacardium pumilum (I3), Nethra vaaman (I4), KAU Nihara (Taliparamba) (I5), V-7 (I6) were used in grafting of V-4(V1) and Bhaskara(V2) variety along with normal grafting of V-4 and Bhaskara. These grafting of inter-stock and main scion were done simultaneously in the month of April-2023. Observations on grafting success and other parameters viz. morphological and physiological traits were recorded monthly interval till 6th month and after 6th month destructive observations were also recorded by estimating wet and dry biomass of root and shoot. This study indicates that, inter-stock grafting gave good success rate in terms of survival percentage and survival percentage varies from 12.5 to 100 %. Highest survival percentage was recorded in single grafting of V-4, Bhaskara and V-7+V-4 (100 %) followed by V-7+Bhaskara and KAU Nihara (Taliparamba) (86..66 %), Nethra Vaman +V4 (83.33%), KAU Nihara (Taliparamba) (80 %), V-4+V4 (50 %), Nethra Vaman +Bhaskara (43.33 %), Bhaskara+V4 (26.67 %), Bhaskara+Bhaskara (20 %), V4+Bhaskara (16.67%), A. Pumilum +V-4 (14.29 %) and A. Pumilum+ Bhaskara (12.5 %). Height of grafts varies from 17 cm-48.42 cm, Girth of root stock, Inter-stock and Scion varies (2.39-10.5 mm, 1.88-7.24 mm and 1.82-7.49 mm, respectively), number of leaves varies from 2.33-11.53, Internodal length varies from 0.06 (I3V1, I3V2) - 0.96 (I5V4), Leaf area varies from 17.78-79.83 cm2, Stomatal density (40 X) varies from 26.22-41.33, height increment varies from 0.33 cm (I3V2) to 8.17 cm (I5V2). Among the destructive sampling observation there is no significance difference observed among different inter-stock grafts. In the nursery experiment it was difficult to observe the dwarf traits, so we have laid out new field experiment by using these successful inter-stock grafts and planted in the field on October, 2023 with 12 different interstocks in 3 replications (4 grafts/replication) with 5 mx 5 m spacing, but I3V1 and I3V2 were not much successful and it was not planted in replicated trail (Fig. 3.2.5 and Table 3.2.5).

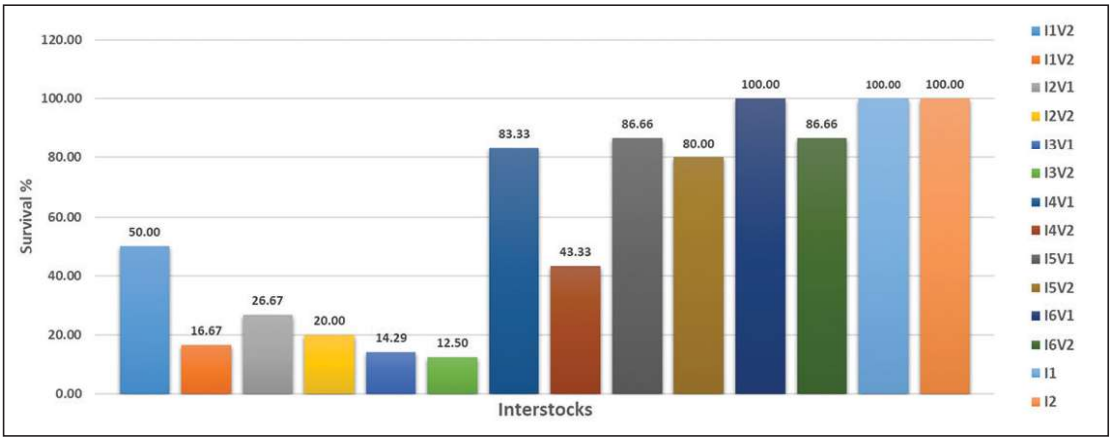


Fig. 3.2.5 Survival percentage of inter-stock grafts in the nursery

Table 3.2.5 Growth and physiological parameters of inter-stock grafting in nursery

Treatments	Height (cm)	Height increment (cm)	Girth (mm)			No. of leaves	Internodal length (cm)	Leaf area (cm^2)	Stomatal at density (40x)
			Root stock	Inter-stock	scion				
I1V2	42.73	5.20	8.59	6.58	7.05	11.53	0.48	73.19	29.66
I1V2	41.50	2.00	9.46	6.85	6.54	8.50	0.49	65.50	29.00
I2V1	40.00	3.13	8.50	7.05	6.92	9.66	0.28	59.04	30.89
I2V2	40.83	3.33	8.30	7.24	7.46	7.50	0.53	68.46	26.77
I3V1	13.33	0.67	2.39	1.88	1.82	2.33	0.06	17.78	33.44
I3V2	17.00	0.33	2.95	2.62	2.68	3.33	0.06	31.04	28.89
I4V1	43.95	5.00	10.50	6.94	7.10	9.85	0.63	79.83	32.11
I4V2	46.24	6.37	9.36	6.50	7.34	8.01	0.91	79.24	33.33
I5V1	44.75	5.60	9.31	7.12	7.19	9.58	0.96	73.18	30.33
I5V2	48.42	8.17	8.35	6.96	7.28	8.68	0.80	69.33	33.22
I6V1	44.57	4.43	9.95	7.17	7.49	9.12	0.57	73.51	41.33
I6V2	48.03	7.10	9.27	7.12	7.29	11.11	0.81	72.52	26.22
I1	40.52	5.30	8.31	0.00	6.73	8.29	0.63	74.21	31.00
I2	44.62	6.23	8.94	0.00	7.10	10.90	0.79	67.31	34.78
CV	24.58	23.03	192.36	28.64	24.19	27.58	44.17	25.30	7.51
CD @ 1 %	22.17	2.35	NS	3.44	3.53	5.29	0.57	37.07	5.37
CD @ 5 %	16.40	1.74	NS	2.54	2.61	3.92	0.42	27.43	3.97

3.2.10 Developing soilless media for developing quality grafts in Cashew (*Anacardium occidentale*)

The nursery experiment on soil less media was initiated during April 2023 with 4 different media *viz.* soil: sand: FYM (1:1:1) (M1), vermicompost (M2), coir pith compost (M3) and vermicompost + coir pith compost (1:1) (M4) with 4 replications in CRD design. Media and soil analysis was carried out to know the nutrient status and it was observed that, Nitrogen content varies from 0.03 - 0.1 %, Phosphorus (0.1 - 0.68 %), Potash (0.17 - 0.97 %), Ca (1.73 -7.41 %), Mg (0.12 - 0.41 %), Na (0.06-0.25 %), Fe (0.61-0.87 %), Mn (0.01-0.08 %), Zn (0.01-0.09 %), Cu (0.03-0.04 %). In this experiment VTH-174 was used as root stock and soil media filled in 15x25" bags were weighed and M1 was 2 kg/bag and M2, M3, M4 were 1 kg/bag filled. Survival percentage and growth parameters of root stock was recorded in monthly interval for 2 months. Survival % was varies from 94 to 98 % among the different media, but it was statistical non-significant. Height of graft was varying from 19.12 to 24.16 cm and 30.40 to 34.64 cm during 30 days and 60 days after sowing respectively and in M1 media height of grafts were recorded less as compared M2, M3 and M4 (Table 3.2.6).

Table 3.2.6 Growth parameters of root stock in soil less media experiment

Treatments	30 days				60 days			
	Survival %	Height of graft (cm)	Girth of Root stock (mm)	No. of leaves	Survival %	Height of graft (cm)	Girth of Root stock (mm)	No. of leaves
M1	96.00	19.12	4.44	10.47	94.00	30.40	5.73	14.51
M2	97.00	21.71	4.32	10.41	94.00	34.09	6.17	15.84
M3	99.00	23.59	4.30	10.86	98.00	34.64	6.55	14.04
M4	98.00	24.16	4.38	11.00	98.00	34.22	6.29	14.17
CV	3.02	3.28	3.92	6.16	4.17	4.41	6.11	8.99
CD @1 %	NS	1.57	NS	NS	NS	3.17	NS	NS
CD @1 %	NS	1.12	NS	NS	NS	2.26	NS	NS

3.2.11 Studies on training and pruning in cashew for better canopy management

A new trial on training and pruning in cashew for better canopy management was planted in November 2023 with Factorial RBD design with 3 replications and 4 plants per replications, were planted at Kemminje field with 3 mx 3 m spacing (Fig. 3.2.6). Two factors were used for imposition of pruning treatment, first factor was retaining of number of primary branches (2, 3 &4), second factor was retaining of secondary branches (2, 3 &4). The variety used in the experiment was VRI-3. Before experiment soil nutrient status was analyzed and initial growth parameters were recorded in VRI-3 grafts planted in the field. Average tree height was 0.38 m, average girth of root stock was0.76 cm, average girth of scion was 0.59 cm and average number leaves was 12.86.

Fig. 3.2.6 Field view of experiment on training and pruning in cashew for better canopy management

3.2.12 Development of cashew (*Anacardium occidentale* L.) based cropping system for west coastal region

Development of cashew-based cropping system for west coast region experiment was planted in November, 2022 at Kemminje with RBD design of 7 treatments with 3 replications in 10 m x 5 m spacing with VRI-3 cashew variety. Six fruit crops viz. Mango var. Amrapali, Guava var. Alahabad Safed, Mangosteen, Acid lime var. Balaji and Rambutan var. N18 and one cover crop (*Stylosanthus hamata*) was included in the treatment. Growth parameters of cashew was recorded and observed that, height of graft varies from 1.51 m (Cashew + Rambutan) to 1.76 m (cashew +cover crop), average canopy spread was more in (Cashew + Guava), average canopy spread was less in (Cashew+Mangosteen). all the growth parameters *viz.,* height of plant, girth of plant, canopy spread and canopy area were shown statistically non-significant**.** The cover crop *stylosanthes hamata* biomass was estimated and 25 tonnes/ha was reported. In this experiment Mangosteen was not established properly due to lack of shade and again we have replanted and provided shade to this crop (Table 3.2.7).

Table 3.2.7 Growth parameters of cashew (VRI-3) in cashew-based cropping system

Treatments	Height (m)	Girth (cm)	Canopy Spread (m)		Average canopy spread (m)	Canopy area (m^2)
			N-S	E-W		
T1	1.64	2.74	1.02	1.04	1.03	0.96
T2	1.61	2.88	0.97	1.03	1.00	0.84
T3	1.56	2.69	1.00	1.09	1.04	0.90
T4	1.58	2.63	0.90	0.95	0.93	0.71
T5	1.61	2.79	0.99	1.00	1.00	0.83
T6	1.51	2.67	0.99	1.01	1.00	0.80
T7	1.76	2.97	0.98	1.03	1.01	0.46
CV	10.43	9.95	12.07	11.36	11.01	32.25
CD @5 %	NS	NS	NS	NS	NS	NS

3.2.13 Influence of weather parameters on growth dynamics of apple and nut in selected varieties of cashew

Adopting the technique of the modified BBCH scale in cashew varieties (Vengurla-4, Vengurla-7, Vridhachalam-3, NRCC Selection-2, Madakathara-2, and Bhaskara) were screened to know the growth dynamics of cashew nut and apple (developmental stages-BBCH code 711 to 719 and maturity stages-BBCH code 811 to 819) stages. The cashew nut weight was highest at code 811 for all the varieties except in Bhaskara and Vengurla-7 (719). Similarly, cashew apple weight from the initial stages up on progression was found highest at 819. The transition from nut and apple gain in weight varied among the varieties at stage 811 except in Vengurla-7 and Bhaskara (719). Included bold nut varieties H-130, and H126 were recorded for the growth of apple and nut as per the BBCH scale and elemental composition in respect of different varieties with BBCH codes in progress. The TMB incidence was not reported during the study.

3.2.14 Design, development and performance evaluation of cashew fruit and nut separator

The existing cashew fruit and nut separator was modified based on the performance evaluation results to address issues such as cashew apple and nut chocking and nut damage. The four different types of mechanisms were used in the separation unit, viz., flat blades with rotating sieve apertures, pegs with flat blades with stationary sieve apertures, flat blades with square rods, and VFDs for speed adjustment to overcome the above issues. Further tests on the improved machine showed that the nuts were getting damaged again. Based on the problems identified, the modification of the developed prototype is in progress.

3.2.15 Design and development of gadgets for cashew fruit harvesting and collection

All the tools developed for cashew fruit harvesting and collecting were tested in the farmer's field, and feedback was collected. The jaw-type cashew fruit and nut collector's weight was reduced from 1.5 kg to 0.8 kg, making it suitable for woman farmers. The self-storing unit was attached to the existing jaw-type fruit and nut collector and tested. The developed tool's average collecting capacity was determined to be 38.81 kg h-1 and the percentage of debris was found to be < 2.5%.

Developed the battery-operated branch shaker and collection device. The shaker was completely powered by a 12V battery. The shaker comprises a telescopic pole, handle, double-shaft DC motor, flexible rods, speed regulator, and battery. The flexible rods are clamped firmly to the hub provided on the shaft. A rotational motion is provided to the shaker by the DC motor. The speed can be easily adjusted by the speed regulator. The collection device is comprised of a handle, telescopic poles, guiding wheels, HDPE green net cloth, hitch frame assembly, and main frame. The net cloth is foldable, the diameter is easily adjustable, and the developed collection device is foldable. Also developed a remotely operated cashew fruit picker.

3.2.16 Mechanization of pesticide and nutrient sprays in cashew orchards through drones (Externally funded project)

A Drone Technology Laboratory was established, aiming to explore, develop, and promote the use of drone technology in plantation crops. The laboratory is equipped with state-of-the-art, cutting-edge technologies, viz., drones, sensors, and software, providing a platform for research, experimentation, and training. I also established a state-of-the-art farm machinery laboratory with the aim of mechanizing cashew cultivation practices. The laboratory was equipped with various advanced tools and equipment, viz., a post-hole digger, a self-propelled power weeder, brush cutters, battery sprayers, tractor-operated aero-blast sprayers, a PPE kit, telescopic tree pruners, etc., to support and optimize cashew cultivation practices. The development of a standard operating procedure (SOP) for spraying pesticides and micronutrients through drones in cashew orchards is underway.

3.2.17 Drone Technology Demonstration (DTD)-(Externally funded project)

Crop spraying is traditionally done by hand or with tractor-operated machinery, both of which have limitations in terms of precision and efficiency. The introduction of drone spraying technology addresses these limitations by providing a more precise and sustainable approach to crop management. In this connection, to create awareness among farmers, extension workers, and other stakeholders about drone applications in agriculture, we purchased two 10-liter capacity agricultural spray drones (AGRIBOT, a model approved by the DGCA) as part of the "Drone Technology Demonstration (DTD)" program, which was funded by the Central Sector

Scheme of the Department of Agriculture and Farmers Welfare and implemented through ATARI (Sub Mission on Agricultural Mechanization). An RPAS training course was completed by one scientist at the Indira Gandhi Rashtriya Uran Akademi in Bangalore, which is a DGCA-approved RPAS training centre. During this project, we organized twenty drone technology demonstrations for spraying agricultural chemicals, micronutrients, and organic pesticides in farmers' fields, covering 39 acres. In all, 819 farmers participated in the program. Farmers provided positive feedback on the drone technology demonstrations. Many people expressed interest in adopting the technology, citing its potential to increase efficiency, lower costs, and improve overall crop management practices.

3.3 CROP PROTECTION

Priority area VIII: Integrated management of pests and diseases and ecosystem services in cashew

3.3.1 Characterization and synthesis of female sex pheromone of Tea Mosquito Bug; (*Helopeltis antonii*) and its bioassay

The virgin females of TMB aged 3-5 days were caged in net cages along with the tender cashew shoot and placed in the circular sticky traps. Those TMB females which showed attraction to the field population of males were immediately transferred to the laboratory. Such virgin females (varying numbers on different days; based on the emergence) were placed in the volatile collection set up and the vacuum pump was operated for 6 hrs. with a flow rate of 2.0 L per hour. The volatiles secreted by such actively calling females were adsorbed onto either Tenax® or Porapak® cartridges. These were suitably stored below freezing temperature for further analysis.at ICAR –NBAIR (Fig. 3.3.1a and Fig. 3.3.1b.).

Fig. 3.3.1a Circular TMB live female baited trap for assessing "calling" stage.

Fig. 3.3.1b Volatiles adsorbed onto Tenax® or Porapak® catridges for future evaluation.

The antennal longevity of both virgin females and unmated males of TMB were tested at ICAR – NBAIR, Bengaluru by recording the responses at different durations after dissection. It was observed that the antennae of both sexes could respond to stimuli for a period of up to 20 minutes after excision.

The lab reared virgin females and unmated males of TMB were tested for their EAG response to determine the responsive parameters using different solvents, DCM, Z-3 Nonanol, E-3 Hexenol, Z-3 Hexenol, Benzene acetaldehyde and Z-3 Hexyl acetate. The trials were repeated for 8 replications and 10 µL of 10 ppm of the test solvents were injected into GCMS – EAG.

It was noticed that though DCM elicited significantly higher response from the antennae of both the males and females; maximum responses were observed in E-3 Hexenol followed by Z-3Nonanol compared to the other test solvents. However, they induced antennal fatigue within 15 – 20 mins minimizing the evaluation period for each antennae. The same trend of EAG response was observed while testing versus the antennae of both males and females of TMB (Fig. 3.3.2).

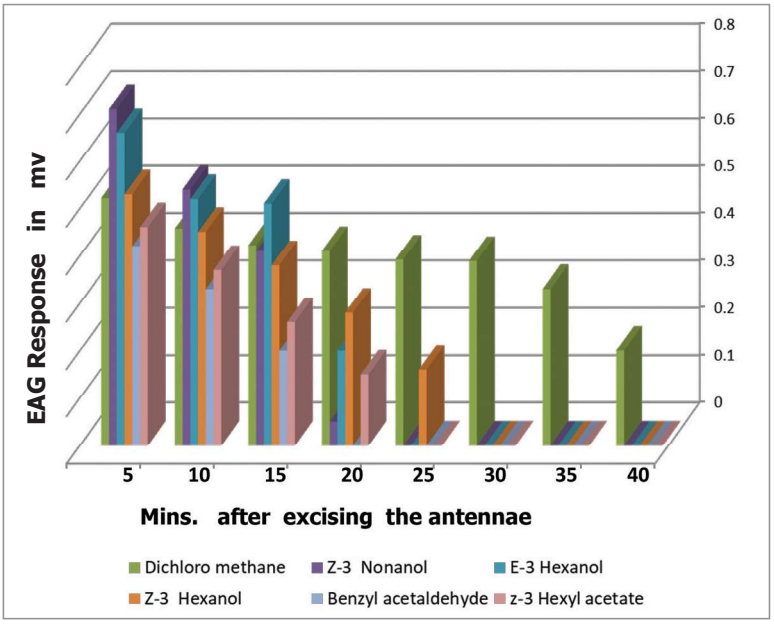


Fig. 3.3.2 Effect of different solvents

3.3.2 Assessing the field effectiveness of entomopathogenic nematodes (EPN) and indigenous strain of entomopathogenic fungus (EPF) in management of cashew stem and root borers (*Plocaederus ferrugineus* and *Plocaederus obesus*)

The trials on evaluation of EPN were conducted in the experimental plots in two locations of Karnataka Cashew Development Corporation (KCDC) plantations at Sowthadka.

The cultures of the EPN were multiplied on the larvae of greater wax moth; *Galleria mellonella.* The IJs were collected by following the White trap methodology and subsequently maintained in aqueous medium. The test solutions of the IJs of EPN of two different species viz., *Heterorhabditis indica* and *Steinernema carpocapsae* were used for the evaluations.

The test solution of 10 LE /L was used at different doses for treatment [by raking the soil around the root zone and sprinkling the known quantity of EPN suspension] and the soil samples were collected after 45 days after treatment and the survival of the EPN and retention of their virulence was studied (Table 3.3.1 & Table 3.3.2).

It was noticed that cent per cent mortality occurred in the bait insects viz., Galleria mellonella larvae when allowed to crawl in the soil samples for 12 h up to 30 days after sampling and gradually reduced further to around 50 per cent during the 120-day evaluations (Fig. 3.3.3a; 3.3.3b; 3.3.4a; 3.3.4b; 3.3.5).

Fig. 3.3.3a Test insect infected by EPN from treated soil samples; *H. indica* (R) and *S. carpocapsae* (L)

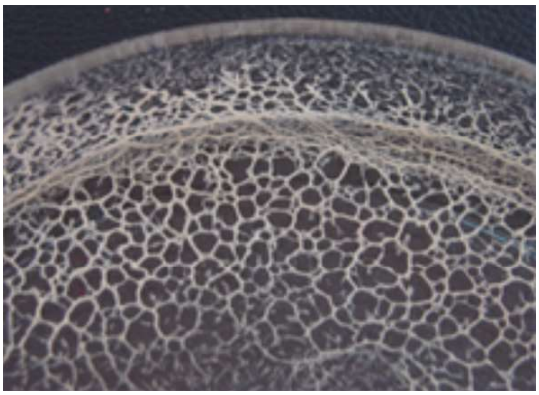


Fig. 3.3.3b Emerging Infective juveniles of EPN webbing on the Petri-dish

Table 3.3.1 Mortality levels of bait insects in soil samples - *Heterorhabditis indica*

Duration after sampling (d)	Mortality levels (%) of the bait insect				
	Location 1		Location 2		Mean mortality
5	100	100	100	100	100
15	100	100	100	100	100
30	100	100	100	100	100
45	100	90	100	90	95.0
60	70	80	90	70	77.5
75	60	60	70	70	65.0
90	60	50	70	60	60.0
120	40	40	50	60	47.5

Table 3.3.2 Mortality levels of bait insects in soil samples - *Steinernema carpocapsae*

Duration after sampling (d)	Mortality levels (%) of the bait insect				
	Location 1		Location 2		Mean mortality
5	100	100	100	100	100
15	100	100	100	100	100
30	100	100	100	100	100
45	100	90	100	90	95.0
60	70	70	80	70	72.50
75	60	70	70	70	67.50
90	60	50	60	50	55.0
120	50	40	40	30	40.0

Fig. 3.3.4aTest insect infected by EPN from treated soil samples; *H.indica* (R) and *S.carpocapsae* (L)

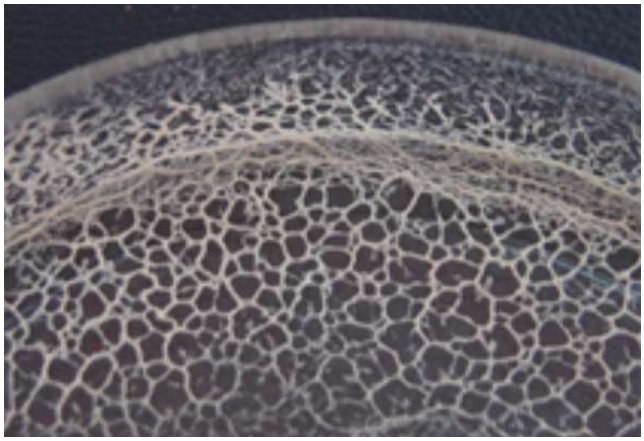


Fig. 3.3.4b Emerging Infective juveniles of EPN webbing on the Petridish

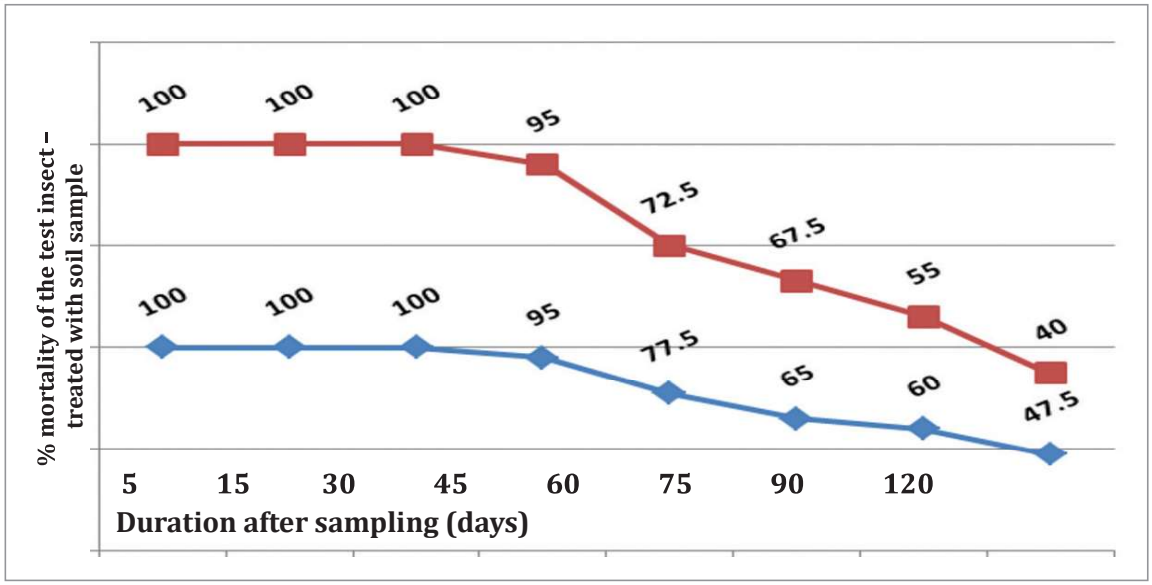


Fig. 3.3.5 Soil survival of both EPN as indicated by mortality levels

3.3.3 Cashew - tea mosquito bug interactions and the defensive responses Influence of foliar nutrient sprays on TMB infestation

Herbivore induced plant volatiles (HIPV)

The studies on identifying the HIPVs for tea mosquito bug in cashew was continued this year also at ICAR-IIHR, Bengaluru. The grafts of two cashew varieties viz., NRCC Sel-2 (highly susceptible to TMB) and Bhaskara (pseudo-resistant) were subjected for the study. The volatiles from both healthy cashew plants and TMB infested plants were collected using 'Air entrainment method' in Porapak -Q® column (Fig.3.3.6). The column was subsequently eluted with diethyl ether and checked using GC-MS. The chromatograms showed different profiles for healthy and TMB infested plants in both the varieties.

