वार्षिक प्रतिवेदन

ANNUAL REPORT 2022

भा. कृ. अनु. प.-काजू अनुसंधान निदेशालय
आई.एस.ओ (9001:2008)
पुत्तूर - 574202, दक्षिण कन्नड़, कर्नाटक, भारत

ICAR- Directorate of Cashew Research
Puttur - 574202. Dakshina Kannada, Karnataka
(ISO 9001:2008)

भाकृअनुप
ICAR

काअनि
DCR

Inaguration of Silver Jubilee building by Honourable Shri. Narendra Singh Tomar, Union Minister of Agriculture and Farmers' Welfare

Drone demonstration at National symposium Kidu

PM Kisan Samman Sammelan 17th October 2022

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Front cover

Front Cover: From Bottom to top: Variety Nethra Ubhaya, Cashew Protect App and Drone Demonstration

Back cover

Images: Website for Beneficial Arthropods of Cashew Plantation, NRC-301

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प्राक्कथन

मुझे आईसीएआर-काजू अनुसंधान निदेशालय (आईसीएआर-डीसीआर), पुत्तूर की वार्षिक रिपोर्ट-2022 प्रस्तुत करते हुए खुशी हो रही है। रिपोर्ट में वर्ष के दौरान फसल सुधार, फसल प्रबंधन, फसल सुरक्षा, कटाई के बाद की तकनीक और अन्य संस्थागत गतिविधियों के साथ प्रौद्योगिकी के हस्तांतरण के क्षेत्रों में की गई गतिविधियों और उपलब्धियों को शामिल किया गया है।

वर्ष के दौरान खेती के लिए दोहरे उद्देश्य वाले काजू जीनोटाइप एनआरसी-175 को विमोचित किया गया। इसके अलावा एक अन्य काजू जीनोटाइप एनआरसी-301 की पहचान एक अद्वितीय जर्मप्लाज्म प्रकार के रूप में की गई। बौनी और अधिक उपज वाली किस्मों को विकसित करने के लिए, 16 बौनी और अर्ध-बौनी प्राप्तियों को शामिल करते हुए एक परीक्षण शुरू किया गया। वर्ष के दौरान अत्याधुनिक जैव प्रौद्योगिकी और जैव सूचना विज्ञान प्रयोगशाला की स्थापना की गई और संस्थान द्वारा दुनिया का पहला 'जीनोम वाईड् काजू माइक्रोसैटेलाइट डेटाबेस' विकसित किया गया। इसके अलावा, कार्बन प्रच्छादन अध्ययनों ने संकेत दिया कि काजू के बागान (CO_2) को लगभग 2.52 टन/हेक्टेयर तक पृथक (sequester) करते हैं। वर्ष के दौरान फलदार वृक्षों को शामिल करने वाले काजू के लिए एक फसल प्रणाली परीक्षण शुरू किया गया। वर्ष के दौरान *इन विट्रो* में पराग अंकुरण, स्कैनिंग इलेक्ट्रॉन सूक्ष्मदर्शक अध्ययन, पराग क्रायोप्रिजवेशन और काजू के क्रायोस्टोरेड पराग से फ्रुट सेट का सफलतापूर्वक अध्ययन किया गया। एक प्रोटोटाइप काजू फल और बीज विभाजक को चैयार किया गया और एक बैटरी संचालित टेलीस्कोपिक काजू फल हारवेस्टर विकसित किया गया। इस वर्ष काजू करे फ़ल और नट बोरर के रूप में उभरता हुआ एक नया कीट *सिट्रिपेस्टिस यूट्रोफेरा* एम. का प्रकोप देखा गया। विभिन्न मधुमक्खी प्रजातियों के संरक्षण के लिए विविध मधुमक्खी वनस्पतियों को एकीकृत करते हुए निदेशालय में एक मधुमक्खी संरक्षण पार्क विकसित किया गया है। खराब हो रहे काजू फ़ल को, कम से कम टैनिन और पूर्व जैसे यथा संभव एस्कॉर्बिक एसिड बनाए रखते हुए स्थिर अमोर्फ़स् रूप में परिवर्तित करने के लिए एक प्रक्रियात्मक तकनीक को मानकीकृत किया गया।

काजू के 6 कीटो और एक रोग की पहचान करने के लिए दुनिया में पहली बार आर्टिफिशियल इंटेलिजेंस (AI) आधारित ऐप और वेबसाइट 'केश्यू प्रोटेक्ट' विकसित की गई। वर्ष के दौरान, निदेशालय ने काजू के विभिन्न पहलुओं से संबंधित फ्रंट लाइन प्रदर्शनों, प्रदर्शनियों, एक्सपोजर दौरों की सुविधा प्रदान की। इसके अलावा काजू दिवस व स्थापना दिवस समारोह आयोजित किया गया। टीएसपी और एससीएसपी कार्यक्रम, कौशल विकास प्रशिक्षण कार्यक्रम, कृषि व्यवसाय ऊष्मायन (ABI) में इनक्यूबेट्स के लिए प्रशिक्षण आयोजित किए गए हैं। नेत्रा जंबों-1 किस्म को व्यावसायिक रूप से लाइसेंस दिया गया और इस वर्ष के दौरान ऐप्स / सॉफ्टवेयर के लिए चार कॉपीराइट प्राप्त किए गए। माननीय श्री. नरेंद्र सिंह तोमर, केंद्रीय कृषि और किसान कल्याण मंत्री ने दिनांक 31.03.2022 को भाकृअनुप-काजू अनुसंधान निदेशालय, पुत्तूर, कर्नाटक के **रजत जयंती भवन** को वर्चुवल रूप में उद्घाटन किया।

मैं, डॉ. हिमांशु पाठक, महानिदेशक, आईसीएआर. डॉ. ए.के. सिंह, डीडीजी (बागवानी), और डॉ.वी.बी. पटेल, एडीजी (बागवानी) को उनके निरंतर प्रोत्साहन, मार्गदर्शन और समर्थन के लिए धन्यवाद प्रकट करता हूं। सभी वेज्ञानिकों और कर्मचारियों को उनके बहुमूल्य योगदान के लिए धन्यवाद प्रकट करता हूं। इस रिपोर्ट को समय पर प्रकाशित करने के लिए संपादकीय और प्रकाशन समिति के सदस्यों द्वारा किए गए प्रयासों के लिए मैं हार्दिक आभार व्यक्त करता हूं।

स्थान : आईसीएआर-डीसीआर पुत्तूर
दिनांक : 02 मार्च, 2023

(जे.दिनकर अडिगा)
निदेशक

PREFACE

I am happy to present the Annual Report-2022 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.

A dual-purpose cashew genotype NRC 175 was released for cultivation during the year. Further another cashew genotype NRC 301 was identified as a unique germplasm type. To develop dwarf and high yielding varieties, a trial involving 16 dwarf and semi-dwarf accessions was initiated. A state of the art biotechnology and bioinformatics lab was established during the year and world's first genome wide cashew microsatellites database was developed by the institute. Further, carbon sequestration studies indicated that cashew plantations sequester CO_2 to the tune of about 2.52 t/ha. A cropping system trial for cashew involving fruit trees was initiated during the year. Pollen germination in vitro, Scanning electron microscopic studies, pollen cryopreservation and fruit set with cryostored pollen of cashew was studied successfully during the year. A prototype cashew fruit and nut separator was fabricated and a battery-operated telescopic cashew fruit harvester was developed. The incidence of Citripestis eutraphera M., a new emerging pest as apple and nut borer of cashew was noticed this year. A bee conservation park has been developed in the Directorate integrating diverse bee flora for different bee species conservation. A procedural technique to convert perishable cashew apples to stable amorphous form with reduced tannin and retaining ascorbic acid was standardized.

An Artificial Intelligence (AI) based app and website 'Cashew Protect' was developed for the first time in the world for identification of 6 pests and one disease in cashew. During the year, the Directorate facilitated front line demonstrations, exhibitions, exposure visits related to various aspects of cashew. Further, cashew day and foundation day celebrations were held. TSP and SCSP programs, skill development training programs, training for incubates in Agri Business incubation have been carried out. Nethra Jumbo-1 variety was commercially licensed and four copyrights were obtained for apps/software during the year. The honourable Shri. Narendra Singh Tomar, Union Minister of Agriculture & Farmers' Welfare virtually inaugurated the Silver Jubilee Building of the ICAR-Directorate of Cashew Research, Puttur, Karnataka on 31.03.2022.

I am grateful to Dr. Himanshu Pathak Director General, ICAR; Dr. A.K. Singh, 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. I sincerely acknowledge the efforts made by the members of the editorial and publication committee for bringing out this report in time.

Place : ICAR-DCR, Puttur
Date : 2nd March, 2023

(J Dinakara Adiga)
Director

CONTENTS

1. कार्यकारी सारांश

आईसीएआर–काजू अनुसंधान निदेशालय, पुत्तूर काजू पर अनुसंधान और विस्तार गतिविधियों में शामिल है। वर्ष 2022 के दौरान फसल सुधार, फसल प्रबंधन, फसल सुरक्षा, फसलोत्तर प्रौद्योगिकी, प्रौद्योगिकी हस्तांतरण एवं अन्य पहलुओं के तहत की गई अनुसंधान गतिविधियों की प्रगति को यहाँ संक्षेप में प्रस्तुत किया गया है। इस वर्ष, कुल 42 अनुसंधान परियोजनाएँ चल रही थीं, जिनमें छह बाह्य वित्तपोषित परियोजनाएँ शामिल थीं।

फसल सुधार

वर्ष के दौरान खेती के लिए दोहरे उद्देश्य वाले काजू जीनोटाइप एनआरसी–175 को विमोचित किया गया। इस किस्म के बीज (20.14 किग्रा/वृक्ष) और काजू फल (233.3 किग्रा/वृक्ष) दोनों के लिए उच्चतम संचयी उपज दर्ज की गयी और यह चेक् किस्म वेंगुरला–8 से अधिक है। इसमें जूस रिकवरी 75.6%, TSS 14.93° ब्रिक्स, एस्कॉर्बिक एसिड 255.6mg/100g, अम्लता 0.63%, फिनोल 142.20mg GAE/100g, फ्लेवोनॉइड 0.11mg CE/100g, टैनिन 3.43mg TAE/100g जैसे वांछनीय जैव रासायनिक गुण भी हैं, एंटीऑक्सीडेंट 124.23mg CE/100 था। ताजा काजू फल के ऑर्गेनोलेप्टिक मूल्यांकन ने संकेत दिया कि एनआरसी–175, 6.05 की समग्र स्वीकार्यता ग्रेड के साथ अधिक स्वीकार्य है। इसके अलावा एक अन्य काजू जीनोटाइप एनआरसी–301 की पहचान एक अद्वितीय जर्मप्लाज्म प्रकार के रूप में की गई, जिसमें काजू फल का औसत वजन 183.10 ग्राम और बीज का वजन 11.94 ग्राम था। ऑर्गेनोलेप्टिक मूल्यांकन ने संकेत दिया कि एनआरसी 301 6.15 की समग्र स्वीकार्यता ग्रेड के साथ अधिक स्वीकार्य है।

वर्तमान में निदेशालय में राष्ट्रीय काजू फील्ड जीन बैंक में 558 जननद्रव्य संग्रहित हैं। वर्ष को दौरान, छह अर्थ बौने और अधिक उपज देने वाली प्रविष्टियां यानी बीडीबी 58, डीबी 626, टीआर 8, एचसी–6, एच–3831, जेजीएम–282 एकत्र की गई हैं। इसके अलावा, 2022 के दौरान, 13 प्राप्तियों की सीएनएसएल (CNSL) का अनुमान लगाया गया। राष्ट्रीय काजू फील्ड जीन बैंक में 450 एक्सेशनों में जर्मप्लाज्म एक्सेसन को पुनश्चेतन करने के लिए लिम्ब प्रूनिंग भी की गई थी। इसके अलावा, 15 अक्सेशन के बीजों से उगाए गए 243 पॉलीक्लोनल हाइब्रिड पौधों को वेंगुरला–4 और भास्कर जैसे चेक् के साथ अगमेंटेड डिजाइन (चार ब्लॉक) में मुख्य क्षेत्र में लगाया गया था।

टी एम बी डैमेज स्केल के अनुसार 57 कोर एक्सेसन में टी मॉस्किटो बग की स्क्रीनिंग पूरी की गई और 20 एक्सेसन मध्यम अतिसंवेदनशील श्रेणी में, 24 मध्यम प्रतिरोधी श्रेणी में, 8 अतिसंवेदनशील श्रेणी मं और केवल 5 प्रतिरोधी श्रेणी में पाए गए। कोल्चसीन (colchicin) उपचारित बीजों और पौधों से विकसित कुल 458 पौधों को चेक के रूप में भास्कर, नेत्र वामन, ६ा–4 के साथ अगमेंटेड ब्लॉक डिजाइन (छह ब्लॉकों के साथ) में लागाया गया था। इसके अलावा, देश के विभिन्न हिस्सों से एकत्र किए गए 16 बौने और अर्ध–बौने पौधों को मूल्यांकन के लिए तीन रिप्लिकेशन में विभाजित प्लॉट डिजाइन में लगाया गया है।

पौधा किस्म पंजीकरण प्रयासों के तहत, क्षेत्रीय फल अनुसेधान केंद्र, वेंगुरला, महाराष्ट्र से वेंगुरला–9 किस्म का आवेदन, जो कि आईसीएआर–काजू अनुसंधान निदेशालय, पुत्तूर के तहत एक एआईसीआरपी (AICRP) केंद्र है, को पीपीवीएफआर ए के साथ पंजीकरण के लिए सुविधा प्रदान की गई थी। वर्ष के दौरान अत्याधुनिक जैव प्रौद्योगिकी और जैव सूचना विज्ञान प्रयोगशाला की स्थापना की गई। इसके अलावा, संस्थान द्वारा दुनिया का पहला जीनोम वाइज काजू माइक्रो सैटेलाइट डेटाबेस विकसित किया गया।

फसल प्रबंधन

बायोमास और कार्बन भंडारण अध्ययनों ने संकेत दिया है कि, एक वर्ष पुराने उल्लाल–3 काजू बागान में, भूमि के ऊपर के बायोमास ने कार्बन के 0.42 टन/हेक्टेयर के साथ 1.55 टन/

हेक्टेयर के समतुल्य CO_2 योगदान दिया। उल्लाल-3 के 1 वर्ष पुराने बगीचे में जमीन को नीचे. 0.27 टन/हेक्टेयर कार्बन संचयन और 0.98 टन/हेक्टेयर समतुल्य के CO_2 के साथ, कार्बन पृथक्करण का कुल CO_2 समतुल्य 2.52 टन/हेक्टेयर था। वर्ष के दौरान पश्चिमी तट क्षेत्र में फलदार वृक्षों को शामिल करते हुए काजू के लिए एक फसल प्रणाली परक्षिण शुरू किया गया।

इन विट्रो स्थिति में पराग अंकुरण, स्कैनिंग इलेक्ट्रॉन सूक्ष्म दर्शक अध्ययन, पराग का क्रायोप्रिजर्वेशन और काजू पराग के क्रायोस्टोर के साथ फ्रुट सेट का सफलतापूर्वक अध्ययन किया गया। PEG (15%) मीडिया ने *इन विट्रो* में महत्वपूर्ण पराग अंकुरण प्राप्त दिखाया। मडक्कतरा-2 ने अन्य जीनोटाइप और प्रजातियों की तुलना में ताजा (90.32%) और क्रयोप्रिजर्वड् (85.53%) पराग दोनों के संबंध में उच्च सफ़लता दर्ज की। परागकणों को छह महीने तक क्रायोसंरक्षित किया गया था और नियमित अंतराल पर व्यवहार्यता मूल्यांकन किया गया था। *इन विवो* प्रजनन क्षमता का मूल्यांकन ताजा और क्रायोस्टोरेड पराग का उपयोग करके क्षेत्र परागण द्वारा किया गय था। फ्रुट् सेट्टिंग रेंज 13.17 से 30.67 प्रतिशत और बीज अंकुरण क्षमता 37.75 से 63.64 प्रतिशत दर्ज की गई । वर्तमान अध्ययन काजू पराग के सफल क्रायोप्रिजर्वेशन पर पहली रिपोर्ट है।

आईसाएआर-सीआईएई, क्षेत्रीय केंद्र, कोयम्बटूर के सहयोग से एक प्रोटोटाइप काजू फल और बीज बिभाजक तैयार किया गया। विकसित प्रोटोटाइप में एक मुख्य फ्रेम, इलेक्ट्रिक मोटर, VFD, हॉपर, स्क्रू कन्वेयर, पहला रोटरी मॉड्यूल और सेकेंडरी रोटरी मॉड्यूल शामिल था। काजू फल और बीज विभाजक का प्रदर्शन मूल्यांकन भाकृअनुप-डीसीआर, पुत्तूर में किया गया था। बैटरी चालित टेलीस्कोपिक काजू फल हार्वेस्टर विकसित किया गया।

फसल सुरक्ष

डाय-क्लोरो मीथेन को टीएमबी के सेक्स फेरोमोन के वाष्पशील क्षालन के लिए सबसे अच्छा विलायक पाया गया। इस वर्ष निदेशालय में काजू के फल और नट बोरर के रूप में एक नया उभरता हुआ कीट *सिट्रीपेस्टिस यूट्राफेरा एम.* का प्रकोप देखा गया। *पेरीक्सेरास्पी.* के प्यूपा से टैचिनीड परजीवी निकला, यह भारत में पहली बार रिकॉर्ड किया गया है और *पेरिक्सरास्पी* पर यह दिखाई पडी, यह एक नया मेजबान रिकॉर्ड है।

तीन मधुमक्खी प्रजातियों जैसे कि *ब्रोनसेपिस मिक्स्टा, टेट्रागोनूला इरिडिपेनिस* और *एपिसेराना इंडिका* की परागण दक्षता का मूल्यांकन, खुले परागस्पर्श होनेवाले पेड़ों की तुलना में वीआरआई-3 पौधों में किया गया। अवलोकनों ने संकेत दिया कि सभी तीन मधुमक्खी प्रजातियों ने काजू के फूलों पर सक्रिय रूप से कैद के तहत भी वनीकरण किया और काजू के फूलों क सफलतापूर्वक परागण किया। मुख्य रूप से विभिन्न मधुमक्खी प्रजातियों के संरक्षण के लिए विविध मधुमक्खी वनस्पतियों को एकीकृत करते हुए आईसीएआर-डीसीआर के फार्म परिसर में एक मधुमक्खी संरक्षण पार्क विकसित किया गया है।

वर्ष के दौरान काजू की लीफ़ ब्लाईट् रोग में *नियोपेस्टलोटॉप्सिस* स्पी. की रोगजनकता की पुष्टि हुई। इस रोगज़नक़ का मल्टीजीन लक्षण वर्णन भी पूरा किया गया।

कटाई उपरांत प्रौद्योगिकी

3-इन-1 नमी मीटर का केलिब्रेसन्, जिसे कच्चे काजू बिना छिलके वाली काजू गिरी (UPK) और छिलके वाली काजू गिरी (PK) की नमी की मात्रा निर्धारित करने के लिए विकसित किया गया है, उसे इस अवधि के दौरान उच्च सटीकता प्राप्त करने के लिए जारी रखा गया। कम से कम टैनिन और यथा संभव एस्कॉर्बिक एसिड को बनाए रखते हुए, खराब हो रहे काजू फल को स्थिर अमोर्फ़स रूप में परिवर्तित करने के लिए एक प्रक्रियात्मक तकनीक मानकीकृत किया गया है। काजू फल में उपलब्ध आंतरिक पोषक घटकों के महत्वपूर्ण स्रोत को ध्यान में रखते हुए, काजू फल के पाउडर का उपयोग, अनाज आधारित एक्सट्रूडेट की तैयारी में बायोफोर्टिफाइंग एजेंट के रूप में किया गया है।

प्रौद्योगिकी हस्तांतरण

वर्ष के दौरान गैर पारंपरिक क्षेत्रों में काजू किसानों का जरूरत और आवश्यकताओं का विश्लेषण किया गया। अध्ययन

ने व्यक्तिगत संपर्क और सूचनाओं के आदान-प्रदान से आईसीटी आधारित तरीकों के लिए किसानों की प्राथमिकता का सूचना दिया। काजू में 6 कीटों और एक बीमारी की पहचान के लिए एक आर्टिफिशियल इंटेलिजेंस (AI) आधारित ऐप (APP) और वेबसाइट 'केश्यू प्रोटेक्ट' विकासित की गई। काजू के लिए दुनिया में और आईसीएआर प्रणाली में एआई आधारित ऐप/वेबसाईट विकासित करने का प्रयास संभवत: यह पहला है।

'केश्यू इंडिया' ऐप का दूसरा संस्करण विकसित किया गया और इसे गूगल् प्ले स्टार् में उपलब्ध कराया गया है। यहां, *स्वदेशी तकनीकी ज्ञान* (ITK) और *काजू में परागण* जैसे दो नए मॉड्यूल शुरू किए गए जो सभी काजू उगाने वाले राज्यों के लिए संबंधित भाषाओं में उपलब्ध है। इसके आलावा, 'कीट प्रबंधन' मॉड्यूल के तहत 'लघु कीट' (Minor Pests) पर जानकारी शामिल किया गया है। क्षेत्र विस्तार कार्यक्रम के तहत, वर्ष के दौरान, 67.81 एकड़ में काजू क्षेत्र के विस्तार के लिए एमआईडीएच दिशानिर्देशों के अनुसार इक्कीस किसानों को वित्तीय सहायता दी गई है। कर्नाटक का शिमोग जिले में, 16 किसानों की 44.26 एकड़ जमीन को शामिल किया गया, चित्रदुर्ग जिले में 5 किसानों की 23.55 एकड़ जमीन को शामिल किया गया।

निदेशालय ने फ्रंट लाइन प्रदर्शनों, विभिन्न मेलों में प्रदर्शनी, किसानों और छात्रों के प्रदर्शन दौरे, काजू दिवस समारोह, स्थापना दिवस समारोह, हिंदी सप्ताह, सतर्कता जागरूकता सप्ताह, टीएसपी और एससीएसपी कार्यक्रमों के कार्यान्वयन, कौशल विकास प्रशिक्षण कार्यक्रमों, 6 इनक्यूबेट्स के लिए प्रशिक्षण की सुविधा आदी को प्रदान की। कृषि व्यवसाय ऊष्मायन में, विश्व मृदा दिवस समारोह के अलावा कई कृषि प्रशिक्षण कार्यक्रम। इसके अलावा, अनुसंधान सलाहकार समिति (RAC), और संस्थान अनुसंधान परिषद (IRC) की बैठकें आयोजित की गई। सबसे महत्वपूर्ण बात यह है कि नेत्रा जंबो-1 किस्म को तैयार करने के लिए पुत्तूर में एक निजी फर्म को व्यावसायिक रूप से लाइसेंस दिया गया। वर्ष के दौरान ऐप्स / सॉफ्टवेयर के लिए कुल चार कॉपीराइट प्राप्त किए गए।

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 2022 under crop improvement, crop management, crop protection, post-harvest technology and transfer of technology and other aspects are summarized here. This year, a total of 42 research projects including six externally funded projects were in operation.

Crop Improvement

A dual purpose cashew genotype NRC 175 was released for cultivation during this year. It recorded highest cumulative yields for both nut (20.14 kg /tree) and cashew apple (233.3 kg / tree) and is higher than check variety Vengurla-8. It also possesses the desirable biochemical qualities such as juice recovery 75.6%, TSS 14.93° Brix, ascorbic acid 255.6mg/100g, acidity 0.63%, phenol 142.20 mg GAE/100g, flavonoid 0.11mg CE/100g, tannin 3.43mg TAE/100g, antioxidant 124.23 mg AEAC/100mg. The organoleptic evaluation of fresh cashew apples indicated that NRC 175 is more acceptable with overall acceptability grade of 6.05. Further another cashew genotype NRC 301 was identified as a unique germplasm type with highest average cashew apple weight of 183.10g and nut weight of 11.94g. The organoleptic evaluation indicated that NRC 301 is more acceptable with overall acceptability grade of 6.15.

At present, the National Cashew Field Gene Bank at the Directorate houses 558 germplasm accessions. During the year, six semi dwarf and high yielding accessions i.e., BDB 58, DB 626, TR8, HC-6, H-3831, JGM-282 have been collected. Further, during 2022, the CNSL content of 13 accessions was estimated. In order to rejuvenate germplasm accessions, limb pruning was also done in 450 accessions in the national cashew field gene bank. Moreover, 243 polyclonal hybrid plants raised from seeds of 15 accessions were planted in the main field in augmented design (four blocks) with checks such as Vengurla - 4 and Bhaskara.

Screening for tea mosquito bug was accomplished in 57 core accessions and 20 accessions were found to be in moderately susceptible category, 24 in moderately resistant, 8 in susceptible category and only 5 in resistant category according to the TMB damage scale. A total of 458 plants developed from colchicine treated seeds and seedlings were planted in augmented block design (with six blocks) along with Bhaskara, Nethra Vaaman, Vengurla-4 as checks. Further, 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.

Under plant variety registration efforts, the application of Vengurla-9 variety from Regional Fruit Research Station, Vengurla, Maharastra which is an AICRP center under ICAR- Directorate of Cashew Research, Puttur was facilitated for registration with PPV FRA. A state of the art biotechnology and bioinformatics lab was established during the year. Further, world's first genome wide cashew microsatellites database was developed by the institute.

Crop Management

The biomass and carbon storage studies have indicated that, in one year old Ullal-3 cashew

plantations, the above ground biomass contributed to 0.42 t/ha of carbon with the CO_2 equivalent of 1.55 t/ha. With 0.27 t/ha of below ground carbon accumulation in 1 year old plantation of Ullal-3 and corresponding CO_2 equivalent of 0.98 t/ha, the total CO_2 equivalent of carbon sequestration was 2.52 t/ha. A cropping system trial for cashew in the west coast region involving fruit trees was initiated during the year

Pollen germination *in vitro*, Scanning electron microscopic studies, pollen cryopreservation and fruit set with cryostored pollen of cashew was studied successfully. PEG (15%) media elicited significant pollen germination in vitro. Madakkathara-2 recorded high viability profiles both with respect to fresh (90.32%) and cryopreserved (85.53%) pollen when compared to other genotypes and species. The pollen grains were cryopreserved for six months and post viability assessment was carried out at regular intervals. In vivo fertility assessment was carried out by field pollinations using fresh and cryostored pollen. Fruit set range of 13.17 to 30.67 per cent and seed germinability range from 37.75 to 63.64 per cent was recorded. The present study is the first report on the successful cryopreservation of cashew pollen.

A prototype cashew fruit and nut separator was fabricated by collaborating with ICAR-CIAE, Regional Center, Coimbatore. The developed prototype consisted of a main frame, electric motor, VFD, hopper, screw conveyor, first rotary module and secondary rotary module. The performance evaluation of the cashew fruit and nut separator was carried out at ICAR-DCR, Puttur.A battery-operated telescopic cashew fruit harvester was developed

Crop Protection

Di-chloro methane was found to be the best solvent for the elution of sex pheromone volatiles of TMB. The incidence of *Citripestis eutraphera* M., a new emerging pest as apple and nut borer of cashew was noticed in the station this year. The tachinid parasitoid emerged out of the pupae of Perixera sp. is recorded for the first time from India and its occurrence on Perixera sp. is a new host record.

Pollination efficiency of three bee species *viz., Braunsapis mixta, Tetragonula iridipennis* and *Apiscerana indica* was assessed in VRI-3 plants in comparison to open pollinated trees. Observations indicated that all the three bee species actively foraged on cashew flowers even under confinement and successfully pollinated the cashew flowers. A bee conservation park has been developed in the farm premises of ICAR-DCR integrating diverse bee flora mainly for the conservation of different bee species.

The pathogenicity of *Neopestalotiopsis* sp. in causing leaf blight of cashew was established during the year. Multigene characterisation of this pathogen was also accomplished.

Post Harvest Technology

Calibration of 3-in-1 moisture meter, which is developed to determine the moisture content of raw cashewnut, unpeeled cashew kernels (UPK) and peeled cashew kernels (PK), continued to achieve higher accuracy was done during the period. A procedural technique to convert perishable cashew apples to stable amorphous form with reduced tannin and retaining ascorbic acid is standardized. Considering the vital source of intrinsic nutritive components available in cashew apples, cashew apple powder is utilized as a biofortifying agent in the preparation of cereal based extrudates.

Transfer of technology

The information need analysis of cashew farmers in non traditional areas was done during the year. The study suggested the preference of farmers for personal contact and ICT based methods of information exchange. An Artificial Intelligence (AI) based app and website 'Cashew Protect' was developed for identification of 6 pests and one disease in cashew. This is probably the first ever attempt of developing an AI based app/ website in the world and in the ICAR system for cashew.

The second version of the 'Cashew India' app is developed and is made available in Google Play Store. Here, two new modules i.e on Indigenous Technical Knowledge (ITK) and Pollination in cashew were introduced for all cashew growing states in respective languages. Further, under "Pest management' module, information on 'Minor pests' is included. Under area expansion program, During the year, twenty-one farmers have been given financial assistance as per MIDH guidelines for expanding the cashew area in 67.81 acres. In Shimoga district, 44.26 acres belonging to 16 farmers were covered. In Chitradurga district, 23.55 acres belonging to 5 farmers were covered.