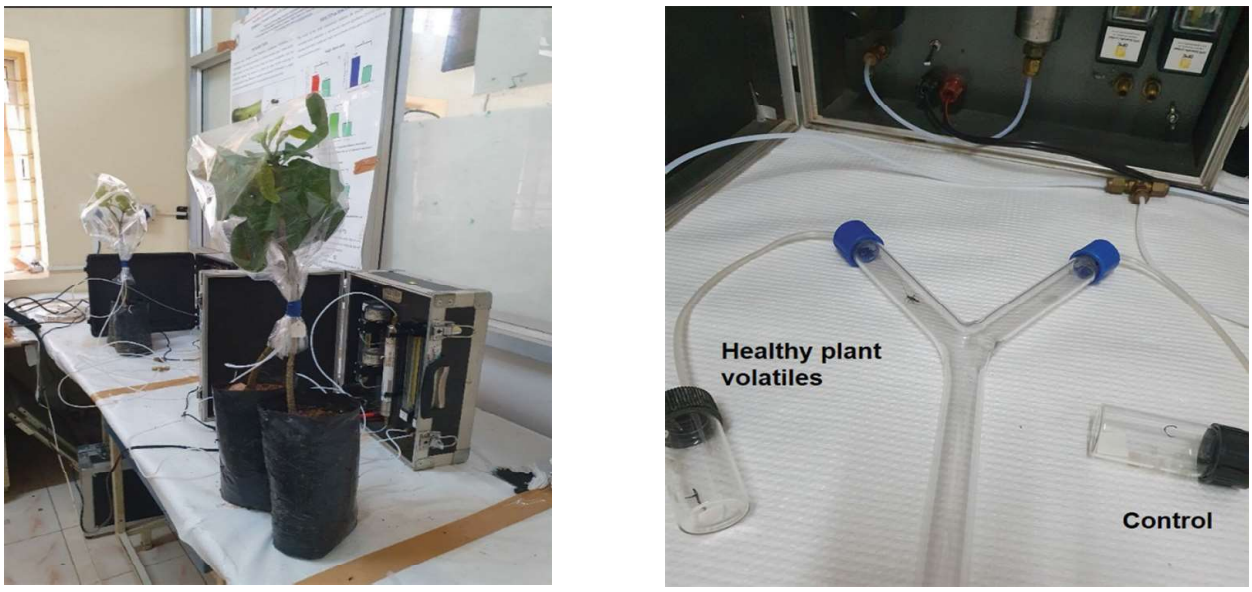


Fig. 3.3.6 Set up for collectin of plant volatiles and conducting bioassys

The volatiles collected from healhty plants of Bhaskara for which TMB females showed response include 2-Methylnonae, β-pinene, 3 – carene, terpinolene, γ-Terpinene, β-caryophyllene etc (Fig.3.3.7). The infested plant volatiles of Bhaskara for which TMB had showed response were identified include P-xylene, o-xylene, 3- carene, γ-Terpinene, 4-Ethylundecane, Acetophenone 4'-ethyl, Heptadecane, β Geraniolene etc (Fig.3.3.8). Similarly, healthy and infested plant volatiles of NRCC sel-2 were also identified and the compounds for which TMB had shown response through GC EAD were identified.

The preliminary bioassys were carried out to examine the response of TMB females to the healthy palnt volatiles and infested plant volatiesl in different combinaiton using y tube olfactometers. Bioassys between healthy plant volatiles and control i.e., solvent indicated more attraction towards healthy plant volatiles than control. Simialraly, bioassays between healthy plant volatiles and infested plant volatiles indicated more attraction of TMB adults towards healthy plant volatiles. Further bioassays are required to confirm the results.

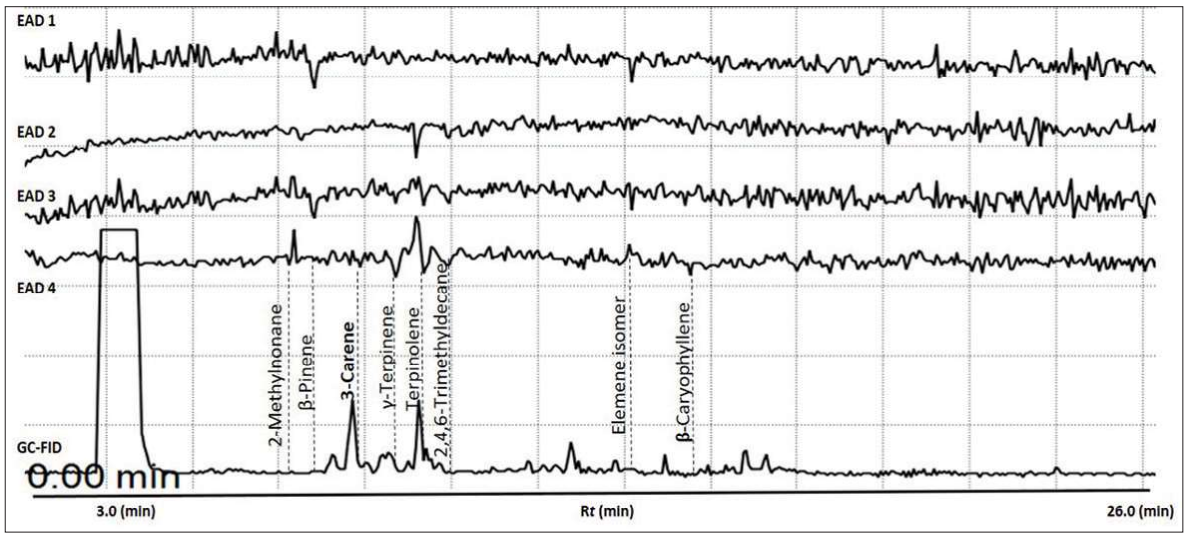


Fig. 3.3.7 Chromatogram and EAD response of TMB to Bhaskara healthy plant volatiles.

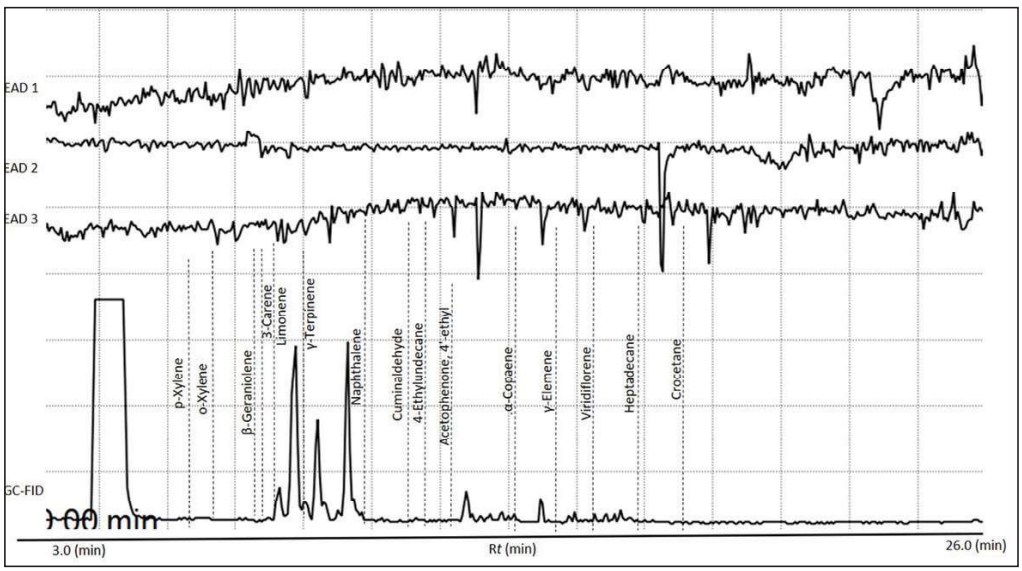


Fig. 3.3.8 Chromatogram and EAD response of TMB to Bhaskara infested plant volatiles.

3.3.4 Influence of *Apis cerana indica* and *Braunsapis* spp. on pollination and fruit set of cashews

Pollination efficiency studies

a. Field studies with *A. c. indica*

In previous years, there was no significant increase in the number of A. c. indica bees visiting the cashew flowers were observed in the plots, where bee colonies were kept @ 4/ha compared to control plot where bees from feral colonies had visited. Thus during 2023, *A. c. indica* colonies were kept @ 8/ha and the bee visits were recorded in the cashew inflorescences compared to control (non-hive) plots (Fig.3.3.9). However, there was no substantial increase in number of bee visits in bee hive plots compared to non-hive plots. Examination of pollen load indicated a greater number of bees carried back pollen grains from different flora including Peltoforum sp., Mimosa sp etc. and only one out of 55 to 60 bees carried cashew pollen load. This clearly indicates preference of the bees to cashew flowers is less, when other preferable flora is present in the surroundings. Further, spraying of jaggery, fresh sugarcane juice, glucose and honey solution on the cashew inflorescences resulted in attraction of different ant species like *Prenolepis* sp., *Diacamma* sp, *Camponotus* sp etc and a few flies to the sprayed trees especially on the leaves, but not much of the bees as expected.

Fig. 3.3.9 Indian bee colonies in cashew plantations

b. Pollination efficiency studies under net cages

Pollination efficiency of three bee species viz., a native bee (*Braunsapis mixta*), stingless bee (*Tetragonula iridipennis*) and Indian bees (*Apis cerana indica*) was assessed in two cashew varieties viz., VRI-3 and MDK-2 in comparison to the open pollinated trees and the trees caged without any bees. Care was also taken to avoid visit of ants in all the caged trees by greasing in the tree trunk and the nests of the stem nesting bees that were present in the caged cashew trees were also checked and removed to understand the role of the particular bee species under observation. Bee confinement method was followed using net cages as in previous year. Sugar feeding was done at weekly intervals for the Indian bees to supplement its food requirement. Observations indicated that all the three bee species actively foraged on cashew flowers under confinement and successfully pollinated the cashew flowers.

Out of five cashew trees that were caged without any bees, no nut set was observed in four trees and only a few nuts (12 no's) were set in one tree, which clearly indicates that bee visits are important for nut set in cashew. The nut yield obtained per tree under different bee pollination was recorded. Similar to the year 2022, the mean nut yield in VRI-3 plants was more in the trees that were confined with stingless bees during 2023 also followed by *Braunsapis* sp. and the honey bees (Fig. 3.3.10). During 2023, the mean nut yield of 2.45 and 1.75 kg/tree was harvested in the trees caged with stingless bees and *Braunsapis* sp., respectively. However, the mean nut yield was less in the trees confined with honey bees (0.7 kg/tree). During 2022, the nut yield was more in open pollinated trees (2.6 kg/tree), but during 2023, it was very less as higher flower drying was observed during the peak flowering season. However, flower drying was less in the caged trees compared to the uncaged i.e., open pollinated ones.

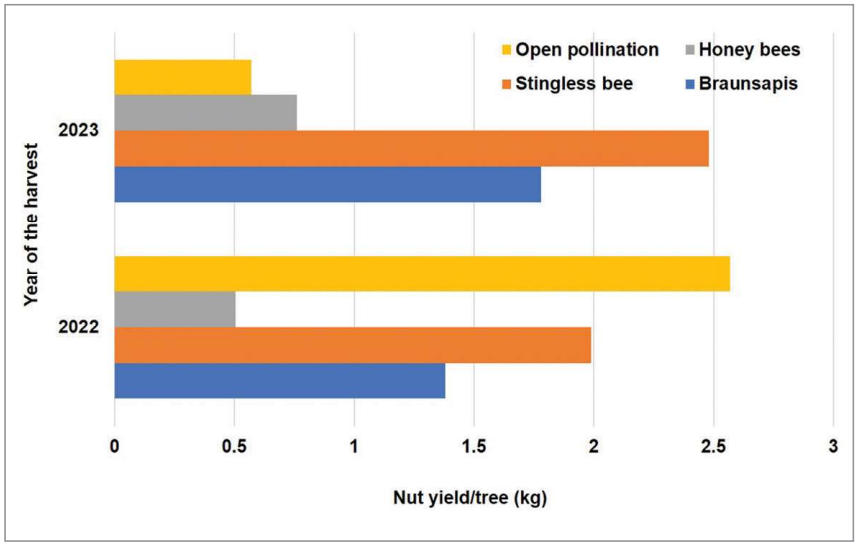


Fig. 3.3.10 Nut yield of VRI-3 plants under different means of pollination

Under different bee pollination, the size of cashew apples and nuts were bigger in the those harvested from *Braunsapis* sp. caged trees followed by stingless bees, hand pollination, open pollinated ones and lastly the honey bees (Fig.3.3.11). The same trend was observed in both VRI-3 and MDK-2.

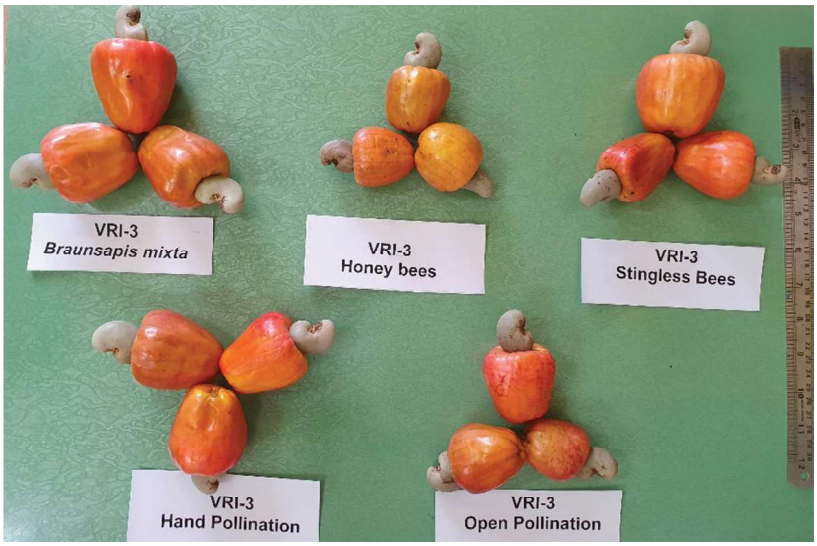


Fig. 3.3.11 VRI-3 fruits harvested under different bee pollination

The influence of different means of pollination on biochemical quality of cashew apples were also assed in VRI-3 fruits. Total phenols and antioxidant activities were higher in the fruits under open pollination, while total flavonoids were more in the fruits harvested in the trees caged with *Braunsapis* sp (Fig. 3.3.12). The kernel biochemical quality was also assessed under different treatments that showed non-significant differences in the content of N, K, Ca and Mg (%).

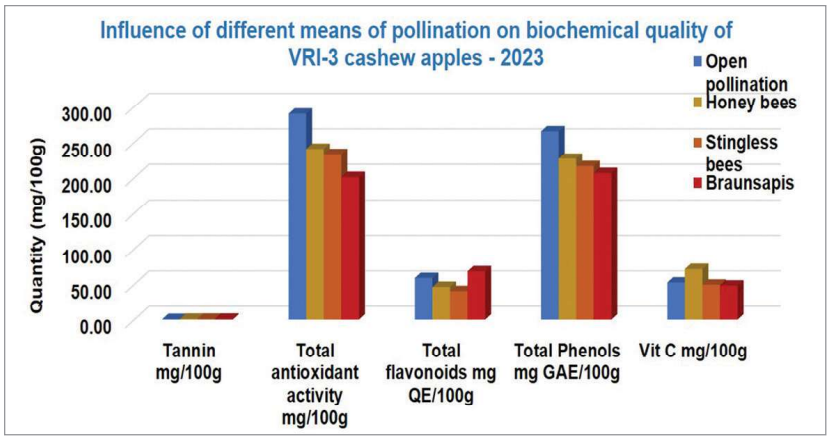


Fig. 3.3.12 Influence of different means of pollination on biochemical quality of cashew apples

Seasonal incidence of *Zodiomyia* sp. (Conopidae) on *B. mixta*

Zodiomyia sp. (Conopidae) are the parasitoids of adult bees of *B. mixta*. The puparia of the conopid flies were collected at 3-4 days intervals from the artificial nests and kept under laboratory conditions to record the emergence of adult flies. The maximum number of puparia (> 160) were collected during January 2023 followed by February and March, 2023. Very few puparia (<20) were collected during April to June, 2032 (Fig. 3.3.13 and Fig. 3.3.14). The percent adult emergence was higher during September, 2023 compared to other months.

Fig. 3.3.13 A female *Zodiomyia* sp.

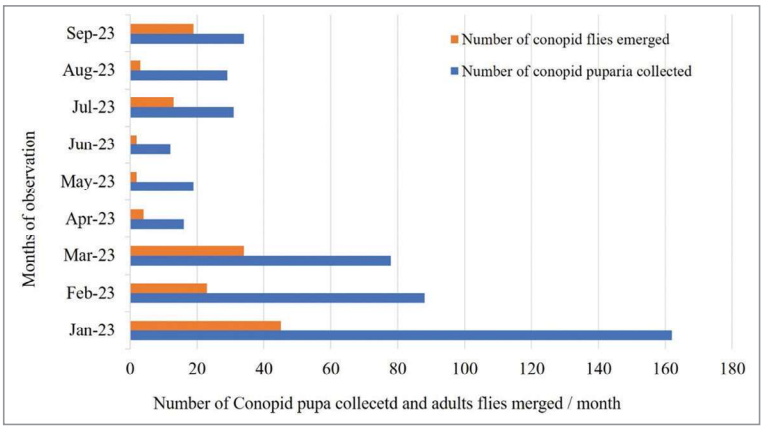


Fig. 3.3.14 Monthly collection of conopid pupa and adult emergence during the year 2023

3.3.5 Species complex of thrips infesting cashew, molecular characterization, and their management measures

In cashew, thrips occur both on the leaves and flowers. Not all the thrips species are pests, some species are predaceous in nature, some are fungal spore feeders and a few are even pollinators. Common thrips that occur on cashew leaves include, *Selenothrips rubrocinctus* Giard, *Rhipiphorothrips cruentatus* Hood, *Retithrips syriacus* (Mayet). The thrips species that occur on cashew flowers include, Scirtothrips dorsalis *H., Rhynchothrips raoensis G., Haplothrips ganglbaueri* (Schmutz), *Thrips hawaiensis, H. ceylonicus* Schmutz and *Frankliniella schultzei* (Trybom) (Thripidae). The tubuliferan thrips like *Haplothrips ganglbaueri* Schmutz that occur on cashew flowers are generally regarded as pollinators and not harmful.

Recent surveys conducted by the scientists of ICAR-DCR, Puttur in the cashew growing regions of Sagar region of Karnataka showed higher incidence of thrips in the cashew nursery and field conditions. Severe infestation caused distortion of leaves and reduced growth of the cashew grafts (Fig. 3.3.15), while in the field conditions, infested plants yielded cashew apples with cracking and reduced size and malformed cashew nuts. Besides S. dorsalis, two new species *viz., Anascirtotrips arorai Bhattti* and *Scirtothrips bispinosis* (Bagnall) were also observed there in the infested cashew plants. These observations indicate that survey and monitoring for thrips incidence in the cashew growing regions is required to understand the species complex and their role.

Fig. 3.3.15 Thrips damage in cashew grafts at a nursery in Sagar region of Karnataka.

Periodical surveys and collection in the cashew plantations at Kemminje and Shantigodu regions during the flowering season of cashew showed occurrence of some more thrips species including *Thrips palmi* on cashew. A total of 2,317 thrips specimens were collected during the season and all were got identified from NBAIR, Bengaluru. Out of the thrips collected, 70.7 % belong to Tubuliferan group, and 29.3 % belong to Terebrantia. Under Terebrantia, a total of six thrips species were recorded.

Thrips was noticed in the inflorescences starting from initial flowering season during December, and the peak collection of specimens was observed during February- March (Fig.3.3.16). Thereafter decreasing trend was observed. The number of thrips per inflorescence ranged between 3 and 17 during the observation period.

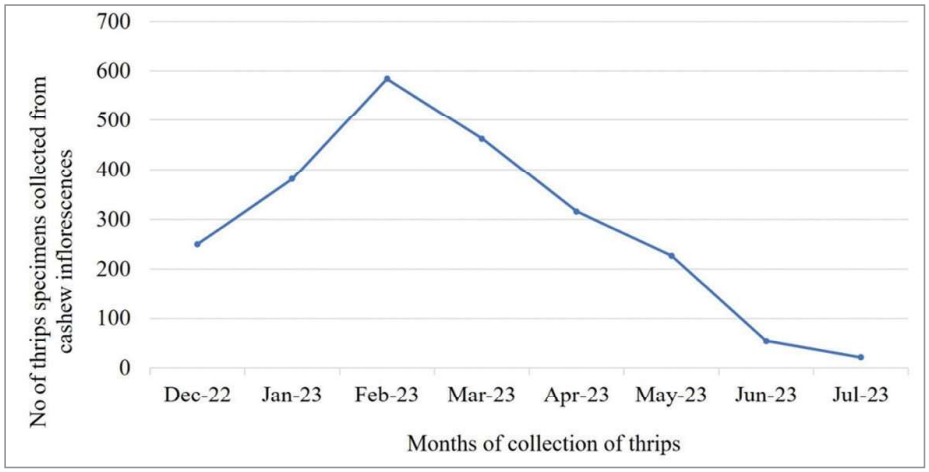


Fig. 3.3.16. Seasonal incidence of flower thrips of cashew

The thrips like *S. dorsalis* and *T. hawaiensis* which occur on cashew were also collected on *Calycopteryx floribunda,* which is a common weed plant in the cashew plantations of west coast regions. Besides, a new species of thrips *viz., Hydatothrips longirostris* (Thysanoptera, Thripidae) was collected in *C. floribunda* from the cashew plantations of Shantigodu region and reported, which is a first report from India.

3.3.6 Survey and diagnosis of diseases occurring in cashew crop and their morphological and molecular characterization

Report of anthracnose disease in cashew apple

The disease infected cashew apple samples suspected for anthracnose were collected from Alankar and Sowthadka plantations of Karnataka Cashew Development Corporation (KCDC) and experimental cashew plots of ICAR-Directorate of Cashew Research during 2021 and examined. The initial symptoms can be observed on ripened cashew apples as irregular small dark brown to black spots. Later, the affected cashew apple develops sunken or depressed, prominent dark brown to black decay spots. The spots initially appear superficial but can coalesce and eventually penetrate deep into the fruit, resulting in fruit rotting (Fig 3.3.17A). The mycelial growth on potato dextrose agar (PDA) medium showed aerial, whitish to greyish coloured fluffy mycelium on upper side and greyish to yellow colour on the reverse side (Fig 3.3.17 B & 17C). The conidia are single celled, hyaline, cylindrical shaped and conidial size ranges from 12.78 ± 1.54μm ? 4.75 ± 0.75?m (Fig 3.3.17D). Based on the symptoms observed and the morphological characteristics, association of *Colletotrichum* spp. causing anthracnose disease of cashew apple is confirmed.

Fig 3.3.17. (A)-Typical symptoms of cashew leaf blight disease, (B)- Pathogen growth on PDA media, (C) – Inverted side of the pathogen growth (D) - Conidia of pathogen at 20x magnification

Establishment of pathogenicity under artificial conditions

The pathogenicity test was done on matured fruits of cashew varieties (n=10). Conidial suspension (2 x 10^6 spores ml^{-1}) *Colletotrichum* spp. was sprayed on the healthy cashew fruits, and kept in inoculation chamber by covering with white polythene sheets for 24 h (25± 2°C and >90 percent relative humidity). The cashew fruits showed similar symptoms (Fig 3.3.18) after 7-10 days post inoculation (DPI).

Fig.3.3.18: Disease symptom development under artificial conditions

Molecular characterization using multi-gene analysis

One isolate (anthracnose of apple) was subjected for molecular characterization based on gene sequence of partial rDNA, Beta tubulin, Glutamine synthetase (GS) and mating type protein (AP-MAT). The genomic DNA was isolate from 10 days old cultures and internal transcribed spacer (ITS) of partial rDNA, Beta tubulin, Glutamine synthetase (GS) and mating type protein (AP-MAT) primer pairs respectively. The band size of 700 bp were amplified for ITS region, 1000 bp were amplified for Beta tubulin, Glutamine synthetase (GS) and mating type protein (AP-MAT) genes. PCR amplicons were sequenced, and the sequences were deposited in GenBank. The phylogeny was constructed based on combined of partial rDNA, Beta tubulin, Glutamine synthetase (GS) and mating type protein (AP-MAT) regions. Neighbour-Joining (NJ) analysis was conducted and the tree was constructed with the substitution models (branch support was evaluated by 500 bootstrap replications). Combined phylogeny confirmed that the sequences shared a common clade with *Colletotrichum siamens* (Fig 3.3.19).

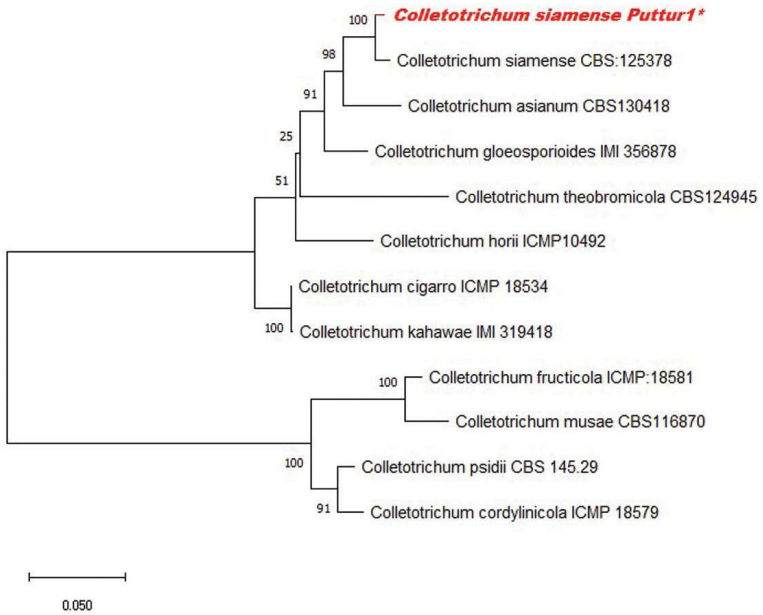


Fig. 3.3.19: Multigene phylogenetic tree constructed using concatenated gene sequence of partial rDNA, Beta tubulin, Glutamine synthetase (GS) and mating type protein (AP-MAT) showing the phylogenetic relationship of *C siamense* Puttur 1 with other *Colletotrichum* species in the *Colletotrichum gloeosporioides* species complex (Cgsc) retrieved from Maximum Likelihood (ML) method.