The Directorate facilitated front line demonstrations, exhibition at various melas, exposure visits of farmers and students, cashew day celebration, foundation day celebration, Hindi week, Vigilance awareness week, implementation of TSP and SCSP programs, skill development training programs, training for 6 incubates in Agri Business incubation, world soil day celebrations in addition to many on farm training programs. Further, the Research advisory Committee (RAC), and IRC Institute Research Council meetings were held. Most importantly, Nethra Jumbo-1 variety was commercially licensed to a private firm in Puttur. A total of four copyrights were obtained for apps/software during the year.

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 69.02 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 germplasm collection and conservation, 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

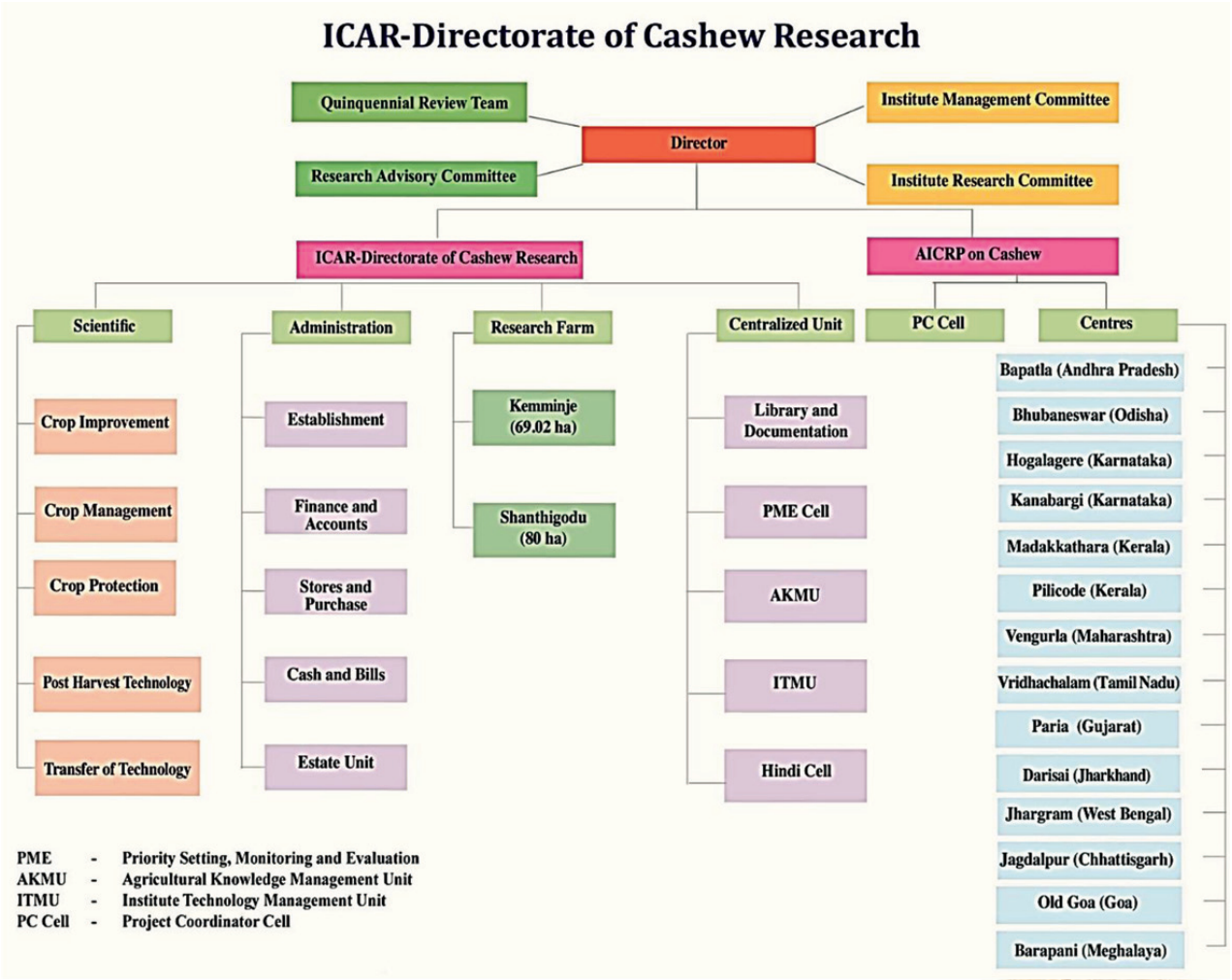
Mandate

- 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 Postharvest 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), Vigilance Cell, Women cell, Library and Museum. The Directorate also functions as headquarter for the All India Coordinated Research Project on Cashew.



2.5 Library/AKMU/ITMU/ABI

The Directorate has got 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 1986 books and 2030 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 AKMU is managing the internet facilities and wi- fi connectivity at the Directorate. 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.

2.6 Staff

The Institute has a sanctioned strength of 22 scientific, 19 technical, 14 administrative, 19 skilled support staff and 1 canteen staff, of which 15 scientists, 10 technical staff, 7 administrative staff and 17 skilled support staff are in position and the remaining are vacant as on 31st December 2021. (Table 2.1).

Table 2.1: Staff strength at ICAR-DCR, Puttur

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	1	-
Scientific	22	15	7
Technical	15	8	7
Administrative	16	5	11
Canteen staff	1	-	1
Skilled support staff	19	16	3
Total	73	45	28

2.7 Budget

During the financial year (FY) 2020-21, the total budget allotted to the Directorate was Rs. 1031.70 Lakhs of which Rs. 999.13 Lakhs were utilized (Table 2.2). Under externally funded projects, the total receipts were Rs. 257.28 Lakhs, of which Rs. 55.305 Lakhs was utilized (Table 2.3). The revenue generation during FY 2020-21 was Rs. 121.50 Lakhs (Table 2.4).

Particulars	Allocation	Utilization
GIA capital	20.00	11.61
GIA salary	736.65	679.96
Pension	92.32	85.89
GIA general	170.00	166.21
TSP	10.00	7.36
SCSP	30.00	18.02
NEH	0.00	0.00
Total	**1058.97**	**969.05**

Table 2.3. Receipts and expenditure under externally funded schemes at DCR for March 2022- Feb 2023 (Rs. in Lakhs)

Particulars	Allocation	Utilization
RKVY-RAFTAAR, Govt. of Karnataka	0	0
PPV&FRA, New Delhi	6.45	4.94
DCCD, Cochin	0.10425	0.03150
DCCD (Training)	0.75	0.60
ABI	7.00	1.69
ITMU	7.25	5.44
Total	**21.55425**	**12.7015**

2.8 Infrastructure and assets

The major infrastructures developed during the year 2020-21, include the instrumental facilities like Double screw extruder, pulverizer, hot air oven, ethylene analyzer, respiratory gas analyzer, Flour mixer. These were purchased and strengthen the laboratory with modern equipment in the project funded by RKVY- RAFTAAR.

Table 2.4. Revenue generation at ICAR-DCRfrom March, 2022 to Feb. 2023 (Rs in Lakhs)

Revenue target (2022-23)	Revenue Generated (2022-23)
114.07	62.83

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 2022, a total of 99,226 cashew grafts (62231 from Kemminje campus and 36955 from Shantigodu campus) were supplied to farmers.

3. RESEARCH ACHIEVEMENTS

3.1. CROP IMPROVEMENT

Priority area I: Management of cashew genetic resources

3.1.1 NRC 175: A dual purpose cashew variety

So far ICAR-DCR has released five varieties viz., NRCC Sel-1, NRCC Sel-2, Bhaskara, Nethra Ganga, Nethra Vaaman, Nethra Jumbo-1. Among them, NRCC Sel-1 was withdrawn due to inconsistent performance in the farmers' field. NRCC Sel-2, Nethra Ganga Nethra Jumbo-1 are bold nut types but show apple cracking and hence not suitable dual-purpose type. Nethra Vaaman is dwarf variety with smaller nuts and apples. Therefore, variety suitable for dual purpose is required and hence research on this line was initiated in the year 2013 to find out a suitable genotype for better cashew apple yield and quality traits along with nut yield.

Fourteen cashew germplasm accessions having big cashew apples were selected from the germplasm maintained in the National Cashew Field Gene Bank. They were multiplied clonally and evaluated with check Vengurla-8 from 2013 to 2022. NRC 175 was identified from this study. It recorded the highest cumulative nut yield of 20.14 kg / tree and cashew apple yield of 233.3 kg / tree which is higher than check variety Vengurla-8. It also possesses the desirable biochemical qualities such as juice recovery 75.6%, TSS 14.930Brix, ascorbic acid 255.6mg/100g, acidity 0.63%, phenol 142.20 mg GAE/100g, flavonoid 0.11mg CE/100g, tannin 3.43mg TAE/100g, antioxidant 124.23mg AEAC/100mg. The organoleptic evaluation of fresh cashew apples indicated that NRC 175 is more acceptable with overall acceptability grade of 6.05.

Table 3.1.1. Distinguish morphological characteristics of NRC 175

1	**Plant and leaf characters**	
	Plant height (at the age of 11 years)	5.5 m
	Branching pattern	Extensive
	Tree spread	6.37m
	Leaf size and shape	Intermediate (107 cm^2) obovate
	Young leaf color	Yellow red
2	**Flowering and fruiting characters**	
	Sex ratio (hermaphrodite to male)	
	Season of flowering	November-March
	Duration of flowering (days)	Intermediate (60-90 days)
	Season of harvest	February – April
3	**Nut characters**	
	Nut weight (g)	7.66 g
	Number of nuts Kg-1	130-135
	CNSL content	23.2%

4	**Kernel characters**	
	Shelling percentage	34.66%
	Attachment of peel to kernel	Loose
	Whole kernel count lb^{-1}	185
	Kernel weight	2.44 g
	Kernel protein	19.52 %
	Total fat	38.72 %
5	**Cashew apple characters**	
	Apple colour	Yellow red
	Apple shape	Conical to obovate
	Apple weight (g)	81.24 (high)
	Apple to nut ratio	11.27 (medium)
	Juice content (%)	75.6
	TSS of juice (ºBrix)	14.93
	Acceptability score	6.05

Tree habit: Tree is semi vigorous, extensive branching pattern with open and spreading habit. The young leaves are yellow red in color while the mature leaves are intermediate size and green with obovate shape.

Flowering and fruit set: Flowers are produced from third year after planting. NRC 175 is an early season bearer with intermediate flowering duration. The flowering starts from November and continues up to March and the peak flowering will be in January and February. The panicles are broadly pyramidal in shape. The sex ratio is high (0.21) which helps to increase to fruit set and responsible for cluster bearing.

Nut and Kernels: The average nut weight of 7.66 g. The nuts have very high shelling percentage (34.66%) with 23.2 % of CNSL content in the shell. The kernels are bold with 2.44 g average weight and fits in to kernel grade W210. The kernels contain good amount of proteins (21 %), sugars (15.6 %) and total fat content (47 %). Kernels are ivory coloured, smooth and crispy, sweet in taste and uniform in size.

Cashew apple: It bears attractive yellow-colored apples which weigh around 80 g per apple with conical to obovate shape. The apples have TSS of 14.93° B with juice content of 75.6%. The apple to nut ratio is 11.27.

Harvesting and yield: The season of harvest starts from January and continues till March end. The duration of harvesting period is less which helps to save the labor on picking of nuts. Fresh apples can be eaten as they are sweet and less astringent. Fresh harvested apples are suitable for making products like jam, jelly, RTS, cider, extruded products, pomace etc. It recorded the highest cumulative nut yield of 20.14 kg / tree and cashew apple yield of 233.3 kg / tree (Table) which is higher than check variety Vengurla-8. A ten-year-old tree has a potential to yield around 10 kg per tree.

Table 3.1.2: Performance of NRC 175 for nut yield in comparison with check variety Vengurla-8 at Kemminje campus of DCR (replicated trial with spacing of 7.5 x 7.5m, @178 plants/ha, Year of planting : October 2013)

Variety	1st harvest (2016)	2nd harvest (2017)	3rd harvest (2018)	4th harvest (2019)	5th harvest (2021)	6th harvest (2022)	Cum. yield (6 harvests)	Average yield per tree (kg)
NRC 175	2.85	4.54	3.02	3.12	1.60	5.01	20.14	3.36
V-8 (check)	0.24	1.05	0.57	0.55	1.30	0.56	4.27	0.71

*During 2020 yield was not recorded due to COVID 19, *Vengurla-8 was planted in 2014.

Table 3.1.3: Performance of NRC 175 for apple yield in comparison with check variety Vengurla-8 at Kemminje campus of DCR (replicated trial with spacing of 7.5 x 7.5m, @178 plants/ha, Year of planting : October 2013)

Variety	1st harvest (2016)	2nd harvest (2017)	3rd harvest (2018)	4th harvest (2019)	5th harvest (2021)	6th harvest (2022)	Cum. yield (6 harvests)	Average yield per tree (kg)
NRC 175	37.89	50.43	36.47	35.66	16.38	56.47	233.3	38.88
Vengurla-8 (check)	2.25	9.77	3.96	4.01	8.82	3.93	32.74	5.46

*During 2020 yield was not recorded due to COVID 19, *Vengurla-8 was planted in 2014.

Cultural requirements: NRC 175 is suitable for wider density at a spacing of 7.5 m x7.5 m accommodating 178 plants per hectare. The manure and fertilizer requirements are similar to other varieties with an adult tree (three years and above) requiring 500g: 250g:250g N, P and K per tree per year. It is recommended to dry the nuts under full sun for 3 days to ensure better storability and market price from processors.

Plant protection tips: NRC 175 is found moderately resistant to TMB in the field conditions. As TMB incidence is regular in every season three sprays of insecticides during flushing, flowering and fruit set is essential to harvest good yield of nuts and apples.

Striking/special features of NRC 175: dual purpose, cluster bearing, bold nuts, very high shelling percentage, easy peeling of testa, W210, kernel grade, bigger cashew apples with less tannin and high TSS, with good acceptability.

Fig. 3.1.1. Fruiting cluster

Fig. 3.1.2. Inflorescence

Fig. 3.1.3. Matured apples and nuts

Fig. 3.1.4. Dried cashew nuts

Fig. 3.1.5. Kernels

NRC 301: A unique type

ICAR-DCR Puttur is the national active germplasm site (NAGS) for cashew and it presently holds collection of 548 accessions in its national cashew field gene bank (NCFGB). Amongst this collection, NRC 301 is bears very big apple and it bears nut in slanting position below the cashew apple. Therefore, it is identified as unique type and is proposed for registering it has unique type.

Fourteen cashew germplasm accessions having big cashew apples were selected from the germplasm maintained in the National Cashew Field Gene Bank. They were multiplied clonally

and evaluated with check Vengurla-8 from 2013 to 2022. NRC 301 was identified as unique type from this study. It holds potential as a unique germplasm type with highest average cashew apple weight of 183.10g and nut weight of 11.94g. It has recorded modest cumulative nut yield of 5.58 kg/tree and cashew apple yield of 88.53 kg/tree over six harvests. Besides, it also possesses the desirable biochemical qualities such as juice recovery 75.6%, TSS 10.230Brix, ascorbic acid 392.4mg/100g, acidity 0.71%, phenol 111.52 mg GAE/100g, flavonoid 2.15g CE/100g, tannin 584mg TAE/100g, antioxidant 157.12mg AEAC/100mg. The organoleptic evaluation of fresh cashew apples indicated that NRC 301 is more acceptable with overall acceptability grade of 6.15.

Table 3.1.4. Distinguish morphological characteristics of NRC 301

1	**Plant and leaf characters**	
	Plant height (at the age of 11 years)	5.13 m
	Branching pattern	Extensive
	Tree spread	7.07 m
	Leaf size and shape	Large (134 cm^2) obovate
	Young leaf color	Yellow red
2	**Flowering and fruiting characters**	
	Sex ratio (hermaphrodite to male)	
	Season of flowering	November-March
	Duration of flowering	Intermediate (60-90 days)
	Season of harvest	February – April
3	**Nut characters**	
	Nut weight	11.94 g
	Number of nuts Kg-1	83-85
	CNSL	19.20%
4	**Kernel characters**	
	Shelling percentage	31.61%
	Attachment of peel to kernel	Loose
	Whole kernel count lb^{-1}	185
	Kernel weight	3.74 g
	Kernel protein	20.12 %
	Total fat	39.22 %
5	**Cashew apple characters**	
	Apple colour	Red
	Apple shape	Conical to obovate
	Apple weight (g)	183.10 (high)
	Apple to nut ratio	15.33 (high)
	Juice content (%)	77.0
	TSS of juice (ºBrix)	10.23
	Acceptability score	6.15

Fig. 3.1.6. Inflorescence

Fig. 3.1.7. Matured apples and nuts

Fig. 3.1.8. Matured apples and nuts

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

Germplasm collection:

At present, the National Cashew Field Gene Bank (NCFGB) at the Directorate houses 558 germplasm accessions. During the year, six semi dwarf and high yielding accessions i.e., BDB 58, DB 626, TR8, HC-6, H-3831, JGM-282 have been collected. Out of these, first three are selected from DCR trials. HC- 6 is collected from RRS, Vridhachalam, H-3831 from RFRS, Vengurla and JGM-282 from CRS, Jhargram have been collected. Efforts for getting the IC numbers for some of these accessions are in progress. IC numbers from NBPGR have been obtained for H -126, H-125, Tree Number 130, 163, 186 and 480 (NRC numbers 547-552 and IC number IC-0639952 to IC-0639957) during the year.

Fig. 3.1.9 Fruit bunch in BDB-58

Fig. 3.1.10 Fruit bunch of TR - 8

Fig. 3.1.11 Flowering in JGM-282

Fig. 3.1.12 JGM-28 in full bearing

Fig. 3.1.13 Fruits & nuts of JGM -282

Germplasm maintenance:

13 unique types (dwarf types, wild species etc.) were maintained in a separate block during the year. Further, 512 germplasm accessions in conservation block are maintained. Core collection of 61 cashew germplasm accessions was also taken care during the period.

Fig. 3.1.14 View of the core collection plot

Germplasm database maintenance

The cashew germplasm database (https://cashew.icar.gov.in/dcr/) was maintained during the year. It was visited 4321 times till date.

Fig. 3.1.15 Cashew germplasm database management system

Cashew Shell Nut Liquid estimation in germplasm accessions

The CNSL extraction was carried out for 418 accessions during 2015-21. During 2022, the CNSL content of 13 accessions was estimated (Table 3.1.5). From the CNSL content of 431 accessions, it was revealed that the range of CNSL content varied from zero per cent to 36.52%. The work of CNSL content estimation will be continued in the ensuing year.

Table: 3.1.5. CNSL content of 13 accessions

Sl. No.	NRC Number	% CNSL
1	323	7.24
2	463	25.88
3	398	15.99
4	273	17.05
5	294	19.29
6	466	15.62
7	226	13.82
8	215	15.72
9	303	13.35
10	388	13.92
11	212	13.18
12	307	11.66
13	462	17.83

Fig. 3.1.16 Difference between CNSL free type (top left and bottom left) and accession with CNSL

Limb pruning in gene bank

In order to rejuvenate germplasm accessions, limb pruning was done in 450 accessions in the gene bank during the year. After care was taken with Bordeaux paste and chlorpyriphos application for avoiding fungal infection and stem borer infestation respectively. Despite the care taken, there were many trees with stem borer infestation. In those trees, grubs of stem borer have been removed and plants are sprayed with Fipronil and were rescued.

Fig. 3.1.17 Limb pruning and Bordeaux paste smearing

Fig. 3.1.18 Flushes in limb pruned tree

Fig. 3.1.19 Rejuvenated tree after limb pruning

Priority Area: Genetic improvement of cashew

3.1.2 Genetic improvement of cashew through hybridization and seedling selection approaches

Evaluation of promising varieties and bold nut hybrids in bulk trial

The promising seedling selection Tree No. 480 performed better over other bold and medium nut types likes H 32/4, NRC 493, H-1616 and Bhaskara for yield. No.480 recorded a cumulative yield of 14.79 kg over 4 harvests as against 6.38 kg cumulative yield recorded in check variety. This seedling selection has been consistently performing better over the years.

Table 3.1.6. Yield of promising varieties and bold nut types

Genotype	Yield(kg/tree) in the 4th harvest	Cumulative yield of 4 harvests (kg/tree)
No.480	4.68	14.79
H 32/4	0.18	1.23
NRC 493	0.22	1.11
H 1616	0.13	0.78
Bhaskara	1.69	6.38
C.D @5%	0.77	
CV(%)	16.50	

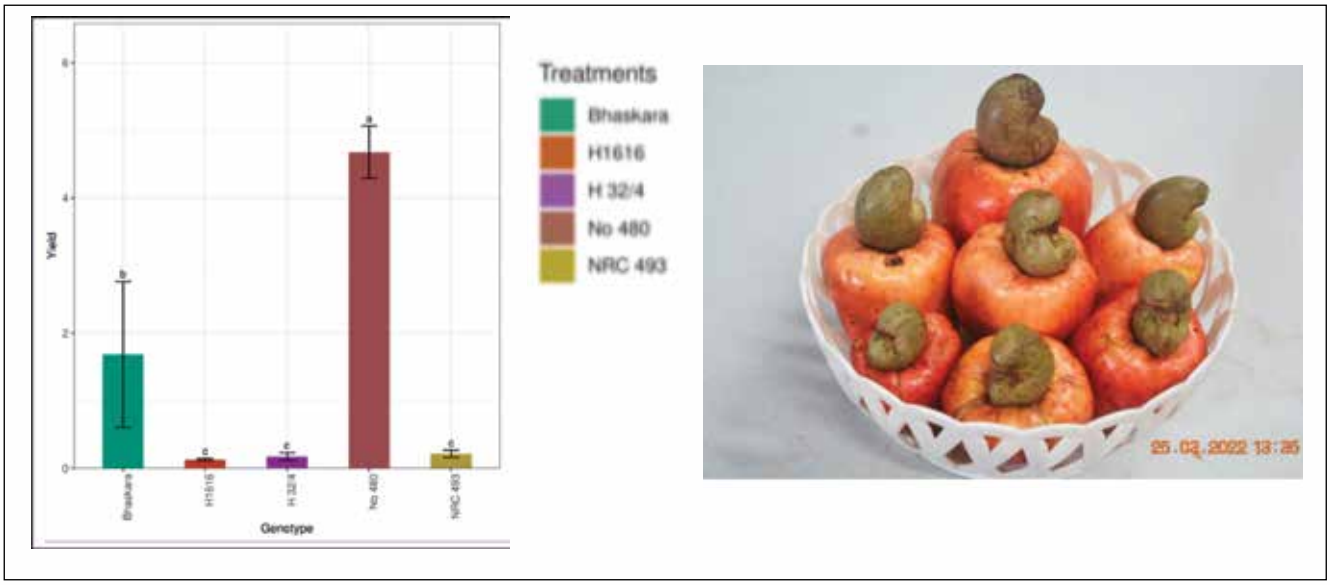


Fig. 3.1.20 No.480- A promising seedling selection

Quality parameters of big apple hybrid H-186

A big apple (90-100g weight) dual purpose hybrid, H-186, identified as a promising type was analyzed for quality parameters. The values of quality parameters are given below. The apples recorded vitamin C content of 142.75mg with an antioxidant activity of 209.25 mg AAE/ 100g.

Table 3.1.7. Quality parameters of big apple dual type cashew hybrid H-186

Parameter	Value
Vit C	142.75 mg/100g
Acidity	0.55%
TSS	11.20 degree Brix
Total phenols	237.8 mg GAE/100g
Total flavonoids	75.34 mg CE/100g
Total anti oxidant activity	209.25 mg AAE/100g
Tannins	4.5 mg/100g
Kernel Fat	48.08%
Kernel Protein	20.31%
CNSL (Raw nut)	19.60%

Fig. 3.1.21. Dual type big apple cashew hybrid, H-186 (center) flanked by VTH-174 on left and right

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. Open pollinated seed nuts from Nethra Ganga, Nethra Vaaman, Nethra Jumbo-1 were collected and sown to obtain 130, 180 and 7 healthy seedlings respectively. Observations on growth and dwarfing traits such as seedling height, length from cotyledon to first leaf, stem girth, intermodal length and total chlorophyll were recorded. All the seedlings were planted in the field in the augmented design during August 2022 at Shantigodu. The identity of numbering of seedling is maintained while planting to see whether effect of dwarfing traits in seedlings is retained in adult trees.

3.1.3 Development of polyclonal hybrids from core collections

At the Directorate, a core collection of cashew 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, we plan to collect seeds (arising out of random mating among core accessions) 10 each from 61 accessions for continuous three years. This will develop a total of 1830 seedling for three years, thus capturing the diverse progeny possible with the core collection. Accordingly, during the year 2022, we could collect 243 seeds from 15 accessions and these are sown in the nursery. The plants were planted in the main field in augmented design (four blocks) with checks such as Vengurla - 4 and Bhaskara.

Fig. 3.1.22 Polyclonal hybrid seedlings from core collections

3.1.4 Breeding approaches for developing Tea Mosquito Bug (TMB) tolerance

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 during the year following agronomic practices. In these seedlings, variations such as puckering of leaves, dwarfness, excessive branching was seen in some seedlings as in the last year. When the M1 generation seedlings are screened for TMB, it was found that out of 104 plants only 3 plants showed resistant reaction and 32 plants showed moderate resistant reaction. Others were in moderately susceptible and susceptible category. They will be further monitored for their reaction against TMB. Screening for TMB was accomplished in 57 core accessions during the year. Out of 57, 20 accessions were found to be in moderately susceptible category, 24 in moderately resistant, 8 in susceptible category and only 5 in resistant category according to the TMB damage scale. These accessions will be observed further for their reaction against TMB.

As for as screening of parent TMB tolerant (TMBT) genotype is concerned, the TMB incidence was very less during the year in the plot. Since TMBT plants are early flowering types, heavy infestation by flower caterpillars was noticed and flower drying was noticed in February-2022 itself. Not much variation was observed between TMB tolerant type and adjacent trees during this year. Since all the young plants of crosses of TMB tolerant plants showed Grade 4 under confined feeding test, further screening was not done at this stage. Screening will be taken up once flowering starts in these accessions. The next generation seedlings (M_2) from all these trees will be screened for TMB tolerance in the nursery. During the year, 57 M_2 seeds from 19 trees were collected and sown in the nursery. These will be screened for TMB in the ensuing season.

Table 3.1.8 : Scoring in Ullal-1 x *A.microcarpum*

Year	TMB grade (0-4)			
	TMBT1	TMBT2	Adjacent Tree 1	Adjacent Tree 2
2019-20	1.0	0.68	0.72	0.72
2020-21	1.78	1.65	1.40	1.28
2021-22	0.29	0.42	0.65	0.21

TMB Scale: Resistant: 0.0-1.0; Moderately Resistant: 1.1-2.0; Moderately Susceptible 2.1 – 3.0., Susceptible 3.1-4.0 Ullal -1 x A. *microcarpum*

Table 3.1.9 : Reaction of interspecific progrenies and core accessions to TMB

Accessions	Reaction
65 interspecific progenies	All Susceptible
57 core accessions	5 Resistant: 24 Moderately resistant: 20 Moderately susceptible 8 Susceptible

TMB Scale: Resistant: 0.0-1.0; Moderately Resistant: 1.1-2.0; Moderately Susceptible 2.1 – 3.0., Susceptible 3.1-4.0

Fig.3.1.23 No choice method of screening of interspecific progenies

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, seedlings and growing tips of mature trees of these two varieties are subjected to Colchicine treatment (details published in the annual report of 2021). It was observed that the mean germination percentage showed an increasing trend with the increase in percentage of Colchicine concentration in both varieties. Further,

the treated seeds showed more germination percentage compared to untreated ones and duration of treatment showed a corresponding decrease in germination percentage. However, statistical significance was observed only for varietal differences but not concentration, duration or interactions (data published in the annual report of 2021).

In seedlings when data was analyzed, there were no significant trends with respect to growth parameters (such as height, girth and cotyledon to first leaf length) in all the treatments across varieties. In other words, variable growth responses were seen with respect to different durations, concentrations of colchicine and varieties. However, few individuals in some treatments showed enhanced growth in terms of plant height, leaf length and width etc. A total of 458 plants (developed from treated seeds and seedlings) were planted in augmented block design (with six blocks) along with Bhaskara, Nethra Vaaman, Vengurla-4 as checks. It may be expected that some plants/progenies may have advantages such as high yield, improved nut and apple size etc. Suspected polyploids in main field will be subjected to flow cytometry studies.

Fig. 3.1.24 Seedlings from the treated seeds (some plants are showing enhanced growth)

Fig. 3.1.25 Twenty days old seedlings treated with colchicine

Fig. 3.1.26 Enhanced growth observed in some Bhaskara seedlings treated with 2% Colchicine with 24 hours duration

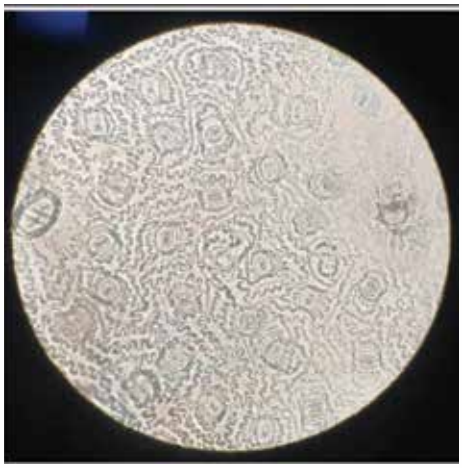


Fig. 3.1.27a Stomatal size in Nethra Vaaman variety treated with 1.5% colchicine and 72 hours duration under 40 x

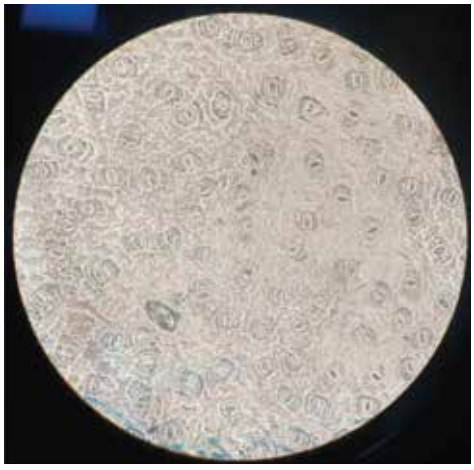


Fig. 3.1.27b Stomatal size in control of Nethra Vaaman variety under 40 x

Fig.3.1.28 Colchicine treated plants in the 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. 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 introgression of genes to dwarf and semi-dwarf accessions. In addition to per se evaluation, seedling selection will be done from these accessions for identification of dwarf types with high yield.

Fig.3.1.29 View of the dwarf variety trial

3.1.7 Breeding in Cashew for Special Traits

Experiment 1: Development of dwarf and compact cashew hybrids

Direct and reciprocal crosses

This approach was initiated in the year 2013 with hybridization between dwarf/compact but low yielding germplasm accessions and tall high yielding varieties. About 800 F1 seedlings of 15 crosses including direct and reciprocal were planted in the year 2013 at Shantigodu and among them 10 trees were selected based on cumulative nut yield and dwarf nature. They were multiplied clonally through grafting for planting in replicated trials. During this year, the grafts of selections along with parents and checks were planted in the field during August 2022 for evaluation with two replications. The list of selections, parents and checks planted is given in the Table 3.1.10.

Table 3.1.10: List of selections, parents & checks planted in the replicated trial

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

Fig.3.1.30 Field view of replicated trial with direct and reciprocal crosses selections, parents and checks

Backcross Progenies

In this approach, 471 back cross progenies were generated by back crossing either Bhaskara or Ullal-3 with semi-dwarf F_1 tree selected from cross between Bhaskara x NRC 492 and Ullal-3 x NRC 492. A total of 545 plants comprising 471 back cross progenies and 74 parent plants were planted during October 2014 at Shantigodu. This year observations on nut yield and growth traits as stem girth (cm), tree height (m), tree spread (m) and yield per tree (kg) were recorded in 6 selected trees. Among them Tree No.BDB-626-58 recorded highest annual nut yield of 2.81 kg while Tree No.BDB-626 -113 recorded second highest annual nut yield of 2.40 kg. For cumulative nut yield, Tree No.BDB-626-58 recorded the highest with 13.15 kg over 6 years. It is semi-tall with height of 4.75m and 6.5m average tree spread. Tree No.BDB-626-113 recorded second highest cumulative nut yield of 10.99 kg over 6 years. Grafts of 6 selected trees along with parents and checks were planted in the field during August 2022 with two replications (Fig.3.1.31). The list of selections, parents and checks planted is given in the Table (3.1.11).

Fig.3.1.31 Field view of replicated trial with backcross selections, parents and checks

Table 3.1.11: 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 work was initiated in the year 2017 to improve nut size of high yielding and cluster bearing varieties with medium and small nuts by crossing with bold nut genotypes. Overall, 408 seedlings of 15 crosses were planted in the year 2018 in augmented block design at Kemminje. 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 precocious types were recorded.

Fig.3.1.32 Growth observations in F1 seedlings of small nut x bold nut types

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. During the previous year, tannin content in cashew apples of trees of interspecific hybrids was estimated and some low tannin trees were identified. For reconfirmation, cashew apples were collected from trees of interspecific hybrids and samples were prepared for estimation of tannin content.

Experiment 4: Breeding for improving shelling percentage in HYVs

Three germplasm accessions viz., NRC 327, NRC 343, NRC 393 were selected from the cashew germplasm database. For confirmation, nuts of those accessions were collected and their shelling percentage was estimated. The shelling percentages of NRC 393, NRC 327, NRC 343 are 38.20%, 37.24%, 35.30% respectively. They are used for hybridization with high yielding varieties with low shelling percentage in the flowering season 2022-23.

Experiment 5: Breeding for improving nut weight in HYVs

Three germplasm accessions viz., NRC 183, NRC 402, NRC 383 were selected from the cashew germplasm database. For confirmation, nuts of accessions were collected and nut weight was estimated. The nut weights of NRC 183, NRC 402, NRC 383 are 14.3g, 13.2g, 12.78g respectively. They are used for hybridization with high yielding varieties with low nut weight in the flowering season 2022-23.

3.1.8 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. Land preparation including terrace making and digging of pits was done for planting. A total of 206 plants of all the six generations were planted in August 2022 in the field at Kemminje. The number of plants planted in each generation is presented in the Table (3.1.12).

Table 3.1.12: 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 F1	68
5	BC_1	F1 x Bhaskara	74
6	BC_2	F1 x NRC-492	37
Total			**206**

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

3.1.8 Genetic dissection of QTLs governing nut yield and Cashew Nut Shell Liquid (CNSL) content in cashew

Field planting of F_1 interspecific mapping populations:

Seedlings of NRC-392 (*A. microcarpum*) x Bhaskara (A. *occidentale*), NRC-142 (A. *microcarpum*) x NRC-153 (A. *othonianum*) crosses produced in the previous year were planted in the

Fig.3.1.33 Interspecific mapping populations planted in augmented block design

field at a spacing of 5x5 m and maintained well by removing the weeds and using of plant protection methods.

Hybridity testing in Interspecific hybrids using novel SSR markers:

Twelve SSR markers were used for screening of parent and the progeny of Bhaskara x NRC-142 (A. *othanianum*). Out of 12 screened primers, four primers i.e., P171, P211, P216, P237 showed polymorphism between DNA samples. Amplification profile of SSR primer 171 is shown in the Fig (3.1.34).

Fig.3.1.34 Gel image showing the hybridity test of Bhaskara x NRC-142 *(A. othanianum)* using SSR primer 171

External Projects

3.1.9 Development of morphological descriptors and DUS test guidelines for cashew

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. The application for NRC-492 (Nethra Vaaman), a novel dwarf variety of cashew recently released at the Directorate has been submitted for its registration in PPVFRA during the year 2021. Further, eight plants of this variety are planted adjacent to reference block for DUS testing. The attempts are under progress for registration of varieties from AICRP centers with PPV FRA, New Delhi. The application of Vengurla-9 variety from Regional Fruit Research Station, Vengurla, Maharastra which is an AICRP center under ICAR- Directorate of Cashew Research, Puttur was facilitated for registration with PPV FRA. Forty-four released varieties that are characterized for 68 characters are maintained in the National Cashew Field Gene Bank

Fig.3.1.35 H-130 (Nethra Ganga) plants under DUS testing

3.1.10 Establishment of Centre of Excellence of Biotechnology

In the Centre of Excellence of Biotechnology, new biotechnology and bioinformatics laboratories were established. In the biotechnology laboratory, specialized laboratory furniture (Central Island table, Wall tables, Seating stools, Reagent cupboard, Lab sinks), Tissue culture racks with controlled light conditions, specialized equipment (Real time PCR, Ultra low temperature freezer, Nano-spectrophotometer, Gel documentation system, Electrophoresis system (powerpack and gel tanks), Cell and Tissue homogenizer) and air conditioners were procured and installed.





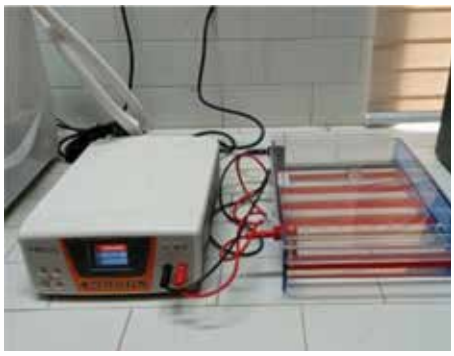



Fig.3.1.36 Lab furniture installed in the Centre of Excellence for Biotechnology

In the Bioinformatics laboratory, lab furniture, air conditioner and Work station (GSOS, NGS Pipelines, Intel Xeon Silver 10 Core, 128 GB DDR RAM, 12 TB SATA) with graphical user interface suitable for simplified NGS data analysis were procured and installed.

Fig.3.1.37 Work station

Genomic resources:

Genomics-assisted breeding assures efficient selections even at seedling stage thereby accelerating the cashew breeding schemes in the country. Genome annotations and KEGG pathway analysis was carried out (Fig. 3.1.38 & 3.1.39.). We have developed whole genome data of cashew and re-sequenced genomes of 20 cashew accessions to develop SNP and InDel markers for cashew.

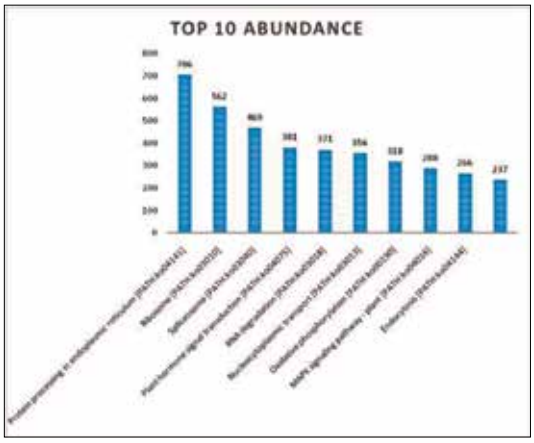


Fig. 3.1.38 KEGG pathway analysis for BD

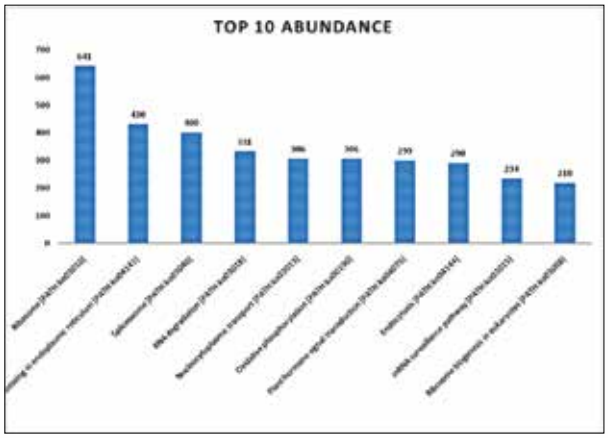


Fig 3.1.39 KEGG pathway analysis for H-130

Development of world's first genome wide microsatellites database CMDB

Considering the importance of SSR markers in enhancing the efficiency of germplasm management, genotype identification (fingerprinting) and Marker-Assisted Selection (MAS), a database of microsatellite/SSRs was thought out for cashew. The microsatellite/SSRs were discovered from the draft genome sequence of cashew generated at ICAR-Directorate of Cashew Research, Puttur, Karnataka, India by an in silico mining for SSRs. Cashew Microsatellite Database (CMDB) is a first microsatellite/SSR marker database for cashew or an *Anacardium* species based on whole genome SSR mining and it collection of over 46000 SSRs.

CMDB presents an interactive interface to query the microsatellite/SSRs information of cashew genome. CMDB allows users to obtain SSRs based on repeat size/length (in bp), repeat units (Nos); nature of repeat motif [Simple (perfect), Compound or Interspersed (imperfect)]; and sequence composition of repeat motif. CMDB provides the users with the list of SSRs with primer sequence, estimated PCR amplicon size and the estimated annealing temperature (Ta) as the output for all the in silico mined SSRs which makes the researchers' job easy (Fig. 3.1.40 & 3.1.41). CMDB also provides list of wet lab validated SSR markers also.

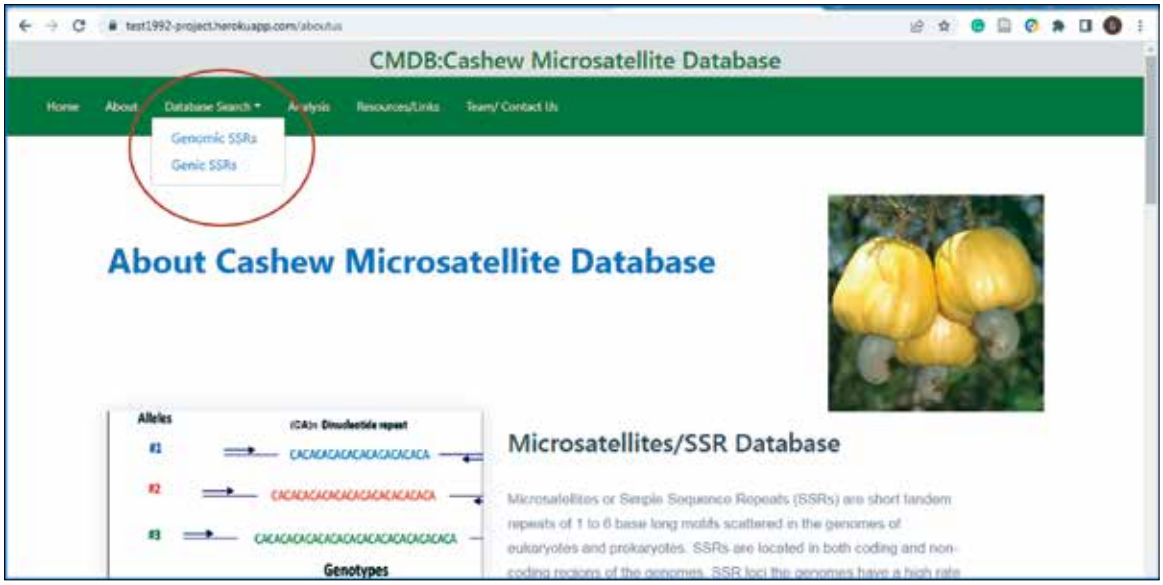


Fig.3.1.40 Database Search: Allows retrieving or searching of CMDB for both genomic and genic microsatellite/ SSRs

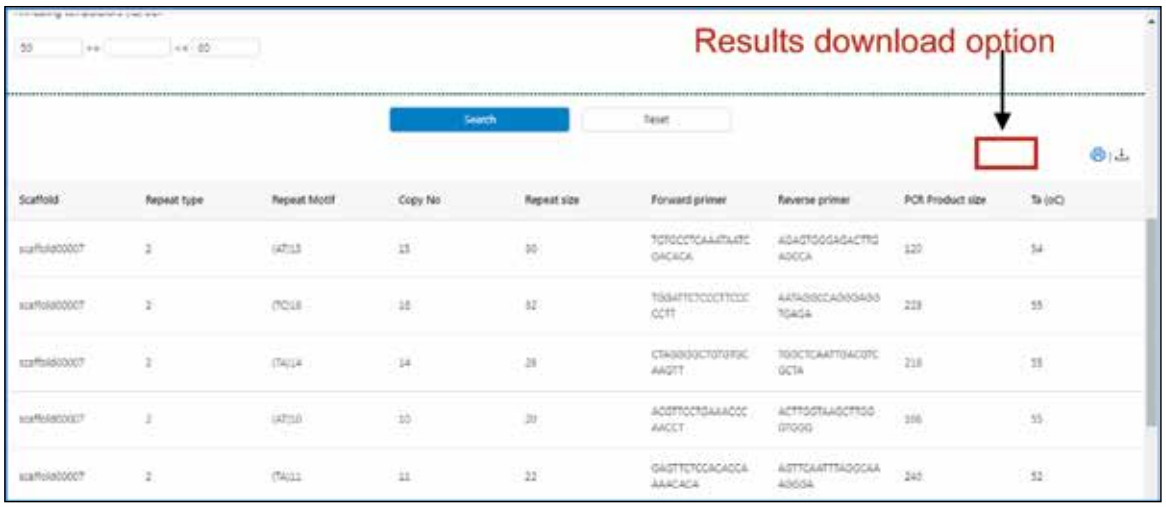


Fig.3.1.41 Results of the CMDB search for SSRs using multiple options at a time and there is option for download.

3.2 CROP MANAGEMENT

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 / ultra-density planting in cashew, the existing ultra-density plots of variety H-130 at 2.5 x 2.5 m spacing was selected. As per the response surface function approach of statistical analysis, 20 treatments comprising different combinations of N, P_2O_5 and K_2O were imposed. During the year 2021-22, the yield ranged from 1.04 to 1.97 kg/tree. The nitrogen content in leaf samples ranged from 1.13 to 1.75%, phosphorus from 0.12 to 0.19%, potassium from 0.46 to 0.81, calcium from 0.14 to 0.31%, and magnesium from 0.14 to 0.20%. The contents of micronutrients such as iron ranged from 32.20 to 99.88 ppm, Mn from 68.96 to 774.1 ppm, zinc from 9.22 to 16.66, and copper from 0.12 to 3.67.

3.2.2 Carbon cycling, sequestration and nutrient dynamics in cashew orchards

The biomass and carbon storage studies have indicated that, in one year old Ullal-3 cashew plantations, the aboveground biomass contributed to 0.42 t/ha of carbon with the CO_2 equivalent of 1.55 t/ha. With 0.27 t/ha of below ground carbon accumulation in 1 year old plantation of Ullal-3 and corresponding CO_2 equivalent of 0.98 t/ha, the total CO_2 equivalent of carbon sequestration was 2.52 t/ha. In case of the variety NRCC Sel-2, the first-year total biomass carbon sequestration in terms of CO2 equivalent was 1.05 t/ha. The carbon sequestration recorded for the variety Ullal-3, was 44.17, 70.94, 97.97 and 157.56 t/ha of CO2 equivalents respectively for the plantations of age 5, 10, 15 and 20 years. The corresponding values for the variety, NRCC Sel-2 was 22.79, 79.99, 108.00 and 184.99 t/ha of CO_2 equivalents for the plantations of age 5, 10, 15 and 20 years. The total carbon sequestered in soil ranged from 44.45 to 99.52 t/ha and 54.07 to 104.6 t/ha in plantations of different age groups.

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

Changes in pollen germination during flowering seasons

Pollen germination of VRI-3, Ullal-3 and vengurla-4 was also recorded at weekly interval during flowering season of January. The weekly pollen germination showed variable response with mean percentage of germination ranging from 46.2% to 63.4% for VRI-3, from 40.2% to 58.9% for Ullal-3 and from 37.8% to 50.2% for Vengurla-4.

The average pollen germination of the three varieties was low (41.4%) during first week of January with minimum temperature of 18.6°C. It increased to 46.5% in the second week with increase in minimum temperature to 19.2°C. Similar trend followed in the third week also where pollen germination increased significantly (51.9%) with rise in temperature (minimum and maximum of 19.9°C and 24°C).

The highest rate of germination of pollen was observed in the fourth and final week (57.5%) with minimum and maximum temperature of 20.3°C and 25.0°C. Pollen germination was also positively correlated to temperature (minimum, maximum and average temperatures) for early varieties in the present study.

Pollen germination rate was assessed for Bhaskara and Madakkathara-2 during March. The weekly pollen germination was highly variable exhibiting the opposite trend than that of early cashew varieties studied. Among the four flowering weeks studied in Bhaskara and Madakkathara-2, the pollen germination was highest (47.9%) during the first week of March followed by a noticeable reduction in the subsequent weeks while it was only 36.1% during final week of March.

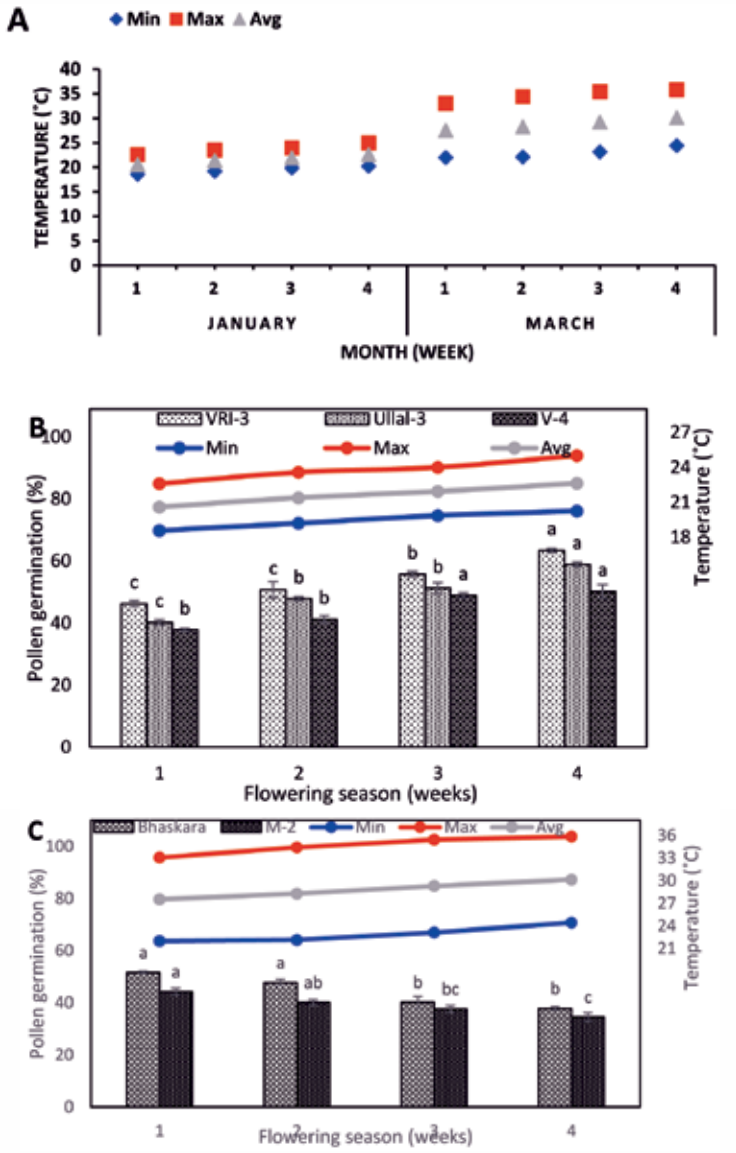


Figure 3.2.1 Germination percentage of five cashew varieties during flowering season.

In vitro pollen germination under controlled condition

At 5°C temperature, pollen germination was not seen. At 10°C, early varieties (VRI-3, Ullal-3 and Vengurla-4) showed germination rate of 4.3%, mid variety (Bhaskara) 1% and no germination for late variety (Madakkathara-2). In early varieties the germination was significantly ($p<0.05$) high at 20°C (59.3%), 25°C (75.2%) and 30°C (33.7%). Further increase in temperature reduced the germination rate was to 21.3% at 35°C, 4.4% at 40°C and no germination above 40°C for early cashew varieties. For mid variety Bhaskara also, the germination was significantly high at 25°C (45.6%), 30°C (57.8%) and 35°C (38.9%). However, it could exhibit relatively higher pollen germination (13.2%) at 40°C compared to early varieties, yet, percentage of pollen germination was significantly affected at temperature more than 45°C. Madakkathara-2 also followed the similar pattern as that of Bhaskara, where, the maximum pollen germination was noticed between 25°C to 35°C and very poor pollen germination beyond 45°C.

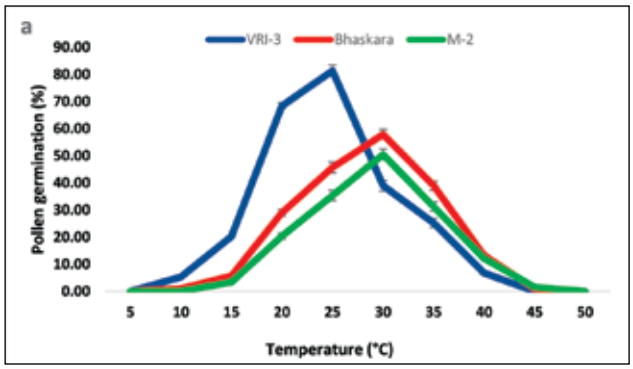


Fig. 3.2.2 Pollen germination of cashew varieties in response to temperature.

3.2.4 New project: Physiological and biochemical basis of salinity tolerance in cashew

Leaf necrosis

Seeds of eight cashew varieties viz., Ullal-3, Bhaskara, Madakathara-2, Vengurla-4, VRI-3, Ullal-1, Dhana and VTH-174 were raised in 5 kg capacity plastic bags containing mixture of soil, sand and cow dung (1:1:1 ratio) in poly house. Seedlings were watered twice a week with Hoagland solution and maintained up to 5 months. Before imposition of salt treatments, soil EC was measured in all the pots. After 5 months of growth, five different concentrations viz., 0, 100, 150, 250 and 350 mM of sodium chloride (NaCl) were imposed on raised cashew seedlings. Five seedlings were maintained for each cashew varieties per treatment. Significant differences in leaf necrosis rate (%) were observed at 250mM and 350mM salt treatments.

Fig. 3.2.3 Visual toxicity symptoms in cashew seedlings after different days of NaCl treatments

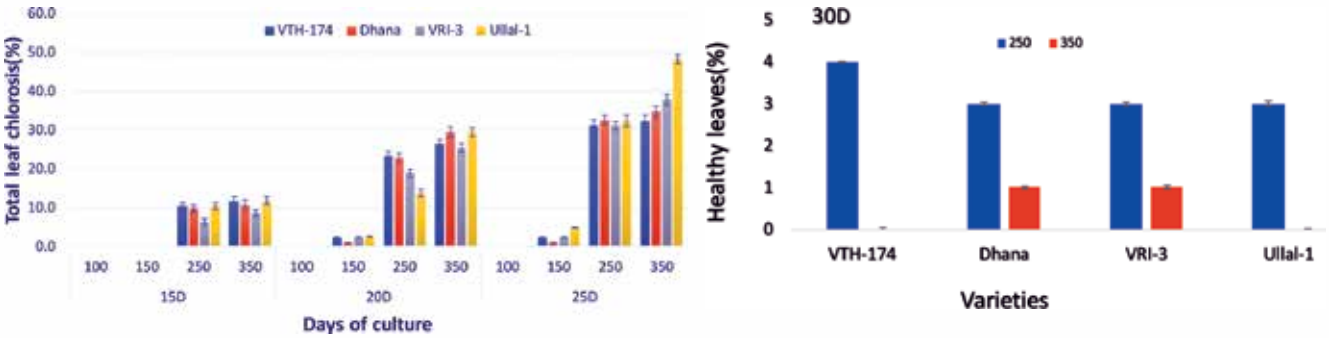


Fig.3.2.4 Leaf necrosis (%) rate after different levels of NaCl treatments

Ion accumulation

Potassium ion content decreased as the salt concentration increased with significant difference at 250 mM and 350mM.Sodium ion content increased with increasing NaCl levels with most significant increase at 250mM and 350 mM.

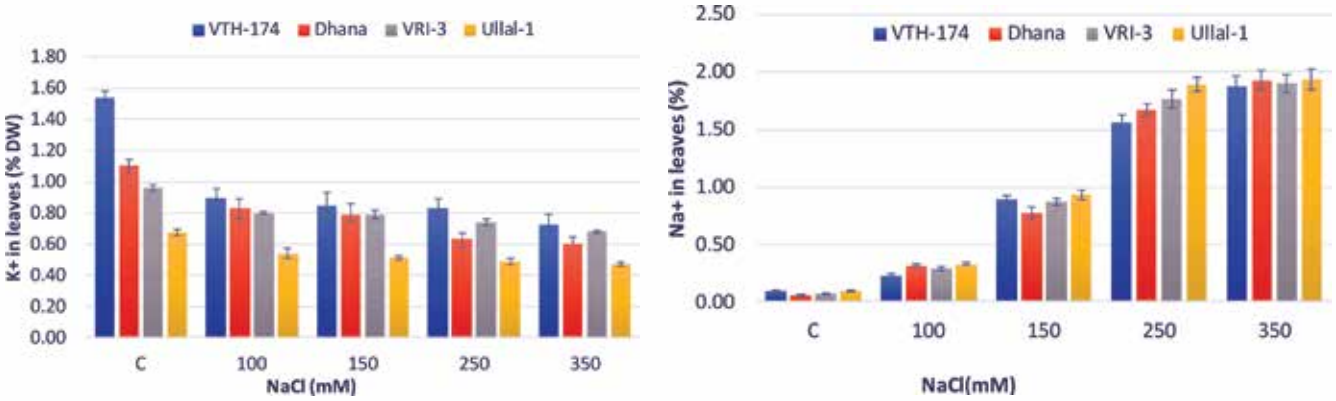


Figure 3.2.5: Potassium ion (K+) and sodium ion (Na+) accumulation in leaves of cashew varieties after different levels of NaCl

3.2.5 Cryopreservation and in vitro pollen germination studies in Cashew:

The present study aims at pollen germination *in vitro,* SEM studies, pollen cryopreservation and fruit set with cryostored pollen of cashew. Two different media at three different concentrations were tested, among which medium consisting of PEG was found to be the best for *in vitro* germination of cashew pollen. 15% PEG media elicited significant pollen germination in vitro. Madakkathara-2 recorded high viability profiles both with respect to fresh (90.32%) and cryopreserved (85.53%) pollen when compared to other genotypes and species. The pollen grains were cryopreserved for six months and post viability assessment was carried out at regular intervals. *In vivo* fertility assessment was carried out by field pollinations using fresh and four month cryostored pollen. Fruit set range of 13.17 to 30.67 per cent and seed germinability range from 37.75 to 63.64 per cent was recorded. The present study is the first report on the successful cryopreservation of cashew pollen.