Bioassay of fungicides against *Neopestalotiopsis clavispora* and *Colletotrichum* spp. causing cashew leaf blight and anthracnose respectively

Invitro bioassay was performed with different chemical fungicides against *Neopestalotiopsis clavispora* and *Colletotrichum* spp. causing cashew leaf blight and anthracnose respectively. The treatment and dosage of fungicide used in the study was given in the table 1. Among the different fungicide treatments, T2- Propiconazole 25% EC @ 0.1%, T4- Propineb 70% WP @ 0.2% and T6- Flusilazole 12.5% + Carbendazim 25% SC @ 0.2% were found effective inhibiting the growth *Neopestalotiopsis clavispora* in comparison to control (Fig. 3.3.20). Similarly, for management of anthracnose pathogen, same set of fungicides used with different doses as given in Table 3.3.3. Among the evaluated fungicides, T2- Propiconazole 25% EC @ 0.1%, T4- Propineb 70% WP @ 0.2%, T6- Flusilazole 12.5% + Carbendazim 25% SC @ 0.2% and T7- Carbendazim 12% + Mancozeb 63% WP @ 0.2 % were found promising compared to control (Fig. 3.3.21).

Table 3.3.3: Details of fungicides treatment and dosage used in bioassay

Treatment	Chemical Name	Trade Name	Manufacturer	Dosage (%)
T1	Hexaconazole 5% SC	Contaf	Rallies India Ltd	0.1
T2	Propiconazole 25% EC	Tilt	Crystal Crop Protection Ltd	0.1
T3	Tebuconazole 38.9% SC	Folicur	Bayer Crop Science Ltd.	0.1
T4	Propineb 70% WP	Antracol	Bayer	0.2
T5	Trifloxystrobin 25%+ Tebuconazole 50% W	Nativo	Bayer	0.05
T6	Flusilazole 12.5% + Carbendazim 25% SC	Lustre	Dhanuka	0.2
T7	Carbendazim 12% + Mancozeb 63% WP	Saaf	UPL	0.2
T8	Control			

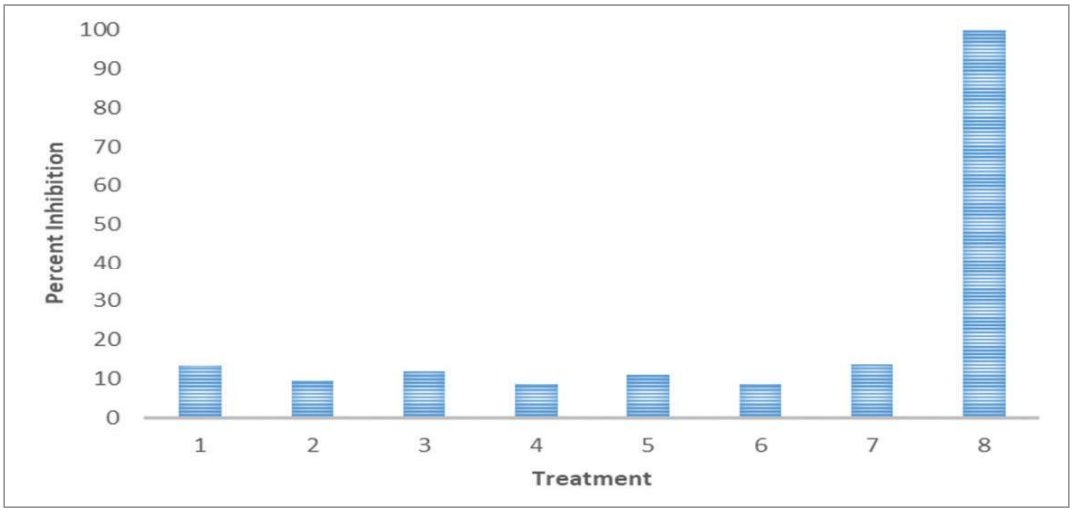


Fig. 3.3.20: Percent inhibition of different fungicides treatment against *Neopestalotiopsis clavispora* under invitro conditions

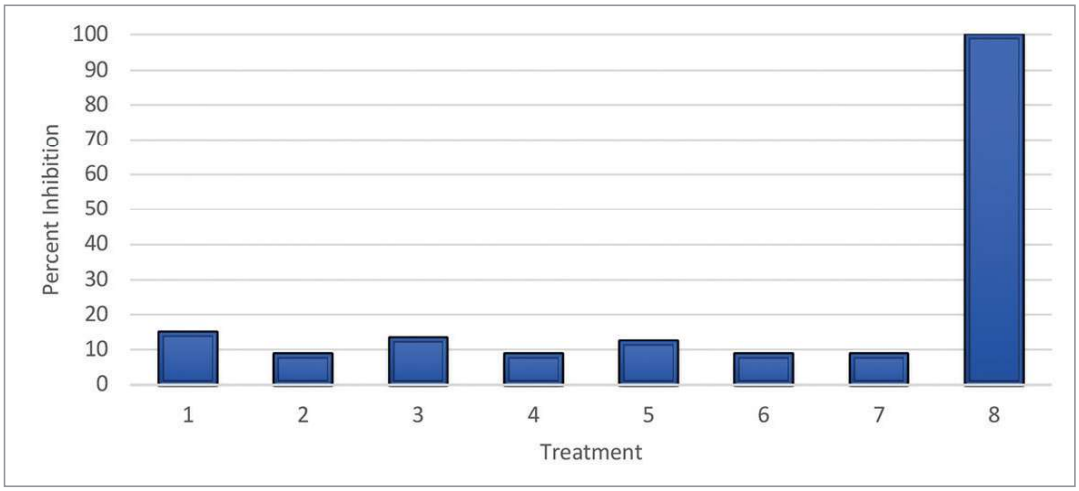


Fig. 3.3.21: Percent inhibition of different fungicides treatment against *Colletotrichum* spp. under invitro conditions

3.3.7 Establishment of Farmer-Centric Pest Diagnostic and Bio-Control Laboratory to Achieve Sustainable Cashew Health Management (Externally funded project)

A well-furnished laboratory with equipment's like compound microscope, laminar air flow, BOD incubator, vertical autoclave, hot air oven, refrigerator and deep freezer installed (Fig. 3.3.22a; 3.3.22b; 3.3.22c; 3.3.22d).

Fig. 3.3.22a Laboratory with work benches

Fig. 3.3.22b Laminar air flow cabinet

Fig. 3.3.22c Compound microscope

Fig. 3.3.22d Volatile collection unit

3.4 POST-HARVEST TECHNOLOGY

Priority area IX: Post-Harvest Technology

3.4.1 Studying comparative performance of Cashewnut processing systems in India

Diagnostic investigation carried out with randomly selected cashewnut processing units located in major cashew growing states viz., Karnataka, Kerala, Tamil Nadu, Odisha, and Andhra Pradesh were analysed for the processing cost per unit weight of raw cashewnuts for various category such as labour oriented, semi-mechanized and fully automated and presented in Table 1. The lowest cost incurred for fully automated unit located in the Odisha state operating with a capacity of 8 TPD whereas processing cost expended for processing unit weight of raw cashewnuts found to be the highest in the Kerala state i.e., ₹ 34.50 having employment strength of 215. Strict labour law in force in the Kerala state and other mandatory benefits are extended to employees are the prime reasons for the hike in processing cost. Depending on the degree of mechanization in semi mechanized sector in Indian cashewnut industry, the processing cost ranged from ₹ 12 to ₹ 20/- per kg of RCN. It explains that the processing cost is directly related to skill level of employees, degree of mechanization and quantum of processing. But profitability of these industry relies on conversion of raw cashewnuts in to white whole kernels sold at better price irrespective of market and control on the discoloration leading to secondary or tertiary grades of final produce (Table 3.4.1).

Table 3.4.1. Processing cost per unit weight (₹ per kg of RCN) for various category of cashewnut processing units in deferent states

State	Mode of processing	Average capacity utilization (TPD)	Strength of labour force	Average processing cost kg^{-1} (₹)
Karnataka	Labour oriented	3.0	200	22.50
	Semi-Mechanized	4.2	300	20.20
	Fully automated	15.0	200	17.50
Tamil Nadu	Labour oriented	1.5	250	16.50
	Semi-Mechanized	2.0	250	19.50
	Fully automated	10.0	180	16.00
Andhra Pradesh	Labour oriented	1.5	75	24.00
	Semi-Mechanized	4.0	200	16.00
	Fully automated	10.0	220	12.00
Odisha	Labour oriented	1.5	<75	15.00
	Semi-Mechanized	3.0	150	12.00
	Fully automated	8.0	100	10.00
Kerala*	Labour oriented	2.4	215	37.50

* Diagnostic investigation with semi mechanized and fully automated processing units yet to be completed

3.4.2 Optimizing processing parameters in cashew for enhancing whole kernel recovery

Design of static and rotary cooking vessels with suitable steam generating boiler are prepared to establish a lab scale processing set up to take up multi trials towards optimization of pertinent processing parameter. Critical parameters influencing whole kernel recovery and discoloration at various stages of processing especially steaming or conditioning the raw cashewnuts, curing, kernel drying, kernel conditioning by moisture infusion and peeling processes have been identified and experimental design prepared following RSM methodology.

3.4.3 Development of finger tool for manual peeling of cashew testa (Observation trial)

Viewing the cost of peeling machine and the necessity of manual peeling with personal hygiene especially for 'Home scale or Cottage level cashew processing', an attempt has been made to develop a finger tool to serve the purpose. Commercially available artificial nails are made out of chemical i.e., acrylic powder, and has allergic effect to human. Therefore, thimble design used in the protection while hand sewing is referred for fabricating metal cap with nail structure to scratch testa of cashew kernels (Fig 3.4.1; 3.4.2).

It is designed for thumb and index fingers and trial conducted. Various treatments applied for short duration thermally conditioned unpeeled cashew kernels prior to peeling are aqueous solutions with different concentration and temperature and steam treatment in recovering whole kernels without any physical damage and discoloration during manual peeling. Performance of finger tools confirmed ease of peeling and retained its surface colour with enhanced whole kernel recovery.

Fig. 3.4.1 Finger tool for peeling cashew

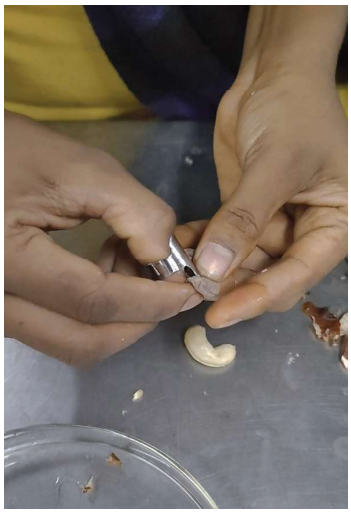


Fig.3.4.2 Manual peeling of unpeeled cashew using finger tool

3.4.4 Development of value-added products from cashew apple and sprouts

Cashew sprouts are an underutilized source of food which is rich in minerals and phytochemicals and hence it is a part of diet for the local people. However, due to the lack of awareness in the management of these sprouts, they tend to get wasted. Development of a product such as Cashew sprout Nutri-bar can help cashew farmers get better returns on their products. Development and evaluation of "Cashew Sprout Nutri-bar" enriched with sprouts of cereals and grains was investigated. Different treatment combinations of the "Cashew Sprout Nutri-bar" were formulated to provide better

nutritional value as well as consumer acceptance. Cashew sprout Nutri bar formulation includes ragi sprouts, green gram sprouts, cashew sprout powder and Jaggery. Eight treatment combinations of Nutri-bar were subjected to different analyses. The samples were analyzed for physiochemical, biochemical and sensory qualities using standard methods. It was observed that the total phenolics and total antioxidant activity was highest in the fresh cashew sprout sample 208.32±0.87 mg GAE/100 g and 210.5±0.32 mg/100g respectively, and there was no significant change in the products formed using cashew sprout powders. The samples received positive feedback from the organoleptic evaluation (Fig. 3.4.3).

Fig. 3.4.3 Cashew sprout nutri bars

Development and standardization of cashew apple pomace powder cookies

Cashew apple pomace powder was used as one of the flour blends for the preparation of cookies and maida (refined flour) was completely avoided. The cookies were subjected to physical, biochemical, and sensory evaluation. The developed cookies had good amount of crude protein (6.84%), crude fat (13.3%), ash (92.30%) contents and higher fibre (6.33%) content. The cookies were further fortified by incorporating 4 types of millets such as ragi, proso, little millet and jowar millet. Proximate, biochemical, sensory, and microbial analysis. The protein content was high in T2 (ragi

mixed cookies compare to other millets. The fat content in cookies were also analysed and it was found to be T3 (proso) fat content compare to other cookies. The ash content in cookies was highest in control that is only cashew apple pomace powder cookies compare to other combinations (Fig. 3.4.4).

Fig. 3.4.4: Cashew apple pomace powder cookies

Development and Standardization of cashew apple-based fruit bars

The cashew apple pulp was blended with guava pulp, to improve the nutritional and organoleptic qualities of the fruit bars. It was also evident that the incorporation of the cashew apple with guava pulp had no negative effect on its proximate composition; rather it had positive effects like the increase in ash content, total phenols, antioxidants, flavonoids, and protein etc. the blend of guava with cashew apple has increased the overall acceptability of fruit bar (Fig. 3.4.5).

Fig 3.4.5: Cashew apple fruit bars

3.4.7 Development of Probiotic Food Products from Cashew Apple

To develop fruit juice-based probiotics along with Cashew apple seasonally available fruits like watermelon, muskmelon, pomegranate, oranges, and cashew kernel milk was blended in different proportion. The blend which is giving good taste and less acidic were selected for screening of probiotic cultures.

3.4.8 Phytochemical characterization of cashew (leaf and apple) nutraceuticals for their utilization in the development of functional foods.

The phytochemical characterization of the Bhaskara variety was initiated for total phenolics, flavonoids, and tannins. This trial is in progress.

3.5 TRANSFER OF TECHNOLOGY

Priority area IX: Transfer of technology and knowledge management

3.5.1 Development of an exclusive android application for cashew cultivation (Externally funded project)

In the project, Cashew India - a state of the art android app that gives comprehensive information on cultivation, processing, marketing and agencies involved in cashew development etc. was developed in 11 languages for 10 cashew growing states with the inputs from AICRP centers on cashew.

Table 3.5.1 Impact of the app

Particulars	Numbers
Number of downloads (as on December 31st, 2023)	6005
Google play store Rating	4.0
Grafts booked via the app so far	33, 796
States for which grafts are booked	Karnataka, Tamil Nadu, Andhra Pradesh

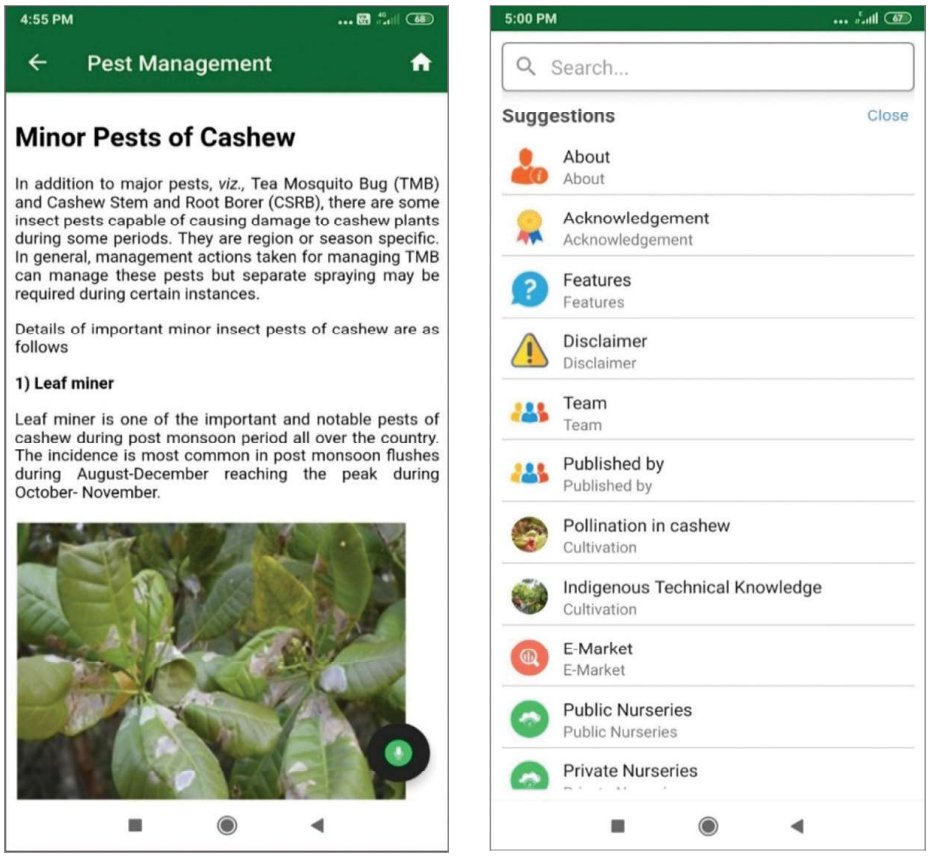


Fig. 3.5.1 A view of android app

3.5.2 Development of an AI-based app for identification of pests and diseases in cashew

Earlier a Comprehensive website i. e. Cashew Protect for AI based diagnosis was developed using Tensor Flow software and others (https://cashewprotect.icar.gov.in/) Cashew Protect app was also developed https://play.google.com/store/apps/details?id=com.tosall.cashewprotect). The website and apps were released during Annual Group Meeting of All India Coordinated Research Project on Cashew held at Dr.YSR Horticultural University, Venkataramannagudem, Andhra Pradesh.

As of now, the software identifies 6 major pests and one disease (pests namely TMB, CSRB, leaf miner, Mealy bug, Aphids, Apple and Nut borer and one disease i.e. leaf blight) Text pertaining to insect morphology, management and precautionary measures is developed for 23 pests and 2 diseases. Content writing for both website and app has been accomplished in all local languages in addition to English.

Images (more than 5000) of various diseases, pests and nutrient deficiencies have been assembled from different scientists and also from centers of All India Coordinated Research Project on Cashew spread across the country.

The app is downloaded 603 times so far with the play store rating of 4.88. The app is being used by more than 10 countries and among them, major countries are India, Nigeria, USA, Ghana, Cambodia and Brazil

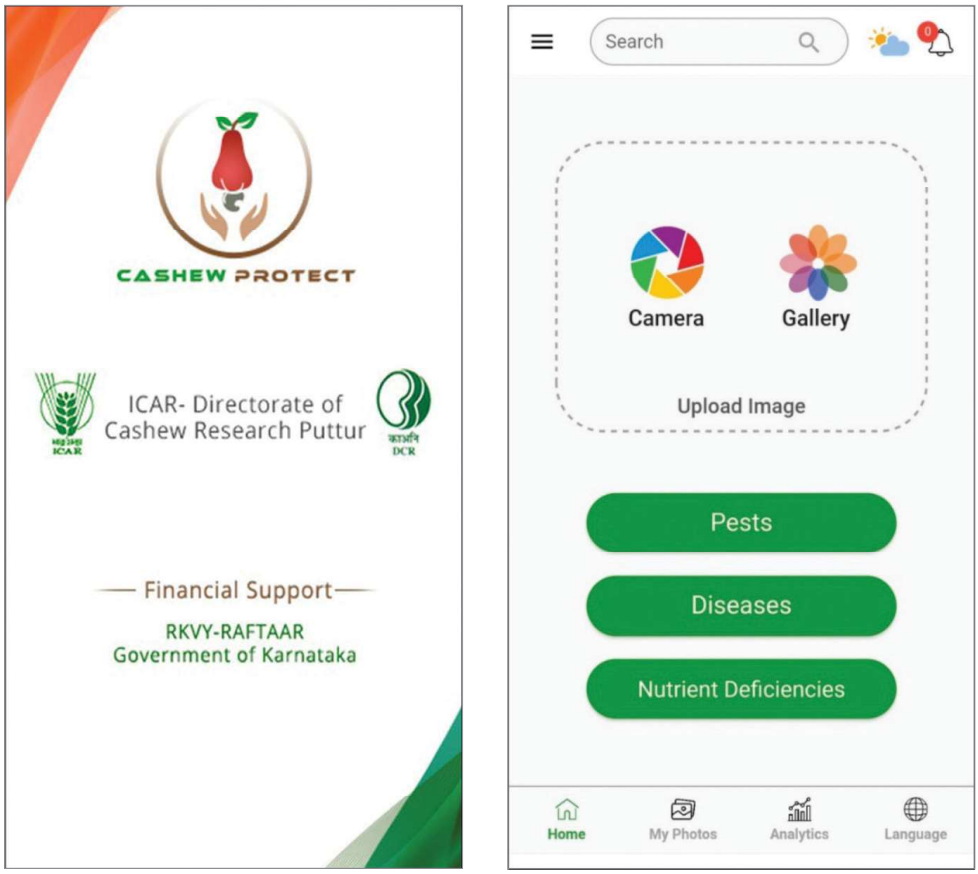


Fig. 3.5.2 A view of AI based cashew protect app

3.6 CONCLUDED PROJECTS

3.6.1 Design and development of mechanized slicer for cashew apple

Principal Investigator : Dr. D Balasubramanian (PI)
Co-Principal Investigator : Dr. Ravindra Naik (Co PI), ICAR-CIAE, Tamil Nadu
Project code : IXX11563
Project duration : 2014-23

Abstract about invention

A mechanized slicer for cashew apples is developed for size reduction for further processing either to vacuum fry to prepare crispy nutritive chips or drying shredded pieces to convert in to amorphous form as basic ingredient in value addition as food, feed or fuel. It consists of feeding, singulation, slicing and discharge mechanism. Performance of the slicer evaluated and its operational capacity found to be in the range of 78 to 90 Kgh^{-1} with average round slice recovery of 68 %. Floor space required is 2.38 M2 and total power requirement is around 1.54 HP.

Protocol for the preparation of cashew apple powder

Freshly harvested fully ripened cashew apples (CA) are washed in running water to remove adhering dirt or other unwanted matter. Cashew apples are sliced with 2-3 mm thick with circular c/s, manually or mechanically and treated it with aqueous solution with specific concentration for a short period. Later the treated CA slices need to be immersed in preservative solution for about 2-3 min. to inactive natural microorganism. Drain excess water adhering to surface of CA slices by transferring to wire mesh tray. Drained CA slices are spread in a thin layer on the wire mesh tray, loaded on to the mobile trolley and shifted to convection dryer maintained at pre-determined air temperature. Change the position of the tray after every 2 h and turn partially dried CA slices after 4-5 h to ensure uniform drying. End point of moisture diffusion process is that CA slices become crispy and appear shriveled on its surface. Grind dried CA slices for size reduction and again dry for short period to facilitate further grinding. Pulverize the dried CA slices and sieve to obtain cashew apple powder of uniform particle size.

3.6.2. Design and development of moisture meter for Cashew

Principal Investigator : Dr. D Balasubramanian (PI)
Co-Principal Investigator : Dr. Sreejith, M/s EMCON, Kerala
Project code : IXX13682
Project duration : 2018-23

Abstract about invention

Moisture content (MC) of Raw cashewnuts (RCN) has direct consequence on the market value of the nuts as it decides ability to store for prolonged period and its usability in the line of processing. Portable moisture meter (MM) of non-destructive nature indicating near accurate moisture of the material is essential for the cashew industry as whole. A 3in1 moisture meter is developed to determine the MC of raw cashewnuts, unpeeled kernels (UPK) and peeled kernels (PK). It has capacitance based parallel plate technique to assess MC and its sensitivity enhanced by innovative approach of 'double cavity'. Calibration of moisture meter carried out with generated data and tested for its accuracy and repeatability. Data mining carried out with experimental data to develop polynomial formulation and its accuracy is ±1%.

Background information and genesis

Cashew is one of the most nutritious and delicious dry fruits of the world. More than 32 countries are engaged in cashewnut production, processing and export. India is the foremost country to begin commercial production of cashew kernels and cashewnut shell liquid (CNSL), the byproduct of the cashew industry and exploited the world trade. India stands first in the production (7.37 lakh MT), processing (20.57 lakh MT) and consumption of cashew kernels (2.32 lakh MT).

Cashew nut is typically reniform and it takes minimum of three weeks after pollination to attain the nut length and width of 30 mm and 25 mm respectively. At this stage of nut development, approximately 33% of the cavity within the shell structure is expected to be filled up by edible kernel. The developing tender nut is green in colour having high moisture and the shell of the mature nut contains a corrosive liquid in honey comb structure, commercially known as Cashew Nut Shell Liquid (CNSL). During the development phase, size of the nut reduces due to desiccation and similar shrinkage occurs in the kernel also. At the end of growth phase, mature nut will be grey in colour, hard and having relatively less moisture compared to the earlier stages of development. It is observed that the weight reduction in the nuts from the beginning to the matured stage is in the range of 15-40 %.

Cashewnuts is the basic raw material for cashewnut processing industry and about 70% of the total cost is incurred towards procurement. Moisture content of raw cashewnuts plays a vital role on the shelf life in order to operate the processing units round the year. Moisture content of raw cashewnuts varies between 12-21% d.b at the time of harvest and it needs to be dried to 8 % d.b. to enhance its shelf life. As such nuts are dried under sun for 2 to 3 days, to reduce the moisture to safer level. End point of drying is decided by rattling sound produced while rubbing the nuts inside the palms of hands. Otherwise, moisture is determined by chemical distillation method which is destructive, time consuming, laborious and lab oriented one. Therefore, moisture has direct consequence on the market value of the nuts as it decides ability to store for prolonged period and its usability in the line of processing while extracting edible kernel with minimal damage and loss of nutrients. Drying operations are energy intensive process and therefore it's advantageous to monitor its moisture content to safer level. Portable moisture meter of non-destructive nature which indicates near accurate moisture of the material is essential at drying site.