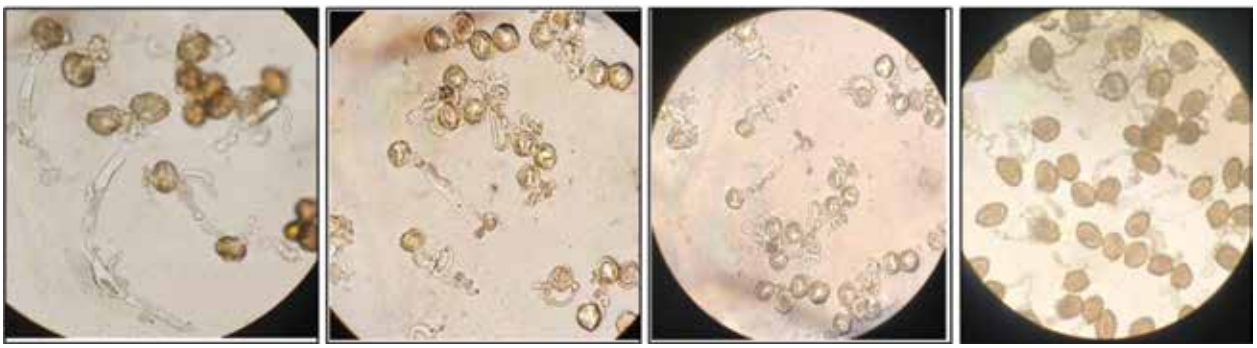


Fig.3.2.6 Invitro pollen germination of fresh and cryopreserved cashew pollen

Fig.3.2.7 Cryopreserved pollen set fruit in field condition

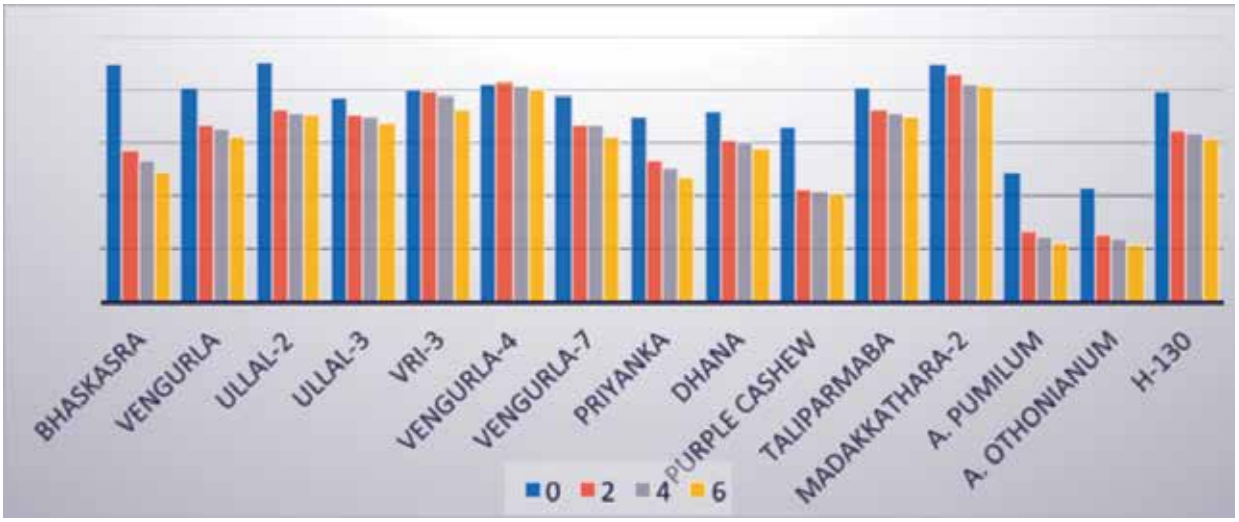


Fig.3.2.8 In vitro Pollen germination (%) after 2,4,6 months of cryopreservation

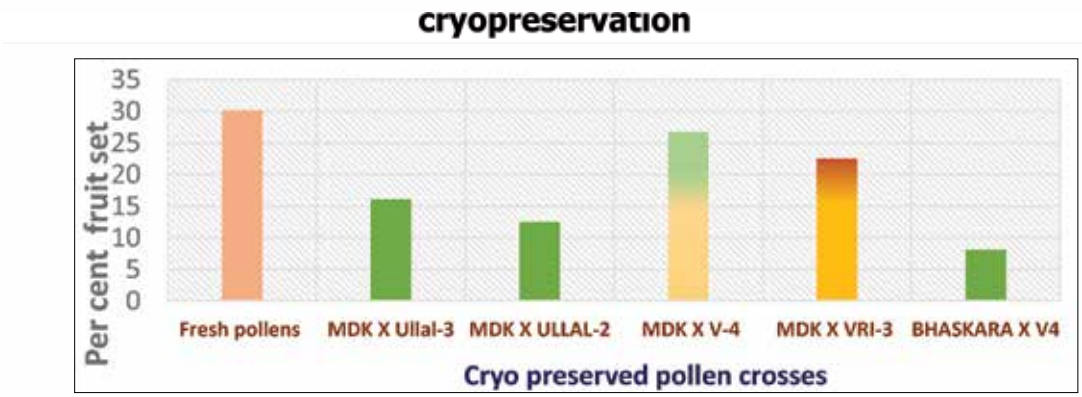


Fig.3.2.9 Per cent of fruit set obtained in different crosses of cryo preserved pollens

3.2.6 Evaluation of cashew apple genotypes for apple quality parameters

25 varied cashew genotypes were subjected for biochemical analysis *viz.,* total phenols, total flavonoids, tannins and carotenoids using spectrophotometer. The total phenols were varied from 179.08 to 720.02 mg GAE/100g, whereas the total flavonoids were ranged between 0.20 to 58.00 mg QE/100g and tannins were varied from 1.002 to 3.995 mg TAE/100g. Total carotenoids estimation was tried in cashew apple which showed significant variation of 0.15 to 2.52 mg/100g. The highest carotenoids content was observed in genotype 144 and the lowest was recorded in Priyanka.

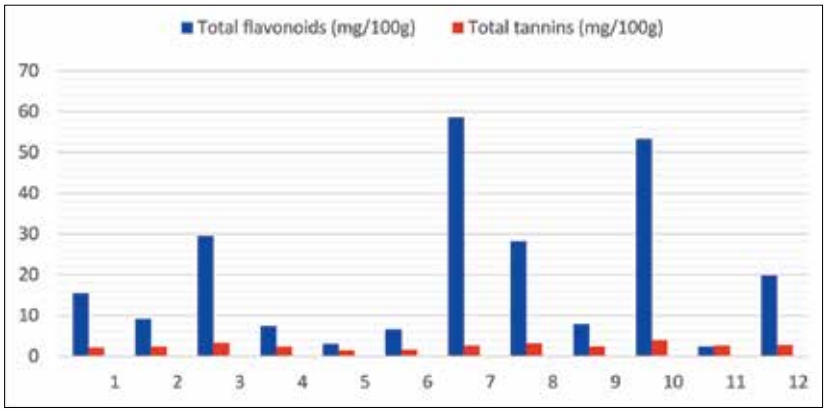


Fig.3.2.10 Total flavonoids and total tannin content of different genotypes

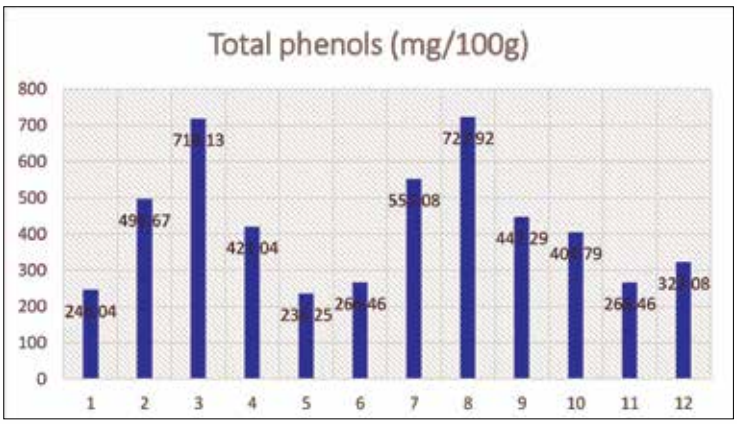


Fig.3.2.11 Total phenol content of different genotypes

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

This study mainly aims to understand the biosynthesis of some of the important bioactive components in different developmental stages of cashew. Total tannins, phenols, flavonoids were estimated in cashew apple phenological stages. During the initial growth phases the components analyzed were in high concentration whereas the graph started declining trend when cashew apple attains maturity. The components analyzed which were in bound and complex form during developmental stages breakdown and converted into other simple molecules. Therefore, at maturity stage it is comparatively less. This study is continued to analyze and understand the biosynthetic pathway involved in major bioactive components of cashew apple and nut.

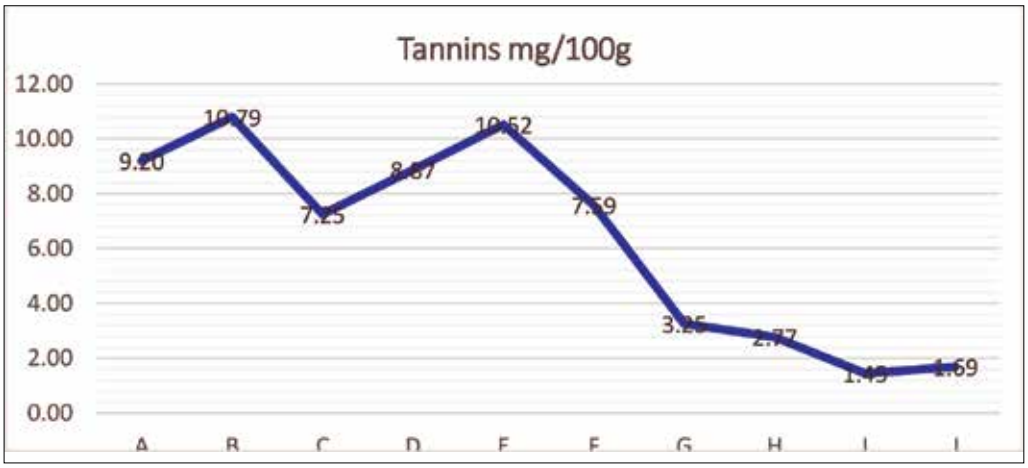


Fig.3.2.12 Total tannin concentration throughout the phenological growth stages of Cashew apple

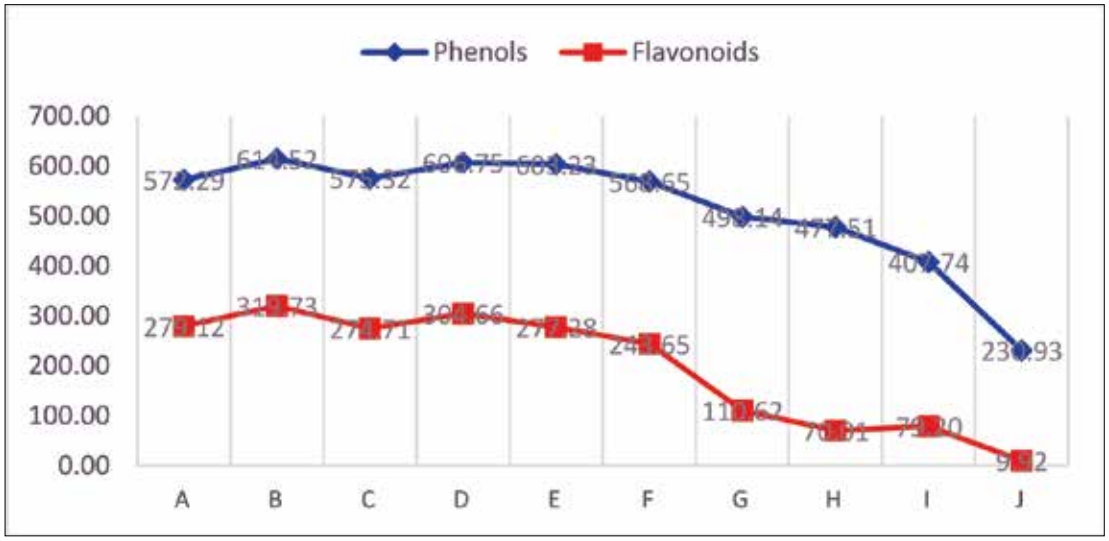


Fig.3.2.13 Total phenols and flavonoids concentration throughout the phenological growth stages of Cashew apple

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

The treatment details of this experiments are T_1- Control, T_2- Cashew + Mango, T_3- Cashew + Sapota, T_4- Cashew + Acid lime, T_5- Cashew + Mangosteen, T_6- Cashew + Rambutan and T_7- Cashew + Cover crop. The trial was replicated thrice under randomized block design. The cashew variety has been planted with the spacing of 10 x 5 m followed by different fruit crops were planted with the same spacing as inter crop. Stylosanthes humata was selected as cover crop and sown.

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

Experiment on Inter-stock studies in cashew initiated and main objective of this experiment was induce dwarfness in cashew by using different interstock like *Anacardium Pumilum*, Nethra vaman, Taliparamba, Vengurla 7 along with two control (V-4 and Bhaskara). In this study *Anacardium pumilum* grafting was not successful and mortality was more and other grafting were showing graft success at 90 days varied from 12.5-100 %, here we did second grafting as V4 and Bhaskara after second month of first grafting. Another set of grafting was also carried out by using interstock and scion simultaneously, here we used Nethra vaman and V-7 as Interstock and V-4 and Bhaskara as scion, in this study 4 different combinations were reported survival % varies from 40-85 % and in control it was recorded 86.67 %-96.67 % at 90 days after grafting (Fig. 3.2.14 & 3.2.15).

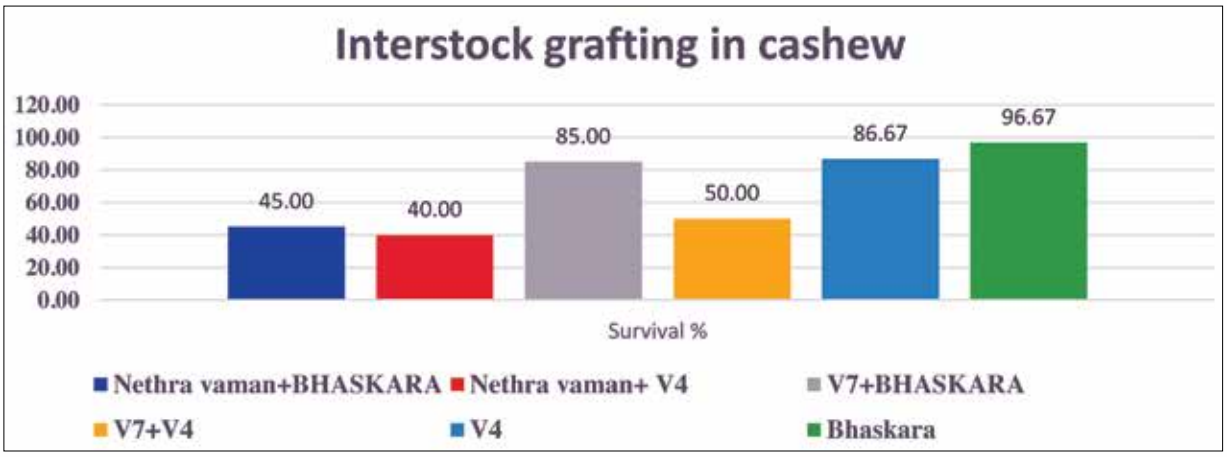


Fig.3.2.14 Survival percentage in interstock studies in cashew

Legends: a)Nethra Vaman + Bhaskara; b) Nethra Vaman + V-4; c) V-7 + Bhaskara; d)V-7 + V-4; e) V-4; f) Bhaskara

Fig. 3.2.15 Photograph of interstock studies in cashew

3.2.10 Influence of weather parameters on growth dynamics of apple and nut in selected varieties of Cashew

In the current study, by adopting the technique of the modified BBCH scale six varieties of cashew (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 (Table-3.2.1) and Bhaskara (719; Table-3.2.2).

Table 3.2.1 : Cashew apple and nut development in respect of BBCH scale in Var. Vengurla - 7

BBCH Code	Cashew apple			Cashew Nut		
	Length (mm)	Width (mm)	Weight (g)	Length (mm)	Width (mm)	Weight (g)
711	6.93	4.98	1.6	16.23	8.1	2
713	11.06	5.69	2.9	26.34	9.3	3.9
715	12.87	7.47	5.2	29.66	17.7	6.1
717	13.82	8.83	13.5	37.83	20.12	10.6
719	24.4	15.13	19.8	37	22.9	13.3
811	31.2	26.5	25.8	34.5	21.3	12.1
813	39.12	33.2	36.7	32.8	19.1	10.1
815	41.39	36.8	48.9	31.9	17.15	8.9
817	47.3	42.1	56.8	30.5	16.62	8.6
819	56.69	49.5	63.8	29.1	15.2	7.6

Table 3.2.2 : Cashew apple and nut development in respect of BBCH scale in Var. Bhaskara

BBCH Code	Cashew apple			Cashew Nut		
	Length (mm)	Width (mm)	Weight (g)	Length (mm)	Width (mm)	Weight (g)
711	5.33	3.78	1.6	17.5	7.4	1.8
713	9.46	4.49	3.1	27.3	8.8	3.5
715	11.27	6.27	5.4	29.66	16.9	5.7
717	12.22	7.63	12.3	37.83	19.25	10.2
719	22.8	13.93	21.2	37.1	21.3	12.9
811	29.6	25.3	29.8	36.6	20.3	11.7
813	37.52	32	38.5	34.9	19.6	10
815	39.79	35.6	46.8	34.2	18.5	8.8
817	45.7	40.9	56	32.6	17.8	8.2
819	55.09	48.3	63.2	31.2	16.6	7.2

3.2.11. IXX15634: Design, development and performance evaluation of cashew fruit and nut separator

The detachment force for separation of nut from the cashew apple/fruit was determined using a torque sensor with a 0.5 % accuracy for selected varieties at various phenological stages. The average force of fruit detachment was found to be in the range of 0.029 to 0.215 Nm at various phenological stages.

A prototype cashew fruit and nut separator was fabricated at ICAR-CIAE, RC Coimbatore. The developed prototype consisted of a main frame, electric motor, VFD, hopper, screw conveyor, first rotary module and secondary rotary module. The performance evaluation of the cashew fruit and nut separator was carried out at ICAR-DCR, Puttur. It was observed that, in the first rotary module nuts were damaged, chocking of cashew apple and nuts in the gap between the screw conveyor and the first rotary module, as well as between the first and second rotary modules, due to the larger gap between the modules and a greater number of blades. Influence of number of blades, gap between the rotary modules, operational speed and gap between the base cover and rotary module has to be investigated to improve the performance of the fruit and nut separator. In addition, based on the problems identified, the modification of the developed prototype is under progress.

Fig. 3.2.16 A View of cashew fruit & nut separator in operation

3.2.12 IXX15635: Design and development of gadgets for cashew fruit harvesting and collection

Commercially available fruit harvesters used in other fruit crops like mango were evaluated for harvesting in cashew. However, the commercially available harvesters were found not suitable for cashew fruit harvesting because these are pulling type harvesters and in cashew, they resulted in breaking at the points of the primary and secondary laterals of the panicle. Breaking at these points results in harvesting of immature fruits also. In cashew fruit harvesting, breaking point should be the point of fruit attachment. In this study, we determined that the force required to dislodge a mature cashew fruit was very low and a low-speed vibration/shacking of panicle using novel battery-operated harvester was shown to dislodge the fruits.

The fruit detachment force from the panicle stalk was determined using load cell with computer interface in 10 selected varieties at ten phenological stages of cashew fruit development. The force required to separate the fruit from the stalk ranged from 1.42 to 17.27 N for different phenological stages. A battery-operated telescopic cashew fruit harvester was developed. The harvester consisted of a lightweight aluminum base pipe of 34 mm Ø and an extension pipe of 25 mm and 19 mm Ø, fruit receiving bowl (305 mm Ø) and a flexible chute (LDPE pipe of 101 mm Ø) to convey the harvested fruits to the collection unit,12V battery, DC motor and switch. The overall length of the harvester is 18 ft and weighs 2.79 kg. The main objective of battery-operated cashew fruit harvester is to enhance speed of operation and comfort of an operator. Performance evaluation of the developed harvester indicated that the average harvesting capacity of 44 kg h^{-1} without fruit damage as the fruits are conveyed instantly through flexible chute to the collection unit. The developed harvester is light in weight, minimizes fruit damage and eliminates repeated unloading of fruits, all of which contribute to a reduction in the load on hand and thereby reduces the drudgery involved in harvesting.

A commercially available fruit collector was evaluated to check its suitability for collecting the cashew apple & nut in the cashew orchard. Performance evaluation of the roller-type fruit collector indicated that the average collection capacity of 55 to 60 kg h^{-1}. The picking efficiency of the collector ranged from 77 to 94.29 % and percentage of debris was fond to be <1%. A jaw type cashew fruit and nut collector has been developed based on the physical properties of the cashew apple and nut. The detailed drawing of the hand-held cashew fruit and nut collector is prepared using SolidWorks software. The prototype consisted of main handle, guiding handle, side covers and spring mechanisms. Performance evaluation of the jaw-type fruit collector indicated that the average collection capacity of 26 kg h^{-1} depending on the density of fruits. The picking efficiency of the collector ranged from 93 to 97 % and percentage of debris was fond to be <3%.

Fig. 3.2.17 A view of Battery-operated telescopic cashew fruit harvester

Fig. 3.2.18 A view of Roller-type fruit collector

Fig. 3.2.19 A view of Jaw-type fruit collector

External Project:

3.2.13 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-RAFTAAR

Various Equipment for laboratory such as extrusion machine, moisture analyzer, PCR thermal cycler, respiratory analyzer was purchased and installed successfully. The online and offline training programmes was conducted for 100 number of youths from different parts of Karnataka.

Infrastructure development

Sl. No.	Equipment
1	Electronic platform scale
2	Extruded machine and associated components
3	IR moisture meter
4	Ethylene analyser
5	Respiratory analyser
6	Deep freezer
7	Centrifuge
8	PCR for food safety test
9	Fumehood
10	Hot air oven
11	Electronic balance
12	Mixer grinder
13	Refrigerator
14	Hot plate-cole parmer
15	Hotplate-Tempo
16	Video conferencing facility for the Silver Jubilee Building
17	Double screw extruder machine
18	Pulverizer and blender
19	Tray drier
20	Flour mixer

Fig. 3.2.20 Extruder Unit Established

Establishment of Centre of Excellence for profiling of bioactive components in Cashew apple and nut

To create modern state of art facilities needed for faster and efficient selection in cashew and also for advanced research programmes for quantification of bioactive components in cashew apple and nut this project has been proposed and accepted by RKVY. The procurement of High-pressure liquid chromatography mass spectrometry, Gas chromatography mass spectrometry, Double beam UV-visible spectrophotometer tender procedure was completed and the purchase order has been issued to the identified firm through GEM.

3.3 CROP PROTECTION

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

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

Various universal solvents generally used for electroantennogram (EAG) trials viz., di-chloro methane (DCM), Z-3 Nonanol, E-3 Hexenol, Z-3 Hexenol, Benzene-acetaldehyde, Z-3 Hexyl acetate were tested for their efficiency and uniformity in inducing antennal response at ICAR-NBAIR, Bengaluru. These solvents were prepared for testing at 10ppm and the thin strips of approximately 2-3 mm strips were used for evaluation. The strips were dipped in the respective solvent and placed in the air puffing tube of the EAG and a puff of air was passed over the antennae mounted on to the electrodes. Antennae of the adult insects [aged 4-5 days] of both the males and females of TMB which were reared in the laboratory were used for the evaluation. It was noticed that all the solvents with the exception of di-chloro methane (DCM) lead to quick antennal fatigue and the antenna lost responsiveness in 5 to 10 minutes. Though all the solvents significantly stimulated the excised antenna; it was seen that the SEm was lowest for DCM which could induce a normal level of response and the antennae retained their responsiveness beyond 20 minutes. This confirmed that the best solvent for elution of the sex pheromone volatiles of TMB was DCM.

Currently the virgin calling females of TMB are utilised for volatile collection by live suction method and the adsorbents used are Tenax and Poropak.

Table 3.3.1 Response of antennae of TMB males to various solvents:

Test Solvents	Mean Response	Mean Response	SEm
DCM	0.0566	0.0481	0.0102
Z-3 Nonanol	0.2727	0.3442	0.1325
E-3 Hexenol	0.4178	0.2700	0.1483
Z-3 Hexenol	0.1068	0.1060	0.0570
Benzene-acetaldehyde	0.0736	0.0700	0.0347
Z-3 Hexyl acetate	0.1997	0.1532	0.0689

Table 3.3.2 Response of antennae of TMB females to various solvents:

Test Solvents	Mean Response	Mean Response	SEm
DCM	0.0410	0.1480	0.0166
Z-3 Nonanol	0.2988	1.2852	0.1294
E-3 Hexenol	0.4568	1.5091	0.1436
Z-3 Hexenol	0.1567	0.3812	0.0484
Benzene-acetaldehyde	0.1215	0.3731	0.0372
Z-3 Hexyl acetate	0.2648	0.7770	0.0634

In order to confirm the stability of the volatile compounds of virgin TMB female which were tested as whole body extracts [WBE] the samples of such WBE extracted and stored for approximately 10 months were placed as baits in the cylindrical sticky traps designed at this Directorate. These traps were placed in cashew plots with minimum incidence of the TMB and observed at hourly intervals from 9.00 am till 3.00 pm. It was noticed that the WBE bait could still attract males of TMB in about 1 -2 hrs after placement. However, the number of TMB males trapped was a maximum of 4 males / trap which endorses the earlier observations wherein similar response was noticed during 2020.

Fig. 3.3.1 Males of TMB attracted to WBE (>10 months old)

3.3.2 Inflorescence pests of cashew and their management

Pest incidence and extent of damage

A total of 67 species of insects have been documented on cashew flowers from 2016-2021. The common inflorescence caterpillars recorded include *Hypatima haligramma, Thylacoptila paurosema, Lamida moncusalis, Anarsia* sp., *Archips* sp., *Hyposidra* spp., *Nanaguna* sp., *Perixera* sp., *Bombotelia jocosatrix* etc in the order of abundance in general, but the relative abundance varied between years. Working out the pest status and estimating yield loss due to a particular species was difficult under field conditions as complex of caterpillars up to five different species do occur on same inflorescences. Documentation of flower pests of cashew was continued during 2022 also. During March 2022, flower damage by Anarsia sp. was more in medium and late flowering varieties in few cashew plantations of ICAR-DCR, Puttur. The infested inflorescences exhibited extensive drying of flowers (Fig. 3.3.2), and as a result up to 30 % reduction in nut set was noticed in MDK-2 cashew variety compared to uninfested ones in a plot. But incidence of *Perixera* sp., *Nanaguna* sp., *Archips* sp. and other caterpillars was minimum during 2022. The incidence of *Citripestis eutraphera* M., a new emerging pest as apple and nut borer of cashew was also noticed on the developing cashew apples and nuts at Puttur this year.

Larva of *Anarsia* sp. on cashew flowers

Drying of flowers due to *Anarsi*a sp.

Reduced nut set in damaged inflorescence

Fig 3.3.2 Flower drying due to caterpillar damage

The flower thrips recorded during April 2022 include, *Haplothrips ganglbaueri* Schmutz, *Scirtothrips dorsalis* Hood, *Thrips palmi* (Karny) and Indothrips bhushani Bhatti in different plots of ICAR-DCR, Puttur. Among all, *H. ganglbaueri* was the abundant species recorded, while, *I. bhushani* was noticed on cashew flowers for the first time, but only one specimen of it was collected out of 100 inflorescences.

New report of *Senometopia quarta* (Baranov) on *Perixera* sp. from India

The tachinid parasitoid emerged out of the pupae of Perixera sp. during 2021-22 was identified at NBAIR, Bengaluru as *Senometopia* quarta (Baranov) which belongs to the tribe Eryciini in the subfamily, Exoristinae. Senometopia quarta. This tachinid is recorded for the first time from India and its occurrence on *Perixera* sp. is a new host record. Further, amplification of mt DNA COI gene of the parasitoid was done at NBAIR, and the sequence was deposited in NCBI GenBank and the accession number obtained was OM371064.

Management measures

A field trial was conducted to test the efficacy of aqueous leaf extracts of certain plants, Bt formulation, Emamectin benzoate, potassium silicate along with lambda-cyhalothrin 5 EC @ 0.6 ml/L against tea mosquito bug and inflorescence caterpillars. Among the treatments, spraying of lambda-chalothrin at 15 days interval was significantly superior in managing TMB as well as the caterpillars followed by sprays at monthly interval. The biopesticides like emamectin benzoate and Bt @ 1g/L were moderately effective on caterpillars when sprayed thrice at 15 days interval, but aqueous leaf extracts of Pongamia, neem, Clerodendron, Clerodendrum and Vitex were not found effective on TMB as well as the inflorescence caterpillars.