Besides, shelled cashew kernels i.e., unpeeled cashew kernels have to undergo moisture diffusion process to ease manual or mechanical peeling. Natural or forced convective air drying is employed to dry unpeeled cashew kernels for further processing. Moisture content of the kernels is the decisive factor to schedule exposure period for the given air temperature. Kernel over dried becomes brittle leading to kernel breakage during peeling and under dried kernels culminate in lower peeling efficiency. As such no moisture meter available to detect the moisture level of unpeeled cashew kernels to minimize energy utilization and maximize quantitative and qualitative efficiency during peeling operation. Finally, cashew kernels at the end need to be packed in an appropriate mode depending on domestic or overseas trade with recommended moisture content. Although certain moisture meters are available, a single moisture meter which can measure moisture content of raw cashewnuts, unpeeled cashew kernels and cashew kernels is very much preferred by the cashew industry.

In view of the aforesaid problems, it is the need of the hour to develop multi-purpose instantaneous moisture meter for the cashew industry to assess the moisture content of raw material for long term

storage, optimize processing parameters and for food safety.

Knowledge/Technology gaps and justification for taking up the invention

Raw cashewnuts has three different layers viz., shell, testa and kernel having different chemical composition. Initial moisture content of raw cashewnut various from 12 to 21 % d.b. at the time of harvest depending upon the variety, maturity level and nut to kernel ratio. During the growth phase, nuts forms first and attains maturity within 30 to 35 days after flowering. Later hardening of nuts and moisture loss takes place. It is recommended to harvest the raw cashewnuts at full maturity as it influences the quality of kernel after processing by either drum roasting or steam boiling mode of processing which are prevalent in the east and west coast of India.

Cashew is subjected to the attack of several seed borne fungi. Fungi like cladosporium (Rangaswamy et.al.,) and Nematospora corilly Peg and Nematospora gossyppi (Goalto,1970), Aspergillus Niger, Aspergillus flavus, Aspergillus tamari, Rhizopus nigricans, Fusarium sp. and Gliocladium sp. (Esurauoso, 1974) were found infecting immature and mature nuts and also the kernel. The fungi Nematospora sp. penetrates into the kernel and cause sunken spots which lower the market value of the nuts (Agnoloni and Giuliani, 1977). Storage diseases are due to imperfect drying or poor storage. Raw cashewnuts are much more contaminated than the processed ones. A seed which is superficially seems to be healthy may carry seeds of disease along with it. Different forms of fungi, bacteria, viruses and insects are carried on or in the seed and fungi is the most predominant one. Gonatobotyum apiculatum, Heminthosporium sp., Corynespora, Alternaris sp. and Verticillium sp are also found to be serious fungi for raw cashewnuts (Joseph, 1984).

Standard gravimetric laboratory tests are tedious, requiring several hours for completion and are destructive in nature. Number of conductivity and capacitive based techniques measure average moisture in bulk materials and need particular size of the sample to be measured. Moisture meters with penetrating probes are suitable for semisolid or grainy material or liquids only. Waveguide resonant cavity techniques have been widely used to perform moisture measurements non- destructively as well as complex permittivity's of semiconductor materials. The waveguide cavity technique is associated with various difficulties like loading and unloading of samples even though it is considered as an accurate technique.

Several modes of direct current conductivity and capacitance measurement-based moisture sensors available in the market can handle bulk grain samples only where it is impossible to measure the range of moisture contents or dielectric parameters of the hard-shell agricultural commodity. It is also affected by the air gaps in the natural geometrical position of the nut samples and conductivities of the nuts due to non-uniform shapes. The conductivity-based moisture meters need constant pressure to be applied to the bulk under measurements for the validity and hence they are subject to the human errors.

Low frequency techniques are associated with the contributions due to the ionic conductivities of the moist grain and hence are subjected to inherent errors. These types of sensors are based on the power measurement and are totally dependent on the calibration of the materials on the custom-made sensor and totally dependent on the dynamic performance of the detector system and its readout system performance. The drawbacks of the conventional methods for determination of moisture content hinder the exact determination of the moisture content. The need has therefore been realized for a method and an instrument for determining the moisture content in various samples which overcomes the problems mentioned above.

Description about the invention

The present invention relates to an instrument for determining moisture content on dry basis for inshell cashewnuts, cashew kernel with testa and cashew kernels without testa. More precisely, it relates to a moisture sensing instrument which uses the measurement of dielectric properties for quantifying the moisture content of the samples while placing between two parallel conductor plates. Sensibly it serves as 3in1 moisture meter, in general for cashew.

The object of the present invention is to provide a non-destructive double cavity instrument for moisture measurement which obliviates the drawbacks in the existing methods and provide accurate, reliable and repeatable results; which are density and volume independent. Measuring and monitoring moisture content of cashew, aids in maintaining the quality and increasing the shelf life of a product.

The prior art cites references to different methods of quantifying the moisture contents in inshell cashewnuts or cashew kernels with or without testa. Moisture can be determined by standard gravimetric laboratory tests which are tedious and require longer duration for completion. Chemical distillation method is a destructive method and used certain solvent chemical for moisture determination.

Distribution of moisture content in different layers viz., inshell nut in whole form, shell and kernel revealed that similar trend observed for all the three different layers irrespective of varieties. In general, moisture content declined from peanut to fully matured stage for the varieties investigated indicating hardening of the nuts. Moreover, it is confirmed that moisture content of freshly harvested nuts varied from 12-17% d.b for investigated varieties. Therefore, a novel instrument to determine the moisture content in the cashew was developed following the principle of measuring the capacitance between parallel plates.

Distance between the parallel plates was designed based on the spatial dimensions of the inshell cashewnuts exclusively the minor axis value and its irregular shape. Various investigations carried out to understand the influence of degree of compaction, size of the inshell cashewnuts vis-à-vis bulk density, artificially infusion of moisture in to the nuts, surrounding environment, and overnight storage in air tight environment.

Essentially, the size of the moisture meter is of utmost importance in view of ease of handling, therefore extensive investigations carried out to decide the size of the instrument or otherwise the total area of the parallel plates to sense the moisture in the nuts or kernels sample loaded between the parallel plates. Accounting the moisture holding capacity of inshell cashewnuts, cashew kernels with and without testa and its variation in dielectric properties based on its size and chemical composition, novel design of double cavity moisture meter circuits is adjusted for suitable resistor towards higher resolution.

Calibration of moisture meter carried out in comparison with chemical distillation method of determining moisture content using toluene as solvent. Mathematical formulation used to correlate between moisture determined by chemical distillation method and instrument mode developed and its coefficients served as the indicator to decide the accuracy. Algorithm developed for inshell cashewnuts and cashew kernels separately as it showed different trend while correlating original moisture and value indicated by moisture meter. Necessary circuitous corrections are made for measuring the moisture content using this novel instrument for in inshell cashewnuts and cashew kernels separately, with push button mechanism.

3.6.3 Improving area, production, and productivity of cashew in Shivamogga and Chitradurga districts in Karnataka

Principal Investigator : Dr. G.S. Mohana
Co-Principal Investigator : Dr. E. Eradasappa
Project code : OXX5458
Project duration : 2020-24

This project was funded by Rashtriya Krishi Vikas Yojana – Remunerative Approaches for Agriculture and Allied Sector Rejuvenation ((RKVY-RAFTAAR). The objective of the project is to expand area under cashew in non-traditional areas such as Shimoga and Chitradurga districts (Table 3.6.1 and Fig. 3.6.1; Fig. 3.6.2). The total sanctioned budget of the project is Rs. 36 lakhs.

Table 3.6.1 Area and beneficiaries covered in the project

Particulars/ Districts	Shimoga	Chitradurga	Total
Total area covered during 2020-21 (acres)	61.54	56.11	117.65
Total area covered during 2021-22 (acres)	44.26	23.55	67.81
Area covered for two years (acres)	105.80	79.66	185.46
# of beneficiaries covered during 2020-21	25	11	36
# of beneficiaries covered during 2021-22	16	5	21
Total number of beneficiaries	41	16	57

Fig. 3.6.1 Farmers' fields in Shimoga district (Third year)

Fig. 3.6.2 Farmers' fields in Chitradurga district (Third year)

4. EXTENSION ACTIVITIES

4.1 Advisories

Dr. Eradasappa E	Advised cashew farmers through whatsapp and phone calls for their problems my side and through subject experts of the institute.
Drs. Bhagya H. P. and Manjesh G. N.	Advisory visit taken to Rajapuram Estate, Plantation Corporation of Kerala, Panathur Post, Kasargod dist, Kerala on 1-8-2023 of cashew plantation of 15 years old and old and senile plantation and juvenile plantation and given recommendation of proper canopy management by proper pruning and training and also thinning of cashew trees in between to reduce dense plantation for proper exposure of sunlight.
Dr. Manjesh G. N.	Provided advisory on the suitability of inter-cultivation of Coffee in existing Cashew orchards to the Horticulture Department of Jagadalpur, Bastar District, Chhattisgarh on 02-03rd March 2023.

4.2 Exposure Visits

Exposure visits to ICAR-DCR, Puttur

Several farmers, input dealers, students, and other officials from various agriculture and Horticulture universities and Departments visited the directorate during this period. They were shown the museum, cashew nursery, and technology showcasing plots to appraise the achievements and technologies developed by ICAR-DCR. Details of the visitors are given below:

Sl. No	Name and address	Purpose of visit	Date of visit	No. of participants	Coordinators
1	Govinda Naik, S Training centre, Malavi	Study tour	11.1.2023	52	Bhagya H P, Manjesh G N and Thondaiman V
2	Government P U College, Puttur	Educational Tour	17.01.2023	98	Bhagya H P, Manjesh G N
3	R T Patil Assistant Professor KRCCH, Arabhavi UHS Bagalkot	Visit of Diploma II year state tour visit	02.02.2023	29	Bhagya H P
4	Meghlaya Trainers	Training and exposure visit	06.02.2023	20	Bhagya H P
5	Shree M Anil Kumar ADH, Somenahalli horticulture training centre, Hasan	Diploma students Exposure visit	09.02.2023	30	Bhagya H P
6	Dr. A Rama Rao, Assistant Professor, Agronomy, College of Horticulture Parvathipuram, Dr. YSRHU, Andhra Pradesh	South India Educational tour of final BSc. Hort. Students	27.02.2023	56	Bhagya H P, Veena GL and Thondaiman V

7	Dr. Amrutha G. Assistant Professor COA, Kalburgi	State exposure visit for III-year BSc, Agri. students	27.03.2023	74	Bhagya H P and Veena G. L
8	M Shyam Rao college of Agriculture, Bheemarayanagudi UAS, Raichur	Exposure visit III-year BSc Agri. Students	29.03.2023	78	Bhagya H P
9	Dr. Vasudev Naik College of Agriculture Gangavathi	State study tour visit	31.03.2023	34	Bhagya H P
10	Dr. Raghu Pathri S J C Diwakar Reddy Horticultural college, Tadipatri, Andhra Pradesh	South India Educational tour	05.04.2023	24	Bhagya H P
11	Rekha A SADH, Department of Horticulture, Dakshina Kannada Zilla Panchayath	Farmer exposure visit	06.04.2023	12	Bhagya H P, Veena GL and Manjesh G N
12	Dr. Keerthima Naik College of Horticulture, Mysore	Exposure visit of III-year BSc Hort. Students	11.04.2023	71	Bhagya H P and Dr. Thondaiman V
13	Dr. Dushanth College of Horticulture, Bidar	exposure visit of III B.Sc. Hort. Students	17.04.2023	61	Bhagya H P and Veena G L
14	Dr. Hadimani College of Horticulture Bagalkot	III-year BSc Students as a part of state tour visit	18.04.2023	40	Bhagya H P
15	Dr. Shreenivas G College of Horticulture CHEFT, Devihosur, UHS Bagalkot	III B Sc. Students state tour visit	19.04.2023	21	Bhagya H P
16	Dr. Shiva Kumar College of Horticulture, Sirsi, UHS Bagalkot	III B Sc. Students state tour visit	19.04.2023	70	Bhagya H P
17	Suvichar Balaga Puttur	Enriching knowledge on cashew Research	28.04.2023	60	T N Raviprasad, Shamsudheen, M and Bhagya H P
18	Breejesh Jethaloga Horticulture officers from Gujarat	For get Information regarding cashew farming	12.05.2023	6	Bhagya H P

19	Dr. Nagaraj and Dr Ravi College of Horticulture, Mudigere, UAHS Shivamogga,	To know the information on cashew research	22.05.2023	75	Bhagya H P
20	Dr Brijesh A S College of Agriculture, shivamogga,	Educational Tour	23.05.2023	45	Bhagya H P
21	Dr. G.N. Hosagoudar College of Agriculture, Shimogga	State tour visit	24.05.2023	46	Bhagya H P
22	Dr. Vasudev College of Horticulture, Hiriyur	State Tour visit	25.05.2023	43	Dr. Bhagya H P, Dr. Veena GL and Dr. Thondaiman V
23	Dr. Jagadeesh Assistant Professor HREC, Hogalgere	Educational tour of diploma students	1.06.2023	25	Dr. Bhagya H and Dr. Rajashekara H
24	Dr. Sudarshan P Assistant Professor SDM college, Ujire	Educational Tour	14.06.2023	28	Bhagya H P, Siddanna Savadi and Rajashekara H
25	D. Sanna thimmappa and dr. Santhosh	TSP farmers exposure visit	15.06.2023	90	Bhagya H P and Rajashekara H
26	Vivekananda college Puttur	exposure visit of BBA students	26.06.2023	49	Bhagya H P
27	Bhavya, N and Anusha, A, College of Horticulture, Bengaluru	Study tour	31.10.2023	2	Bhagya H P
28	Dr. S Elain Apsara, Principal Scientist (Hort.), CPCRI RS, Vittal	Institute visit with Trainees	3.11.2023	18	Bhagya H P
29	Mr. Santhosh Assistant Professor BESTIU, Andhra Pradesh	Educational tour	3.11.2023	23	Bhagya H P
30	B S Mokesh Farmer, Bagalkot	Exposure visit	4.11.2023	4	Bhagya H P & Veena G L
31	Kushal V Gowda COH, Mudigere Karnataka	Exposure visit	29.12.2023	13	Bhagya H P

4.3 Exhibitions

1. Exhibited ICAR-DCR Stall in the Yantra Mela, 10-12 February 2023 at Vivekananda College of Engineering and Technology, Puttur and disseminated cashew production technologies to farmers (Staff involved: Drs. Balasubramanian D and Eradasappa E).
2. Pariticiapted in ICAR Foundation Day / Technology Day celebrations organized at ICAR, New Delhi on 16th June 2023. (Staff involved: Dr. J.D. Adiga, Dr. Shamsudheen, M., Dr. Manjesh G N and Dr. Veena G L).
3. Organized and Exhibited DCR technologies in Horti-Expo 2023 held at ICAR-IIHR, Bengaluru from 17th to 19th October 2023, and showcased the DCR technologies, achievements, and activities of DCR. (Staff involved: Drs. Veena G. L and Manjesh G. N).
4. Organized and Exhibited DCR technologies on Cashew Day 10.03.2023 at ICAR-DCR Puttur (Staff involved: Drs. Veena G. L. and Manjesh G. N).
5. Participated in Nursery Mela (Sasya Jathre) organized by Suddi Mahiti Trust from 7 to 8 January 2023 at Puttur to showcase the technologies, achievements, and activities of ICAR-DCR, Puttur and facilitated in explaining the information to farmers and other stakeholders. (Staff involved: Dr. Manjesh G. N.).
6. Organized and exhibited DCR technologies at 10th Indian Horticulture Congress organized at Assam Agriculture University Guwahati from November 6th to 9th 2023. (Staff involved: Drs. Balasubramanian D and Veena G.L).
7. Participated 'National Horticultural Fair' conducted at ICAR- Indian Institute of Horticultural Research, Hessaragatta, Bangalore from 22-25 March, 2023. (Staff involved: Dr. Balasubramanian D).
8. Exhibited ICAR-Directorate of Cashew Research Technologies at Krishi yantra mela organized by Campo at Puttur from 10.02.2023 to 12.02.2023 (Staff involved: Dr. Bhagya H P).
9. Participated and Exhibited ICAR - DCR Technology at the National Horticulture fair-2023 held at ICAR - IIHR, Bangalore during 22-25th February, 2023 (Staff involved: Dr. Bhagya H P).

4.4 Students guided

Dr. Siddanna Savadi guided the following students for project/thesis/internship

Sl No	Name	Institute/College	project/thesis/ internship report title	Year
1.	Mr. Revanasiddappa D. M.	College of Agriculture, Hassan, UAS Bengaluru	Phenotypic and genotypic characterisation of parents and mapping population in cashew	2023
2.	Mr. Sharanabasappa	College of Agriculture, Hassan, UAS Bengaluru	Phenotypic and genotypic characterisation of parents and mapping population in cashew	2023
3.	Mr. Lester Jobin	Dcunha of St. Aloysius College, Mangaluru	Screening of InDel markers to identify dwarfism specific markers and quantification of kernel lipids in cashew	2023

Dr. Veena G.L guided the following students for project/thesis/internship

Sl No.	Name	Institute	Project/Thesis / Internship report title	Year
1.	Mr. Kalaikannan, S M.Sc. (Food Processing)	P.G.P. College of Arts and Science affiliated to Periyar University, Tamil Nadu	Development and evaluation of Cashew Apple and other Fruit Blended RTS beverage	2023
2.	Mr. Srishankar M.Sc. (Food Processing)	P.G.P. College of Arts and Science affiliated to Periyar University, Tamil Nadu	Development and evaluation of Cashew Apple Pomace Powder Cookies	2023
3.	Mr. Kalaikannan, S M.Sc. (Food Processing)	P.G.P. College of Arts and Science affiliated to Periyar University, Tamil Nadu	Development and evaluation of Cashew Apple Pulp Based Ice-creams	2023
4.	Mr. Surya, S. M.Sc. (Food Processing)	P.G.P. College of Arts and Science affiliated to Periyar University, Tamil Nadu	Development and evaluation of Cashew Apple and Guava blended Fruit Bar	2023
5.	Muhammad Amaan B.Sc (Food Technology)	PA. First Grade College, Nadupadav, Mangalore	Development and evaluation of Cashew Apple fruit blended Jam	2023
6.	Ms. Delma Lora Dcunha. M.Sc. (Food Science and Technology)	St. Aloysius College Autonomous, Mangalore	Development and evaluation of Cashew Sprout based Nutribars	2023
7.	Ms. Preethal Milan crasta M.Sc. (Food Science and Technology)	St. Aloysius College Autonomous, Mangalore	Development and evaluation of Sensory and Nutritional Properties of cashew apple pomace powder cookies fortified with millets	2023

5. IMPLEMENTATION OF STC/TSP AND SCSP

5.1 Brainstorming session on "Prospects of Cashew Cultivation in non-traditional areas of Karnataka" and "Distribution of Agriculture implements" to Schedule Caste beneficiaries under the SCSP scheme

On 17/02/2023 Brainstorming session on "Prospects of Cashew Cultivation in non-traditional areas of Karnataka," and Distribution of Agriculture implements to Schedule caste (SC) beneficiaries of Gadag District was organized in collaboration with ICAR-K.H. Patil, KVK, Hulkoti, Gadag, Karnataka. In this programme, Dr. Eradasappa, E. Senior Scientist, (Plant breeding), ICAR-DCR, Puttur, Chief guest addressed the farmers on the importance of Cashew cultivation in a non-traditional area of Karnataka. He also emphasized the scope for farm-level processing units of raw cashew nuts for realizing better income. Further, Dr. Manjesh G.N. Scientist (SPM&AP), Nodal officer SCSP, ICAR-DCR, Puttur addressed the gathering and highlighted the importance of Cashew apple utilization and value addition. The objective of the SCSP scheme was also briefed to the beneficiaries. Dr. Sudha V. Mankani, Subject Matter Specialist (Home Science) ICAR-K.H. Patil KVK, Hulkoti, Gadag, said about the importance of balanced nutrition in the daily diet and emphasized on the benefits of the kitchen garden. The President of the programme Dr. L.G. Hiregoudar, Senior Scientist and Head, ICAR-K.H. Patil KVK, Hulkoti, Gadag spoke about the implementation of the SCSP scheme of ICAR-DCR, Puttur in collaboration with KVK and appreciated the activities under the scheme. This was followed by the distribution of 8 various agricultural inputs (Battery sprayers, Pickaxe, Spade, threshing rakes, Baskets, Wooden grain gatherer, Kurphi-5" and 7") and Vegetable seed kits of 8 different vegetable seeds to promote nutrition/kitchen garden among the 100 beneficiaries.

5.2 Distribution of brush cutters and Vegetable seed kits for the beneficiaries

On the annual Cashew Day celebration at our Directorate, the SC beneficiaries were invited to participate in the event on 10th March 2023 and distributed vegetable seed kits (75 No) for taking up the kitchen garden. On the same occasion in collaboration with ICAR-KVK, Dakshina Kannada we have identified the SC beneficiaries from Puduvettu village of D.K District and distributed the brush cutters to the beneficiaries (15 No.).

5.3 Training Programme on Cashew Cultivation and apple Utilization and distribution of Inputs under SCSP-scheme

Training Programme on Cashew Cultivation and apple Utilization and distribution of Inputs under the SCSP scheme to Schedule caste (SC) beneficiaries of Gadag District was organized on 26th September 2023 in collaboration with ICAR-K.H. Patil, KVK, Hulkoti, Gadag, Karnataka. In this programme, Dr. H Rajashekara Scientist, (Plant Pathology), ICAR-DCR, Puttur, Chief guest briefed about the institute activities and gave a lecture on pest management practices in cashew. Further, Dr. Manjesh G.N. Scientist (SPM&AP), Nodal officer SCSP, ICAR-DCR, Puttur addressed the gathering highlighted the SCSP activities, and gave a lecture on Cashew cultivation. Dr. Veena G L., Scientist (Fruit Science) addressed the gathering and delivered a lecture on the scope and importance of value addition in cashew apple. Dr. Narayan H. Bhandi addressed the gathering stating the collaborative efforts in the implementation of the SCSP scheme at Gadag and emphasized on self-utilization of inputs provided under the scheme. The President of the programme Dr. Sudha V. Mankani, Senior Scientist and Head ICAR-K.H. Patil KVK, Hulkoti, Gadag, briefed about the importance of balanced nutrition in the daily diet and emphasized the benefits of the kitchen garden. Radio talk on cashew cultivation, Cashew apple Utilization, and the Varietal wealth of cashew were delivered at the community radio station (FM 89.6Hz) for the benefit of new cashew farmers at Gadag. This was followed by the distribution of inputs (Tarpaulins, Vegetable seed kit, and Vegetable special- nutrient mixture") to 100 SC beneficiaries of Gadag District.

5.4 Distribution of inputs to SCSP beneficiaries of Dakshina Kannada, Karnataka

As a part of the Scheduled Caste Sub Plan (SCSP) program of this Directorate, the inputs for the Scheduled caste community were distributed with a collaboration of ICAR, KVK, Dakshina Kannada on 05.09.2023. During the program, Dr. K. Ramesh (Senior scientist & Head), ICAR-KVK, Dakshina Kannada briefed about the scheme of the Scheduled Caste sub-plan (SCSP) program of ICAR-DCR and implementation. The guest of honor Dr. J.D. Adiga, Director, ICAR-DCR, Puttur addressed the beneficiaries and informed them about the proper use of the inputs for their utilization. Dr. Mallikarjuna L (Scientist, Soil Science, N/O SCSP, ICAR-KVK, D.K.) gave a brief note on the process of selection of beneficiaries under the scheme. The inputs were distributed to SC beneficiaries of taluks - Mangalore, Ullal, Mulki, Moodabidre, and Bantwal covering 90 beneficiaries (75 for Tarpaulins and 15 for Solar lights). Dr. Manjesh G.N. Scientist, Nodal officer SCSP, ICAR-DCR coordinated the programme.

5.5 Training Programme on Cashew Cultivation and Nursery Management and Distribution of inputs under the SCSP scheme to the beneficiaries of Dakshina Kannada, Karnataka

As a part of the Scheduled Caste Sub Plan (SCSP) scheme of this Directorate, the inputs for the Scheduled caste community were distributed in collaboration with ICAR, KVK, Dakshina Kannada on 08.09.2023. Dr. J Dinakara Adiga, Director of ICAR-DCR Puttur chaired the program. Dr. Mallikarjuna, L. (Scientist), ICAR- KVK, Dakshina Kannada was chief guest. Dr. Manjesh G N, Nodal officer SCSP briefed about the scheme of the Scheduled Caste sub-plan (SCSP) scheme of ICAR- DCR and its implementation and the basis of selection of beneficiaries. Dr. J.D. Adiga the Director (ICAR-DCR, Puttur) addressed the beneficiaries and informed them about the proper use of the inputs for their utilization. Dr. Mallikarjuna L (Scientist, Soil Science, N/O SCSP, ICAR-KVK, D.K.) gave a brief note on the process of selection of beneficiaries under the scheme. The inputs were distributed to SC beneficiaries of Belthangadi, Sulia, Puttur, Kadaba, and talukas covering 49 beneficiaries (25 for Tarpaulins and 24 for Solar lights). On this occasion, one-day training programme was organized for the beneficiaries on cashew cultivation and nursery management. Dr. Manjesh G.N. Scientist, Nodal officer, and the members of the SCSP scheme of ICAR-DCR coordinated the programme.

5.6 Distribution of farm input Cow mats to SCSP beneficiaries of Dakshina Kannada, Karnataka

As a part of the Scheduled Caste Sub Plan (SCSP) program of this Directorate, the input-Cow Mats for the Scheduled caste community was provided with a collaboration of ICAR, KVK, Dakshina Kannada on 03rd November 2023. The distribution program was organized at ICAR DCR, Puttur covering 30 beneficiaries from Puttur, Sullia, and Belthangadi taluk on 03.11.2023. During this program, Dr. Adiga J.D. Director, ICR-DCR, Puttur emphasized various central government schemes being implemented for the welfare of the SC community for the benefit of farmers and suggested utilizing the inputs for their use.

5.7 Distribution of farm input-Cow mats to SCSP beneficiaries of Dakshina Kannada and technical workshop on Nutritional management in Dairy animals

The distribution of Cow mats to SC beneficiaries of Mangalore and Bantwal taluks covering 20 farmers was organized at ICAR-KVK, D.K., and a technical workshop on Nutritional management in Dairy animals on the occasion. During this program, Dr. Ramesh Head of KVK, DK briefed about the implementation of the SCSP scheme in collaboration with ICAR-DCR and spoke about an overview of the Dairy sector in D.K. and insisted on minimizing the cost input towards rearing of dairy animals to realize higher profits. The resource person Dr. NKS Gowda, Principal Scientist, ICAR-NAINP, Bengaluru addressed the gathering and briefed about the importance of nutritional feed for the dairy animals. The chief guest Dr. Mohana G.S. Principal Scientist (G&PB) in his remarks insisted on exploring the possible utilization of agricultural wastes (jackfruit, cashew apple, etc.,) as a source of fiber and nutritional components for dairy animals and appreciated the efforts from the Head and N/O SCSP-ICAR-KVK D.K. for their collaborative activities.

6. Agri Business Incubation

ICAR IP & TM Scheme: Agri Business Incubation (ABI), ICAR-DCR, Puttur

Agri Business Incubator (ABI) operated in this institute funded by the National Agricultural Innovation Fund (NAIF) under the Division of Intellectual Property and Technology Management, Indian Council of Agricultural Research, New Delhi has the 'State-of-the-Art' processing facility for promotion of entrepreneurship and business environment in the cashew eco system. During the reporting period, six incubates viz., Mr. Ganapathy Annamathesi, Tamil Nadu; Mr. Ankur Agrawal, Uttar Pradesh; Mr. Aswath Hebbar, Karnataka; Mr. Prakash P, Karnataka; Mr. B Narendra Baliga, Karnataka and Mrs. Sumana, K, Karnataka registered with ABIC have undergone three days training on 'Starting Cashewnut processing' and utilized the facility on the basis of 'Custom hiring' (Fig. 3.4.5). Among the incubatees registered with ABIC. Mr. Aswath Hebbar and Mr. Gururaj Kolathaiya signed MoU with this institute and utilized the processing facility. World awareness program organized along with Institute Technology Management Unit (ITMU) as 'Intellectual Property Day' at ICAR-DCR, Puttur on 26 April, 2023. Activities of ABIC to promote cashew business and technologies developed in this institute were exhibited during Indian Horticultural congress held at Assam Agricultural University, Guwahati and Horticultural exhibition conducted at Indian Institute of Horticultural Institute, Bangalore. Any further information, visit ICAR-DCR website https://cashew.icar.gov.in/

Manual peeling process of cashew kernels

Steam boiling of raw cashewnuts

Operating Nitrogen packig machine

Women entreprenuer at ABIC

Sorting raw cashewnuts – Incubation Phase

Incubating receiving certificate from Director, ICAR-DCR

Working with mechanized de-shelling

Learning by doing – Manual de-shelling

Fig. 3.4.5 Incubation program at ABIC – ICAR-DCR

7. AWARDS/RECOGNITIONS/RESOURCE PERSONS/LECTURES

7.1 Awards and Recognitions

ICAR-DCR	• The technology, CASHEW Apple Crisp developed by Dr. Preethi. P, Dr. Shamsudheen. M, Dr. Veena. G.L., Dr. M.R. Manikantan and Dr. R. Pandiselvam has received ICAR certificate (No. ICAR-HS-DCR-Product-2023-021) on 16 July 2023.
Dr. Balasubramanian, D.	• Institute representative to participate in International Conference on Millets conducted by Min. of Agriculture and farmers Welfare at ICAR- Indian Agricultural Research institute, New Deli during 18-19 March, 2023. • Invited to participate in the 'Training, demonstration of Improved technologies of cashew cultivation to the cashew growing small and marginal farmers' of Garo hills of Meghalaya' conducted by College of Community Science, Central Agricultural University (CAU), Tura, Meghalaya from 28-30 March, 2023. • Editorial member of Journal of Plantation Crops published by Indian Society of Plantation Crops, ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala for the period up to 2026. • Chairman, Editorial Committee, ICAR--Directorate of Cashew Research, Puttur, D.K., Karnataka. • Acted as Coordinator and organized the World Intellectual Property (IP) day jointly by Agribusiness Incubation (ABI) center and Institute Technology Management Unit (ITMU) of ICAR-DCR, Puttur on 26.04.2023.
Dr. Babli Mog	• Received Scientist of the year award in the International Conference on Multidisciplinary approaches in Engineering, Science, Agriculture and Social Studies through hybrid mode during 3th to 4th June, 2023 organized by Dr. Bhimrao Ambedkar University, Agra.
Dr. Bhagya H P	• Reviewed research article in the International Journal of Agricultural Research on January 2023 (2023 NAAS rating: 4.73). • Act as external expert for selection committee for the field assistant post on a contractual basis under the project establishment of demonstration plots on areca nut dwarf hybrids funded by DASD, Calicut at ICAR-CPCRI RS, Vittal on 19.1.2023. • Reviewed Research article in JENE journal during April, 2023. • Deputed as an expert for the advisory for the farmer of Sampaje, Dakshina Kannada, Kodagu regarding pruning in cashew • Participated in ICAR south zone sports at ICAR-IIHR, Bengaluru during 13th to 16th December, 2023 and won silver medal in Discus throw event (Women). • Reviewed research article in Euphytica journal in July 2023 (2023 Naas rating: 8.19). • Reviewed research article in International Journal of Environmental sciences and climate change in July 2023 (2023 Naas rating: 5.13).

	• Reviewed research article in physiology and molecular biology of plants in October, 2023 (2023 Naas rating:9.02). • Two copyrights received for technical bulletin and software in oil palm during July 2023 (Registration no- L-128689/2023 and SW-16714/2023). • Associated in technology developed on A method for identifying dwarf oil palm plant by using SSR Marker. • Discharged the duties as presiding officer for Karnataka legislative assembly election in May, 2023. • Reviewed Research article in international journal of plant and soil science during May and July, 2023 (2023 Naas rating:5.07).
Dr. Eradasappa E	• Invited speaker for Recently developed Cashew Varieties of ICAR-D CR, Puttur and their special features in the national Conference is on 'Encashing technological innovations for production and productivity of Cashew, 30-31 January, 2023, Bhubaneswar, Odisha organized by DCCD. • Rapporteur for the International Conference Technical session IV: 2nd International Conference: Prospects and challenges of environment and biological sciences in food production system for livelihood security of farmers (ICFPLS-2023) held during September 18-20, 2023 at ICAR-CIARI, Port Blair Andaman & Nicobar Islands, India.
Dr. Jyoti Nishad	• Inducted into PG faculty as faculty member of regional academic hubs of IARI- Bengaluru hub of ICAR-IARI in Food Technology (No. PGS-I/12-2/2023 Dt. 22.12.2023).
Dr Manjesh G N	• Bagged best oral presentation award for presenting the paper entitled "Growth and Maturity of Cashew Nut and Apple in Relation to Climate Variables and Modified Biologische Bundesantalt, Bundessortenamt, and Chemische Industrie (BBCH) Scale" at 5th International Conference on "Sustainable Natural Resource Management under Global Climate Change", November 7-10, 2023, Soil Conservation Society of India, New Delhi, India. • Acted as Jury Member for evaluation of posters presentation at the international seminar on Exotic and underutilized horticultural crops: Priorities and emerging trends from 17th to 19th October 2023, organized by ICAR-IIHR, Bengaluru. • Received DGCA-Certified Remote Pilot Certificate with certificate No. PC092300005MV for the ROTORCRAFT Unmanned Aircraft System (UAS) to fly the small class UAV in the visible line of sight (VLOS) on 24 September 2023.
Dr. Manjunath K	• Member of the board of studies for the Dept. of Agricultural Engineering, Alvas Institute of Engineering & Technology, Moodabidri for crafting the curriculum and syllabus and to give insights into the latest technological advancements in the field of Agricultural Engineering (FMP) from 04.12.2023 to till date.

Dr. G.S. Mohana	• Best oral presentation award for the paper on 'Cashew Protect: Problems and Prospects of developing an AI based app for identification of pests, diseases and nutrient deficiencies in cashew" in the ICT session of the national level Plantation Crop Symposium (PLACROSYM) – 25. This was conducted by Indian Society of Plantation crops at IIOPR, Pedavegi, Andhra Pradesh during December 12 to 14, 2023. • External expert member for selection of persons on contract basis under revolving fund scheme at Nettana, Kidu, CPCRI for coconut climbing during 25-01-2023. • External Expert in selection committee for selection of YP- II under DUS center for Cocoa at CPCRI Vittal on 12-04-2023. • As In charge of the Shantigodu farm, 13,500 Grafts of Bhaskara variety were sold during the year. • Provided orientation to Dr. Jyoti Nishad on 26-08-2023 regarding cashew germplasm and cashew apps and AKMU at ICAR- DCR, Puttur. • Made monitoring visit to Tura, Meghalaya, AICRP centre as PC cell In-charge Meghalaya on 29-03-2023.
Dr. Rajashekara, H	• Inducted into PG faculty as faculty member of regional academic hubs of IARI- Bengaluru hub of ICAR-IARI in Agricultural Entomology (No. PGS-I/12-2/2023 Dt. 22.12.2023). • Nominated as member of Departmental Promotion Committee (DPC) for the promotion of office staff on 24.03.2023 at ICAR-DCR, Puttur. • Acted as an outside expert in selection committee for walk in interview of Project Fellow under the external funded project on 19.04.2023 at ICAR-CPCRI, Regional Station, Vittal.
Dr. Shamsudheen M	• Served as Rapporteur during the 5th International Conference on Sustainable Natural Resources Management under Climate Change during 7-10 November 2023 at ICAR-NASC Complex, New Delhi organized by the Soil Conservation Society of India.
Dr. Siddanna Savadi	• Received DCR Best Publication Award-2023 instituted by the Directorate for the research article 'De novo transcriptome assembly and its utility in development and characterization of the first set of genic SSR markers in Cashew' published in Industrial Crops and Products journal.
Dr. Vanitha K	• Received 'Kanwar Virender Singh Memorial All India Best publication award – 2022' during 2023 for the research paper - Vanitha, K. and Raviprasad, T. N. 2021. Artificial nests conserve important native bees, Braunsapis spp. pollinating cashew. Current Science, 121 (1): 127-132. • Bagged first oral presentation award for the paper 'Role of Apis cerana indica on cashew yield and quality on comparison with a native bee, Braunsapis mixta' presented in the 2nd International Conference on 'Prospects and challenges of environmental and biological sciences in food production system

	for livelihood security of farmers (ICFPLS-2023), during 18-20 September, 2023 at ICAR-CIARI, Port Blair, Andaman and Nicobar Islands, India. • Received 'Women Scientist Award' by Pragathi International Scientific Research foundation conferred during 2nd International Conference on 'Prospects and challenges of environmental and biological sciences in food production system for livelihood security of farmers (ICFPLS-2023), 18-20 September, 2023 at ICAR-CIARI, Port Blair, Andaman and Nicobar Islands, India. • Awarded 'Plant Protection award - 2023' by Insect Environment Journal & AVIAN Trust, Bengaluru. • Acted as chairperson of the selection committee of YP- 1 (Audit and Account section) held on 24.03.2023 at ICAR-DCR, Puttur. • Acted as member in the selection committee of YP- II for AKMU (Networking and hardware) work held on 29.12.2023 at ICAR-DCR, Puttur (F.No. 2-12/ DCR/Estt/Rectt. Dt. 28.12.2023). • Served as external examiner for the qualifying viva-voce for three M.Sc. Students and one Ph.D. student of College of Agriculture, Padannakad held on 18.10.2023 at College of Agriculture, Padannakad (KAU), Kasargod Dt. (F.No. 14/2023-PME (HRD-Students Dt. 18.10.2023). • Inducted into PG faculty as faculty member of regional academic hubs of IARI- Bengaluru hub of ICAR-IARI in Agricultural Entomology (No. PGS-I/12-2/2023 Dt. 22.12.2023).
Dr. Veena G L	• Acted as Jury Member for evaluation of posters presentation at international seminar on Exotic and underutilized horticultural crops: Priorities and emerging trends from 17th to 19th October 2023, organized by ICAR-IIHR, Bengaluru. • The technology, Cashew Apple Crisp developed by Dr. Preethi. P, Dr. Shamsudheen. M, Dr. Veena. G.L., Dr. M.R. Manikantan and Dr. R. Pandiselvam has received ICAR certificate (No. ICAR-HS-DCR-Product-2023-021) on 16 July 2023. • Acted as rapporteur for in international seminar on Exotic and underutilized horticultural crops: Priorities and emerging trends from 17th to 19th October 2023, organized by ICAR-IIHR, Bengaluru. • Acting as a member in IP & TM- Agri Business Incubation scheme of ICAR-DCR, Puttur (F.No. 27-26/2016 - Esst dated 11.08.2023). • Acted as Reviewer for an International Journal Emergent Life sciences Research 2023. • Acted as a member in the selection committee of young profession- I for PC cell at ICAR-DCR, Puttur on 19.05.2023.

	• Acted as thesis evaluator for the thesis entitled "Standardization of Harvesting stage and pretreatment for dehydration of tender jack" from University of Agriculture and Horticultural Sciences Shimoga. • Discharged the duties as presiding officer for Karnataka legislative assembly election in May, 2023. • Participated in south one sports at ICAR-IIHR, Bengaluru. • Nominated as Hindi committee member for organizing Hindi fortnight from 14th to 28th September, 2023. • Discharged the duty of member secretary for identification of germplasm with unique traits to registering at ICAR-NBPGR, New Delhi from ICAR-DCR, Puttur on November, 2023. • Nominated as Co-nodal Officer of RKVY w.e.f. 11.12.2023 • Inducted into PG faculty as faculty member of regional academic hubs of IARI- Bengaluru hub of ICAR-IARI in Fruit Science (No. PGS-I/12-2/2023 Dt. 22.12.2023).

7.2 Resource Person / Lecture delivered

Dr. Aswathy Chandrakumar	• Delivered oral presentation on Advancing the application of systems thinking to understand the dynamics of community-based conservation in Periyar Tiger Reserve in India. In. 1st International Conference on Extension Education on Rural Transformation and Sustainable Agri-food System through Community Based Organisation (CBO) Oriented Extension Strategy organised by Society for Extension Education, RARI, Durgapura, Jaipur during December 18-20, 2023.
Dr. D. Balasubramanian	• Delivered technical lecture on "Cashew processing and value addition in India – viable opportunities and emerging challenges" during the One district – One Product (ODOP) webinar on plantation crops processing and value addition organized by NIFTEMT, Tamil Nadu on 23 June, 2023. • Delivered a lecture on Equipment's Specification of Machines in Cashew Processing. Lecture delivered in the 'Training of master Trainers on Spices and plantation Crops Processing' under PMFME Scheme conducted by National Institute of Food technology and entrepreneurship Management – Thanjavur (NIFTEM-T), Tamil Nadu on 20 September, 2023. • Delivered a lecture on Processing Mechanism and Value addition in Cashew. Lecture delivered in the 'National level training program on Cashew' conducted jointly by Kheladi Shivappa Nayaka University of Agricultural and horticultural Sciences, Shivamogga and Directorate of Cashew and cocoa Development, Cochin during 6-8 September, 2023. • Delivered a lecture on 'Indian Cashew Processing- An Overview' and 'Entrepreneurs Development in Cashewnut Processing – A Viable Approach for NEH Region', In. 'Training, demonstration of Improved technologies of

	cashew cultivation to the cashew growing small and marginal farmers' of Garo hills of Meghalaya' conducted by College of Community Science, Central Agricultural University (CAU), Tura, Meghalaya from 28-30 March, 2023.
Dr. Babli Mog	• Delivered lecture on "Changing scenario in cashew nut processing and entrepreneurial opportunities for youth in India" at Alvas Institute of Engineering and Technology, Moodbidri. Karnataka on 20 June, 2023. • Delivered a lecture on "Role of plant growth regulators in cashew" during Short Course on improved Crop Production Technologies in Cashew with Major Emphasis on integrated Pest Management, 13-20 February, 2023 at ICAR-DCR, Puttur. • Delivered a lecture on "Cashew cultivation under changing climate" during training on Cashew Production and Post-Harvest Technologies, organized jointly by ICAR-DCR, Puttur and MANAGE, Hyderabad.
Dr Bhagya H P	• Delivered a lecture on Training and Pruning in cashew in short course on Improved crop production technologies in cashew with a major emphasis on integrated pest management from 13-20th February, 2023 from the crop protection section, at ICAR-DCR, Puttur. • Delivered a lecture on Canopy management in cashew in online collaborative training on Agripreneurship development through cashew production and post-harvest technologies organized by the National Institute of Agricultural Extension Management (MANAGE), Hyderabad and ICAR-Directorate of Cashew Research, Puttur on 22nd November to 24 November, 2023.
Dr. Eradasappa E	• Delivered a lecture on Recently developed Cashew Varieties of ICAR-D CR, Puttur and their special features in the national Conference is on 'Encashing technological innovations for production and productivity of Cashew 30-31 January, 2023, Bhubaneswar, Odisha organized by DCCD. • Delivered a lecture on "Improved varieties and production technologies" on 07.02.2023 in the training programme at ICAR-IIHR, Bengaluru for the farmers and Programme Implementation Agencies of NABARD TDF Projects on "Scientific management practices for fruit crop-based production systems" from 7th to 9th March, 2023. • Delivered a lecture on Improved cashew varieties in India and their suitability for processing in the training programme on 'Raw Cashewnut Processing and Value-added products of Cashew Apples, 6-10 February, 2023 organized by ICAR-DCR Puttur. • Delivered a lecture on Breeding in cashew for special traits. In: Short Course on Improved Crop Production Technologies in Cashew with Major Emphasis on Integrated Pest Management, 13-20 February, 2023 organized by ICAR-DCR Puttur sponsored by ICAR, New Delhi. • Delivered a lecture on Cashew production technologies in the Brainstorming Session and training programme on "Prospects of cashew cultivation in non-traditional areas of Karnataka" cum-distribution of Inputs under the SCSP scheme at Gadag on 17-02-2023, in collaboration with ICAR-K.H. Patil Krishi Vigyan Kendra, Hulkoti, Gadag.

	• Delivered a lecture on Improved cashew varieties for doubling the farm income of cashew farmers in the Short Course on Improved Crop Production Technologies in Cashew with Major Emphasis on Integrated Pest Management, 13-20 February, 2023 organized by ICAR-DCR Puttur. • Delivered a lecture on Popular Cashew varieties in India during the three days online training programme on "Agripreneurship Development through Cashew Production and Postharvest Technologies" organised by National Institute of Agricultural Extension Management (MANAGE), Hyderabad in collaboration with ICAR-Directorate of Cashew Research, Puttur, D.K., Karnataka, during November 22-24, 2023.
Dr. J D Adiga	• Delivered a lead talk on A quest for self-reliance in Cashew nut: Issues and strategies. 10th Indian Horticulture Congress, 06-09th November 2023. Pp 115. • Delivered a lead talk on Cashew Present status, Issues and Strategies. XXV placrosym 2023 organized by ICAR-Indian Institute of Oilpalm Research Pedavegi 12-14th December 2023. Pp 1-8. • Delivered a lead talk on
Dr. Manjesh G N	• Delivered a lecture on Commercial nursery management and softwood grafting in Cashew organized by the National Institute of Agricultural Extension Management (MANAGE), Hyderabad in collaboration with ICAR-DCR, Puttur, from November 22-24th, 2023. • Delivered a lecture on "Cashew cultivation and Nursery management in Cashew" during the distribution of inputs to the SC beneficiaries of Dakshina Kannada district on 08.09.2023 under SCSP scheme in collaboration with ICAR- KVK, Dakshina Kannada. • Delivered a lecture on "Scientific Cashew cultivation" during a training program on Cashew cultivation and Cashew apple utilization and promotion of Kitchen gardening cum distribution of inputs to the SC beneficiaries of Gadag district on 26.09.2023 under the SCSP scheme in collaboration with ICAR-K H Patil KVK Hulkoti.
Dr. Manjunath K	• Delivered a lecture on Mechanization in harvesting of Cashew on 06.02.2023 as part of the training program on "Raw Cashew nut Processing and Value-added Products of Cashew Apples" for the Farmers and Officials from Meghalaya state organized by ICAR-DCR, Puttur. • Delivered a talk on Application of drones in agriculture with emphasis on plantation crops and demonstrated the Drone Technology on 16.02.2023 during the Short Course on improved Crop Production Technologies in Cashew with Major Emphasis on integrated Pest Management organized by ICAR-DCR, Puttur. • Delivered a talk on Mechanization in plantation crops to reduce the cost of cultivation on 17.02.2023 during the Short Course on improved Crop Production Technologies in Cashew with Major Emphasis on integrated Pest Management organized by ICAR-DCR, Puttur.

Dr. Rajashekara, H	• Delivered a talk (online) on "Recent developments in blast disease of cereal crops" commemorating the occasion of International Plant Health Day on 12.05.2023 at Department of Plant Pathology, Bihar Agricultural University, Sabour. • Delivered a lecture on 'Tribal empowerment in India: status and challenges' on 18th May, 2023 in the 'Azadi ka Amrit Mahotsav' lecture series of this Directorate. • Delivered oral presentation on "Report of cashew leaf blight disease (CLB) caused by Neopestalotiposis clavispora from India" in Platinum Jubilee Conference Plant and Soil Health Management: Issues and Innovations from 2-4, February, 2023 at University of Mysore, Mysuru, Karnataka in association with Indian Phytopathological Society (IPS), New Delhi.
Dr. Shamsudheen M	• Delivered a lecture on "Soil test based nutritional recommendation in cashew" during the National Level Training Programme on Cashew from 6-8 September 2023 at Keladi Shivappa Nayak University of Agricultural and Horticultural Sciences (KSNUAHS), Shivamogga, organized by DCCD, Kochi. • Delivered a lecture on "Management of soil, water and nutrients in cashew" during the Online collaborative training on "Agripreneurship development through cashew production and post-harvest technologies" from 22-24 November 2023 organized jointly by ICAR-DCR, Puttur and MANAGE, Hyderabad. • Delivered a lecture on "Soil, water and nutrient management in cashew for enhancing productivity" during the ICAR sponsored Short Course on "Improved Crop Production Technologies in Cashew with Major Emphasis on Integrated Pest Management" organized during 13-20 February 2023 by and at ICAR- Directorate of Cashew Research, Puttur, Karnataka.
Dr. Siddanna Savadi	• Delivered a lecture on the topic "Biotechnological Interventions in Cashew" in the Short Course on Improved crop production technologies in cashew with major emphasis on integrated pest management at ICAR-DCR, Puttur during 13–20 February, 2023. • Delivered a lecture on the topic "Intellectual property rights and technology commercialization" in the training programme on "Agripreneurship Development through Cashew Production and Postharvest Technologies" organised by ICAR-DCR, Puttur in collaboration with MANAGE, Hyderabad during 22-24, November, 2023.
Dr. Vanitha K	• Delivered a talk on 'Women health in India: Challenges and welfare schemes' on 28th April, 2023 under AKAM webinar series at ICAR-DCR, Puttur. • Delivered a talk on 'Women work force in India – Challenges and Initiatives' on 8th March, 2023 at ICAR-DCR, Puttur on the occasion of International Women's Day programme.

	• Made a presentation on 'Pollinators of cashew: Species diversity and their role' in 'Annual Group Meeting of scientists of AICRP on cashew- 2022' held at Horticultural Research Station, Venkataramannagudem, Andhra Pradesh during 19-21 January, 2023 during the crop protection session.
Dr. Veena G L	• Delivered a lecture on value addition of cashew nut and cashew apple during three days online training programme on Agripreneurship development through Cashew Production and Postharvest Technologies organized by National Institute of Agricultural Extension Management (MANAGE), Hyderabad in collaboration with ICAR-DCR, Puttur, from November 22-24th, 2023. • Delivered a lecture and given demonstration on Utilization of cashew apple and sprouts in short course on "Improved Crop Production technologies in cashew with major emphasis on integrated pest management" from February 13th to 20th 2023. • As a Resource person delivered lecture on Value addition in cashew apple for SCSP/ TSP trainees of ICAR-CPCRI, Regional station Vittal on 3.11.2023. (F.No.7/2023-PME(TOT) dated 06.11.2023). • Acted as resource person for five days training programme "Raw cashewnut processing and value-added products of cashew apples" for the farmers and officials of Meghalaya, funded by Meghalaya Basin Management From 5-10 February, 2023. • Delivered a lecture on Utilization of cashew apple and quality testing on 8th February 2023 during 5 days training programme on Raw cashewnut processing and Value-added products of Cashew apples from 6-10th February 2023. • Given hands on training on cashew apple processing on on 8th February 2023 during 5 days training programme on Raw cashewnut processing and Value-added products of Cashew apples from 6-10th February, 2023. • Delivered a lecture on Starting cashew apple processing and cost economics on 10th February, 2023. During 5 days training programme on Raw cashewnut processing and Value-added products of Cashew apples from 6-10th February, 2023. • Delivered a lecture on Cashew apple utilization during training programme on Cashew cultivation and Cashew apple utilization and promotion of Kitchen gardening cum distribution of inputs to the SC beneficiaries of Gadag district on 26.09.2023 under SCSP scheme in collaboration with ICAR-K H Patil KVK Hulkoti. [(F.No. 26/2023-PME(SCSP) dated 22.09.2023]. • Delivered a talk on 'Palynological studies in fruits' on 8th August, 2023 under AKAM webinar series at ICAR-DCR, Puttur.

8. PUBLICATIONS

8.1 RESEARCH PAPERS/REVIEW ARTICLES

International Journals

Babli M., Veena, G.L., Adiga, J.D., Hebbar, K.B., Shamsudheen, M., Manjesh, G.N., Eradasappa, E., Mohana, G.S., Thandaiman, V., Vanitha K. and Kumar, A. Y. 2023. Pollen morphological study and temperature effect on the pollen germination of cashew (*Anacardium occidentale* L.) varieties. *Scientia Horticulturae,* Volume 314:111957. https://doi.org/10.1016/j.scienta.2023.111957. (NAAS Score: 10.30).