Tale 3.3.3. Efficacy of biopesticides, botanicals, potassium silicate and insecticides against TMB and inflorescence caterpillars

Treatments	Dose	TMB		Inflorescence Caterpillars	
		Pre treatment	7 days after 3rd spray	Pre treatment	7 days after 3rd spray
Neem azal (Azadirachtin 0.15% EC)	7.5 ml/L	0.34	0.98 (0.98)^{b}	0.48	0.77(0.87)^{de}
***Pongamia* sp. + *Vitex* sp. leaf extract**	25+25 g	0.42	1.19 (1.09)^{cde}	0.48	0.77(0.88)^{de}
***Clerodendron*+ *Clerodendrum* (dried leaf powder)**	25+25 g	0.25	1.21 (1.10)^{cde}	0.31	0.67(0.81)^{cd}
***Clerodendrum* - fresh leaf extract**	50g/L	0.28	1.44 (1.20)^{cd}	0.31	0.69(0.83)^{cde}
***Clerodendron* – fresh leaf extract**	50g/L	0.21	1.17 (1.07)^{de}	0.35	0.79(0.88)^{de}
Bt Kurstaki Serotype III	1 g/L	0.27	1.36 (1.16)^{e}	0.33	0.52(0.72)^{bc}
Emamectin benzoate 5 % SG	1 g/L	0.42	1.23(1.10)^{cde}	0.29	0.40(0.63)^{b}
Potassium silicate (Foliar spray)	2 ml/L	0.27	1.50 (1.23)^{de}	0.38	0.94 (0.97)^{e}

Potassium silicate (Foliar spray)	3 ml/L	0.28	1.44 (1.20)^{de}	0.27	0.75(0.86)^{cde}
Lambda cyhalothrin 5 EC (15 d interval)	0.6 ml/L	0.42	0.23 (0.47)^{a}	0.44	0.15(0.37)^{a}
Lambda cyhalothrin 5 EC (1 month interval)	0.6 ml/L	0.36	0.92 (0.96)^{b}	0.38	0.56(0.75)^{bcd}
Untreated Control	-	0.42	1.25 (1.12)^{cde}	0.38	0.73(0.85)^{cde}
CD (5 %)	NS		0.167	NS	0.145

(Figures in parenthesis are square root transformed values).

Similarly, a laboratory trial was taken up to check the efficacy of insecticides and biopesticides against larvae of *Anarsia* sp. After 24 hours of treatment (HAT), maximum mortality (96 %) was recorded under both lambda cyhalothrin 5 EC @ 0.6 ml/L and Fipronil 5 SC 2 ml/L treatments followed by Bt Kurstaki (88 %) and emamectin benzoate (58 %). But, neem azal did not induce more than 10 % mortality in the larvae of *Anarsia* sp. until 24 hours of treatment

Cashew - tea mosquito bug interactions and the defensive responses

a. Influence of foliar nutrient sprays on TMB infestation

Seven nutrient treatments including K_2SO_4 (1.5 %), KNO_3 (1.5 %), MPP (1.5 %), B (0.1 %), Zn (0.5 %) and $MgSO_4$ (0.2 %) and their combinations as in Table 3. were taken up in a cashew experimental plot at ICAR-DCR, Regional station, Shantigodu, where TMB is of regular occurrence. Trees of three cashew varieties viz., Ullal-4, Dhana and Bhaskara were selected randomly and three rounds of foliar nutrient sprays were done at monthly intervals starting from November, 2021 till January 2022. Three replications were maintained for each treatment.

TMB incidence was less during November, 2021, and it was moderate during January 2021 in the plot. After three rounds of sprays, none of the nutrient treatments tested were found effective in reducing TMB damage when compared to the insecticide, lambda cyhalothrin 5 EC. Overall, TMB damage grade varied from 0.39 to 2.5 in the individual treated trees after third spray. The pooled mean TMB damage grade of three cashew varieties viz., Ullal-4, Dhana and Bhaskara varied from 0.40 to 1.86. Among the nutrient treatments, the pooled damage grade was less in K_2SO_4+$MgSO_4$ treatment (1.28), while it was high in the trees sprayed with mono potassium phosphate (MPP) @ 1.5 % (1.64). A spray with lambda cyhalothrin was taken up throughout the plot during first week of March 2021 as there was high TMB population.

Table 3.3.4 Influence of nutrient treatments on TMB damage in cashew varieties

Treatments	Dose	Mean TMB damage grade			
		Ullal-4	Dhana	Bhaskara	(Pooled)
K_2SO_4	1.50%	(2.22)^{bc}	(1.17)^{bc}	(1.08)^{b}	(1.42)^{b}
KNO_3	1.50%	(2.17)^{bc}	(1.14)^{bc}	(1.03)^{b}	(1.45)^{b}
MPP	1.50%	(2.50)^{c}	(1.56)^{c}	(0.86)^{b}	(1.64)^{bc}
K_2SO_4+B+Zn	1.0+0.1%+0.5%	(1.89)^{bc}	(1.67)^{c}	(1.00)^{b}	(1.52)^{bc}

Treatments	Dose	Mean TMB damage grade			
		Ullal-4	Dhana	Bhaskara	(Pooled)
K_2SO_4	1.50%	$(2.22)^{bc}$	$(1.17)^{bc}$	$(1.08)^{b}$	$(1.42)^{b}$
KNO_3	1.50%	$(2.17)^{bc}$	$(1.14)^{bc}$	$(1.03)^{b}$	$(1.45)^{b}$
MPP	1.50%	$(2.50)^{c}$	$(1.56)^{c}$	$(0.86)^{b}$	$(1.64)^{bc}$
K_2SO_4+B+Zn	1.0+0.1%+0.5%	$(1.89)^{bc}$	$(1.67)^{c}$	$(1.00)^{b}$	$(1.52)^{bc}$
K_2SO_4+$MgSO_4$	1.5%+0.2%	$(1.79)^{b}$	$(1.11)^{bc}$	$(0.88)^{b}$	$(1.28)^{b}$
B+Zn+$MgSO_4$	0.1%+0.5%+0.2%	$(2.13)^{bc}$	$(1.40)^{c}$	$(1.98)^{c}$	$(1.94)^{c}$
K_2SO_4+ L- cyhalothrin 5 EC	1.0%+0.003 %	$(0.40)^{a}$	$(0.41)^{a}$	$(0.50)^{b}$	$(0.43)^{a}$
L- cyhalothrin 5 EC	0.003%	$(0.42)^{a}$	$(0.41)^{a}$	$(0.39)^{a}$	$(0.40)^{a}$
Control	-	$(2.89)^{c}$	$(1.78)^{c}$	$(2.50)^{c}$	$(1.86)^{c}$
	CD (5%)	0.67	0.78	0.79	0.47

Nut weight was more in the trees that received combination spray of K_2SO_4+$MgSO_4$ in Bhaskara and Ullal-4, whereas, it was high under K_2SO_4 in Dhana. Number of harvested nuts per tree pooled over three varieties was high (210 Nos) in the insecticide treated trees followed by combination spray of lambda cyhalothrin and K_2SO_4 (197 nos) as against 95.2, 99.11 and 108.7 nuts, respectively in the control, KNO_3 and MPP treated trees. Besides, physical parameters and shelling percentage of nuts under different treatments showed significant differences.

b. Influence of plant growth regulators in the TMB infested plants

To find out the influence of plant growth regulators on TMB infestation, a set of seven treatments viz., NAA @ 20 and 40 ppm, GA3 @ 25 and 50 ppm, BAP @ 75 and 100 ppm as foliar sprays and the mechanical removal of shoot tip as control was imposed on to the TMB infested 4-months old cashew seedlings. The regrowth pattern especially the new shoot emergence was observed after 20 days of spray. Though time taken to produce new shoots after TMB damage was almost same among all the treatments, number of shoots produced was more in GA3 treated seedlings (Fig. 3.3.3). Field trial indicted that sprays of plant growth regulators on the severely infested trees of cashew variety Bhaskara during February, 2022 did not show any difference in flushing pattern compared to untreated ones.

Fig 3.3.3. Appearance of new shoots in TMB infested seedlings

C. Herbivore induced plant volatiles (HIPV)

To understand the role of HIPVs for tea mosquito bug in cashew, a study was taken up in collaboration with 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 healthy plant volatiles were collected using 'Air entrainment method' (Fig. 3.3.4) in Porapak -Q® column. The column was subsequently eluted with diethyl ether solvent. In the same way, plant volatiles were collected after 24 hours of TMB feeding.

Fig 3.3.4. Set up for collction of HIPVs

The chromatograms of the eluted volatiles were quite different for both the varieties. Similarly, the volatile profile was different for healthy and TMB infested plants in both the varieties. The chromatogram of volatiles collected from healthy and infested Bhaskara plants are shown in Fig. 3.3.5. Electro-antennogram studies indicated more response of female TMB antenna to HIPVs than the volatiles from healthy plants. The confirmation studies and bioassays will be taken up in the forthcoming season.

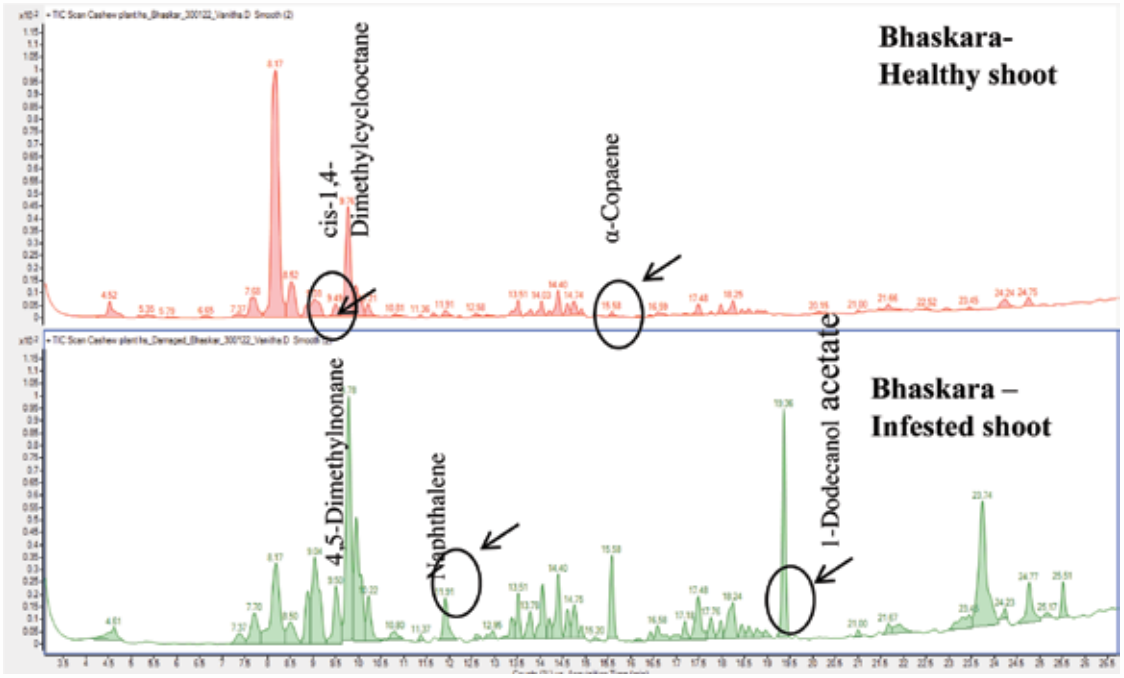


Fig. 3.3.5. Chromatogram of plant volatiles of healthy and TMB infested Bhaskara plants

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

Pollination efficiency studies

Pollination efficiency of three bee species viz., *Braunsapis mixta*, *Tetragonula iridipennis* and *Apis cerana indica* was assessed in VRI-3 plants in comparison to open pollinated trees. Bee confinement method was adopted, where whole cashew trees which were in 20-30% flowering stage were covered securely with fine mesh nylon net cage during 1st week of January and the bee hives were kept inside (Fig. 3.3.6). For *B. mixta*, a single tree was confined with artificial bee nest having approx. 130 active nests. For *T. iridipennis*, a single tree was covered with a small stingless bee colony, and for *A. cerana indica*, two trees were covered with net cage and a three framed bee colony was kept inside. Sugar feeding was done at weekly intervals for the honey bees to supplement its food requirement.

Observations indicated that all the three bee species actively foraged on cashew flowers even under confinement and successfully pollinated the cashew flowers. Number of nuts set/tree was 257, 333 and 167 in the cashew trees confined with colonies of T. iridipennis, B. mixta and Apis cerana indica, respectively. Whereas, the number of nuts set/tree in open pollinated trees was 320 - 415 nos/ tree, because in nature more bees shall visit same flower and multiple bee species shall visit the flowers that might lead to higher nut set. On the other hand, out of 30 inflorescences that were caged throughout the flowering period without bee visits, only three nuts were harvested indicating the need of flower visitors for more pollination in cashew.

Fig 3.3.6. Net caging of cashew trees and inflorescences for pollination efficiency studies

Under open field conditions, in a cashew plantation where A. cerana indica colonies were kept @ 4 /ac, no significant difference in number of bee visits was observed in the cashew flowers compared to the plots without bee colonies, because honey bees foraged on other flora also. Further, the plots without bee colonies also had bee visits from the feral colonies. In the forthcoming season, higher number of colonies will be kept in the cashew plantations and the bee visits will be recorded.

Distribution, viability and germination of pollen grains collected on bee body parts

Distribution of pollen grains on the body parts of bee species indicated more pollen grains in the hind legs in all the three bee species examined as follows.

- *A. cerana indica* : hind legs >middle legs > forelegs > head > thorax > abdomen
- *B. mixta* : hind legs > thorax > abdomen > middle legs > head > forelegs
- *T. iridipennis* : hind legs > thorax > middle legs > fore legs > head > abdomen

After 24 hours, the mean pollen viability was high (89.5 %) for the pollen grains collected from cashew flowers, and it was 84.63, 83.5 and 71.93 % for the pollen grains collected from the hindlegs of *B. mixta, T. iridipennis* and *A. cerana* indica, respectively. After 72 hours, the viability has reduced drastically to 11.87 % for the pollen grains collected on flowers, and to 9.00, 8.5 and 4.17 % for the pollen grains adhered on *B. mixta, T. iridipennis* and *A. cerana indica*, respectively. Similarly, pollen grains collected from flowers showed 77.33 % germination after 24 hours of collection, while germination was 66.33, 60.37 and 45.6 % for the pollen grains adhered on *B. mixta, T. iridipennis* and *A. cerana*

indica, respectively. Observations taken at 48 hours of collection showed that germination percentage fell below 10 % in all the samples.

The preliminary observation involving hand pollination of hermaphrodite flowers using pollen grains collected on body parts of all three bee species resulted successful pollination and nut set during April 2022.

Zodiomyia sp. – a parasitoid of *B. mixta* and its hyperparasitoid

Observations in the artificial bee nests of *B. mixta* developed at ICAR-DCR, indicated that the adults of *B. mixta* are parasitized by the Conopid flies belonging to the genus, *Zodiomyia* (Conopidae), as identified at NBAIR, Bengaluru (Fig. 3.3.7 a). The pupae of parasitoids were collected at 3 - 4 days intervals from the artificial bee nests and kept under laboratory conditions to record the emergence period of adult parasitoids and hyperparasitoids, if any (Fig. 3.3.7 b). The maximum emergence period for adults recorded was 26 days during September, 2022. Besides, hyperparasitoids belong to Eulophid family emerged out of the conopid pupae (Fig. 3.3.7 c). These parasitoids stayed alive up to 11 days under laboratory conditions when provided with cotton swab soaked with honey 10 %. The extent of hyperparasitism was < 1 % in the Conopid pupae.

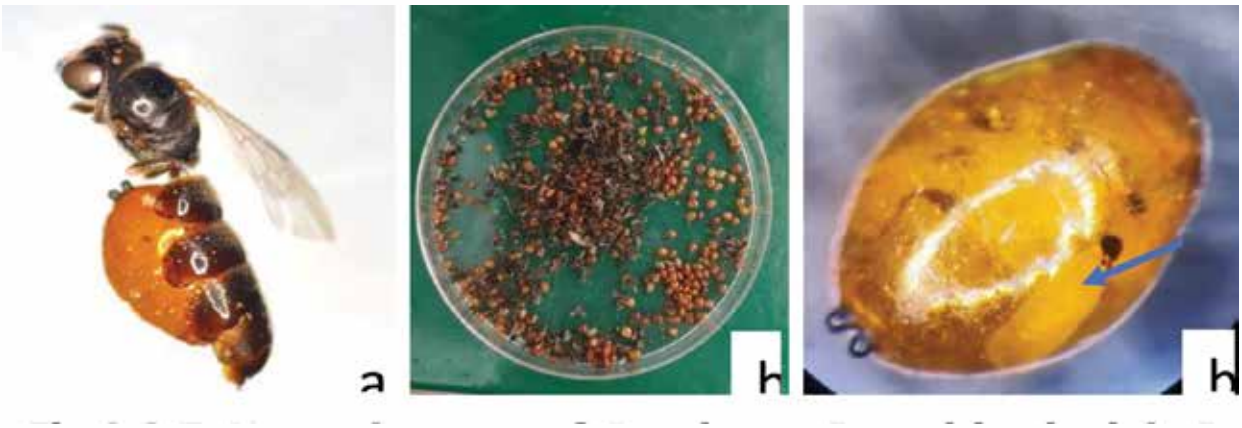


Fig 3.3.7. Natural enemy of *B. mixta* a. Parasitized adult *B. mixta* with pupa of Conopid fly, b. Pupae of Conopid flies and, c. Hyperparasitoid larva inside Conopid pupa

Bee conservation park at ICAR-DCR, Puttur

A bee conservation park has been developed in the farm premises of ICAR-DCR integrating diverse bee flora mainly for the conservation of different bee species (Fig. 7). The flora established include *Antigonon leptopus, Cuphea* sp., *Cosmos* sp., *Caesalpinia* sp., *Combretum indicum, Lantana camara, Bambusa* sp., *Alternanthera sessilis, Mussaenda* sp., *Ixora* sp., *Vedalia trilobata, Leucas aspera, Melastoma malabathricum, Passiflora* sp., *Barleria* sp., *Heliconium* sp., *Jasminum* sp., *Duranta* sp., *Hamelia* sp. etc. The plants of lantana, bamboo and Ixora are regularly pruned to have more branches with pruned ends so that stem nesting bees can make nests in them. The colonies of *Apis cerana indica, Tetragonula* sp. were kept under shade along with the artificial bee nests developed for *B. mixta*. Compared to all other flora, *A. leptopus* and *Cuphea* sp. were found to flower throughout the year, and attract lot of bee species, hence amenable for conservation of bee species.


Fig 3.3.8. View of bee conservation park established at ICAR-DCR, Puttur.

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

Cultural and morphological characterization of *Neopestalotiopsis* sp.

The pathogen was isolated from the cashew leaf blight infected samples, and the growth pattern on the PDA media was observed. A white-greyish, aerial, cottony mycelium on upper side with light yellow colour on the reverse side was constantly isolated (Fig 3.3.9). The black viscous acervuli were observed after 10-12 days of incubation. The conidia were fusiform, five-celled, versicoloured with three olivaceous brown median cells, two terminal hyaline cells, measured 23.3±2.12 – 28.33±2.7 x 3.6±0.8 – 4.28±0.78 µm (n=30). The apical cells had two to three flexuous, unbranched appendages, and basal appendage was solitary, tubular and unbranched (Fig 3.3.10). morphological and cultural characteristics confirmed the pathogen as *Neopestalotiopsis* sp.

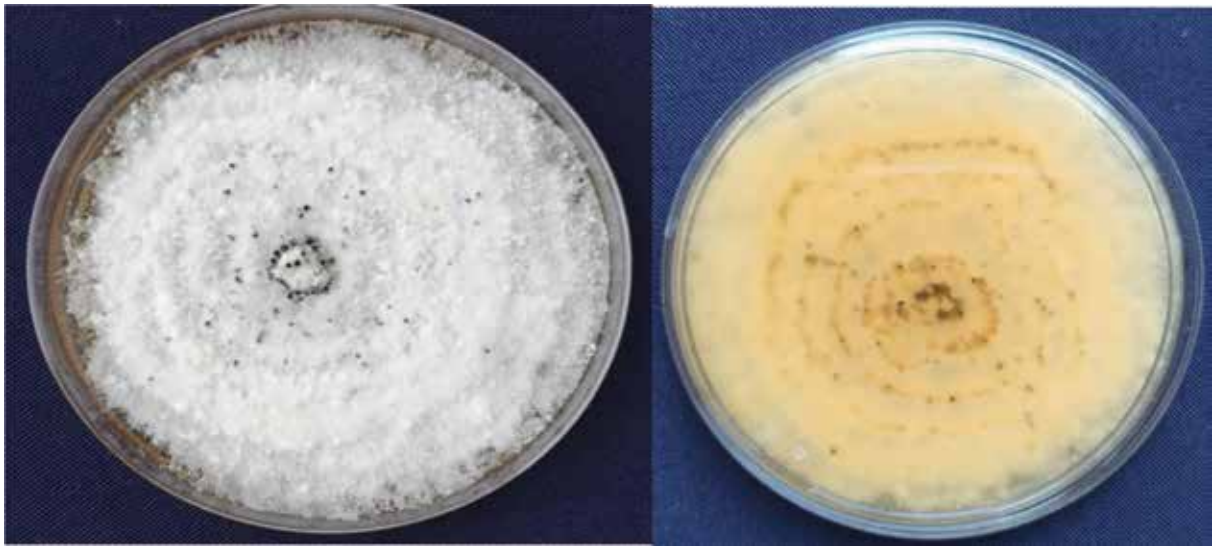


Fig 3.3.9. Pathogen growth on PDA media both upright and reverse

Fig. 3.3.10. Conidia of *Neopestalotiopsis* sp.

Establishment of pathogenicity under artificial conditions

The pathogenicity test was done on six-months old healthy grafts of Priyanka, Ullal-3 and H-130 cashew varieties (n=3). Conidial suspension (2 x 106 spores ml-1) N. clavispora Puttur-1 was sprayed on the healthy cashew seedlings, and kept in inoculation chamber by covering with black polythene sheets for 24 h (25± 2 °C and >90 percent relative humidity). The control grafts were sprayed with sterile distilled water, and 24 hr after inoculation the black polythene sheet was removed both from control and treated seedlings. All the three inoculated varieties developed similar symptoms after 7-10 days post inoculation (dpi), while the control grafts could not produce any symptoms.

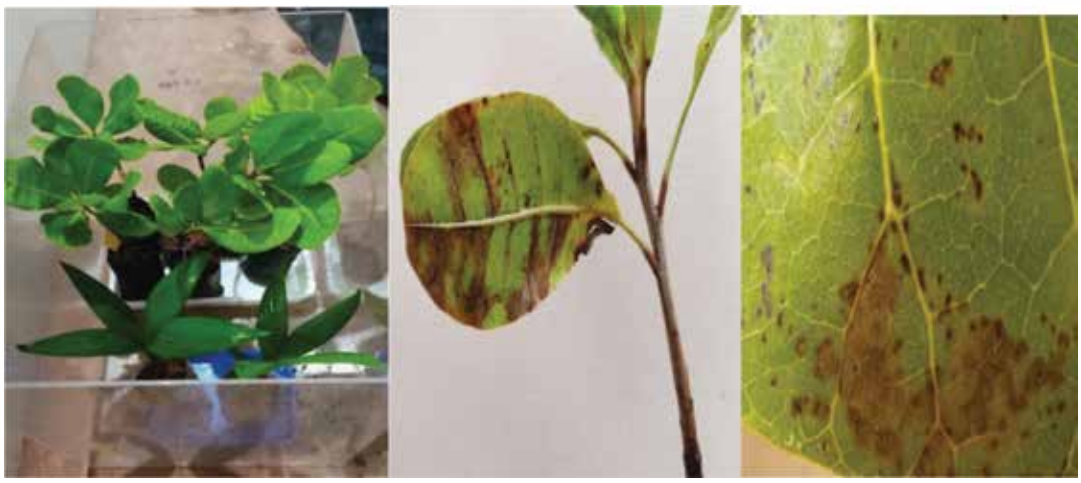


Fig. 3.3.11. Disease symptom development under artificial conditions

Multigene characterization of cashew leaf blight pathogen

Two representative isolates (CLBP1) were subjected for molecular characterization selected for molecular identification based on ITS-rDNA, tef-1α, LSU and tub2 gene sequences and phylogenetic analysis. Genomic DNA was isolated from 15 days old cultures and internal transcribed spacer (ITS) of ribosomal DNA (rDNA), translation elongation factor 1a (tef-1α) gene, LSU gene and beta tubulin (tub2) using ITS1/ITS4, TEF1/TEF2 and Bt2a/Bt2b primer pairs respectively. The band size of 650 bp was amplified for ITS region, 1000 bp were amplified for TEF-1 gene, 750 bp for β-tubulin gene and 500 bp for larger subunit gene. PCR amplicons were sequenced, and the

sequences were deposited in GenBank (accession numbers: ITS: OP880881.1, OP880882.1; tef-1α: OP882579.1, OP882580.1; and tub2: OP882581., OP882582.1). The phylogeny was constructed based on combined ITS, tef-1α, and tub2 regions. Neighbour-Joining (NJ) analysis was conducted and the tree was constructed with the substitution models (branch support was evaluated by 1,000 bootstrap replications). Combined phylogeny confirmed that the sequences shared a common clade with *N. clavispora*.

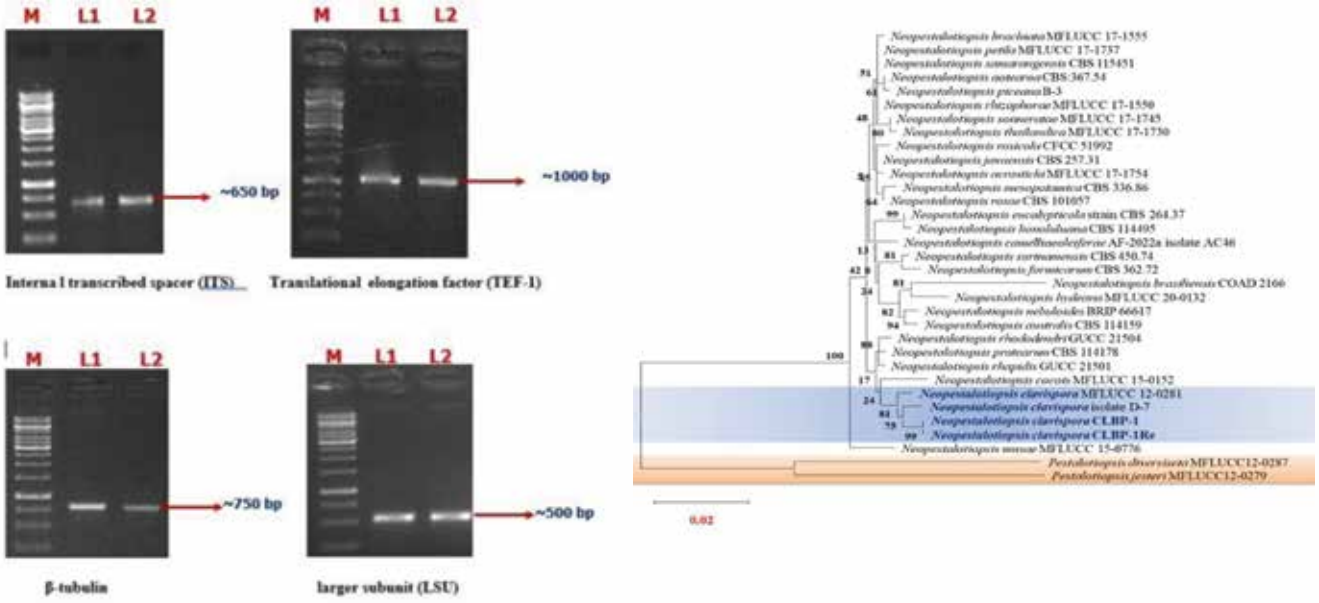


Fig. 3.3.12. Phylogenetic tree produced using partial ribosomal DNA (rDNA) gene sequences showing the phylogenetic relationship of *N. clavispora* isolated from cashew (Bold with asterisk mark) with other *N. clavispor*a isolates and *Pestalotiopsis* as out-group retrieved from Gen Bank, using the Maximum-likelihood (ML) method

Establishment of Farmer-Centric Pest Diagnostic and Bio-Control Laboratory to Achieve Sustainable Cashew Health Management (KA/RKVY-AGRE/2022/1345)

Budget: 100 lakhs

Scientist Involved: Dr. H Rajashekara (PI)
Dr. T. N. Raviprasad (Co-PI)
Dr. K. Vanitha (Co-PI)
Dr. Siddanna S (Co-PI)

The proposed items (compound microscope, laminar air flow, BOD incubators, autoclave, hot air oven, refrigerator, deep freezer and other miscellaneous equipment's) for purchase and supply and installation of lab furniture along with other consumable items are under process

3.4 POST-HARVEST MANAGEMENT

3.4.1 Design and development of mechanized slicer for cashew apple

Certain modifications were made to the existing mechanical slicer for cashew apples to address issues such as: i) bulk transfer of fruits from vibratory tray to fluted rollers; ii) overlapping during singulation of cashew apples while moving on fluted rollers; iii) orientation of cashew apples while transferring cashew apples through compartmental belt conveyor; iv) angular position of feeding guide against rotary disc blades; v) control over distortion of blades and v) inclination of arrestor and outlet chute. Experiments were carried out to optimize angular position of various components viz., Vibratory feed tray inclination (15°); Fruit singulation unit (32°); Feeding guide inlet angle (30°); Feed guide curvature angle (12°) and Discharge outlet (45°). The performance of the slicer was evaluated at the Agricultural Research Station (TNAU), Vamban, Tamilnadu and its operational capacity was found to be in the range of 60-70 kgh^{-1} with a qualitative efficiency of around 78%.

3.4.2 Design and development of moisture meter for raw cashewnuts

Calibration of 3-in-1 moisture meter which is developed to determine the moisture content of raw cashewnut, unpeeled cashew kernels (UPK) and Peeled cashew kernels (PK), continued to achieve higher accuracy. Based on the experiments conducted to assess the influence of resistance in the moisture meter i.e., 100 to 750 Ω, appropriate value was fixed for raw cashewnuts (RCN) and kernels (UPK and PK) due to variation in the cross-sectional texture and moisture holding capacity. Data mining was carried out to understand the correlation between the original moisture content and moisture meter value at different ranges of moisture levels. The accuracy of the moisture meter was found to be higher at lower range and showed deviation above 12% d.b. Due to the non-availability of freshly harvested nuts, samples of moisture infused nuts were used for calibration purpose during the off-season. Comparatively better performance was achieved and needs to be evaluated with freshly harvested nuts.

3.4.3 Studying comparative performance of cashewnut processing systems in India

A diagnostic survey was conducted in Andhra Pradesh state and it is learnt that two different modes of processing viz., Drum roasting and Steaming raw cashewnuts followed to extract edible kernels primarily in three districts viz., Palasa and Kasibugga in Srikakulam, Vetapalem in Bapatla and Tuni in Kakinada. Around 1.25 lakh Mt of raw cashewnuts produced in Andhra Pradesh during the year 2020-21 catering to the need of 228 processing units located in the state. A total of 3.2 lakh MT of raw cashewnuts processed in the facility developed and 80% of which is derived from import especially from African countries. As far as distribution of processing units are concerned, 79% of the units are located in Srikakulam and 12% and 9% of units are spread in Kakinada and Bapatla districts, respectively. Palasa and Kasibugga located in Srikakulam district is considered to be the hotspot for cashewnut processing. Cashew processing is operating in this region under two different administration i.e., Palasa Cashew manufacturers Association (PCMA) and Industrial Area Cashew Processors' Association, Palasa after introducing ban on drum roasting process in residential area by the High court of Andhra Pradesh during the year 2008.

Cashewnut processing units located in this region are categorized into labour oriented, semi mechanized and fully automatic processing units depending on the deployed labour force, degree of mechanization and quantum of production.

Calibrator with hydro washer, Static steam cookers with IBR boilers, multi-channel shelling setup, steam assisted dryer, optical sorters and moulded vacuum packaging are certain machinery deployed for bulk production. Various issues encountered by these processing units are i) Although moisture content of the raw cashewnuts is an Important parameter while assessing quality which has led to spoilage during long term storage; ii) processing parameters are not optimized due to which discolouration and breakage of kernels, reducing profitability; iii) Kernel grading is not up to specifications prescribed by GoI; iv) Necessity to follow advanced packaging technique leaving traditional method (Oil tin containers) demanding skill development training for employees; v) Value addition to cashew kernels is not in practice and vi) Few expeller units are involved in CNSL extraction, but crude oil exported to other regions. The cost of processing for a labour oriented system is worked out to be Rs 24-26 per kg of RCN whereas for semi-automatic and fully mechanized units incurring an amount of Rs 18 and Rs 12 per kg of RCN, respectively.

3.4.5 Optimizing processing parameters in cashew for enhancing whole kernel recovery

Project proposed to Chhattisgarh State Minor Forest Produce (CSMFP), Chhattisgarh seeking financial assistance through SMD (Horticulture) as per the directives of DG, ICAR, New Delhi. In view of administrative and implementation constraints, competent authority advised to propose an institute research project in Research Advisory Committee for approval. Design of lab scale steam boiler is prepared on account of sample size and number of experiments to optimize relevant parameters during conditioning raw cashewnuts. Indian Institute of Packaging, Mumbai visited to explore the possibility of alternative packaging system in lieu of traditional method of 'Vita packaging' in tin containers in view of structural and aesthetic design of packaging. On account of strength to withstand the pressure of handling and transport, leak proof, shelf life of cashew kernels, resistance to microbial attack and price, 'Bag-in Box' packaging is recommended. This method includes flexi pack made up of aluminium foils and HDPE layers as container and carton box with a handle.

3.4.6 New Project: Development of ready to eat alternate snack food using cashew apple - Extrusion and Vacuum frying approach

A procedural technique to convert perishable cashew apples to stable amorphous form with reduced tannin and retaining ascorbic acid is standardized. Considering the vital source of intrinsic nutritive components available in cashew apples, cashew apple powder is utilized as a biofortifying agent in the preparation of cereal based extrudates. The effect of selective proportion of rice flour (25 – 35%) and cashew apple powder (5 – 15%) on product characteristics viz., bulk density, expansion ratio, water solubility and water absorption index, compression force and cutting strength were investigated using mixture-process design. Corn flour was added to the extent of sixty percentage in all the combinations to obtain the desired extrudates. The extrusion was carried out at different screw speeds (27.5, 30.0 and 32.5 Hz) under the fixed barrel temperature (110 oC) and die diameter (4 mm). The extrusion condition of 12% cashew apple powder, 28% rice flour, 60% corn flour and a 30 Hz screw speed were determined as optimum conditions for the development of cashew apple powder incorporated rice-corn based extrudates with a desirability value of 1.00 using mixture-process design with optimum responses of expansion ratio 2.43, bulk density 0.13?gcm-3, cutting force 19.61?N, and bending strength 38.14?N. The incorporation of cashew apple powder as an ingredient in the cereal based extrudates had significantly increased their protein, overall mineral content, phenolic (7.25 mg gallic acid equivalents g-1) and total antioxidant activity (8.95 mg Trolox equivalents g-1). Cashew apple slices are vacuum fried in a pilot scale unit

at private firm and end product with crispy texture indicated that a snack food could be prepared by optimizing material and machine parameters.

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

Development of Cashew apple Fig/ Chunks: The cashew apple was cut into different shapes and immersed in varied concentrations of sugar. The shape of the slices had an important role in percent water loss. Less water loss was noticed in cashew apple fig whereas in the other types the percentage of water loss was higher (disk shape). The biochemical components like flavonoids, phenols, tannins, vitamin C and other mineral components were analyzed. The total phenols ranged from 97.93 to 146.23 mg GAE/g. The flavonoids content was ranged from 136.71 to 172.5 mg catechin equivalent per gram. The total antioxidant activity was found to be 278.28 mg ascorbic acid equivalent per gram. The tannin content was in the range of 10.49 to 14.41 mg/100g.

Fig. 3.4.1 Cashew Apple Fig

Fig. 3.4.2 Cashew Apple Chips

Effect of brine solution on storage life of cashew sprouts

Cashew sprouts were stored in a brine solution prepared using Sodium chloride (NaCl), Lactic acid (LA) and water (control) to study their effect on storage life. Cashew sprouts stored in 5% NaCl solution increased the storage life of cashew sprout (17 days) compared to the control (2 days) with a significant reduction in fat content without further significant reduction in phytic acid content

Development of Probiotic Food Product/s from Cashew Apple

Screening of different fruit juice blends along with cashew apple juice was carried out to standardize the best one for probiotic culture inoculation. The different fruit like pomegranate, guava, oranges, mandarins, Muskmelon were mixed in different combinations with cashew apple juice. Standardization and screening are continued to select the best beverage combination.

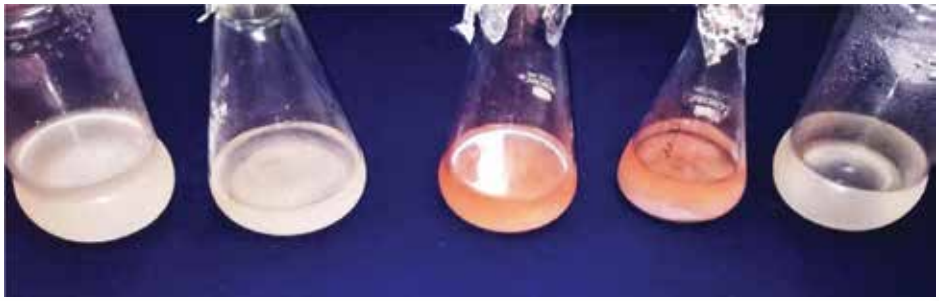


Fig 3.4.3 Screening of Cashew apple juice and other fruit juice blend

3.5 CONCLUDED PROJECTS

3.5.1. Project No. IXX10492: Evaluation of cashew apple genotypes for apple and nut yield and quality

Principal Investigators	:	Dr. Eradasappa, E (August 2020-2022) Dr. Preethi P (2016- August 2020) Dr. P.L. Saroj (2013-2016)
Co-Principal Investigators	:	Dr. Eradasappa E (2013-Aug 2015; Nov 2017- August 2020) Dr. Meena, R.K. (2013-2015) Dr. Vanitha K (2013-2022) Dr. M.G. Nayak (2013-2018) Dr. Rajkumar A.D. (2015-2017) Dr. Loganathan, M. (2015-2016) Dr. Janani P (2017) Dr. Veena G.L. (2021-2022)
Project code	:	1.8
Project duration	:	2013-2022

Introduction

The origin of cashew is Brazil however it spread very fast to India and other parts of the world during the 16th century. It is very interesting note here that most countries were enthusiastic about the cashew apple and discarded the nut. It was India that started utilizing the nut and pioneered in the processing of raw nuts to kernels and exporting them to different countries. While doing so India discarded the cashew apple and is being continued in most parts of cashew growing regions of India. Now in many cashew-producing countries, the kernel from the nut is being enjoyed most by the local populations.

The cashew tree bears a false fruit known as the cashew apple from which the nut protrudes. It has a pulpy, juicy structure, with a pleasant but strong astringent flavour. The cashew apple is some edible fruit rich in vitamin C (262 mg/100 ml of juice) and contains five times more vitamin C than an orange. A glass of cashew apple juice meets an adult individual's daily vitamin C (30 mg) requirement. The cashew apple is also rich in sugars, and contains considerable amounts of tannins and minerals, mainly calcium, iron and phosphorous. It can be dried, canned as a preserve, or eaten fresh from the tree. It can also be squeezed for fresh juice, which can then be fermented into cashew wine which is a very popular drink in West Africa. In parts of India, it is used to distil cashew liquor referred to as feni. In some parts of South America, local inhabitants regard the apple, rather than the nut kernel, as a delicacy. In Brazil, the apple is used to manufacture jams, and soft and alcoholic drinks. Furthermore, the fruit has medicinal properties. It is used for curing scurvy and diarrhoea, and it is effective in preventing cholera. It is applied for the cure of neurological pain and rheumatism. It is also regarded as a first-class source of energy. It is quite unfortunate that cashew apples are highly perishable. Unless frozen or kept at very cool temperatures, the cashew apple lasts only for 5 days once plucked from the tree.

Until recently, the potential of cashew apple had not been explored due to its highly astringent and acrid taste which is believed to originate in the waxy layer of the skin and which causes tongue and throat irritation after eating. Cashew apple can be made suitable for consumption by removing the undesirable tannins and processing the apples into value-added products, such as juices, syrups, canned fruits, pickles, jams, chutneys, candy and toffee. The recommended methods for removing the astringent properties of the cashew apple include steaming the fruit for five minutes before washing it in cold water, boiling the fruit in salt water for five minutes, or adding gelatine solution to the expressed juice.

In India cashew apples are available in plenty across different cashew growing states and huge quantities of cashew apples are being wasted every growing season with an exception of Goa where it is being used for the preparation of alcoholic beverage. Currently only six percent of world cashew apple production is exploited, since the producer only has a guaranteed market for cashew nuts (FAO, 2004).At the international level, the work on selection of clones possessing better cashew apple yield and quality traits was carried out at Pacajus Experimental Station, Ceara, Brazil and released clones such as CCP 09 (Barros et al., 1984, 2000; Oliveira 1999; Paiva et al., 2003a), CCP 76, CCP 1001 (Barroa et al., 1984, 2000; Oliveira 1999; Paiva et al., 2003), BRS 189 and BRS 265 (Barros et al., 2002).

Cashew varieties developed so far in India are confined to better nut yield and nut quality traits. But cashew apple an important product of cashew tree is not given much importance by the researchers. Hence at present not a single variety with desirable attributes for cashew apple is available in the public domain. However, in the germplasm collections at DCR Puttur, there are some accessions which give better cashew apple yield and possess good quality apples are available. Hence a project on evaluating these cashew germplasm accessions for cashew apple yield and quality traits was formulated to find out a suitable genotype having better cashew apple yield and quality traits along with nut yield.

Objective

To find out a suitable genotype for better cashew apple yield and quality traits along with nut yield.

Materials and methods

This project was initiated in the year 2012-13 and during that period14 cashew germplasm accessions having big cashew apples were selected from the germplasm maintained in the National Cashew Field Gene Bank. They were multiplied clonally through grafting in the nursery. Then 5-6 months old were planted at a spacing of 7.5 m x 7.5 m in RBD with three replications along with check Vengurla-8 at Kemminje during October 2013. The accessions were managed following cultural operations to raise the good crop. Observations on growth characters such as stem girth, plant height, canopy spread in East-West and N-S direction, cashew apple weight, cashew apple length, cashew apple breadth, cashew apple yield, cashew nut weight, cashew nut yield and TMB incidence were recorded since 2015-16. They were also evaluated for biochemical properties like contents of ascorbic acid, tannin, phenols, flavonoids, anti-oxidant, acidity, TSS, fat in cashew apples and nut qualities like shelling percentage, CNSL, protein. Besides, fresh cashew apples of those accessions were subjected for organoleptic evaluation for determining the acceptability.

Results

The results of analysis for the data of morphological traits for the year 2021-22 are presented in Table 3.5.1. The analysis revealed that NRC 112 had maximum stem girth (104 cm). For plant height, NRC 112 was tallest (7.75 m) and NRC 120 was shortest (3.50 m). The average tree spread was maximum in NRC 12 (9.64 m)

while Vengurla-8 presented lowest (5.82 m). NRC 301 had heaviest apples (183.10 g) while NRC 176 had less heavy apples (62.67 g). NRC 493 presented lengthy apples (10.13 cm) while NRC 176 gave shortest apples (5.50 cm). NRC 112 had broadest apples (6.15 cm) while NRC 493 had narrow apples (4.52 cm). For nut weight, NRC 183 recorded the maximum nut weight (13.41 g) and minimum was in NRC 75 with 6.48 g. NRC 175 presented maximum cashew apple yield (56.47 kg / tree) as well as nut yield (5.54 kg /tree). the apple to nut ratio was maximum in NRC 301 (15.01) while it was lowest in vengurla-8 (6.95).

Cumulative yield analysis for nut and apple

The cumulative yield analysis for both nut and apples over six years (Table 3.5.2) reveals that NRC 175 has recorded highest cumulative nut yield of 20.14 kg / tree and cashew apple yield of 233.3 kg / tree (Table 3.5.3). This was followed by NRC 140 with cumulative nut yield of 10.94 kg / tree and cashew apple yield of 127.51 kg / tree.

Reaction to TMB incidence

The reaction to TMB incidence in all the accessions was recorded for eight years from the year 2014 to 2022 (Table 3.5.4). The reaction was graded from 0 to 4 scale based on the damage symptoms. The overall lowest damage grade of 0.53 was observed in Vengurla-8 and overall highest damage grade of 1.17 was recorded in NRC 75.

Biochemical characterization of cashew apples

The accessions were also evaluated for biochemical characters such as TSS, ascorbic acid, acidity, flavonoids, tannins, total phenols and anti-oxidant activity (Table 3.5.5). NRC 175 presented highest TSS of 14.93 0 Brix. NRC 144 recorded the maximum ascorbic acid content of 572 mg / 100 ml of cashew apple juice. Acidity was maximum (0.76%) in NRC 183. The highest phenol content was obtained in NRC 270 (174.37 mg / 100g). the flavonoid content was maximum in NRC 301 (2.15g/ 100g). The lowest content was in NRC 175 (343 mg/100g). The anti-oxidant activity was maximum in NRC 120 (204.74 mg / 100g).

Organoleptic evaluation of fresh cashew apple

All the 14 accessions along with check Vengurla-8 were subjected for organoleptic evaluation of fresh cashew apples for the parameters such as colour and fragrance, flavor, texture, taste and overall acceptability as per 9-point Hedonic scale recommended by Society of Sensory Professionals (USA) (Table 3.5.6). The results indicated that NRC 301 is more acceptable with overall acceptability grade of 6.15 followed by NRC 175 with 6.05. However, their acceptability is little lesser than the check variety Vengurle-8 which has 6.53.

Conclusions

Based on the results obtained, it is observed that NRC 175 (Fig. 3.5.1) holds promise as a dual purpose cashew genotype as it recorded highest cumulative yields for both nut (20.14 kg /tree) and cashew apple (233.3 kg /tree) and is higher than check variety Vengurla-8. It also possesses the desirable biochemical qualities such as juice recovery 75.6%, TSS 14.93°Brix, ascorbic acid 255.6mg/100g, acidity 0.63%, phenol 142.20 mg GAE/100g, flavonoid 0.11mg CE/100g, tannin 3.43mg TAE/100g, antioxidant 124.23mg AEAC/100mg. The organoleptic evaluation of fresh cashew apples indicated that NRC 175 is more acceptable with overall acceptability grade of 6.05.

NRC 301 holds potential as a unique germplasm type with highest average cashew apple weight of 183.10g and nut weight of 11.94g. It has recorded modest cumulative nut yield of 5.58 kg/tree and cashew apple yield of 88.53 kg/tree over six harvests. Besides, it also possesses the desirable biochemical qualities such

as juice recovery 75.6%, TSS 10.230Brix, ascorbic acid 392.4mg/100g, acidity 0.71%, phenol 111.52 mg GAE/100g, flavonoid 2.15g CE/100g, tannin 584mg TAE/100g, antioxidant 157.12mg AEAC/100mg. The organoleptic evaluation of fresh cashew apples indicated that NRC 301 is more acceptable with overall acceptability grade of 6.15.

Based on the merits displayed by the above accessions, NRC 175 is proposed for release as dual type and NRC 301 is proposed for registering as unique genotype.

NRC 175

NRC 301

Fig 3.5.1. NRC 175 and NRC 301 bearing cashew apple and nut

Table 3.5.1: Mean performance of morphological traits during 2021-22

Acc.No.	Stem Girth (cm)	Plant height (m)	Tree Spread (m)	Apple wt (g)	Apple length (mm)	Apple breadth (mm)	Nut wt (g)	Apple yield (kg/tr)	Nut yield (kg/tr)	Apple to nut ratio
NRC-301	64.18	5.13	7.07	183.10	100.58	58.22	11.94	1.21	0.08	15.34
NRC-389	77.00	4.33	7.18	88.40	81.04	54.58	9.38	2.35	0.25	9.42
NRC-120	63.22	3.50	6.68	107.87	99.57	57.33	9.33	3.51	0.30	11.56
NRC-189	65.00	4.50	7.07	87.25	57.10	48.14	10.14	5.73	0.67	8.60
NRC-175	72.39	5.50	6.37	81.24	59.34	46.67	7.21	56.47	5.01	11.27
NRC-493	75.92	6.18	7.81	88.23	101.33	45.22	12.13	1.42	0.20	7.27
NRC-176	85.00	4.66	7.28	62.27	54.98	51.41	8.64	14.30	1.98	7.21
NRC-183	75.28	4.75	7.66	118.08	61.83	59.18	13.41	11.71	1.33	8.81
NRC-111	91.56	4.88	7.15	114.04	97.80	54.07	12.50	16.09	1.76	9.12
NRC-270	104.13	6.25	6.57	127.46	79.31	47.67	11.76	10.74	0.99	10.84
NRC-75	85.51	4.65	6.64	80.60	59.63	49.34	6.48	1.21	0.10	12.44
NRC-144	85.84	4.75	7.34	119.23	74.25	53.67	9.36	18.21	1.43	12.74
NRC-112	104.00	7.75	9.64	124.85	99.94	61.49	12.55	12.83	1.29	9.95
NRC-140	73.83	5.06	5.79	129.27	95.84	55.56	8.89	27.47	1.89	14.54
V-8	61.12	3.93	5.82	67.08	71.05	56.93	9.65	3.93	0.56	6.95
CD (5%)	5.30	0.09	0.33	11.39	6.56	8.25	0.78	13.71	1.35	-

Table 3.5.2: Cumulative nut yield (kg /tree) of accessions for 6 six years

Acc.No.	2015-16	2016-17	2017-18	2018-19	2020-21	2021-22	Cum yield (kg/tree)
NRC 75	0.12	0.39	0.39	0.41	0.37	0.1	1.78
NRC 111	0.39	1.44	2.48	2.65	2.79	1.76	11.51
NRC 112	0.47	1.93	2.19	2.48	0.94	1.29	9.30
NRC 120	0.28	1.94	1.51	1.74	1.26	0.3	7.03
NRC 140	0.83	2.21	1.41	1.58	1.14	1.89	9.06
NRC 144	0.68	0.82	0.79	0.866	0.57	1.43	5.16
NRC 175	2.85	4.54	3.02	**3.12**	1.6	**5.01**	20.14
NRC 176	0.86	1.87	1.31	1.24	1.29	1.98	8.55
NRC 183	0.01	0.46	0.24	0.254	1.07	1.33	3.36
NRC 189	0.38	1.42	1.65	1.59	1.42	0.67	7.13
NRC 270	0.4	1.45	1.05	1.12	1.55	0.99	6.56
NRC 301	0.71	0.99	0.87	0.888	2.04	0.08	5.58
NRC 389	0.15	1.69	0.75	0.792	1.39	0.25	5.02
NRC 493	0.32	2.02	1.02	1.13	0.69	0.2	5.38
V-8	0.24	1.05	0.57	0.551	1.3	0.56	4.27
CD (5%)	0.75	1.56	0.38		0.55	3.29	

Table .3.5.3: Cumulative cashew apple yield (kg /tree) of accessions for 6 six years

Acc.No.	2015-16	2016-17	2017-18	2018-19	2020-21	2021-22	Cum apple yield (6 yrs)
NRC 75	1.55	3.54	4.78	3.17	0.37	1.21	18.84
NRC 111	4.70	14.51	22.60	21.80	2.79	16.09	105.13
NRC 112	4.54	20.11	21.56	20.84	0.94	12.83	89.24
NRC 120	3.43	23.06	17.50	17.55	1.26	3.51	79.61
NRC 140	18.56	31.45	17.43	17.54	15.06	27.47	127.51
NRC 144	7.02	8.51	10.11	10.08	6.94	18.21	60.87
NRC 175	37.89	50.43	36.47	35.66	16.38	56.47	233.3
NRC 176	8.52	20.96	15.43	14.83	9.63	14.3	83.67
NRC 183	0.09	3.84	1.95	2.01	1.07	11.71	29.05
NRC 189	5.37	12.32	13.59	14.10	10.42	5.73	61.53
NRC 270	3.18	11.28	10.95	11.54	16.48	10.74	64.17
NRC 301	12.92	14.44	13.07	12.08	34.81	1.21	88.53
NRC 389	14.96	16.82	6.64	6.32	12.28	2.35	59.37
NRC 493	3.24	18.24	5.57	5.81	4.88	1.42	39.16
Vengurla-8	2.25	9.77	3.96	4.01	8.82	3.93	32.74
CD (5%)	12.17	16.49	3.65	-	6.30	13.71	-

Table 3.5.4: Reaction of accessions to TMB incidence over 8 years

Acc.No.	2014	2015	2016	2017	2019	2020	2021	2022	Overall damage grade
NRC 176	0.80	0.60	0.15	0.49	0.89	1.34	2.16	1.38	0.98
NRC 389	1.30	1.00	0.58	0.50	0.99	1.05	1.96	0.82	1.03
NRC 144	1.40	1.30	0.04	0.33	0.65	1.79	1.91	0.83	1.03
NRC 175	1.50	1.20	0.50	0.62	1.23	0.75	1.99	0.65	1.06
NRC 112	1.60	1.40	0.00	0.35	0.42	1.06	2.45	0.81	1.01
NRC 75	0.80	0.60	0.78	0.31	1.13	2.01	1.97	1.76	1.17
NRC 270	1.00	0.80	0.15	0.36	0.71	0.80	1.71	0.93	0.81
NRC 301	0.70	0.50	0.00	0.15	0.26	0.93	1.39	0.50	0.55
NRC 140	1.20	1.00	0.87	0.49	0.84	1.31	1.28	0.94	0.99
NRC 120	1.00	0.60	1.11	0.50	1.00	1.06	1.88	0.64	0.97
NRC 183	0.80	0.80	0.00	0.52	0.97	1.09	1.34	0.70	0.78
NRC 493	0.90	0.80	0.14	0.60	1.04	1.97	1.35	1.25	1.01
NRC 189	0.80	1.10	0.60	0.43	0.86	1.73	0.84	0.50	0.86
NRC 111	0.70	0.50	0.20	0.31	0.62	0.72	1.81	1.09	0.74
V-8	_	0.20	0.56	0.21	0.61	0.21	1.52	0.37	0.53

Table 3.5.5: Biochemical characterization of cashew apples of accessions

Acc.No.	TSS (^{0}Brix)	Ascorbic acid content (mg/100g)	Acidity (%)	Phenol content (mg GAE/100g)	Flavonoid content(g CE/100g)	Tannin content (mg TAE/100g)	Antioxidant content (mg AEAC/100mg)
NRC-301	10.23	392.40	0.71	111.52	2.15	5.84	157.12
NRC-389	11.83	396.00	0.53	133.02	1.80	4.94	24.85
NRC-120	12.57	342.00	0.56	138.37	1.95	6.11	204.74
NRC-189	13.80	309.60	0.53	110.80	1.69	7.86	155.64
NRC-175	14.93	255.60	0.63	142.20	0.11	3.43	124.23
NRC-493	10.70	369.00	0.54	86.01	1.75	7.83	166.35
NRC-176	14.03	450.00	0.51	120.32	0.79	6.14	146.56
NRC-183	13.43	486.00	0.76	109.60	0.42	5.87	86.15
NRC-111	10.10	387.00	0.56	134.77	0.70	4.84	101.48
NRC-270	10.13	450.00	0.71	174.37	1.27	5.34	199.98
NRC-75	10.27	347.40	0.35	161.30	0.61	3.58	43.45
NRC-144	9.77	572.40	0.53	75.62	0.70	5.95	126.62
NRC-112	12.63	423.00	0.52	134.60	0.20	5.23	139.42

NRC-140	10.17	390.60	0.55	129.68	1.43	5.74	186.73
V-8	12.00	396.00	0.72	165.36	0.40	5.18	104.60
CD @ 5%	1.18	78.39	0.05	11.16	0.83	1.76	67.92

Table 3.5.6: Organoleptic evaluation of fresh cashew apples of accessions

Genotypes	Taste	Texture	Colour	Fragrance	Overall acceptability
NRC-301	5.53	6.06	6.80	6.00	6.15
NRC-389	3.40	4.46	4.46	4.33	4.23
NRC-120	4.93	5.26	5.93	5.33	5.40
NRC-189	4.20	4.80	5.20	5.20	5.13
NRC-175	6.00	6.06	4.60	5.26	6.05
NRC-493	5.26	5.93	6.60	5.53	5.41
NRC-176	5.33	5.20	5.20	5.13	5.30
NRC-183	4.80	4.73	4.66	4.73	4.73
NRC-111	4.73	5.00	5.86	4.86	5.15
NRC-270	5.06	5.46	6.80	5.66	5.61
NRC-144	4.73	4.60	4.93	4.86	4.96
NRC-112	4.26	4.66	5.06	4.60	4.73
NRC-140	4.53	5.00	5.40	4.40	4.96
V-8 (check)	5.73	6.06	6.00	5.93	6.53

3.5.2. De novo genome assembly, linkage analysis and population structure studies in cashew *(Anacardium occidentale L.)*

First draft genome of cashew, annotation, and phylogeny:

First draft genome of cashew was generated by de novo assembly and reported by ICAR-DCR, Puttur. The hybrid assembly of long Oxford nanopore reads (19 x) and short accurate Illumina reads (103 x) yielded a 356 Mb genome. BUSCO analysis of the generated assembly showed 92% completeness. Leaf transcriptome mapping showed 93% transcripts aligning with the draft genome. A total of 31,263 genes were predicted in the assembled genome. Nearly, 165 Mb (46%) of the cashew genome comprised of repetitive sequences. Phylogenetic analyses 10 species including cashew showed that cashew was closely related to *Mangifera indica*. Shared and unique orthologous gene families in the A. occidentale and four tree species (*M. indica, P. vera, P. deltoides, M. domestica*) is represented in the Venn diagram (Fig. 3.5.2). Further analysis of cashew genome for putative R-genes resulted in identification of 3104 genes possessing R-gene motifs. The genome, transcriptome and R gene information generated would be the useful for understanding the molecular basis of economic traits and genomics assisted breeding in cashew.