Charishma, K., Ashajyothi, M., Reddy, B., Kumar, M., Sahu, K. P., Patel, A., Neelam, S., Rajashekara, H., Govindasamy, V. and Kumar, A. 2023. Fine-scale mapping of the microbiome on phylloplane and spermoplane of aromatic and non-aromatic rice genotypes. *Folia Microbiologica*, 1-22. (NAAS Score: 8.60).

Chethan, C.R., Shrivastava, A.K., Nare, B., Kumar, S.P., Singh, P.K., Venu, S.A., Manjunatha K. and Chaturvedi, S. 2023. Effect of Tuber Shape, Picking Cup Size and Peripheral Speed of Metering Unit on Tuber Metering Efficiency of Belt Type Automatic Potato Planter. Agricultural Mechanization in Asia, Africa and Latin America, 54(2): 38-45. (NAAS Score:6.30)

Dev, R., Mangalassery, S., Dayal, D., Louhaichi, M. and Hassan, S. 2023. Genetic variability, characters association and principal component study for morphological and fodder quality of *Opuntia* and *Nopalea* sp. in India. *Genetic Resources and Crop Evolution* https://doi.org/10.1007/s10722-023-01773-8. (NAAS Score: 8.0).

Francis, F., Alimudeen, S., Valsalan, N., Dominic, D. M., and Chandrakumar, A. 2023. Stress and its Sources among Professional Students of Kerala. *Biological Forum-An International Journal* 15 (6): 715-719. (NAAS Score: 4.96).

Jeevan, B., Rajashekara, H., Prasanna, S. K., Vinaykumar, H. D., Umakanta, N., Pramesh D. *et al. 2023*. Phenotypic and genotypic screening of fifty-two rice (*Oryza sativa* L.) genotypes for desirable cultivars against blast disease. PLoS one, 18(3):1-19. (NAAS Score: 9.70).

Kalyana B., Mathur, R. K., Ravichandran G., Anitha, P., Bhagya, H.P. and Venu M.V.B 2023. A Novel QTL linked to Aspargine Synthetase gene for stem height increment in oil palm (*E. guineensis* Jacq.) identified and validated through integrated genomic approaches. *Euphytica,* 219(7):1-14. (NAAS Score: 7.90).

Mandal, N., Adak, S., Das, D. K., Sahoo, R. N., Mukherjee, J., Kumar A., Viswanathan, C., Das, B., Mukhopadhyay A., Rajashekara, H. and Shalini, G. 2023. Spectral characterization and severity assessment of rice blast disease using univariate and multivariate models. *Frontiers in Plant Science,* 14, 1067189. (NAAS Score: 11.60).

Manjunatha K., Nayak, M. G., Mangalassery, S., Palpandian, P., Muralidhara, B.M. and Siddanna S. 2023. Energy budgeting and life cycle assessment of cashew cultivation under different planting densities. *Environment Conservation Journal,* 24 (3): 67-78. (NAAS Score: 5.01).

Manjunatha, K., Balasubramanian, D., Naik, R. and Adiga, J. D. 2023. Engineering properties of cashew apple and nut in relation to design of cashew apple and nut separator. *Journal of Applied Horticulture,* 25(2). (NAAS Score: 5.43).

Palanna K. B., Vinaykumar, H. D., Prasanna, S. K., Rajashekara, H., Devanna B. N.....*et al*. 2023. Exploring the diversity of virulence genes in the *Magnaporthe* population infecting millets and rice in India. Frontiers in Plant Science, 2023 14, 1131315. (NAAS Score: 11.60).

Prasad, P., Jain, N., Chaudhary, J., Thakur, R. K., Savadi, S., Bhardwaj, S. C. and Gupta, P. K. 2023. Candidate effectors for leaf rust resistance gene Lr28 identified through transcriptome and in-silico analysis. *Frontiers in Microbiology,* 14: 1242025. (NAAS Score: 11.20).

Prasad, P., Thakur, R., Bhardwaj, S. C., Savadi, S., Gangwar, O. P., Lata, C. and Singh, D. G. 2023. Virulence and genetic analysis of *Puccinia graminis tritici* in the Indian sub-continent from 2016 to 2022 and evaluation of wheat varieties for stem rust resistance. *Frontiers in Plant Science,* 14, 1196808. (NAAS Score: 11.60).

Rachana, R.R., Amarendra, B. and Vanitha, K. 2023. A new species of Hydatothrips (Thysanoptera, Thripidae) from India with one new record. *Zootaxa,* 5319 (4): 589–594. (NAAS Score: 6.90).

Rajashekara, H., Pandian, R. T. P., Mahadevkumar, S., Raviprasad T. N., Vanitha K., Siddanna, S., Thube, S. H., Vikas, K. and Chandranayaka S. 2023. First report of *Neopestalotiopsis clavispora* causing cashew leaf blight disease in India. *Plant Disease*, 107:2864. (NAAS Score: 10.50).

Savadi, S., Adiga, J. D., Muralidhara, B. M., Prasad, P., Manjunatha, K., Ashwitha, K. and Manoj, K. 2023. Discovery of genome-wide genetic variations and development of first set of InDel markers for genetics research in cashew. *Scientia Horticulturae,* 320, 112233. (NAAS Score: 10.30).

Sood S., Joshi, D. C., Rajashekara, H., Tiwari, A., Bhinda, M.S., Kumar, A., Kant, L. and Pattanayak A. 2023. Deciphering the genomic regions governing major agronomic traits and blast resistance using genome wide association mapping in finger millet. *Gene,* 854, 147115. (NAAS Score: 9.60).

National Journals

Chandrakumar, A., Mohana, G. S., Adiga, J. D., Raviprasad, T. N. and Manjesh, G. N. 2023. Analysis of information needs and search behaviour of cashew farmers in non-traditional areas of India: A pilot study. Information Development. https://doi.org/10.1177/02666669231189265. (Impact factor: 1.9).

Lakshmipathi., Adiga, J.D., Kalaivanan, D., Bhagya, H. P., Thondaiman, V., Babli, M., Manjesh, G. N., Veena, G. L., Shamsudheen, M., Vanitha, K. and Manjunatha, K. 2023. Effect of growth regulators and micronutrients on quality parameters in cashew (*Anacardium occidentale* L.). *Journal Horticultural Sciences.*18 (1): 98-103. (NAAS Score: 6.10).

Muralidhara, B. M., Sakthivel, T., Karunakaran, G., Venugopalan, R., Venkatravanappa, V., Savadi, S., and Honnabyraiah, M. K. (2023). Survey, collection and characterization of Indian avocado (*Persea americana*) germplasm for morphological characters. *The Indian Journal of Agricultural Sciences,* 93(2), 139-144. (NAAS Score: 6.40).

Muralidhara, B.M., Siddanna, S., Adiga, J.D., Manjunatha, K., Lokesha, A.N., Veena, G.L., Thondaiman, V. and Manjesh, G. N. 2023. A first report on morphological and biochemical characterization of a rare CNSL free Cashew mutant. *Natl Acad Sci Lett.* 46:285-288 https://doi.org/10.1007/s40009-023-01262-7 (NAAS Score=7.10).

Preethi, P., Shamsudheen, M., Reddy, S.V.R., Veena, G.L., Kalal, P. and Pandiselvam, R. 2023. Biochemical quality comparison of forced air dried osmo-dehydrated cashew apple products infused with spice mixture and sugar. *Journal of Horticultural Sciences,* 18(2): 00-00. (NAAS Score= 6.10).

Rajashekara, H., Mishra, K. K., Aditya, J. P., Pattanayak, A. and Kant L. 2023. Race distribution pattern of *Magnaporthe oryzae* causing rice blast in mid and high altitudes of North-Western Himalayan region of India. *Indian Phytopathology*. PP 1-9. (NAAS Score: 5.95).

Vanitha, K., Raviprasad, T N., Rajashekara, H. and Babli, M. 2022. Occurrence of *Aphis odinae* van der Goot and its natural enemies in cashew. *Pest Management in Horticultural Ecosystems,* 28(2): 53-57. (NAAS Score: 5.14).

Vanitha. K. 2023. Nesting behaviour of three species of Ceratina pollinating cashew. *Indian Journal of Entomology,* 85 (Special Issue): 88-91. (NAAS Score: 5.59).

Veena, G.L., Adiga, J.D., Mohana G.S., Eradasappa, E., Siddanna, S., Vanitha, K., Thandaiman, V. and Shamsudheen, M. 2023. Purple cashew (*Anacardium occidentale* L.): A unique cashew type. *Nat. Acad. Sci. Lett.* https://doi.org/10.1007/s40009-023-01307. (NAAS Score: 7.10).

8.2 PARTICIPATION AND PRESENTATION IN SYMPOSIA/ WORKSHOPS/ SEMINARS/ WEBINARS / MEETINGS

International Conference

Babli, M. *et al. 2023*. Effect of paclobutrazol on vegetative and reproductive traits of cashew (*Anacardium occidentale* L.)" in International Conference on "Prospects and challenges of environment and biological sciences in food production system for livelihood security of farmers (ICFPLS-2023)" during September 18-20, 2023 at ICAR-CIARI, Port Blair, Andaman & Nicobar Islands, India.

Babli, M. *et al. 2023*. Effect of temperature on the pollen germination of cashew (*Anacardium occidentale* L" in International Conference on Impact of Climate Changes on Global Food, Livestock, Livelihood and Environmental Security: Advanced Approaches and Mitigation Strategies "ICCGFLLES-2023" December 28 - 30, 2023; through Hybrid Mode organized by Navsari Agricultural University (NAU) Navsari, Gujarat & National Agriculture Development Cooperative Ltd, Baramulla, Jammu and Kashmir.

Balasubramanian, D. 2023. Small scale Agro processing: Case of India. In. International Webinar on strengthening International Trade and Investments in Africa – Agricultural commodities and investment opportunities conducted by World Business Society Club, Ivory Coast, West Africa on 16th March, 2023.

Chandrakumar, A., Rajeev, P., Thomas L. and Dwivedi, R. P. 2023. Advancing the application of systems thinking to understand the dynamics of community-based conservation in Periyar Tiger Reserve in India. In. 1st International Conference on Extension Education on Rural Transformation and Sustainable Agri-food System through Community Based Organisation (CBO) Oriented Extension Strategy organised by Society for Extension Education, RARI, Durgapura, Jaipur during December 18-20, 2023.

Eradasappa, E., Vanitha, K., Babli, M. and Anilkumar, C. 2023. Genotype by year interaction for tea mosquito bug incidence in cashew (*Anacardium occidentale* L). 2nd International Conference: Prospects and challenges of environment and biological sciences in food production system for livelihood security of farmers (ICFPLS-2023) held during September 18-20, 2023 at ICAR-CIARI, Port Blair Andaman & Nicobar Islands, India.

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Babli, M., Adiga, J. D., Vanitha, K., Ibandalin, M., Sujith, M. K. and Rajkumar, A. D. 2023. Increased revenue from cashew: Focusing on cashew apple utilization. Agri Tech Today. Volume 1, special issue, November 2023.

Ibandalin, M., Sujith, M.S. K., Rani, R., Meena L. K. and Babli, M. 2023. Cultivating healthier fats: The quest for sustainable plant-based omega fatty acids. Agri Tech Today. Volume 1, special issue, November 2023.

Sujith M. S. K., Ibandalin M., Rani R. and Babli, M. 2023. Sinapine: Nature's multi-purpose compound. Agri Tech Today. Volume 1, special issue, November, 2023.

Vanitha, K., Babli, M. and Aswathy, C. 2023. Red banded thrips infestation in cashew plants. AgriGate- An International Multidisciplinary e-Magazine. 3 (11): 562-566.

Vanitha, K., Raviprasad, T. N. and Rajashekara, H. 2023. Flower feeding caterpillars can be a menace to cashew growers: Notes on species, seasonal incidence and management. Agriculture and Food- e newsletter: 5 (8): 56-58.

Vanitha, K., Veena, G.L., Babli, M., Aswathy, C., Ravishankar, P. and Muralikrishna, K. 2023. Tiny flowers of *Cuphea hyssopifolia* entice diverse pollinators, an observation at Puttur, Karnataka. Kerala Karshakan e - journal, 10 (8):32-36.

Vanitha, K., Veena, G.L., Babli, M., Aswathy, C. and Bhagya, H.P. 2023. Artificial bee nests serve as residing places for stem nesting bees. AgriGate- An International Multidisciplinary e-Magazine. 3 (11): 362-366.

8.9 WEBSITE/e-PUBLICATIONS

Balasubramanian, D. 2023. Raw cashewnut processing. In. Cashew Production and Post-Harvest Technologies. Eds. Eradassappa, E., B Venkat Rao and Aswathy Chandrakumar. E-book published by ICAR- Directorate of Cashew Research, (ICAR-DCR), Karnataka and National Institute of Agricultural Extension Management (MANAGE), Hyderabad. pp: 102-109.

Cashew Protect App (both for android and iOS) that aims at identification of pests, diseases and nutrient deficiencies in cashew was released during the Annual Group Meeting of AICRP-Cashew held at Dr. YSR Horticultural University, Venkataramannagudem during 19-21st of January 2023.

9. LINKAGES / COLLABORATION

Dr. T. N. Raviprasad	• ICAR-NBAIR, Bengaluru, Karnataka
Dr. D. Balasubramanian	• ICAR-Central Institute of Agricultural engineering (Regional Centre), Coimbatore, Tamil Nadu. • M/s Environmental Control, Cochin, Kerala
Dr. Vanitha K	• ICAR-IIHR, Bengaluru, Karnataka • ICAR-NBAIR, Bengaluru, Karnataka
Dr. Rajashekara H	• ICAR-CPCRI, Regional Station, Vittal, Karnataka
Dr. Veena G.L.	• ICAR-IIHR, Bengaluru, Karnataka
Dr. Manjunatha K	• ICAR-Central Institute of Agricultural engineering (Regional Centre), Coimbatore, Tamil Nadu

10. HUMAN RESOURCE DEVELOPMENT / TRAINING AND CAPACITY BUILDING

Dr. D. Balasubramanian	• Training on 'Start-up Masterclass Series 'organized by IPTM Unit, ICAR, New Delhi in collaboration with ABI, ICAR-IARI, New Delhi during 24 April to 18 May, 2023 in virtual mode. • Training on SAMAGRA: Enabling the Incubators – 'Sensitization Workshop of ICAR-ABI's organized by Intellectual Property and Technology Management (IPTM), ICAR, New Delhi during 17-18 October, 2023.
Dr. Mohana G.S.	• Attended on international workshop on "E-Processing and Management of DUS Testing Data in Plant Variety Examination" organised by The Protection of Plant Varieties and Farmers' Rights Authority (PPVFRA), Ministry of Agriculture & Farmers Welfare, GOI, New Delhi in collaboration with Federal Ministry of Food and Agriculture, Germany under Indo-German Bilateral Cooperation on Seed Sector Development during 25-26 May, 2023 in virtual mode.
Dr. Shamsudheen M	• Training on "Administrative Vigilance Role of IO/PO" organized by Institute of Secretariat Training & Management, New Delhi during 24-26 May, 2023. • Training on "Agricultural Research Management System (ARMS)" for Nodal Officers organised by the IT Unit of the ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi during 13 June, 2023 in virtual mode. • Training on SPARROW (Online APAR) of ICAR Scientists for Nodal Officers of ICAR Institutes organised by the IT Unit of the ICAR-Indian Agricultural Statistics Research Institute (IASRI), New Delhi during 16, 20 June and 06 July, 2023 in virtual mode.
Dr. Siddanna Savadi	• Training on Omics Data Analysis: Genome to Proteome organized by ICAR-IASRI, New Delhi during 09-18 October, 2023.
Dr. Veena G L	• Training on Emerging problems and recent advances in applied sciences: basic to molecular approaches organized by Astha foundation, Meerut UP during 26 February to 18 March, 2023.
Dr. Manjesh G N	• Training on Competency enhancement program for effective implementation of training functions by HRD nodal officers of ICAR organized by ICAR-NAARM, Hyderabad AP during 27 February to 01 March, 2023.

	• Completed the DGCA-Certified Remotely Piloted Aircraft System (RPAS) course for the Category: Small, (Ground class from 15-16 May, 2023 and Flying and Simulation training 22 to 24 May, 2023) conducted by IGRUA-RPAS flying and pilot licensing at Drone Destination, Pvt. Ltd., Bengaluru, Karnataka, India.
Dr. Aswathy Chandrakumar	• Participated in ICAR Sponsored Winter School on "Advanced Analytical Tools for Social Science Research organised at ICAR-CMFRI, Kochi during 11 - 31, January, 2023. • Participated in National training on Research Methodology using ChatGPT and AI tools organised by KVASU, Wayanad during 11 – 12, December, 2023.
Dr. Jyoti Nishad	• Training attended 112th Foundation Course for Agricultural Research Service (FOCARS) at ICAR-National Academy of Agricultural Research Management (NAARM), Rajendra Nagar, Hyderabad during 11 April to 10 July, 2023. • Attended Orientation training at ICAR- Directorate of Cashew Research, Puttur, Karnataka during 17 to 23 July, 2023. • Completed professional attachment training at Centre for Conservation and Utilization of Blue Green Algae (CCUBGA), Division of Microbiology, ICAR-IARI, New Delhi during 24 July to 08 December, 2023.

11. ONGOING AND CONCLUDED RESEARCH PROJECTS

Ongoing projects

Continuous No.	Division-wise No.	Title, duration, Number	PI	Co-PIs
	CROP IMPROVEMENT			
	Priority area I: Management of cashew genetic resources (Leader: Dr. Mohana. G.S)			
1.	1.	Collection, conservation, characterisation and evaluation of cashew genetic resources, [1986 – Long term] **PIMS Number: IXX00382**	Mohana. G.S.	Vanitha. K Eradasappa. E Veena. G.L. Rajashekara. H
	Priority area II. Genetic improvement of cashew for yield and quality traits (Leader: Dr. Mohana. G.S)			
2.	2.	Genetic improvement of cashew through hybridisation and seedling selection approaches [1986 - Long Term] **PIMS Number: IXX00393**	J.D. Adiga	Mohana, G.S. Eradasappa, E. Veena. G.L. Siddanna Savadi Manjesh G.N. Bhagya. H.P.
3.	3.	Breeding in cashew for special traits [06/2012-05/2027] **PIMS Number: IXX09323**	Eradasappa, E.	Mohana, G.S. Veena. G.L. Vanitha. K Raviprasad. T.N. Rajashekara. H
4.	4.	Breeding approaches for developing TMB tolerance [09/2017-08/2030] **PIMS Number: IXX13687**	Mohana, G.S.	Eradasappa, E. K. Vanitha
5.	5.	Genetics of traits in cashew [05/2019 – 04/2025] **PIMS Number: IXX15237**	Eradasappa, E.	Mohana, G.S. Siddanna Savadi
6.	6.	Polyploidy breeding in cashew [10/2020-09/2030] **PIMS Number: IXX17064**	Mohana, G.S.	Eradasappa, E.
7.	7.	Evaluation of dwarf and semi dwarf accessions and their seedling progenies for high density planting system [09/2021-08/2032] **PIMS Number: IXX17065**	Mohana G.S.	Eradasappa, E

8.	8.	***Externally Funded Project:*** Development of morphological descriptors and DUS test guidelines for cashew Funded by: Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), New Delhi Budget: Rs.10 Lakhs [04/2015-03/2024] **PIMS Number: OXX03473**	Mohana, G.S.	-
		Priority area III. Development, refinement and use of biotechnological approaches in cashew (Leader: Dr. Siddanna Savadi)		
9.	9.	Genetic dissection of QTLs governing nut yield and cashew nut shell liquid (CNSL) content in cashew [06/2018-05/2025] **PIMS Number: IXX14347**	Siddanna Savadi	Eradasappa, E Mohana, G.S. Manjunatha. K Manjesh. G.N. Veena. G.L.
10.	10	Deciphering the molecular basis of Cashew-Tea Mosquito Bug (TMB) interactions to understand host response and TMB effectors [09/2022-09/2026] **PIMS Number: IXX17066**	Siddanna Savadi	T.N. Raviprasad K. Vanitha Rajashekara. H
		CROP MANAGEMENT **Priority area IV: Enhancing input use efficiency and productivity (Leader: Dr. Shamsudheen M)**		
11.	1.	Developing nutrient management strategies for cashew based on soil and leaf status [10/2020-09/2024] **PIMS Number: IXX16218**	Shamsudheen Mangalassery	V. Thondaiman Babli Mog Manjesh. G.N Aswathy Chandrakumar
12.	2.	Carbon cycling, sequestration and nutrient dynamics in cashew orchards [10/2020-09/2024] **PIMS Number: IXX16199**	Shamsudheen Mangalassery	Babli Mog K. Manjunatha Bhagya. H.P.

		Priority area V: Physiological and basic studies (Leader: Dr. Babli Mog)		
13.	3.	In-vitro pollen germination and pollen tube growth of cashew varieties in response to high temperature stress [05/2019 – 04/2024] **PIMS Number: IXX15130**	Babli Mog	Eradasappa, E. Veena. G.L. V. Thondaiman Manjesh. G.N Ramesh.S.V. (CPCRI, Kasaragod)
14.	4.	Physiological and biochemical basis of salinity tolerance in cashew rootstocks [09/2021-08/2026] **PIMS Number: IXX16223**	Babli Mog	Shamsudheen M Manjesh. G.N. Veena. G.L. V. Thondaiman Bhagya. H.P. Ramesh.S.V. (CPCRI, Kasaragod)
		Priority area VI: Horticulture production technologies (Leader: Dr. J.D. Adiga)		
15.	5	Effect of growth regulator in combination with flower and fruit-set enhancing chemicals on cashew (*Anacardium occidentale* L.) [10/2020-09/2024] **PIMS Number: IXX16215**	V. Thondaiman	K. Vanitha Babli Mog Veena. G.L. Bhagya. H.P.
16.	6	Development of cashew (*Anacardium occidentale* L.) based cropping system for west coastal region [10/2020-09/2025] **PIMS Number: IXX16363**	V. Thondaiman	Shamsudheen Mangalassery K. Vanitha Babli Mog H. Rajashekhara
17.	7	Design, development and performance evaluation of Cashew fruit and nut separator [10/2020-09/2024] **PIMS Number: IXX15634**	Manjunatha. K	D. Balasubramanian Ravindra Naik
18.	8	Design and development of gadgets for cashew fruit harvesting and collection [10/2020-09/2024] **PIMS Number: IXX15635**	Manjunatha. K	D. Balasubramanian Ravindra Naik J.D. Adiga
19.	9	Influence of weather parameters on growth dynamics of apple and nut in selected varieties of Cashew [09/2021-08/2024] **PIMS Number: IXX16942**	Manjesh, G. N.	Babli Mog K. Vanitha Siddanna Savadi Bhagya. H.P.

20.	10	Effect of inter-stocks in Cashew (*Anacardium occidentale*) [09/2021-08/2024] **PIMS Number: IXX16474**	H.P. Bhagya	V. Thondaiman J.D. Adiga Veena. G.L. Manjesh. G.N. Babli Mog
21.	11	Biochemical and mineral composition studies in relation to phenology of fruit development and maturity in cashew [09/2021-08/2023] **PIMS Number: IXX16364**	Veena. G.L.	V. Thondaiman Shamsudheen M Manjesh. G.N Bhagya. H.P.
22.	12	Studies on training and pruning in cashew for better canopy management [08/2023 – 08/2029]	Bhagya. H.P.	J.D. Adiga Shamsudheen M Thondaiman, V Veena, G.L. Manjesh, G.N. Babli Mog
23.	13	***Externally Funded Project:*** Demonstration of drone technology, Funded by DA&FW, GoI, Rs.35.0 lakhs [24-06-2022 to 31-03-2023 **PIMS Number: OXX5457**	Manjunatha. K	T.N. Raviprasad J.D. Adiga Shamsudheen M Siddanna Savadi Aswathy Chandrakumar Manjesh. G.N.
24.	14	***Externally Funded Project:*** Mechanization of pesticide and nutrient sprays in cashew orchards through drones, Funded by: RKVY-RAFTAAR, Budget Rs. 83 lakhs [2021-22 to 2023-24]; **PIMS Number: OXX5543**	Manjunatha. K	Vanitha. K Shamsudheen Mangalassery
25.	15	***Externally Funded Project:*** Establishment of centre of excellence for profiling of bioactive components in cashew apple and nut, Funded by: RKVY-RAFTAAR, Budget Rs. 95 lakhs; [2021-22 to 2022-23], **PIMS Number: OXX5544**	Veena. G.L.	Shamsudheen Mangalassery Siddanna Savadi

		CROP PROTECTION **Priority area VIII: Integrated management of pests and diseases & ecosystem services in cashew** **(Leader: Dr. T.N. Raviprasad)**		
26.	1	Cashew tea mosquito bug interactions and the defensive responses [05/2019 – 04/2024] **PIMS Number: IXX14975**	K. Vanitha	T.N. Raviprasad V. Thondaiman Shamsudheen Mangalassery Veena. G.L.
27.	2	Characterization and synthesis of female sex pheromone of Tea Mosquito Bug; (*Helopeltis antonii*) and its bioassay [10/2020-09/2025] **PIMS Number: IXX16224**	T N Raviprasad	K. Vanitha K. Subaharan (ICAR-NBAIR)
28.	3	Influence of *Apis cerana indica* and *Braunsapis* spp. on pollination and fruit set of cashew [05/2019 – 10/2023] **PIMS Number: IXX14974**	K. Vanitha	Veena. G.L
29.	4	Assessing the field effectiveness of entomopathogenic nematodes (EPN) and indigenous strain of entomopathogenic fungus (EPF) in management of cashew stem and root borers (*Plocaederus ferrugineus* and *Plocaederus obesus*) [09/2021-08/2026] **PIMS Number: IXX16225**	T.N. Raviprasad,	K.Vanitha Rajkumar (ICAR-CPCRI) *
30.	5	Survey and diagnosis of diseases occurring in cashew crop and their morphological and molecular characterization [09/2021-08/2024] **PIMS Number: IXX17045**	H. Rajashekara	T N Raviprasad Siddanna Savadi RTP Pandian (ICAR-CPCRI, RS, Vittal)*
31.	6	Species complex of thrips infesting cashew, their role and management measures [09/2022-09/2025] **PIMS Number: IXX17067**	K. Vanitha	T.N. Raviprasad Rachana, R (ICAR-NBAIR)* Rajashekara, H Mohana, G.S.

32.	7	***Externally Funded Project*:** Establishment of farmer-centric pest diagnostic and bio-control laboratory to achieve sustainable cashew health management, (KA/RKVY-AGRE/ 2022/1345) Funded by: RKVY-RAFTAAR, Budget Rs.100 lakhs; [2022-23 to 2023-24] **PIMS Number: OXX5545**	H. Rajashekara	T.N. Raiprasad K. Vanitha Siddanna Savadi
		POST HARVEST TECHNOLOGY		
		Priority area VIII: Post-Harvest Technology (Leader: Dr. D. Balasubramanian)		
33.	1	Studying comparative performance of cashewnut processing systems in India [10/2017-09/2023] IXX13902 IXX13683	D. Balasubramanian	-
34.	2	Development of value-added products from cashew apple and sprouts [06/2018-05/2024] **PIMS Number: IXX14346**	Veena. G.L.	Shamsudheen Mangalassery Jyoti Nishad
35.	3	Optimizing processing parameters in cashew for enhancing whole kernel recovery [09/2022-09/2025] **PIMS Number: IXX17068**	D. Balasubramanian	-
36.	4	Development of ready to eat alternate snack food using cashew apple - extrusion and vacuum frying approach [09/2021-08/2024] **PIMS Number: IXX17069**	D. Balasubramanian	M R Manikandan (ICAR-CPCRI)
37.	5	Development of probiotic food products from cashew apple [09/2021-08/2024] **PIMS Number: IXX16226**	Veena. G.L.	H. Rajashekara Manjesh. G.N. Jyoti Nishad K. Renjitha (ICAR-IIHR)*
38.	6	Phytochemical characterization of cashew (leaf and apple) nutraceuticals for its utilization in development of functional food [09/2021-08/2025] **PIMS Number: IXX16286**	Manjesh. G.N.	Veena. G.L. Bhagya. H.P. Jyoti Nishad Shabbir A (ICAR-NRCG)* Rajkumar. A.D, (ICAR-DOGR)*

39.	7	Enhancing the shelf life of cashew apple to increase the market potential Duration: 3 years [08/2023-08/2026]	Jyoti Nishad	D. Balasubramanian
		TRANSFER OF TECHNOLOGY **Priority area IX: Transfer of technology and knowledge management (Leader: Dr. Aswathy Chandrakumar)**		
40.	1	Knowledge management and technology transfer in cashew [09/2021-Long term] **PIMS Number: IXX17070**	Aswathy Chandrakumar	T N Raviprasad Mohana G S Manjesh. G.N Bhagya. H.P
41.	2	Socio-economic and innovation system analysis in Cashew sector [09/2021-Long term] **PIMS Number: IXX17071**	Aswathy Chandrakumar	D. Balasubramanian Eradasappa E V Thondaiman C Thamban, (ICAR-CPCRI) Jayasekhar S, (ICAR-CPCRI)
42.	3	***Externally Funded Project:*** Utilization of cashew apple for new products and entrepreneurship development of rural women and youth in Karnataka for mitigating the effect of COVID-19 Funded by: RKVY-FAFTAAR, Government of Karnatak Budget: Rs. 57.0 lakhs [04/2020 to 03/2024] **PIMS Number: OXX5068**	Veena. G.L.	Shamsudheen Mangalassery Aswathy Chandrakumar
43.	4	Externally Funded Project: Improving area, production and productivity of cashew in Shivamogga and Chitradurga districts in Karnataka Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 36 lakhs [04/2020 to 03/2024] **PIMS Number: OXX5458**	Mohana, G.S.	E. Eradasappa

44.	5	***Externally Funded Project:*** Development of an AI-based app for identification of pests and diseases in cashew, Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 16 lakhs [04/2020 to 03/2024] **PIMS Number: OXX5459**	Mohana, G.S.	K. Vanitha Shamsudheen Mangalassery H Rajashekara
45.	6	***Externally Funded Project:*** Front line demonstration of newly developed cashew varieties of ICAR-DCR Puttur, funded by DCCD, Kochi Budget: Rs. 10.0 lakhs [20-06-2023 to 31-03-2024]	E. Eradasappa	Aswathy Chanda Kumar Mohana. G.S. J.D. Adiga

List of projects concluded in 36th IRC

Continuous No.	Title, duration, Number	Project workers	Level and Duration of involvement
1.	Design and development of mechanized slicer for cashew apple [10/2014 – 06/2023] PIMS Number: IXX11563	D. Balasubramanian (PI) Ravindra Naik (ICAR-CIAE)	10/2014 09/2017 Approved by the Director & MoU signed
2.	Design and development of moisture meter for raw cashewnuts [07/2018-06/2023] PIMS Number: IXX13901 IXX13682	D. Balasubramanian (PI) Sri. Sreejith (M/s EMCON, Kerala)	07/2018 18-09-2018 MoU signed

12. Consultancy, Patents and Commercialization of Technology

12.1 Commercialization of ICAR-DCR technologies:

- Memorandum of Understanding (MoU) was signed with Shri Chandra Tavarappa Nayak, Gadag for licensing the production and sale of Cashew apple fruit bar and Cashew apple Jam on 05th December, 2023 for period of three years.
- Memorandum of Understanding (MoU) was signed with Shri Narayan Roop Singh Lamani, Gadag for licensing the production and sale of Cashew apple jelly and Cashew apple pomace powder cookies on 05th December, 2023 for period of three years.
- Memorandum of Understanding (MoU) was signed Shri Praveen Nayak, Gadag for licensing the production and sale of Cashew apple fruit bar and Cashew apple pomace powder cookies on 05th December, 2023 for period of three years.

12.2 Copyrights/Patent/Plant Variety registration: ITMU facilitated the following copyrights, patent, and plant variety registration processes.

- ICAR-DCR filed application for registration of Nethra Ubhay (NRC 175): Cashew hybrid with registered no. Reg/2023/0125 on 05/10/2023.
- Patent number 359214 was renewed on 13th January 2023 with application number 3483/CHE/2013.
- A total of 3 copyrights were granted by Copyrights office, Govt. of India to ICAR-DCR, Puttur during the year.

I. Soil health card generator [135/2022-CO/SW] on 26/06/2023.

II. Cashew leaf diagnosis [8066/2022-CO/SW] on 05/07/2023.

III. Cashew diseases and their management [8060/2022-CO/SW] on 23/11/2023.

- A total of 6 copyrights including two computer applications and four videos were filed with Copyrights office, Govt. of India.

I. Cashew Microsatellites Database (CMDB)[29766/2023-CO/SW] filed on 09/11/2023.

II. Cashew Single Nucleotide Polymorphisms Database (CSNPDB)[29769/2023-CO/SW] filed on 09/11/2023.

III. Video copyright on High density and ultra-high-density planting in cashew (English) [34949/2023-CO/CF] filed on 27/12/2023.

IV. Video copyright on Gerumaragalige aakara needuvike matthu savaruvike (Kannada) [34947/2023-CO/CF] filed on 27/12/2023.

V. Video copyright on Training and pruning in cashew (English) [34952/CO/CF] filed on 27/12/2023.

VI. Video on Gerinalli Sandra besaya hagu athisandra besaya (Kannada) [34876/CO/CF] filed on 27/12/2023.

13. RAC/ IRC/ IMC/ IJSC MEETINGS

13.1 Research Advisory Committee (RAC)

The ninth Research Advisory Committee (27th RAC) of ICAR-DCR, Puttur was held during 7 and 8 June, 2023 at ICAR-DCR, Puttur on hybrid mode under the Chairmanship of Dr. N. K. Krishna Kumar, Former-DDG (Hort. Sci.), ICAR. Dr. J. D. Adiga, Director, ICAR - DCR, Puttur welcomed the Chairman, members of RAC and the scientists of ICAR - DCR. In his opening remarks, Dr. N. K. Krishna Kumar, the Chairman and the members of the RAC commented on research progress and the expectations of the members. After the brief introductory remarks by the Chairman and the members, action taken report on the recommendations of 2nd meeting of the 9th RAC was presented by Dr. K. Vanitha, Member Secretary (9th RAC). This was followed by the presentations on the research progress of the ongoing research projects by the scientists of ICAR-DCR. There were 48 research projects including eight externally funded projects under nine mega projects. On 7th June, 2023 presentations under crop improvement and crop management & farm machinery were completed. On 8th June, 2023 research progress under crop protection, post-harvest technology and transfer of technology sections was presented. There were critical observations by the RAC on the research results and the recommendations were finalized after detailed deliberations. The RAC strongly recommended to take up the studies on influence of micronutrients on flowering, yield and quality of cashew; research interventions to enhance productivity of cashew including pheromone-based pest management, and also impact analysis of ICAR-DCR technologies. The meeting ended with the concluding remarks by the RAC Chairman and the members.

13.2 Institute Research Committee (IRC)

The meeting of the 36th Institute Research Committee (IRC) was held during 9-10, August 2023 under the Chairmanship of Dr. J.D. Adiga, Director, ICAR-DCR, Puttur in hybrid mode at Videoconference hall of Silver Jubilee Building, DCR, Puttur and through Zoom platform. Dr. Shamsudheen M, Member Secretary, IRC welcomed the Chairman, members of IRC and the resource persons. In a brief address, the Chairman, IRC, Dr. J.D. Adiga welcomed the scientists and appreciated the efforts of the scientists. The scientists presented the achievements made under various ongoing projects and presented some new project proposals also. The summary of projects presented in IRC and approvals are given below.

Division	Ongoing institute projects presented	Ongoing external projects presented	Ongoing activity presented	New projects approved	New activity approved	Project concluded in 36th IRC	External projects concluded	Total institute projects approved for 2023-24 = (a+d)=f	Activity concluded	Total activity for FY 2023-24 = (c+e) = i	Total External projects 2023-24 (b-
	a	b	c	d	e	f	g	h	i	j	k
Crop Improvement	9	1	-	-	2	-	-	9	-	2	3
Crop Management	11	3	1	1	3	-	-	12	-	4	3
Crop Protection	6	1	1	-	-	-	-	6	-	1	1
Post Harvest Technology / Food											
Technlogy	8	-	1	1	1	2	-	7	-	2	-
Transfer of Technology	2	4	-	-	-	-	-	2	-	-	4
Total	**36**	**9**	**3**	**2**	**6**	**2**		**36**	**-**	**9**	**9**

13.3 Institute Management Committee (IMC) Meeting

The 52th meeting of the IMC was held on 22nd November 2023 under the Chairmanship of Dr. J. Dinakara Adiga, Director, ICAR-DCR, Puttur. The Chairman informed the members about research and achievements of the Directorate. Various administrative and financial matters were discussed and finalized. Director Dept. of Horticulture Govt, of Karnataka, Lalbagh, Banglore, Karnataka; Director Dept. of Agricultural Development and Farmers Welfare Government of Kerala, Vikas Bhavan, Thiruvananthapuram - 33; Vice-Chancellor, Keladi Shivappa Nayak , University of Agricultural & Horticultural Sciences Iruvakki, Sagar Taluk, Shivamogga - 574 412 Karnataka; Dr. V B Patel, ADG, Fruit & Plantation Crops, ICAR, New Delhi; Dr. M K Rajesh, Head, ICAR-CPCRI, Regional Station, Vittal – 574 243, Karnataka; Dr. Arun Kumar Sit, Principal Scientist & Scientist-in-charge, ICAR-CPCRI. Research Centre, Mohitanagar, West Bengal; Dr. D K Singh, Professor & Principal Scientist, Division of Agricultural Engineering, IARI, New Delhi – 110 001; Dr. Om Prakash Awasthi Head, Divn. of Fruits & Horticulture Technology IIAR, New Delhi; Mr. Ram Avtar Parashar, Chief Finance & Accounts Officer/ICAR-CPCRI, Kasaragod, Kerala; Mr. K K Sasi, Asst. Finance & Accounts Officer, ICAR-DCR, Puttur; Mr. K R Nithianandan, Administrative Officer, ICAR-DCR, Puttur, attended the meeting.

13.4 Institute Joint Staff Council (IJSC)

The XI IJSC meeting was held on 29.08.2023 under the chairmanship of Dr. J. Dinakara Adiga, Director, ICAR-DCR, Puttur. The following members were present in the meeting:

1	**Dr. J. D. Adiga, Director**	**Chairman**
2	Dr. Mohana G. S.	Member, official side
3	Shri. Muralikrishna K.	Member, official side
4	Shri. Sasi K. K.	Member, official side
5	Smt. Leela M.	Secretary, Staff side
6	Smt. Reshma K	Member, Staff side
7	Ms. Winnie Lobo	Secretary, Staff Side
8	Shri. Bojappa Gowda	Member, Staff side
9	Shri. Vijaya Achary	Member, Staff side
10	Shri. T Padmanabha	Member, Staff side

14. PROGRAMMES, WORKSHOPS, SEMINARS, TRAINING, FARMERS DAYS AND OTHER RELEVANT EVENTS ORGANISED

14.1 Programmes

International Women's Day, 2023

International Women's Day programme was organized on 8th March, 2023 at ICAR-DCR, Puttur. Mrs. Reshma, K., PS to Director, welcomed the Director, chief guest and the staff of ICAR-DCR for the programme. Mrs. Annapoorna Sharma, an entrepreneur, Poorna Enterprises, Aryapu, Puttur, who was the chief guest of the programme delivered a talk on 'Gender Quality in entrepreneurship'. She mentioned that women are more powerful, multitasking and they deserve respect. Dr. K. Vanitha, Senior Scientist and Chairperson of Women Cell of the Directorate made a presentation on 'Women work force in India – Challenges and Initiatives' during the occasion. Dr. J.D. Adiga, Director, ICAR-DCR presided over the function and expressed his wishes on International Women's Day - 2023. Then, there were cultural activities like singing and quiz for the staff. The programme ended with national anthem. Dr. Veena, G.L. was the moderator of the programme and Dr. Babli Mog proposed vote of thanks.

International Yoga Day celebration at ICAR-DCR, Puttur

Celebration of International Yoga Day has been a pride practice in the directorate since 2014. Even this year, for the benefit of the staff members 'Yoga Day' was celebrated on 21st June, 2023. A program was arranged to mark the occasion. Dr. Udayakumar, Department of Yogic Science, Mangalore University was the Chief Guest of the function.

Dr. D. Balasubramanian, Prin. Scientist and Director in Charge of the day wished the staff members a happy and healthy life. He recollected that Yoga was one of the finest contributions India had given to the whole world and felt that it should become a part of our daily life to keep us healthy and lively.

Dr. Udaykumar, the Yoga teacher tried to explain to the members the importance of Yoga as science and its importance in leading a stress-free life. He said, it is not important just to perform some acrobatic physical exercises in the name of Yogasana, but it is important to understand the science behind such movements and their minute effect on the body. It was emphasized that proper way of breathing and its synchronization with the Asana that we perform were very important. It was also told how regular practice of Yoga and Pranayama would help us to reduce the mental stress we come across our daily life. The importance of healthy food was

also discussed. Saff members also practiced some of the basic Yogasanas like Surya namaskar under the guidance of Dr Udaykumar on the occasion. The Chief Guest was honored for his contributions in popularizing Yoga and meaningful way of healthy living.

Annual Cashew Day

The Annual Cashew Day – 2023 was organized at ICAR-Directorate of Cashew Research, Puttur on 10.03.2023 (Friday). The programme commenced with ICAR Song followed by the welcome address by Dr. Bhagya, H P, Scientist (SP&MAP). The one of the guests of honor of the event Dr. K.B Hebbar, Director, ICAR-CPCRI, Kasaragod, Kerala addressed the gathering by mentioning importance of cashew crop and its suitability in growing marginal lands and highlighted the technologies and products which are developed by the ICAR- DCR, Puttur. The other guest of honor of the event Dr. T.J. Ramesh, Senior Scientist and Head, ICAR-KVK, Mangalore, Karnataka spoke about the adoption of new technologies in cashew and trainings available for cashew cultivation. In the course of event, the cashew variety Nethra Ubhaya (Dual purpose variety) was released and dedicated to the cashew farmers. Besides, Cashew Protect app was released and the training manual on "Raw Cashew Nut Processing and Value-added products of Cashew Apple", extension folders on "Cultivation of Cashew" in Kannada and English and Cashew Protect app were released for the cashew stakeholders. The chief guest of the event Shri. Gurunatha R Odugoudar, President, Gadag District Cashew Growers Association, Gadag, Karnataka addressed the event by emphasizing the marketing and value addition of cashew for doubling the farmers' income. During this programme, two progressive farmers (Shri. Vishwa Keshava Kuruveri and Shri Venkatesh Nanditale) were felicitated for their outstanding achievements and contributions in cashew cultivation, processing and nursery management. The Cashew Day – 2023 was presided by Dr. J. Dinakara Adiga, Director, ICAR-DCR, Puttur and the presidential address was given by him. In his presidential speech, he highlighted the contributions of the ICAR-DCR, Puttur in the field of cashew cultivation, processing, value addition and extension activities. During the event, the seed kits

and brush cutter were distributed to the identified SCSP beneficiaries under the SCSP scheme. A total of 205 farmers had participated in this programme. At the end of the event, Dr. Manjesh, G.N. proposed the formal vote of thanks. In relation to this event, an exhibition stall was arranged by displaying

cultivation technologies and products of cashew nut and apple which was inaugurated by the chief guest and guests of honour. Further, field visit was arranged for the benefit of the farmers.

World Intellectual Property (IP) day celebration at ICAR-DCR, Puttur

World Intellectual Property (IP) day was jointly organized Agribusiness Incubation (ABI) centre and Institute Technology Management Unit (ITMU) of ICAR-DCR, Puttur on 26th April 2023. On the occasion, Smt. Chandravathy T., Advocate, Civil Court, Puttur was invited as the speaker to deliver talk on the theme Women in IP: Accelerating innovations and creativity. In the beginning, Dr. D. Balasubramanian, Principal Scientist (PHT) & PI (ABI), ICAR-DCR, Puttur delivered the welcome

speech and highlighted the importance of IP with illuminating examples. Dr. Manjunatha K., Scientist (FM&P) introduced the chief guest to the audience. Then Chief Guest delivered her talk the topic and emphasized on the IP role and woman contribution in the IP arena. Dr. Raviprasad TN., Director (i/c), ICAR-DCR, Puttur gave the presidential remarks after the guest speakers talk and shared his opinion on the IPs and women role. At the end of the programme, vote of thanks was proposed by Dr. Siddanna Savadi, Scientist (Biotechnology) & PI (ITMU), ICAR-DCR, Puttur.

Foundation day celebration at DCR, Puttur

Foundation Day celebration 19th June 2023 at ICAR-DCR, Puttur ICAR- Directorate of Cashew Research celebrated its Foundation Day, marking the occasion with several new initiatives. The Foundation Day program was inaugurated by Mr. Girish Nandan, M, Assistant Commissioner, Puttur and Shri. Shree Padre, Editor, Adike Patrike. Dr. V. B. Patel, ADG (Fruits and Plantation Crops), ICAR, New Delhi was the guest of honor of the day who attended the program online. The program was presided by Dr. J. D. Adiga, Director, ICAR-DCR, Puttur. Inaugurating the foundation day, Mr. Girish Nandan observed that this Directorate has developed several research technologies and varieties for the betterment of farming communities, especially the cashew farmers. He appreciated this Directorate for their efforts and urged them to take up more extension-oriented actives including field demonstration of DCR technologies at the farmer's field in order to educate them about cashew production technologies. He also highlighted about increased domestic cashew nut consumption in recent years which necessitates the enhancement of product and in turn holds huge potential for area expansion for yield enhancement. The foundation day lecture was delivered by Shri. Shree Padre on the topic 'Assumptions and realities in Agriculture'. Dr. V. B. Patel also addressed the gathering virtually with a brief introduction on cashew research in India, contributions of former directors of DCR in bringing significant changes in research, infrastructure development of cashew etc. He also stressed about increasing the production and productivity of cashew nut to reduce dependence on import of raw nuts from other countries. In a new initiate aimed at encouraging DCR scientists in research, this Directorate conferred DCR best publication award to Dr. Siddanna Savadi, Scientist (Plant Biotechnology) for his research work on 'De novo transcriptome assembly and its utility in development and characterization of the first set of genic SSR markers in Cashew'. Various extension folders on 'Nutrient deficiency in Cashew: symptoms and management', 'Nethra Ubhaya: A dual purpose cashew variety' and 'Inflorescence pests of Cashew' were also released. More than 150 participants including former directors of the institute, staff

members, farmers and representatives from various institutions took part in the program.

Awareness programme to MGMG village farmers

Distribution of vegetable seed kit to MGMG village farmers of mottetadka village on 11.08.2023 to 15 farmers and awareness programme conducted about the importance of vegetable garden and nutritive value of vegetables and how it helps in improving health conditions. These farmers were very happy with this awareness programme.

Vigilance Awareness Week

ICAR-Directorate of Cashew Research, Puttur celebrated the Vigilance Awareness Week - 2023. A week-long programme was conducted by the Directorate from 31st October 2023 to 6th November 2023. The Vigilance Awareness week was started by taking the integrity pledge by staff members and general public on 31st October 2023. The week-long activities during the period were intended to create awareness about the transparency, accountability and corruption free governance, among the staff members and the civil society. Various internal housekeeping activities were attended by different sections. Awareness posters on PIDPI was also displayed during the vigilance awareness week programme.

The valedictory function was held at the main conference hall of the Directorate on 07-11-2023. Dr. Shamsudheen. M, Senior Scientist & Vigilance Officer, ICAR-DCR, Puttur welcomed the gathering. The programme was inaugurated by all the dignitaries by lighting the lamp. The programme was presided over by introductory remarks of Dr. J. Dinakara Adiga, Director of the Directorate. He highlighted that it is the duty of citizen to not to give opportunity for corrupt people. Smt. Archana K. Unnithan., Principal Civil Judge Puttur, addressed the gathering by mentioning that small changes in our daily life and discipline can help to curb the corruption and leads to corruption free tomorrow. Sri. Shyam Prasad Kailar, Advocate and Treasurer, Bar Association, Puttur also talked on the occasion and he indicated that employment generation will minimize the corruption. He also indicated that, the students and youth should be motivated to give importance for being honest right from the beginning.

The resource person, Adv. Nanda Kishore, Puttur, delivered a special talk on the theme "Say No to Corruption; Commit to the Nation". He narrated in detail how the corruption comes, different forms of corruption, consequences of corruption and how it can be curbed at system level.

The programme was concluded with vote of thanks by Dr. Veena. G.L., Scientist (Fruit Science), ICAR-DCR, Puttur. The programme was organised jointly by ICAR-DCR, Puttur, Legal Cell, Puttur and Bar Association, Puttur. The programme was attended by 120 members including the students from Sandeepani School.

Sl. No.	Programme details	Date	Male	Female	Total
1	Valedictory function of Vigilance Awareness Week 2023	06-11-2023	80	40	120

World Soil Day celebrations

Every year World Soil Day is celebrated on 5th December, 2023 advocating the importance of healthy soils and the need for sustainable management of soil resources. The theme for this year is "Soils and water: A Source of life". As a part of the World Soil Day celebrations at the Directorate, an awareness training and demonstration on soil health management was organized. During the programme, Dr. Shamsudheen. M, Senior Scientist (Soil Science) and Coordinator explained about the importance of soil and water management and highlighted the significance of celebrating the World Soil Day. Dr. Veena. G.L., Scientist (Fruit Science) and convenor explained about the nutrient management in cashew. This was followed a field visit and demonstration on soil sampling.

Kisan Diwas

Kisan Diwas was celebrated at ICAR-Directorate of Cashew Research Puttur on 23/12/2023, for the cashew farmers. The programme commenced with ICAR Song followed by the welcome address by Dr. Veena G.L, Scientist (Fruit Science). The presidential address was delivered by Dr. J. Dinakara Adiga, Director, ICAR-DCR, Puttur. In his speech, he narrated about the objective of conducting Kisan Diwas and briefed about ICAR-DCR's achievements and schemes for the benefit of the cashew farmers. Dr. Manjunatha K, Scientist (Farm Machinery), ICAR-Directorate of Cashew Research oriented the farmers towards cashew farming. He gave a detailed demonstration on tractor operated spraying of micronutrients and pesticides in cashew orchards. The farmers were also given exposure to cashew production technologies viz., information on newly released cashew varieties, grafting technique, management of tea mosquito bug, processing of Cashew nut and apple etc. Following the training session, as a part of the Kisan Diwas celebration, DCR publication kits both in English and Kannada were distributed to the farmers of Bettampady and Mottethdka villages at the end of the event.

Swacchata Pakhwada

The ICAR- Directorate of Cashew Research, Puttur, Karnataka observed "Swacchata Pakhwada" from 16.12.2023 to 31.12.2023 by conducting various day-wise activities as per the guidelines received from the Government of India. The Inauguration and Pledge Taking Ceremony of Swacchata Pakhwada marked a pivotal moment on December 16, 2023, as every staff member enthusiastically participated in this initiative. The event was inaugurated with great zeal with the aim of fostering cleanliness and hygiene. Various activities were planned to kickstart the Pakhwada. Notable among these were the prominent display of banners at key locations, serving as a visual reminder to uphold the spirit of cleanliness across the premises. Planting of trees was also taken up in our institute premise. This served as a guiding compass for the upcoming events, ensuring a structured and impactful series of cleanliness-oriented programs. The series of activities include cleaning of Office building and Residential campus, talk on waste management, recycling of waste water, debate on Swacchata, celebration of Kisan Diwas, quiz competition among DCR staff to create awareness on Swacchata and VIP address on Swacchata.

14.2 FRONTLINE DEMONSTRATIONS

Drone Demonstration

Conducted fifteen Drone technology demonstrations for spraying of agricultural chemicals/micro nutrients/organic pesticide under the scheme "Drone Technology Demonstration (DTD)" funded by Central Sector Scheme of Dept. of Agriculture & Farmers Welfare, implemented through ATARI (Sub Mission on Agricultural Mechanization) with aim to create awareness about Drone applications in agriculture among the farmers, extension workers and other stakeholders.