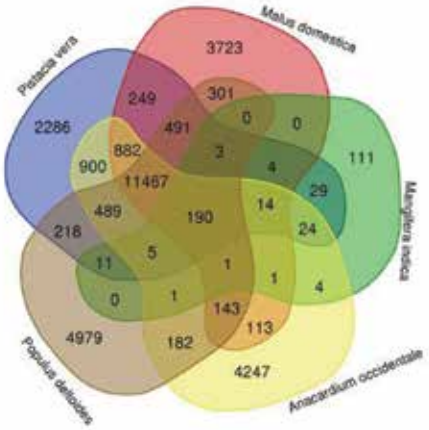


Fig. 3.5.2 Venn diagrams displaying clusters of shared and unique orthologous gene families in the *A. occidentale* and four tree species (*M. indica, P. vera, P. deltoides, M. domestica*)

Development of novel genic SSRs from the transcriptomes data:

In silico SSR mining from assembled transcriptome identified 4271 SSRs. Among the mined SSRs, tri-nucleotide (49.12 %) SSRs were most dominant class of SSRs, followed by di-nucleotide (38.75 %), tetra-nucleotide (3.54 %), hexa-nucleotide (1.59 %) and pentanucleotide (1.10 %) SSRs. The frequency of Class I SSRs (≥20 bp) was 32.1 %. Fifty-four of 80 primers synthesized successfully PCR amplified the cashew genomic DNA and 36 of them were polymorphic. Cross-species amplification rates of SSRs were 100 % in two *Anacardium* species whereas 61 % in *Semecarpus anacardium* and 87 % in *S. prainii.* Polymorphism detection by a novel genic SSR markers tAo-DCR-1 and tAo-DCR-2 is shown in the Fig. 3.5.3.

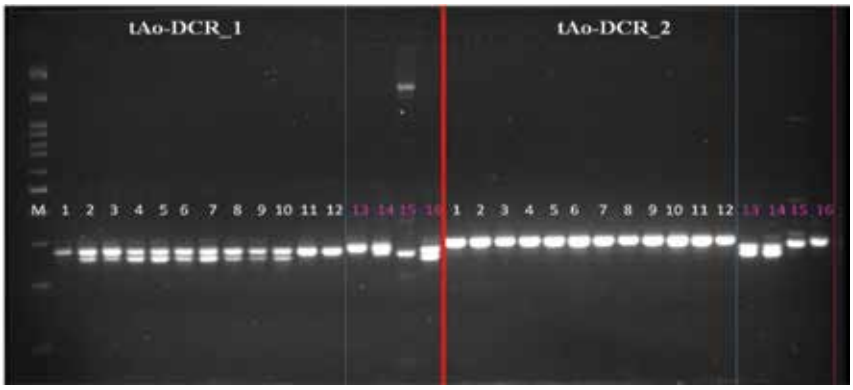


Fig. 3.5.3. Amplification profile of transcriptome based SSR markers viz. tAo-DCR_1 and tAo-DCR_2 in cashew accessions and two Anacardiaceae species. Lanes 13-14 represent two Semecarpus species and Lanes 15-16 represent two mango accessions.

Genetic Diversity analysis in germplasm accessions using genic SSRs:

Nineteen genic SSR markers were used for genetic diversity analysis in 64 accessions. The number of alleles per SSR locus ranged from 6 to 20 with a mean of 10.84. Major allele frequency (MAF) ranged from 0.14 to 0.58 with a mean of 30. The gene diversity in the assayed accessions ranged from 0.58 and 0.92 with a mean of 0.80. The heterozygosity at the SSR loci ranged from 0 to 0.95 with an average of 0.32 in the 64 accessions. The PIC values of SSR markers varied from 0.53 to 0.92 with a mean of 0.77. The cashew accessions were grouped into three major

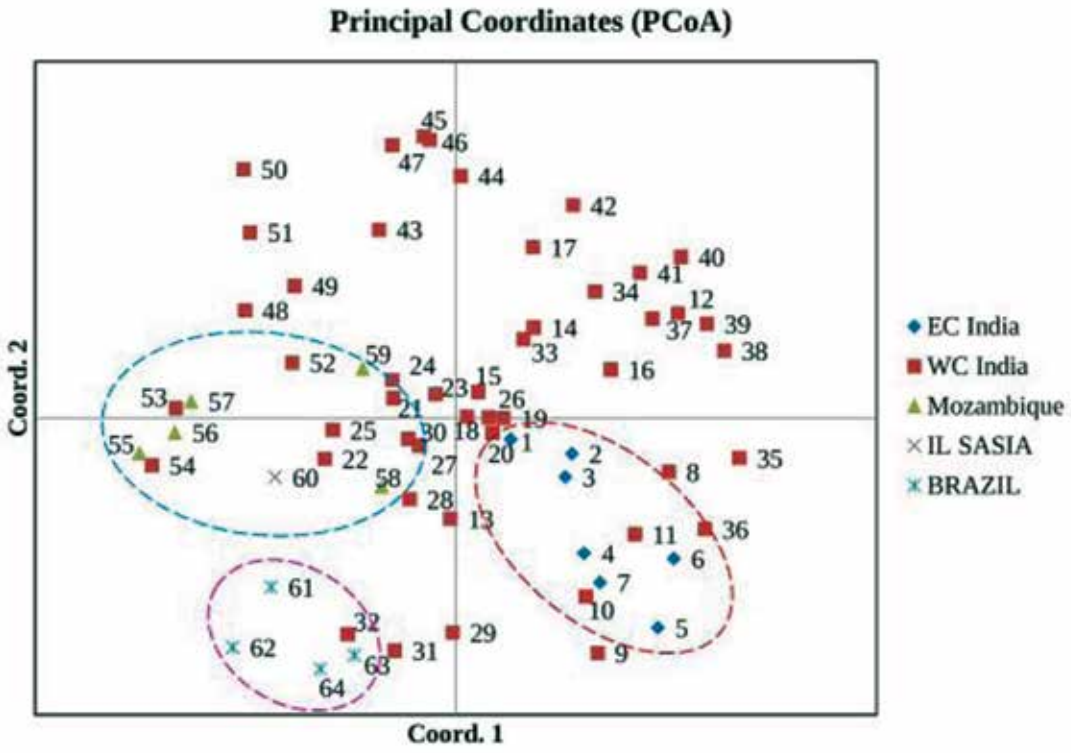
clusters. Principal coordinates analysis (PCoA) of 64 accessions could differentiate them based on geographic regions to a certain extent (Fig.). The STRUCTURE analysis using the Bayesian model-based clustering revealed the existence of three genetic subpopulations (K=3).

Principal coordinates analysis (PCoA) of 64 accessions from different geographic origins (Savadi *et al.* 2022).

Morphological characterization and Resequencing the whole genome of NRC-385:

NRC-385 is a bold nut (11-11.5 g) and big hypocarp/cashew apple (153-175 g) type accession with attractive red colour and shape appearing like the apple (*Malus* sp.). Fruit and leaf size of NRC-385 was compared with Bhaskara, one of the reference varieties.

Nut size of NRC-385 was 1.5 times larger than the Bhaskara (7.5 g) and was comparable with H-130 (Nethra Ganga), a released jumbo nut cashew hybrid, but the number of nuts per panicle is less. However, superior with respect to the filling of the nuts /the Kernel weight (2.9-3.1 g) and shelling percentage (32%) (Fig. 6). With respect to cashew apple size, NRC-385 produced about 3-4 times larger than the Bhaskara cultivar and 1.5 -2 times that of H-130 hybrid cultivar.

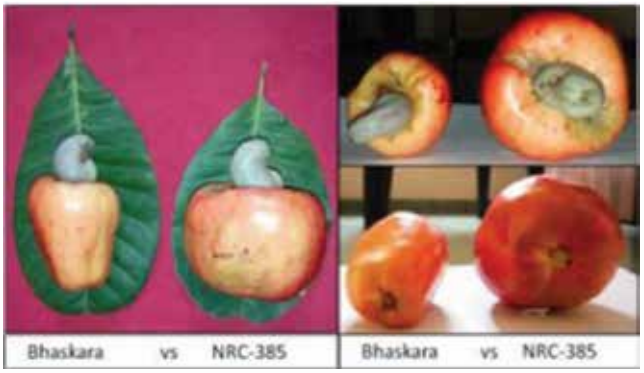


The whole genome sequence of the accession was generated using the Illumina sequencing. A total of 9212829214 paired end (PE) reads providing a 22 x of genome coverage was developed to understand the genetic variations by comparison with the first draft genome of cashew cv. Bhaskara reported by ICAR-DCR, Puttur.

A) Flower bud & Flower

Staminate Hermophrodite

B) Fruit and leaf size of Bhaskara and NRC-385



C) Nut size and filling

Bhaskara **Nethra Ganga (H-130)** **NRC-385**

Fig.3.5.4 Flower, leaf, cashew apple and nut characteristics of NRC-385 accession

3.5.3 Title of the project: Farmer participatory soil and plant health management – An attempt for improving livelihood of cashew farmers of coastal Karnataka

Funded by	:	RKVY-FAFTAAR, Government of Karnataka
Budget	:	Rs. 189 lakhs
Project duration	:	04/2018 to 03/2022
PI	:	Dr. Shamsudheen M
Co-PIs	:	Dr. M.G. Nayak (Till 31-07-201) Dr. J.D. Adiga Dr. Preethi. P (Till 30-12-2020) Dr. B.M. Muralidhara (Till 07-10-2021)

I. On farm demonstration

For establishing demonstration plot on improved production technology for the visiting farmers, an additional plot area of 4.5 acres developed. Of these 4.5 acres, 3 acres was planted with normal density planting and 1.5 acres under high density planting. The entire area was fenced and provided with gates. To demonstrate the usefulness of precision agricultural activities drip and fertigation systems was installed.

Fig. 3.5.5. Field view of demonstration plot

II. Front line demonstration in farmer's field and farmer participatory research

On-farm trials were organised across 59 farmers fields located in three coastal districts of Karnataka, namely Uttara Kannada, Dakshina Kannada and Udupi during 2018-19 and 2019-20 under rainfed conditions (Fig. 3.5.6). The farmers were selected based on reconnaissance visits and in consultation with field level extension workers, people's representatives, group discussion and participatory rural appraisal exercises with farmers. The farmers selected were such that they possess cashew plantations in the age group of 5 to 10 years under normal planting density and ready to implement the programme as per the guidelines. The information such as age of the plantation, variety of cashew grown, and current fertiliser application rate if any were collected along with other baseline data. The details of varieties of cashew and age of the plantation of the selected fields are provided in Table 3.5.7. The farmers were instructed to follow the recommended soil fertiliser application based on soil test data for a patch of 1 acre consisting of 80 trees. In the rest of the area, they shall continue to do farming as was followed by them earlier. They also need to record the data on raw cashewnut yield on both the fields. They were given financial support for all the inputs as well other agronomic management required for cashew such as weeding, training and pruning, plant protection and soil and water conservation activities.

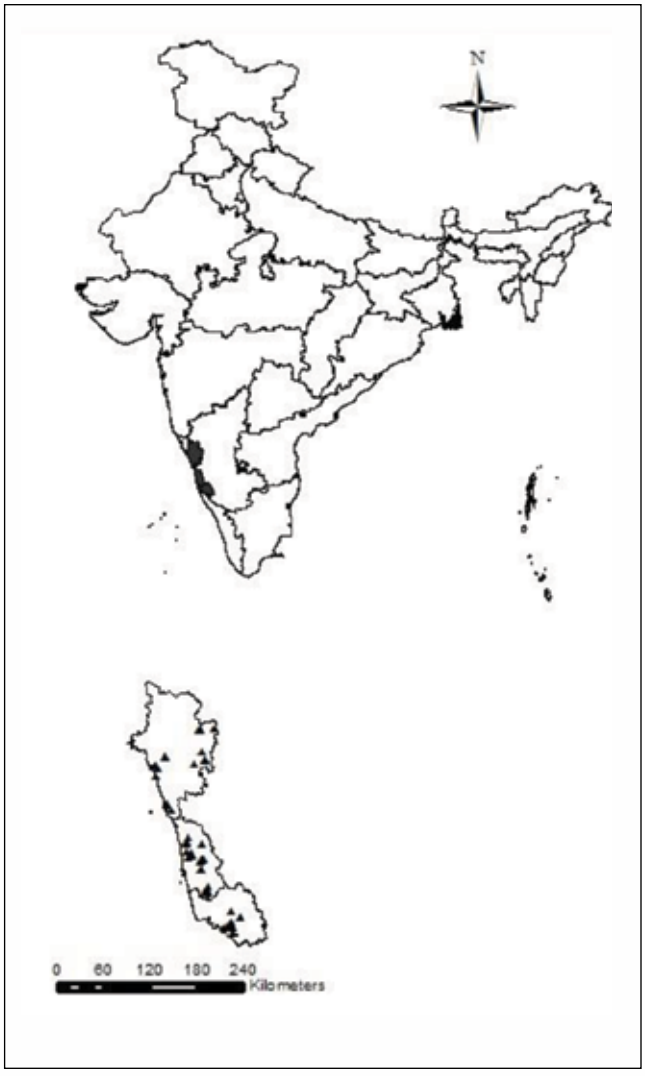


Fig.3.5.6. Location map of the study area

Table 3.5.7. Details of variety of cashew grown, age of the plantation and baseline raw cashewnut yield

Variety of cashew	Age of the plantation	No. of farmers	Baseline yield of raw cashewnut (2017-18)		
			Range (kg acre^{-1})	Mean	SD
Bhaskara	5	2	88.0 – 120.0	104.0	22.6
	6	5	80.8 – 176.0	120.2	36.4
	7	2	64.0 – 248.0	156.0	130.1
	8	5	96.0 – 352.0	214.4	95.7
Ullal-1	5	4	52.0-184.0	90.0	62.9
	6	3	80.0 – 104.0	88.5	13.4
	8	4	64.0 – 200.0	111.0	61.1
Ullal-2	8	2	96.0 – 176.0	136.0	56.6
Ullal-3	5	4	52.0 – 200.0	98.0	69.0
	6	4	80.0 – 200.0	124.0	53.3
	8	2	168.0 – 240.0	204.0	50.9
Vengurla-4	5	3	68.0-120.0	89.3	27.2
Vengurla-7	5	6	56.0 – 160.0	90.0	38.2
	6	4	64.0 – 160.0	108.0	40.0
	8	4	120.0 – 176.0	150.0	23.9
	10	2	264.0 – 360.0	312.0	67.9
VRI-3	5	3	68.0 – 160.0	105.3	48.4

Fig. 3.5.7. Glimpses of field visits conducted during 2019-20

III. Vermicompost units

Preparation of vermicompost from cashew biomass using earthworm Eudrillus sp. has been standardized by DCR, Puttur. The reported recovery from 5.5 tonnes of cashew biomass is 3.5 tonnes of compost or vermicompost. It can be easily adopted in cashew plantations. To demonstrate the same for practicing farmers vermicompost units were constructed.

IV. Training and exposure visits

Various trainings were conducted in the selected districts for the benefit of farmers on advanced cashew production technology. Exposure visits of farmers were carried out to the demonstration plots for lateral spread of scientific knowledge. Soil health cards were distributed to 60 farmers participating in the demonstration.

Field day at Ankola

A field day on soil and plant health management in cashew was organized at Ankola, Uttara Kannada district on 06-01-2020. The field day was attended by 46 farmers. Leaflets on different cashew production technologies were distributed to the farmers during the programme. Classes on soil nutrient and water management was taken by Dr. Shamsudheen M and class on different cashew production technologies were handled by Mr. B.M. Muralidhara. Farmers were taken to their own fields and various scientific management aspects were demonstrated and explained in the field itself. Farmers also shared their experiences.

Fig. 3.5.8. Field day at Ankola

Field day at Mundgod

A field day on soil and plant health management in cashew was organised at Mundgod, Uttara Kannada district on 07-01-2020. The field day was attended by 41 farmers. The field day was also attended by Sri. S.F. Patil, AHO, Dept of Horticulture, Govt. of Karnataka. During the field day, live demonstrations were conducted on different cashew production technology apart from lectures. Various extension pamphlets were also distributed to farmers.

Fig. 3.5.9. Field day at Mundgoda

Field day at Kundapura, Udupi

A field day on soil and plant health management in cashew was organized at Kundapura, Udupi district on 31-01-2020. The field day was attended by 35 farmers. Dr. J.D. Adiga, Principal Scientist (Horticulture) explained about different aspects of cashew cultivation including crop management and pest management. He demonstrated how to carry out pruning in cashew plantations. The farmer's queries on pest attack, pruning etc were answered in their field itself. Various extension pamphlets were also distributed to farmers. Dr. Shamsudheen. M explained about soil nutrient management including micronutrients.



Fig. 3.5.10. Field day at Kundapura

Field day at Alankar, Dakshina Kannada

A field day on soil and plant health management in cashew was organized at Alankar, Dakshina Kannada district on 07-02-2020. The field day was attended by 54 farmers. Dr. M.G. Nayak sensitized farmers about the importance of high-density planting and crop management in cashew plantations. Farmer's queries on converting rubber plantations to cashew were addressed.


Fig. 3.5.11. Field day at Alankar

Fig. 3.5.12. Exposure visits of farmers from Uttara Kannada district

Fig. 3.5.13. Exposure visit of farmers from Dakshina Kannada

Fig. 3.5.14 Exposure visits of farmers from Udupi

Exposure visits of farmers

Exposure visits of farmers were organized to DCR, Puttur and CPCRI, Regional Station, Vittal.

V. Plant health clinic cashew museum

The plant health clinic museums are aimed at giving advice and recommendations to the farmers on various aspects of modern agrotechniques1. The traditional plant health clinic museums rely on samples preserved in formalin, herbariums, insectariums to aid farmers in the diagnosis of different field problems and considered as one of the extension strategies to solve field problems2&3.

With the increased use of the information and communication technologies (ICTs) in agricultural extension, the facets of plant health clinics have also revolutionised. A modern plant health clinic museum with interactive ICTs have been set up for cashew at the ICAR-Directorate of Cashew Research, Puttur.

It depicts the relevant information on cashew cultivation, pest and disease management, nutrient and water management, post-harvest and value addition in an appealing manner. For

a perennial crop with seasonal production, it is difficult to provide practical field exposure on various aspects of scientific management and agro techniques for the visitors. The incorporation of information with the help of information and communication technologies made it possible to provide a holistic overview of crop and related activities at a single place. The museum provides information about cashew right from the journey to India from its centre of origin in North East Brazil during the 1500s through Portuguese. It is depicted in the form of murals in 2D representation. Three-dimensional depiction through models on softwood grafting and other aspects of cashew

processing shall help the visitors in imbibing the information in a faster manner. Kiosks and touch screen with custom made software let the farmers, students, researchers and other visitors to explore areas of their interest. Farmers can compare the symptoms of various diseases, disorders, pest damages, nutrient deficiencies and find out the remedial measures on their own. Storytelling boards and press button boards in the museum facilitates interactive learning involving three senses which will have long persistence of information. Scrolling translates provided in the museum increases the linguistic capacity of the museum to cater to the requirements of visitors from different states. Models and specimens made available are intended to cover all the possible spectrum of knowledge on cashew.

The use of information and communication technologies in modern museums shall make it an ideal one-stop point for providing information on various aspects of modern agro techniques for the benefit of farmers, students, researchers and other visitors.

VI. Software and mobile apps developed

The following software and mobile apps were developed under the project.

S. N	Details of software/mobile app
Software- Offline	
1.	**Cashew Site Suitability Evaluator** In non-traditional areas, the site suitability is important factor deciding the success of plantation. This calculator is aimed at identifying site suitability based on agro-climatic parameters.
2.	**Cashew Nutrient Deficiency Management** This software is intended to help growers identifying the nutrient deficiency by comparing with the prominent symptoms on the leaves.
3.	**Cashew pest management** This software is designed to help farmers to identify the major and minor pests of cashew and suggest remedial measures.
4.	**Cashew diseases and their management** This software intended to assist the farmers to identify the diseases affecting cashew based on various symptoms and suggest remedial measures.
5.	**Soil health card generator** Offline software in both English and Kannada was developed to generate the soil health card. It enables to generate error-free soil health card from the analytical results as single and multiple pdf files.

Software- Online	
6.	**Cashew Nutrient Management** Software for nutrient management in cashew was developed and is available in both English and Kannada. It is available on the ICAR-DCR website for calculating fertilizer requirement, lime requirement, foliar application of major and micronutrients. The deficiency symptoms of major and micronutrients commonly observed in the field also included in the software. The software also lets the farmers to download the soil health card issued by DCR, Puttur.
7.	**DCR- Cashew Drip/Fertigation Calculator** The scheduling of irrigation and application of correct doses of fertilizers through drip are important which depends on many factors. Under the actual field conditions, the no. of drippers, flow rate, availability of labour to run the system daily, age of the cashew trees, its development stages etc vary widely and user needs to customize his/her requirement. This software is developed to empower the users to do drip/fertigation calculations and scheduling at their convenience by inputting their specific needs and resource.
8.	**Cashew leaf diagnosis** Leaf analysis is suggested as a reliable tool for assessing how well the plant is supplied with nutrients from the soil. It is done by assessing the nutrient concentration in the index leaf tissues. In cashew, the 4th and 5th leaves from the tip of matured branches are considered as the index leaf. The user has to first get analyzed their leaf samples from a laboratory after following the proper leaf sampling and processing procedures.
Mobile Apps	
9.	**DCR-Cashew Nutrient Manager** A mobile app on soil nutrient management was developed. It is available on Google Play Store for calculating fertilizer requirement, lime requirement, foliar application of major and micronutrients. The deficiency symptoms of major and micronutrients commonly observed in the field also included in the software. The farmers can click on the images and understand the symptoms and find out the options to correct the deficiency. The App also lets the farmers to download the soil health card issued by DCR, Puttur.
10.	**DCR-Cashew Nutrient Manager – Offline** [This is the offline version of the above mobile app] A mobile app on soil nutrient management was developed. It is available on Google Play Store for calculating fertilizer requirement, lime requirement, foliar application of major and micronutrients. The deficiency symptoms of major and micronutrients commonly observed in the field also included in the software. The farmers can click on the images and understand the symptoms and find out the options to correct the deficiency. The App also lets the farmers to download the soil health card issued by DCR, Puttur.
11.	**DCR- Cashew Drip/Fertigation Calculator** The scheduling of irrigation and application of correct doses of fertilizers through drip are important which depends on many factors. Under the actual field conditions, the no. of drippers, flow rate, availability of labour to run the system daily, age of the cashew trees, its development stages etc vary widely and user needs to customize his/her requirement. This mobile app is developed to empower the users to do drip/fertigation calculations and scheduling at their convenience by inputting their specific needs and resource.

12.	**Cashew leaf diagnosis** Leaf analysis is suggested as a reliable tool for assessing how well the plant is supplied with nutrients from the soil. It is done by assessing the nutrient concentration in the index leaf tissues. In cashew, the 4th and 5th leaves from the tip of matured branches are considered as the index leaf. The user has to first get analysed their leaf samples from a laboratory after following the proper leaf sampling and processing procedures.
13.	**Cashew Site Suitability** In non-traditional areas, the site suitability is important factor deciding the success of plantation. This mobile app is aimed at identifying site suitability based on agro-climatic parameters.
14.	**Cashew Nutrient Deficiency** This mobile app is intended to help growers identifying the nutrient deficiency by comparing with the prominent symptoms on the leaves.
15.	**Cashew pest management** This mobile app is designed to help farmers to identify the major and minor pests of cashew and suggest remedial measures.
16.	**Cashew diseases** This mobile app intended to assist the farmers to identify the diseases affecting cashew based on various symptoms and suggest remedial measures.

The developed software and mobile apps are being registered for copy rights.

VI. Strengthening soil, plant and water diagnostic centre at DCR, Puttur

Following equipment were purchased for strengthening laboratory facilities in Soil Science section.

Sl. No.	Item
1	Microwave Plasma Atomic Emission Spectrometer
2	UV-Visible Spectrophotometer
3.	Electronic balance
4.	Microwave plant digestion
5.	Motorized sprayer
6.	GPS
7.	Camera
8.	Tree pruner
9.	Earth auger
10.	Centrifuge
11.	Field balance
12.	Refrigerator
13.	Laboratory Island tables



VII. Production of educational videos

Videos detailing the cultivation and plant protection was developed in English and Kannada for dissemination of technologies to the farmers and other stake holders.

Sl. No.	Title
1.	Cashew production technology
2.	High density and Ultra density planting in cashew
3.	Nutrient management in cashew
4.	Water management in cashew
5.	Management of TMB in cashew
6.	Management of CSRB in cashew
7.	About ICAR-Directorate of Cashew Research, Puttur
8.	Training and pruning in cashew
9.	Cashew Plant Health Clinic Museum
10.	ಗೇರು ಉತ್ಪಾದನಾ ತಂತ್ರಜ್ಞಾನ (Geru uthpadana tanthrajnana)
11.	ಗೇರಿನಲ್ಲಿ ಸಾಂದ್ರ ಬೇಸಾಯ ಹಾಗೂ ಅತಿ ಸಾಂದ್ರ ಬೇಸಾಯ (Gerinalli Sandra besaya hagu athi sandra besaya)
12.	ಗೇರು ಬೆಳೆಯಲ್ಲಿ ಪೋಷಕಾಂಶಗಳ ನಿರ್ವಹಣೆ (Geru beleyalli poshkamshagala nirvahane)
13.	ಗೇರು ಬೆಳೆಯಲ್ಲಿ ನೀರಿನ ನಿರ್ವಹಣೆ (Geru beleyalli neerina nirvahane)
14.	ಗೇರಿನಲ್ಲಿ ಚಹಾ ಸೊಳ್ಳೆ (ಟಿಎಂಬಿ)ಯ ನಿರ್ವಹಣೆ (Gerinalli chaha sole(TMB)ya nirvahane)
15.	ಗೇರಿನಲ್ಲಿ ಗೇರು ಕಾಂಡ ಮತ್ತು ಬೇರು ಕೊರಕ (ಸಿಎಸ್‌ಆರ್‌ಬಿ)ದ ನಿರ್ವಹಣೆ (Gerinalli Geru kanda mattu beru koraka(CSRB)ya nirvahane)
16.	ಐ.ಸಿ.ಎ.ಆರ್. - ಗೇರು ಸಂಶೋಧನಾ ನಿರ್ದೇಶನಾಲಯ, ಪುತ್ತೂರು (ICAR-Geru samshodhana Nirdeshanalaya, Puttur)
17.	ಗೇರು ಮರಗಳಿಂಗ ಆಕಾರ ನೀಡುವಿಕೆ ಮತ್ತು ಸವರುವಿಕೆ (Geru maragalige akara needuvike mattu savaruvike)
18.	ಗೇರು ಸಸ್ಯ ಆರೋಗ್ಯ ಚಿಕಿತ್ಸಾಲಯ - ವಸ್ತು ಸಂಗ್ರಾಹಲಯ (Geru sasya arogya chikithsalaya- Vasthu Sangrahalaya)

3.5.3 Characterization of physiological responses of cashew (*Anacardium occidentale* L.) to salinity and drought stresses

Project duration: [2015-2022]

Project leaders:

Year	Principal Investigator	Co-PI
2015-2016	Dr. Babli Mog	Dr. T.R. Rupa
2016-2017	Dr. Babli Mog	Dr. T.R. Rupa
2017-2018	Dr. Babli Mog	-
2018-2019	Dr. Babli Mog	-
2019-2020	Dr. Babli Mog	Dr. Veena G. L and Dr. Thondaiman V
2020-2021	Dr. Babli Mog	Dr. Veena G. L and Dr. Thondaiman V
2021-2022	Dr. Babli Mog	Dr. Veena G. L and Dr. Thondaiman V

Screening of cashew varieties for salinity and drought stresses

Two separate experiments were conducted at ICAR-Directorate of Cashew Research, Puttur, Karnataka during 2015 to 2022 to screen cashew varieties for salinity and drought stresses. In first set of experiments, cashew varieties were screened at different salt concentrations in order to identify the critical salt concentration for further screening based on pot culture studies. In second set of experiment, seventeen cashew varieties were screened for deficit moisture stress in five-year-old cashew trees in field.

1. Objectives

- To evaluate the physiological and biochemical responses of cashew accessions grown in various salinity stress levels
- To evaluate the physiological and biochemical responses of screen cashew accessions under drought stress.

2. Materials and methods:

Cashew varieties were evaluated to test their performance in response to varying levels of salt and drought stress under pot culture experiments.

The nuts were first disinfected in 0.2% (v/v) sodium hypochlorite solution for 10 mins, rinsed thoroughly with running tap water and imbibed in distilled water for 24 hours and were sown in plastic trays containing mixture of soil, sand and FYM (1:1:1). Each cashew varieties had 20 trays containing 100 nuts. During germination, moisture of sand was kept close to field capacity by daily irrigation with distilled water. After 20 days of germination, homogenous seedlings with same physiological phase (eight leaf stage) were selected and carefully transferred to 10 L pots containing field soil. Premixing of recommended fertilizers with the soil were done.