A team of scientists involved in Drone technology demonstration are Dr. Manjunatha K., Scientist (Farm Machinery & Power) & PI of the project; Dr. T.N. Raviprasad, Principal Scientist (Agrl. Entomology); Dr. J Dinakara Adiga, Principal Scientist (Horticulture); Dr. Siddanna Savadi, Scientist (Biotechnology) and Dr. Aswathy Chandrakumar, Scientist (Agrl. Extension).

Details of demonstrations

Sl. No.	Date	Place	No. of Demo.	Area covered (acres)	Crop	No of participants	Coordinator	Co-coordinator
1.	16.10.2023	Neechadi and Hosabale, Shivamogga (D)	5	10	Cashew	127	Dr. Manjunatha K,	Dr. T.N. Raviprasad Dr. Mohan, G.S.
2.	17.10.2023	Dombe and Shadthikere, Shivamogga (D)	5	9	Cashew	74	Dr. Manjunatha K,	Dr. T.N. Raviprasad Dr. Mohan, G.S.
3.	18.10.2023	Talavata and Chandragutti, Shivamogga (D)	5	12	Cashew	75	Dr. Manjunatha K,	Dr. T.N. Raviprasad Dr. Mohan, G.S.

On the occasion of Gramotsava held in Balpa, demonstrated drone technology to the farmers by ICAR-Directorate of Cashew Research, Puttur on 10.01.2024. Balpa village is adopted by Shri Nalin Kumar Kateel, Member of Parliament under the Sansad Grama Yojana scheme.

14.3 Trainings/ Workshops

ICAR sponsored Short Course on Improved Crop Production Technologies organized at ICAR-DCR, Puttur

The ICAR-Directorate of Cashew Research, Puttur, Karnataka organized a ICAR sponsored short course on "Improved Crop Production Technologies in Cashew with Major Emphasis on Integrated Pest Management" from 13 – 20th February, 2023.

A total of 19 participants from different research institutes/universities and KVKs from different parts of the country have participated in the short course. The short course covered important aspects on cashew IPM and included all the aspects of cashew production starting from nursery management to post harvest processing and value addition in detail with practical demonstrations and exposure visits during the program. The presentations comprised both inhouse and eminent guest speakers from other ICAR institutes on various aspects of cashew production technology. (Course director: Dr. T. N. Raviprasad; Course Coordinators: Drs. Vanitha K and Rajashekara H).

Five days training program on Cashewnut processing and value addition of cashew apples

The ICAR-Directorate of Cashew Research, Puttur conducted 5-days Training Programme on "Raw Cashewnut processing and value-added products of cashew apple" from 6th to 10th February 2023. This training programme was for the farmers and officials from the state of Meghalaya, sponsored by the Meghalaya Basin Management Agency. Dr. J. Dinakara Adiga, Director inaugurated the programme and he addressed the research as well as technology adoption gaps. Mr. Saurabh Bose, Senior Manager, Megha-LAMP Project, Meghalaya explained the activities of Meghalaya Livelihoods Access to Market Project funded by International Fund for Agricultural Development and Govt. of Meghalaya, being implemented by the Meghalaya Basin Management Agency (MBMA). The Training Coordinator, Dr. D. Balasubramanian briefed the whole training programme content and said the training has been designed to equip the participants about the latest technological developments in raw Cashewnut processing and value addition of cashew apple. The training course consisted of class room lectures, hands on experience, visits to experimental fields, farmers' fields and processing factories. (Training Coordinator: Dr. D. Balasubramanian; Conveners: Drs. Thondaiman and Veena G. L.)

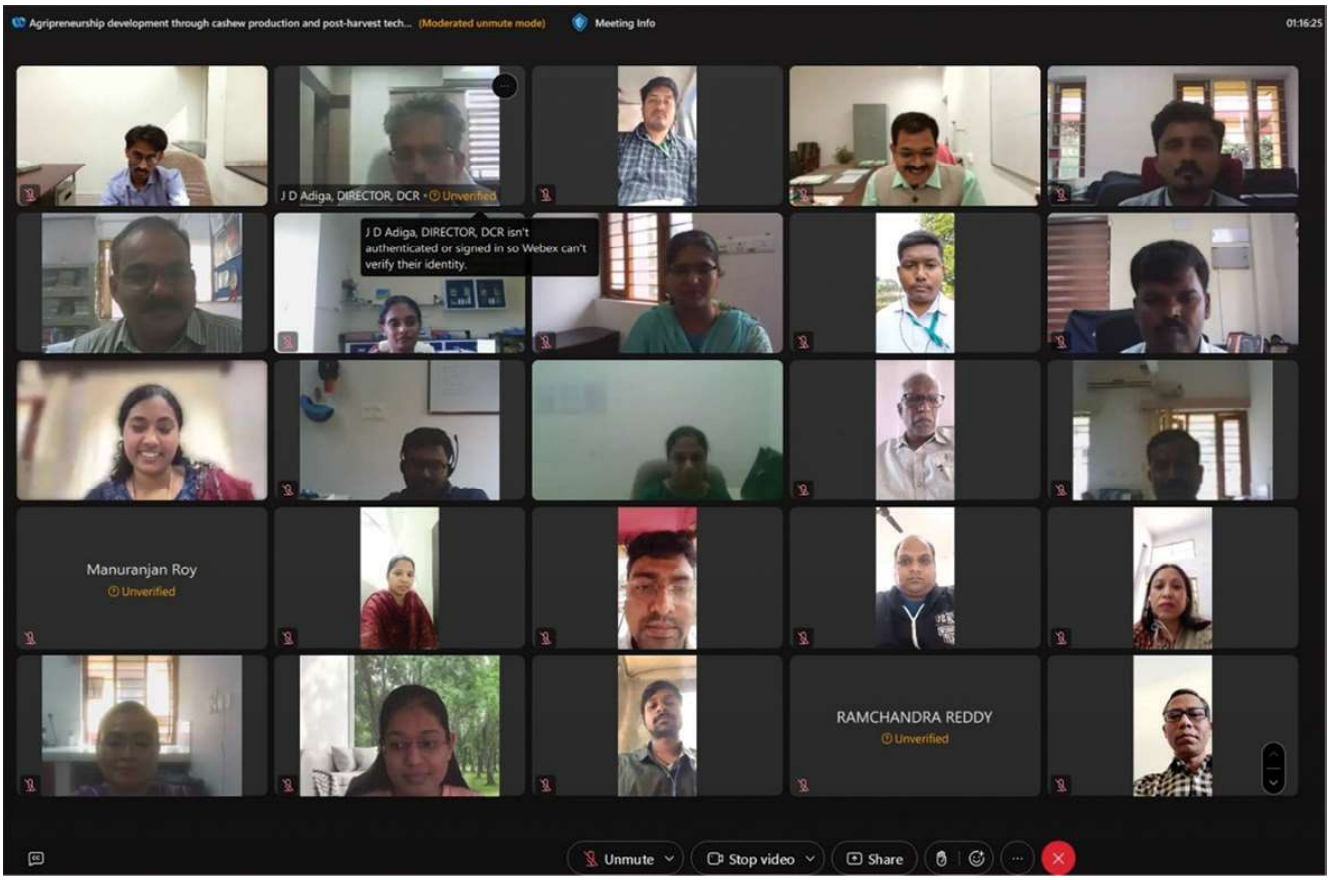
Three days trainings program conducted for incubatees under ABIC, ICAR-DCR, Puttur as detailed below:

Three days training program conducted for incubatees under ABIC, ICAR-DCR, Puttur as detailed below (6 Nos.). (Training Coordinator: Dr. D. Balasubramanian).

Sl. No	Name of the trainee / incubatees	Place	Incubation period
1	Ganapathy Annamathesi	Tamil Nadu	19-21 April, 2023
2	Ankur Agrawal	Uttar Pradesh	19-21 April, 2023
3	Ashwath Hebbar	Karnataka	5-7 July, 2023
4	Prakash P	Karnataka	25-27 September, 2023
5	B. Narendra Baliga	Karnataka	25-27 September, 2023
6	Sumana K	Karnataka	22-24 November 2023

Online Training programme on "Agripreneurship Development through Cashew Production and Post harvest technologies" concludes at ICAR-Directorate of Cashew Research, Puttur

A three days online training programme on "Agripreneurship Development through Cashew Production and Post harvest technologies" was jointly organized by ICAR-Directorate of Cashew Research, Puttur and MANAGE, Hyderabad from 22-24, November, 2023. The training was attended by 47 participants from 16 states and comprised of students, Assistant Professors, scientists, subject matter specialists from KVKs, officials from agriculture departments and entrepreneurs. The technical sessions focused on imparting knowledge on various aspects of cashew production, protection, post-harvest processing, marketing and export and threw light on opportunities of Agripreneurship development in cashew through commercial nursery management, raw cashew nut processing and value addition of cashew apple. The training was useful for the participants as expressed through their feedbacks. (Training Coordinator: Dr. Aswathy C; Conveners: Drs. Bhagya H. P. and Manjunatha K)



One day training on Cashew Processing and Value Addition

Organized one day training on Cashew Processing and Value Addition for Maharashtra farmers conducted at Agri-Business Incubator, ICAR-DCR, Puttur on 28 December, 2023.

15. राजभाषा कार्यान्वयन एवं प्रगति

राजभाषा कार्यान्वयन समिति

1.	डा. जे. दिनक अडिग	निदेशक	अध्यक्ष
2.	श्री. नित्तियानन्दन	प्र. अधिकारी	सदस्य
3.	डा. तोन्डाईमन	(सितंबर 2023 तक)	सदस्य
4.	डा. अश्वती चंद्रकुमार		सदस्य
5.	डा. रघुराम कुक्कडे		सदस्य
6.	श्रीमती रेष्मा के.		सदस्य
7.	श्रीमती लीला एम.		सदस्य
8.	श्री. विजय आचारी		सदस्य
9.	श्री प्रकाश जी. भट्		सदस्य सचिव

राजभाषा विभाग, गृह मंत्रालय और भारतीय कृषि अनुसंधान परिषद की ओर से जारी किए जा रहे राजभाषा कार्यान्वयन संबंधी दिशानिर्देश और भारत सरकार की राजभाषा नीति के अनुपालन के संबंध में राजभाषा विभाग द्वारा निर्धारित वार्षिक कार्यक्रम में उल्लिखित लक्ष्यों की पूर्ति तथा राजभाषा हिंदी के उत्तरोत्तर प्रगति हेतु राजभाषा कार्यान्वयन के सभी पहलुओं पर इस निदेशालय में प्रयास किया जा रहा है। राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद के निर्देश एवं आदेशों के अनुपालन एवं राजभाषा कार्यान्वयन की प्रगति की समीक्षा हेतु इस निदेशालय में निदेशक महोदय की अध्यक्षता में गठित राजभाषा कार्यान्वयन समिति की बैठक नियमित रूप से आयोजित की जा रही है। इस बैठक को हर तिमाही में एक बार आयोजन की जा रही है।

इस समिति में राजभाषा विभाग के वार्षिक कार्यक्रम के अनुसार राजभाषा कार्यान्वयन प्रगति तथा भारतीय कृषि अनुसंधान परिषद के आदेशों के अनुपालन पर चर्चा एवं समीक्षा की जाती है। इस निदेशालय के प्रशासनिक अधिकारी, विभिन्न अनुभागों के छः कर्मचारी इस समिति के सदस्य हैं। प्रत्येक बैठक के कार्यवृत्त की समीक्षा निदेशक (राजभाषा) भारतीय कृषि अनुसंधान परिषद की ओर से की जाती है और तदनुसार अगली बैठक में चर्चा कर निदेशक महोदय की अनुमति से पुष्टि की जाती है।

राजभाषा अधिनियम 1963 धारा 3(3) के अनुपालन का अधिकाधिक प्रयास किया जाता है। तदनुसार निदेशालय की ओर से जारी किए जा रहे प्रपत्रों को द्विभाषीकरण कर नियम का अनुपालन सुनिश्चित किया जाता है। वार्षिक प्रतिवेदनों को पूर्णरूप से हिंदी में भी तैयार कर अधिनियम का अनुपालन किया जा रहा है। राजभाषा के प्रति जागरुकता पैदा कराने हेतु राजभाषा विभाग की ओर से जारी किए गए वार्षिक कार्यक्रम के अनुसार हर साल इस निदेशालय में सितंबर में हिंदी सप्ताह समारोह आयोजन किया जाता है। इस अवसर पर कर्मचारियों के लिए विभिन्न प्रतियोगिताओं जैसे हिंदी निबंध लेखन, प्रारूप, टिप्पण एवं मसौदा लेखन प्रतियोगिता, क्विझ प्रतियोगिता आदी आयोजित की जाती है।

इस वर्ष भी पुत्तूर नगर राजभाषा कार्यान्वयन समिति की दो अर्ध वार्षिक बैठक और चार तिमाहि बैठकों को आयोजन किया गया। इन बैठकों में निदेशालय की हिन्दी गतिविधियों के बारे में विस्तृत रूप से चर्चा किया गया। राजभाषा में कार्यालय के कामकाज करने के बारे में जरूरी कदम उठाने के बारे में और कर्मचारियों को हिन्दी ज्ञान दिलाने के लिए आवश्यक कदम उठाने के बारे में योजना बनाई गई। सितंबर महिने में दिनांक 14–28 तक हिन्दी पखावाडा मनाया गया। पखवाडा के अवर पर विध्यार्थियों और कर्मचारियों के लिए भाषण, निबंध लेखन और सामान्य ज्ञान प्रतियोगिता आदी आयोजन किया गया।

हिन्दी में कार्यालयीन काम करने वाले निदेशालय के कर्मचारियों को नकद पुरस्कार से सम्मान किया गया। निदेशालय के तीन कर्मचारी प्रवीण और पारंगत हिन्दी परीक्षा में उत्तीर्ण हुए है। इस तरह राजभाषा की कार्यन्वयन को बढ़ावा देने के लिए पूरी कोशिश किया गया।

राजभाषा नियम 1976 नियम 11 के अनुपालन हेतु आवश्यक सामग्रियों जैसे प्रपत्र, रबड़ की मोहरें, नाम पट्ट आवश्यकतानुसार द्विभाषी में तैयार कर समय समय पर मार्गनिर्देश दिया जाता है। सम्मेलनों का बैनर एवं निमंत्रण पत्र द्विभाषा में ही प्रदर्शित किया जाता है। हिंदी पत्रों की आवति के लिए प्रत्येक रजिस्टर रखकर राजभाषा नियम 1976 नियम 5 का अनुपालन पूर्ण रूप से शत प्रतिशत किया जाता है।

वेबसाइट का प्रदर्शन :

निदेशालय की वेबसाइट संपूर्ण द्विभाषा में प्रदर्शित किया गया है। राजभाषा से संबंधित सभी गतिविधियों का विवरण वेबसाइट पर दिया जाता है।

हिंदी कार्यशाला

सरकारी काम काज में हिंदी का प्रयोग बढ़ाने एवं हिंदी कार्य का उपयोगी ज्ञान प्राप्त कराने हेतु निदेशालय में कार्यशालाओं को आयोजन किया जा रहा है। इस वर्ष भी अनुभवी मार्गदर्शकों की मार्गदर्शन में मसौदा लेखन, टिप्पणी लेखन, अनुवाद, राजभाषा नियम एवं अधिनियम पर जनवरी में हिंदी कार्यशाला आयोजित की गई और उन्हें अभ्यास भी कराया गया है। उपर्युक्त कार्यशालाओं में निदेशालय के अधिकारियों तथा नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों के अधिकारियों एवं कर्मचारियों को भी उपस्थित होने का सुअवसर प्रदान किया गया।

पुत्तूर नगर राजभाषा कार्यान्वयन समिति

पुत्तूर नगर और आस पास के केन्द्र सरकारी कार्यलयों में राजभाषा हिन्दी का कार्यान्वयन सुनिश्चित करने की दृष्टी से पुत्तूर और विट्टल में स्थित केंद्रीय सरकार के कार्यालय, उपक्रम, बैंक सहित 12 सदस्य कार्यालय सम्मिलित नगर राजभाषा कार्यान्वयन समिति (नराकास) का घटन किया गया है। पुत्तूर नराकास की अर्धवार्षिक बैठक दिनांक 23.1.2023 एवं 26.07.2023 को निदेशक महोदय की अध्यक्षता में आयोजित की गई। बैठक में सदस्य कार्यालयों से राजभाषा कार्यान्वयन से संबंधित अर्धवार्षिक प्रगति रिपोर्ट की समीक्षा की गई । काजू अनुसंधान निदेशालय की ओर से आयोजित हिंदी कार्यशाला और प्रशिक्षण में नराकास के सदस्य कार्यालयों को भी आमंत्रित किया गया और संयुक्त रूप से आयोजन किया गया।

निदेशालय में निम्नलिखित रिपोर्ट हिंदी में प्रकाशित किया गया:

1. निदेशालय का वार्षिक प्रतिवेदन (वर्ष 2022) हिंदी में।
2. अखिल भारतीय समन्वित काजू अनुसंधान परियोजना की वार्षिक प्रतिवेदन सारांश (वर्ष 2022)।
3. अर्ध वार्षिक, पत्रिका 'काजू समाचार' में हिंदी समिती की गतिविधियों के बारे में प्रतिवेदन।
4. दैनंदिन प्रयोग में आने वाले प्रपत्रों का हिंदी रूपान्तरण।

निदेशालय के सभी वैज्ञानिक, अधिकारी एवं कर्मचारी कार्यालयीन काम में राजभाषा हिंदी के कार्यान्वयन के लिए अपनी प्रतिबद्धता दोहराते हैं।

16. DISTINGUISHED VISITORS

Sl. No.	Name and designation	Address	Date of visit
1.	Prof. Subrashmanyas V, Former research Fellow Senior Vice-president	Infosys Limited, Bengaluru	03/01/2023
2.	Dr. R. T. Patil	KRCCH, Arabhavi	02/02/2023
3.	G. M. Lakaing, MBMA	Shillong, Meghalaya	06/02/2023
4.	Mr. Anil Kumar, SADH	Horticulture dept., Hassan	09/02/2023
5.	Dr. R. C. Jagadeesh Vice-Chancellor	KSNUAHS, Shivamogga	13/02/2023
6.	Dr. Raviraj Shetty Head, AHRS	Ullal, Mangalore	13/02/2023
7.	Mr. Naveen M. P. Head, HRCC	Kanabargi, Belagavi	13/02/2023
8.	Dr. R. Jagadeesan Asst. Professor (Hort.) AICRP, Tiruchirappalli	TNAU, Tamilnadu	13/02/2023
9.	Dr. K. Geethanjali Asst. Professor (Plant Pathology), COH	Dr. Y.S.R. Horticultural University, Parvathipuram	27/02/2023
10.	Dr. Ravindra Naik, Principal scientist,	ICAR CIAE-RC Coimbatore	09/03/2023
11.	Dr. Vasudeva Naik K., Asst. Professor	COA, Gangavathi, Koppal	31/03/2023
12.	Dr. Raghupathi B., Assist. Professor	JCDRHC, Tadipatri	09/03/2023
13.	Dr. J. J. Amarchari Asst. Director	Horticulture dept., Gujarat	12/05/2023
14.	Dr. Vikramaditya Pandey Principal scientist,	ICAR, Pusa New delhi	03/06/2023
15.	Dr. Sudarshan P. Asst. Professor	PG dept. of Biotech	14/06/2023
16.	Girish Nandan M. Asst. Commissioner	KAS, Puttur subdivision, Dakshina Kanna	19/06/2023

17.	Kishan N. Rao Asst. Professor	Vivekananda College, Puttur	26/06/2023
18.	Dr. M. Loganathan Principal scientist, Plant pathology	ICAR-NRCB Tiruchirappalli	28/06/2023
19.	Dr. K. S. Shivashankara Principal scientist	ICAR-IIHR	28/06/2023
20.	Manjunatha Hebbar Founder & CEO,	Buoyanci Innovations	04/10/2023
21.	Anil Koushik Chief Manager	Karnataka Bank, Mangalore	09/10/2023
22.	Shwetha T. R	Kadur, Chikkamangaluru	27/10/2023
23.	Dr. T. Janakiram Vice-Chancellor	Dr. Y.S.R. Horticultural University, Venkataramannagudem	30/10/2023
24.	Satheesh, Asst. Professo	BESTIU, Andhra pradesh	03/11/2023
25.	Dr. Chandrakala M Scientist	ICAR-NBSS & LUP, RC, Bengaluru	29/12/2023

17. PERSONNEL

Research Management Position		
1.	Dr. J. Dinakara Adiga	Director
Scientific		
1.	Dr. T.N. Raviprasad	Principal Scientist (Agricultural Entomology)
2.	Dr. D. Balasubramanian	Principal Scientist (Agricultural Structures and Processing Engineering)
3.	Dr. Mohana, G.S.	Principal Scientist (Genetics & Cytogenetics)
4.	Dr. Eradasappa, E.	Scientist (Plant Breeding)
5.	Dr. K. Vanitha	Senior Scientist (Agricultural Entomology)
6.	Dr. Babli Mog	Senior Scientist (Plant Physiology)
7.	Dr. Siddanna Savadi	Scientist (Agricultural Biotechnology)
8.	Dr. Rajashekara, H.	Scientist (Plant pathology)
9.	Dr. Veena, G.L.	Scientist (Fruit Science)
10.	Dr. Bhagya, H. P.	Scientist (Plantation medicinal spices and aromatic crops)
11.	Dr. Manjesh G. N.	Scientist (Plantation medicinal spices and aromatic crops)
12.	Dr. Manjunatha, K.	Scientist (Farm Machinery & Power)
13.	Dr. Aswathy Chandrakumar	Scientist (Agriculture Extension)
14.	Dr. Jyoti Nishad	Scientist (Food Technology)
Technical		
1.	Shri. K. Muralikrishna	Chief Technical Officer
2.	Shri. Prakash G. Bhat	Chief Technical Officer
3.	Shri. N. Manikandan	Asst. Chief Technical Officer
4.	Dr. Raghurama Kukude	Asst. Chief Technical Officer
5.	Shri. Ravishankar Prasad	Technical Officer
Administration		
1.	Smt. M. Leela	Asst. Admn. Officer
2.	Smt. Reshma, K	Private Secretary, PS to Director
3.	Shri. Umashankar	Assistant

Skilled Supporting Staff

S. No.	Name	S. No.	Name
1.	Sri. N. Narayana Naik	9.	Sri. B. Narayana Poojari
2.	Sri. Vijaya Achari	10.	Sri. B. Kushalappa
3.	Sri. Veerappa	11.	Sri. B. Babu Gowda
4.	Sri. K. Annu	12	Sri. T. Padmanabha
5.	Sri. Krishnappa Naik	13.	Sri. S. Monappa
6.	Sri. V. Sundara	14.	Sri. B. Seetharama
7.	Sri. C.H. Hariya Naik	15.	Sri. K. Gopalakrishna
8.	Sri. K. Narayana	16.	Smt. S. Kasturi

Inter- Institutional Transfers

1 Dr. V. Thondaiman, Scientist (Spices, Plantation, Medical & Aromatic Plants) lien of Technical transferred to CUTN, Tiruvarur Tamil Nadu on 14.11.2023.

2 Dr. Shamsudheen M, Senior Scientist (Soil Science) transferred to Indian Institute of Spices Research, Kozhikode on 29.12.2023

Inter- Institutional Transfers - Join

1 Sri. Nithianandan K. R, Administrative Officer, from ICAR-CPCRI, Kasaragod, has reported for duty to this Directorate w.e.f 30.06.2023.

2 Sri. Sasi. K. K, Assistant Finance and Accounts Officer, from ICAR- CPCRI Regional station, Kayamkulam, has reported for duty to this Directorate w.e.f 18.07.2023.

Retirement

1. Sri. P. Abdulla, CTO/ Farm Superintendent retired on superannuation w.e.f – 31.05.2023.

2. Sri. Veerappa, SSS retired on superannuation w.e.f – 30.06.2023.

3. Miss. Winnie Lobo, Assistant retired on superannuation w.e.f – 31.08.2023.

4. Sri. Bhojappa Gowda. M, TO retired on superannuation w.e.f – 30.11.2023.

Appointment

1. Dr. Jyoti Nishad, appointed as Scientist (Food Technology) w.e.f 17.07.2023.

Promotion

1 Smt. Padminikutty, Under Division Clerk has been promoted to Assistant w.e.f – 28.03.2023.

18. WEATHER DATA (2023)

Month	Rain (mm)	T max (oC)	T min (oC)
January	0	30.32	16.59
February	0	31.97	17.62
March	0.95	32.92	19.25
April	16.50	33.77	21.86
May	97.84	32.57	22.15
June	267.90	29.88	21.66
July	1443.37	26.78	20.76
August	195.87	29.05	21.42
September	460.43	28.44	21.06
October	291.05	30.48	21.11
November	178.32	30.24	20.91
December	39.77	30.36	19.84
Annual	**2992.05**	**30.56**	**20.35**

19. PUBLICATIONS FOR SALE

Details of sale of Institute publications

Sl. No.	Name of the Publication sold	Qty.	Amount
1	Cashew production technology	8	480-00
2	Process catalogue on development of economically viable on-farm cashewnut processing	4	180-00
3	Pruning and canopy architecturing in cashew	4	160-00
4	Soil and water mgt. in cashew plantations	2	60-00
5	Softwood grafting and nursery mgt. in cashew	5	225-00
6	Catalogue of minimum descriptors of cashew: Germplasm accessions -1 Germplasm accessions -II Germplasm accessions -III	 1 1 1	 165-00 125-00 128-00
7	Annotated bibliography on cashew	1	205-00
8	Development of dual-mode dryer for raw cashewnuts	1	90-00
	Total	**28**	**1818-00**

Price indicated above does not include postage.

Address your enquiries to the Director,
ICAR-Directorate of Cashew Research,
Puttur-574 202, Dakshina Kannada,
Karnataka.

Distribution of brush cutters and Vegetable seed kits for the beneficiaries

Incubatee receiving certificate from Director, ICAR-DCR

International Women's Day, 2023

Cashew Microsatellite database

Drone Technology Demonstration in Progressive Farmer field

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किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
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