Imposition of salt stress:

After 8 days of transplanting, salt treatments were imposed by direct addition of 50 mM/lit/day to 30 homogenous seedlings per each cashew accession in order to avoid osmotic shock. After 4 days, the following treatments were followed: 0, 50 100, 150 and 200 mM NaCl for 30 days. A set of homogenous plants of each cashew accession were harvested at beginning of salt treatment for determination of initial fresh weight and dry weight. Several physiological and growth parameters were also be recorded on alternate

days after imposition of salt treatments. Thirty days after imposition of salt treatments, the final harvest was performed to evaluate same physiological and growth parameters. Thirty days after salt treatments, seedlings were irrigated with distilled water in order to recover them from salt stress given for 30 days. Two weeks after recovery from salt stress, physiological and growth parameters were assessed. To evaluate salt resistance measured by capacity to survive in presence of NaCl lethal dose, plants were evaluated when total number of leaves decreased by 50% at 200 mM NaCl treatment. After harvest, seedlings were divided into leaves, stem and roots and immediately frozen and stored at -80˚C for further biochemical determinations.

Drought treatments:

Seventeen cashew varieties were screened for deficit moisture stress in five-year-old cashew trees in field. Usually, Cashew experiences severe moisture stress from January to March where the experimental plots receive no irrigation. Hence, morphological, physiological and flowering parameters were recorded during January to March to screen varieties for deficit moisture stress.

Experimental results:

2.1. Effect of different levels of salinity on morphological and physiological parameters:

The growth responses of six cashew cultivars to salinity were investigated at seedling stage. Changes in morphological parameters, growth, pigment content and biomass partitioning parameters were assessed during salinity stress.

Leaf toxicity symptoms

The toxic effects observed on the leaves were mainly chlorosis and necrosis. At 50 mM, no leaf necrosis was observed. At 100 Mm, the rate of leaf necrosis was 5%. At 150 and 200mM, the rate surpassed 39.5% and 50.2%. The higher and lower leaf necrosis (%) were recorded in M-2 (68.8%) and Bhaskara (34.3%) at 200mM.

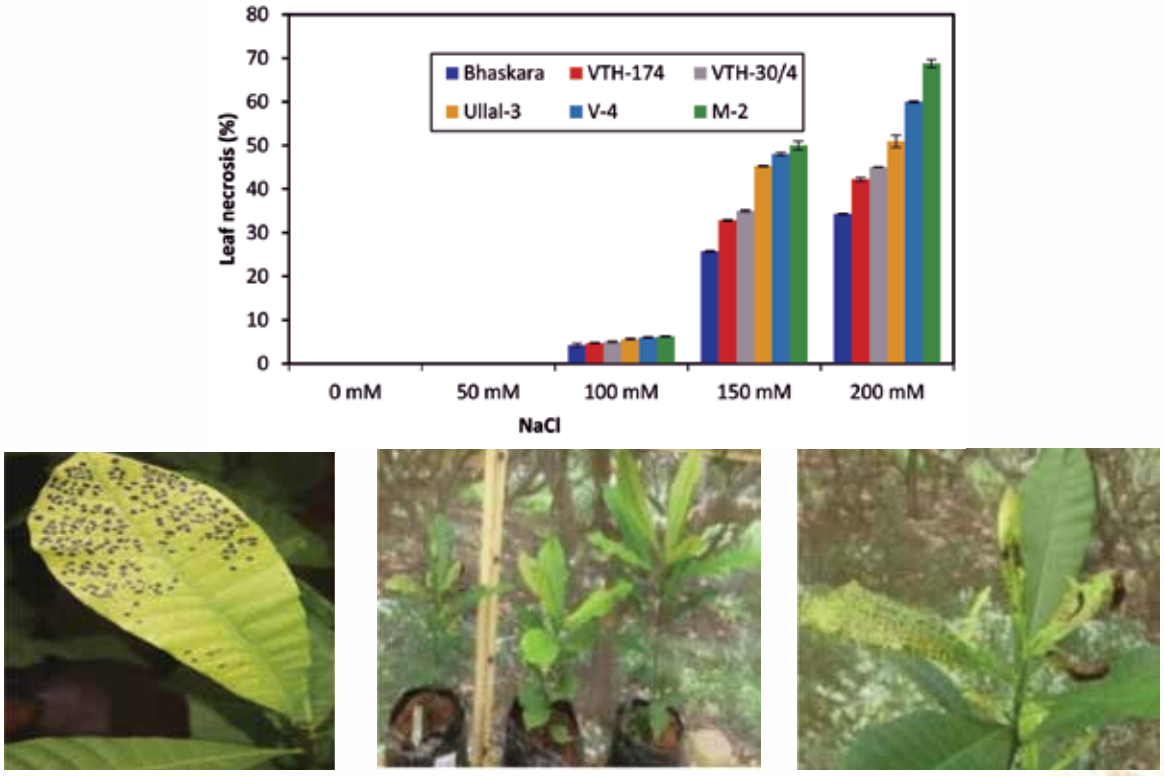


Fig 3.5.15: Salinity induced leaf toxicity symptoms at 150 and 200 mM NaCl treatments

Effect on morphological parameters

- Plant height reduced by 3.8%, 22.1%, 41% and 62.7% after exposure to 50, 100, 150 and 200mM over control. Reduction in plant height was maximum and minimum in M-2 (93.3%) and Bhaskara (49.2%) at 200mM
- Total leaf area reduced by 19.9%, 38%, 60.8% and 86.9% at 50, 100, 150 and 200mM over control. Reduction in leaf area was maximum and minimum in M-2 (87.7%) and Bhaskara (38.1%) at 200mM
- Reduction in MSI (%) was 20.1%, 28.5%, 39.8% and 46.9% at 50, 100, 150 and 200 mM NaCl over control. Bhaskara was able to maintain higher cell membrane stability (48.9%), while the same was lower in M-2 (18.9%) among accessions at 200mM.

Table 3.5.8: Influence of different levels of salinity stress on growth parameters of cashew cultivars

Variety	NaCl	LDW	RDW	SDW	PB	SRRatio
Bhaskara	0	$0.67^{a}\pm0.02$	$1.1^{a}\pm0.02$	$5.1^{a}\pm0.20$	$6.8^{a}\pm0.09$	$5.25^{a}\pm0.21$
	50	$0.57^{b}\pm0.02$	$1.06^{b}\pm0.03$	$4.7^{ab}\pm0.20$	$6.3^{b}\pm0.15$	$5.0^{a}\pm0.30$
	100	$0.52^{c}\pm0.01$	$1.0^{c}\pm0.01$	$4.5^{bc}\pm0.18$	$6.0^{b}\pm0.11$	$5.0^{a}\pm0.17$
	150	$0.45^{d}\pm0.01$	$0.98^{c}\pm0.01$	$4.1^{bc}\pm0.07$	$5.6^{c}\pm0.11$	$4.65^{ab}\pm0.09$
	200	$0.38^{e}\pm0.01$	$0.94^{c}\pm0.02$	$3.5^{c}\pm0.12$	$4.8^{c}\pm0.11$	$4.125^{b}\pm0.14$
VTH-174	0	$0.62^{a}\pm0.01$	$1.06^{a}\pm0.02$	$4.9^{a}\pm0.07$	$6.6^{a}\pm0.11$	$5.2^{a}\pm0.01$
	50	$0.53^{b}\pm0.011$	$1.0^{ab}\pm0.01$	$4.5^{b}\pm0.08$	$6^{b}\pm0.11$	$5.1^{ab}\pm0.13$
	100	$0.47^{c}\pm0.01$	$0.96^{bc}\pm0.04$	$4.4^{b}\pm0.09$	$5.8^{b}\pm0.11$	$5.1^{ab}\pm0.27$
	150	$0.42^{d}\pm0.01$	$0.92^{cd}\pm0.01$	$3.9^{c}\pm0.11$	$5.2^{c}\pm0.20$	$4.67^{b}\pm0.14$
	200	$0.34^{e}\pm0.01$	$0.86^{d}\pm0.018$	$3.0d\pm0.04$	$4.2^{d}\pm0.09$	$3.875^{c}\pm0.05$
VTH-30/4	0	$0.52^{a}\pm0.01$	$0.99^{a}\pm0.01$	$4.9^{a}\pm0.09$	$6.4^{a}\pm0.09$	$5.5^{a}\pm0.15$
	50	$0.43^{b}\pm0.01$	$0.94^{b}\pm0.01$	$4.5^{b}\pm0.09$	$5.9^{b}\pm0.11$	$5.25^{a}\pm0.06$
	100	$0.39^{bc}\pm0.01$	$0.91^{b}\pm0.01$	$4.3^{b}\pm0.07$	$5.6^{b}\pm0.09$	$5.15^{a}\pm0.09$
	150	$0.34^{c}\pm0.02$	$0.86^{c}\pm0.02$	$3.6^{c}\pm0.09$	$4.8^{c}\pm0.09$	$4.6^{b}\pm0.19$
	200	$0.28^{d}\pm0.02$	$0.82^{c}\pm0.01$	$2.6^{d}\pm0.07$	$3.7^{d}\pm0.13$	$3.5^{c}\pm0.12$
Ullal-3	0	$0.48^{a}\pm0.01$	$0.98^{a}\pm0.02$	$4.8^{a}\pm0.16$	$6.2^{a}\pm0.07$	$5.375^{a}\pm0.15$
	50	$0.39^{b}\pm0.01$	$0.95^{ab}\pm0.02$	$4.6^{a}\pm0.21$	$5.9^{a}\pm0.04$	$5.25^{a}\pm0.24$
	100	$0.35^{c}\pm0.01$	$0.91^{b}\pm0.02$	$3.9^{b}\pm0.07$	$5.2^{b}\pm0.09$	$4.675^{b}\pm0.15$
	150	$0.3^{d}\pm0.01$	$0.83^{c}\pm0.01$	$3.3^{c}\pm0.04$	$4.4^{c}\pm0.18$	$4.35^{b}\pm0.05$
	200	$0.25^{e}\pm0.01$	$0.8^{c}\pm0.03$	$1.9^{d}\pm0.09$	$3.0^{d}\pm0.11$	$2.675^{c}\pm0.09$
V-4	0	$0.37^{a}\pm0.01$	$0.96^{a}\pm0.01$	$4.0^{a}\pm0.18$	$5.3^{a}\pm0.04$	$4.55^{a}\pm0.19$
	50	$0.3^{b}\pm0.01$	$0.92^{a}\pm0.01$	$3.8^{a}\pm0.20$	$5.0^{ab}\pm0.04$	$4.475^{a}\pm0.19$
	100	$0.26^{bc}\pm0.02$	$0.85^{b}\pm0.03$	$3.6^{a}\pm0.11$	$4.7^{b}\pm0.09$	$4.55^{a}\pm0.19$
	150	$0.21^{cd}\pm0.01$	$0.8^{bc}\pm0.02$	$2.7^{b}\pm0.20$	$3.7^{c}\pm0.20412$	$3.65^{b}\pm0.24$
	200	$0.18^{d}\pm0.03$	$0.77^{c}\pm0.02$	$1.9^{c}\pm0.07$	$2.8^{d}\pm0.09129$	$2.725^{c}\pm0.18$

M-2	0	0.32^{a}±0.02	0.81^{a}±0.01	4.0^{a}±0.11	5.1^{a}±0.20412	5.325^{a}±0.08
	50	0.24^{b}±0.02	0.79^{a}±0.02	3.9^{a}±0.156	4.9^{a}±0.07071	5.25^{a}±0.28
	100	0.21^{bc}±0.01	0.74^{ab}±0.02	3.4^{b}±0.04	4.3^{b}±0.07071	4.875^{a}±0.18
	150	0.18^{cd}±0.01	0.7^{b}±0.02	2.4^{c}±0.24	3.3^{c}±0.10801	3.675^{b}±0.33
	200	0.15^{d}±0.01	0.68^{b}±0.03	1.2^{d}±0.11	2.0^{d}±0.10801	2.0^{c}±0.15
NaCl		225.298**	71.305**	285.984**	498.075**	131.936**
Varieties (V)		318.597**	106.082**	86.666**	215.423**	18.657**
VxNaCl		1.665*	0.416NS	3.621**	4.017**	4.372**

Values are expressed as mean±S.E. (n=4). Means followed by a different letter within a column for each cashew variety are significantly different at P<0.05 according to the Duncan's Multiple Range Test (DMRT)

* and **, Significant at 1% and 5%, respectively; NS, not significant.

PHT denotes plant height (cm), SL, shoot length (cm), RL, root length (cm), LA, leaf area (cm2), MSI, membrane stability index (%)

Effect on growth parameters

Significant changes in leaf dry weight, root dry weight, shoot dry weight and shoot to root ratio were also observed at 150 and 200mM

At 200mM, 88.9% reduction in leaf dry weight was observed with least reduction in Bhaskara (43.4%) and maximum reduction in M-2 (53.5%) over control

Root dry weight was reduced by 20.9% with Bhaskara (16.6%) and M-2 (20.5%) recording lower and higher reduction at 200mM

45% reduction in shoot dry weight was observed at 200mM. M-2 recorded higher reduction (40.2%) and Bhaskara recorded lower reduction (28.9%)

Total plant biomass reduced by 7.4%, 15.5%, 35.7% and 78% at 50, 100, 150 and 200mM over control. At 200mM, M-2 exhibited higher reduction (70%) while Bhaskara exhibited lower reduction (42%).

Table 3.5.9: Influence of different levels of salinity stress on growth parameters of cashew cultivars

Variety	NaCl	LDW	RDW	SDW	PB	SRRatio
Bhaskara	0	0.67^{a}±0.02	1.1^{a}±0.02	5.1^{a}±0.20	6.8^{a}±0.09	5.25^{a}±0.21
	50	0.57^{b}±0.02	1.06^{b}±0.03	4.7^{ab}±0.20	6.3^{b}±0.15	5.0^{a}±0.30
	100	0.52^{c}±0.01	1.0^{c}±0.01	4.5^{bc}±0.18	6.0^{b}±0.11	5.0^{a}±0.17
	150	0.45^{d}±0.01	0.98^{c}±0.01	4.1^{bc}±0.07	5.6^{c}±0.11	4.65^{ab}±0.09
	200	0.38^{e}±0.01	0.94^{c}±0.02	3.5^{c}±0.12	4.8^{c}±0.11	4.125^{b}±0.14
VTH-174	0	0.62^{a}±0.01	1.06^{a}±0.02	4.9^{a}±0.07	6.6^{a}±0.11	5.2^{a}±0.01
	50	0.53^{b}±0.011	1.0^{ab}±0.01	4.5^{b}±0.08	6^{b}±0.11	5.1^{ab}±0.13
	100	0.47^{c}±0.01	0.96^{bc}±0.04	4.4^{b}±0.09	5.8^{b}±0.11	5.1^{ab}±0.27
	150	0.42^{d}±0.01	0.92^{cd}±0.01	3.9^{c}±0.11	5.2^{c}±0.20	4.67^{b}±0.14
	200	0.34^{e}±0.01	0.86^{d}±0.018	3.0d±0.04	4.2^{d}±0.09	3.875^{c}±0.05

VTH-30/4	0	$0.52^{a}\pm0.01$	$0.99^{a}\pm0.01$	$4.9^{a}\pm0.09$	$6.4^{a}\pm0.09$	$5.5^{a}\pm0.15$
	50	$0.43^{b}\pm0.01$	$0.94^{b}\pm0.01$	$4.5^{b}\pm0.09$	$5.9^{b}\pm0.11$	$5.25^{a}\pm0.06$
	100	$0.39^{bc}\pm0.01$	$0.91^{b}\pm0.01$	$4.3^{b}\pm0.07$	$5.6^{b}\pm0.09$	$5.15^{a}\pm0.09$
	150	$0.34^{c}\pm0.02$	$0.86^{c}\pm0.02$	$3.6^{c}\pm0.09$	$4.8^{c}\pm0.09$	$4.6^{b}\pm0.19$
	200	$0.28^{d}\pm0.02$	$0.82^{c}\pm0.01$	$2.6^{d}\pm0.07$	$3.7^{d}\pm0.13$	$3.5^{c}\pm0.12$
Ullal-3	0	$0.48^{a}\pm0.01$	$0.98^{a}\pm0.02$	$4.8^{a}\pm0.16$	$6.2^{a}\pm0.07$	$5.375^{a}\pm0.15$
	50	$0.39^{b}\pm0.01$	$0.95^{ab}\pm0.02$	$4.6^{a}\pm0.21$	$5.9^{a}\pm0.04$	$5.25^{a}\pm0.24$
	100	$0.35^{c}\pm0.01$	$0.91^{b}\pm0.02$	$3.9^{b}\pm0.07$	$5.2^{b}\pm0.09$	$4.675^{b}\pm0.15$
	150	$0.3^{d}\pm0.01$	$0.83^{c}\pm0.01$	$3.3^{c}\pm0.04$	$4.4^{c}\pm0.18$	$4.35^{b}\pm0.05$
	200	$0.25^{e}\pm0.01$	$0.8^{c}\pm0.03$	$1.9^{d}\pm0.09$	$3.0^{d}\pm0.11$	$2.675^{c}\pm0.09$
V-4	0	$0.37^{a}\pm0.01$	$0.96^{a}\pm0.01$	$4.0^{a}\pm0.18$	$5.3^{a}\pm0.04$	$4.55^{a}\pm0.19$
	50	$0.3^{b}\pm0.01$	$0.92^{a}\pm0.01$	$3.8^{a}\pm0.20$	$5.0^{ab}\pm0.04$	$4.475^{a}\pm0.19$
	100	$0.26^{bc}\pm0.02$	$0.85^{b}\pm0.03$	$3.6^{a}\pm0.11$	$4.7^{b}\pm0.09$	$4.55^{a}\pm0.19$
	150	$0.21^{cd}\pm0.01$	$0.8^{bc}\pm0.02$	$2.7^{b}\pm0.20$	$3.7^{c}\pm0.20412$	$3.65^{b}\pm0.24$
	200	$0.18^{d}\pm0.03$	$0.77^{c}\pm0.02$	$1.9^{c}\pm0.07$	$2.8^{d}\pm0.09129$	$2.725^{c}\pm0.18$
M-2	0	$0.32^{a}\pm0.02$	$0.81^{a}\pm0.01$	$4.0^{a}\pm0.11$	$5.1^{a}\pm0.20412$	$5.325^{a}\pm0.08$
	50	$0.24^{b}\pm0.02$	$0.79^{a}\pm0.02$	$3.9^{a}\pm0.156$	$4.9^{a}\pm0.07071$	$5.25^{a}\pm0.28$
	100	$0.21^{bc}\pm0.01$	$0.74^{ab}\pm0.02$	$3.4^{b}\pm0.04$	$4.3^{b}\pm0.07071$	$4.875^{a}\pm0.18$
	150	$0.18^{cd}\pm0.01$	$0.7^{b}\pm0.02$	$2.4^{c}\pm0.24$	$3.3^{c}\pm0.10801$	$3.675^{b}\pm0.33$
	200	$0.15^{d}\pm0.01$	$0.68^{b}\pm0.03$	$1.2^{d}\pm0.11$	$2.0^{d}\pm0.10801$	$2.0^{c}\pm0.15$
NaCl		225.298**	71.305**	285.984**	498.075**	131.936**
Varieties (V)		318.597**	106.082**	86.666**	215.423**	18.657**
VxNaCl		1.665*	0.416NS	3.621**	4.017**	4.372**

Values are expressed as mean±S.E. (n=4). Means followed by a different letter within a column for each cashew variety are significantly different at $P<0.05$ according to the Duncan's Multiple Range Test (DMRT)

* and **, Significant at 1% and 5%, respectively; NS, not significant.

LWD denotes leaf dry weight (g), RDW, root dry weight (g), SDW, shoot dry weight (g), PB, total plant biomass (g), SR ratio, shoot to root ratio

Relative water content (RWC) and membrane leakage (ML)

- Significant reduction in leaf water content was observed at 150 mM (30.1%) and 200mM (39.4%) over control. Reduction in RWC was maximum and minimum in M-2 (61.4%) and Bhaskara (26.1%) at 200mM

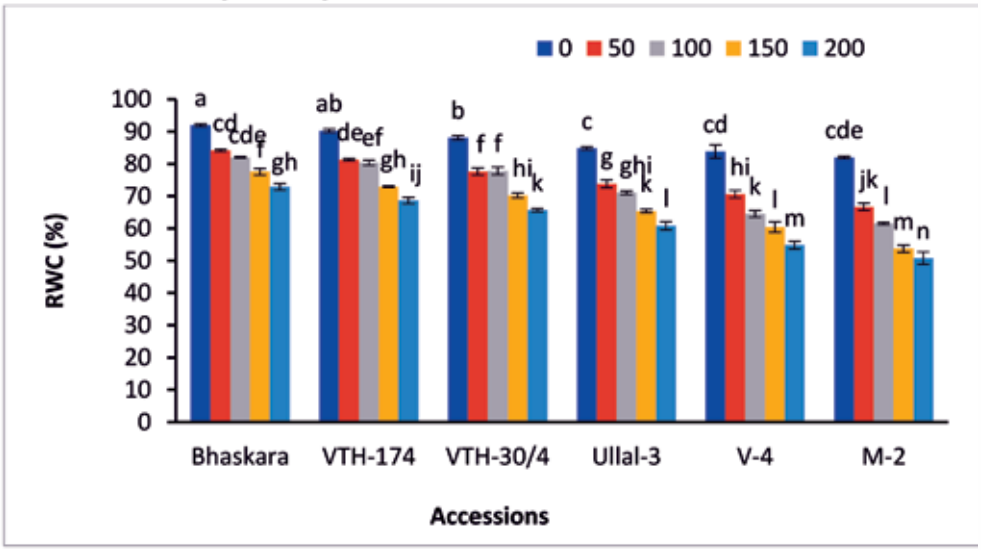


Fig.3.5.16: Salinity stress induced reduction in leaf relative water content after 3o days of treatments.

- Loss of cell membrane in leaves was highest at 150 mM (63.2%) and 200mM (67.6%) among treatments over control. At 200mM, the percent membrane loss was 48.7% in Bhaskara, while the same was 79.6% in M-2 among accessions

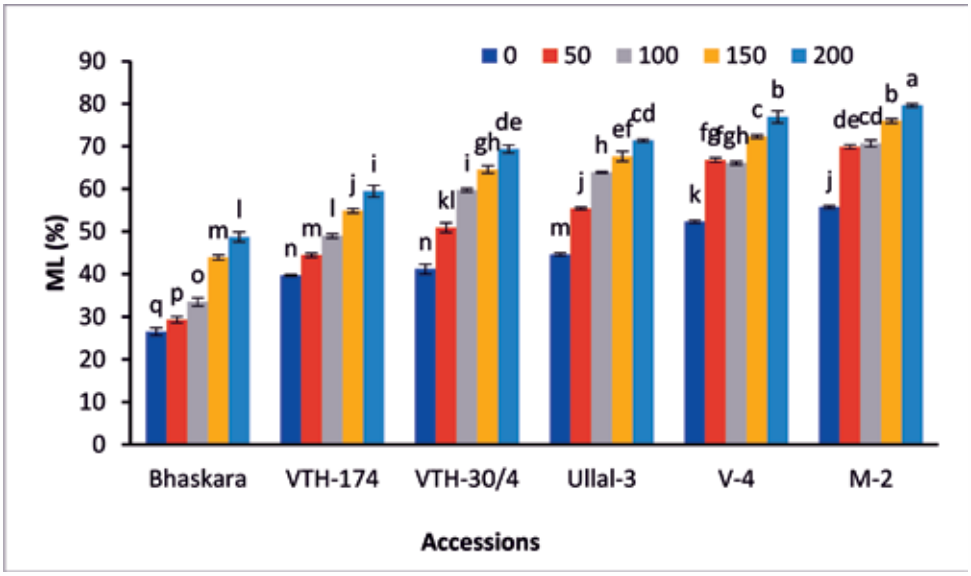


Fig 3.5.17 Extent of membrane leakage in leaves of cashew cultivars after Salinity stress

Photosynthetic pigment contents

- Significant reduction in the contents of Chl a (by 27.6% and 35.4%), Chl b (32.9% and 50.9%) and total Chl (16.6% and 40.4%) were observed at 150 and 200mM. The pigment contents were higher in Bhaskara, while M-2 recoded lower pigment contents

Table 3.5.10 Influence of different levels of salinity stress on photosynthetic pigment contents of cashew cultivars

Variety	NaCl	Chl a	Chl b	TChl	Caro	Chla/Chlb	TChl/Caro
Bhaskara	0	0.87±0.01^{a}	0.48±0.02^{a}	1.35±0.01^{a}	0.4±0.01^{a}	1.81±0.00^{d}	3.38±0.03^{c}
	50	0.83±0.01^{b}	0.45±0.01^{ab}	1.28±0.01^{b}	0.37±0.00^{b}	1.84±0.01^{d}	3.46±0.03^{c}
	100	0.8±0.02^{bc}	0.42±0.01^{bc}	1.22±0.01^{c}	0.33±0.01^{c}	1.9±0.02^{c}	3.7±0.03^{b}
	150	0.77±0.01^{cd}	0.38±0.01^{cd}	1.15±0.01^{d}	0.3±0.01^{d}	2.03±0.01^{b}	3.83±0.01^{a}
	200	0.74±0.00^{d}	0.35±0.01^{d}	1.09±0.03^{e}	0.28±0.01^{d}	2.11±0.01^{a}	3.89±0.03^{a}
VTH-174	0	0.78±0.02^{a}	0.44±0.01^{a}	1.22±0.01^{a}	0.39±0.01^{a}	1.77±0.02^{d}	3.13±0.00^{d}
	50	0.74±0.0^{ab}	0.41±0.01^{ab}	1.15±0.02^{b}	0.35±0.01^{b}	1.8±0.01^{d}	3.29±0.03^{c}
	100	0.7±0.02^{bc}	0.38±0.01^{b}	1.08±0.02^{c}	0.31±0.01^{c}	1.84±0.01^{c}	3.48±0.02^{b}
	150	0.67±0.02^{cd}	0.33±0.01^{c}	1.0±0.02^{d}	0.29±0.01^{c}	2.03±0.01^{b}	3.45±0.02^{b}
	200	0.64±0.01^{d}	0.3±0.02^{c}	0.94±0.00^{e}	0.26±0.01^{d}	2.13±0.00^{a}	3.62±0.01^{a}
VTH-30/4	0	0.77±0.0^{a}	0.42±0.01^{a}	1.19±0.02^{a}	0.38±0.02^{a}	1.83±0.01^{c}	3.13±0.01^{d}
	50	0.72±0.01^{b}	0.38±0.01^{b}	1.1±0.01^{b}	0.33±0.02^{ab}	1.89±0.01^{b}	3.33±0.01^{c}
	100	0.67±0.01^{c}	0.36±0.01^{b}	1.03±0.01^{c}	0.3±0.02^{bc}	1.86±0.01^{bc}	3.43±0.01^{a}
	150	0.61±0.01^{d}	0.3±0.02^{c}	0.91±0.00^{d}	0.27±0.01^{c}	2.03±0.01^{a}	3.37±0.02^{bc}
	200	0.57±0.0^{e}	0.28±0.01^{c}	0.85±0.02^{e}	0.25±0.02^{c}	2.04±0.01^{a}	3.4±0.02^{ab}
Ullal-3	0	0.75±0.01^{a}	0.4±0.01^{a}	1.15±0.01^{a}	0.37±0.02^{a}	1.88±0.02^{b}	3.11±0.01^{d}
	50	0.7±0.01^{b}	0.35±0.03^{a}	1.05±0.02^{b}	0.31±0.01^{b}	2±0.02^{a}	3.39±0.03^{c}
	100	0.64±0.0^{c}	0.34±0.01^{ab}	0.98±0.02^{c}	0.28±0.02^{bc}	1.88±0.01^{b}	3.5±0.03^{b}
	150	0.56±0.01^{d}	0.28±0.03^{bc}	0.84±0.01^{d}	0.25±0.02^{cd}	2±0.02^{a}	3.36±0.01^{c}
	200	0.53±0.01^{e}	0.26±0.01^{c}	0.79±0.01^{e}	0.22±0.01^{d}	2.04±0.01^{a}	3.59±0.02^{a}
V-4	0	0.75±0.01^{a}	0.37±0.01^{a}	1.12±0.01^{a}	0.34±0.01^{a}	2.03±0.01^{c}	3.29±0.04^{c}
	50	0.67±0.01^{b}	0.31±0.03^{ab}	0.98±0.01^{b}	0.28±0.01^{b}	2.16±0.01^{ab}	3.5±0.03^{b}
	100	0.62±0.01^{c}	0.3±0.03^{b}	0.92±0.01^{c}	0.25±0.02^{bc}	2.07±0.02^{c}	3.68±0.02^{a}
	150	0.53±0.0^{d}	0.25±0.01^{cd}	0.78±0.01^{d}	0.22±0.01^{cd}	2.12±0.01^{b}	3.55±0.02^{b}
	200	0.5±0.02^{e}	0.23±0.01^{d}	0.73±0.01^{e}	0.2±0.02^{d}	2.17±0.02^{a}	3.65±0.01^{a}
M-2	0	0.7±0.03^{a}	0.35±0.02^{a}	1.05±0.02^{a}	0.31±0.01^{a}	2±0.02^{b}	3.39±0.04^{d}
	50	0.62±0.01^{b}	0.29±0.02^{b}	0.91±0.00^{b}	0.25±0.01^{b}	2.14±0.01^{a}	3.64±0.01^{b}
	100	0.56±0.01^{c}	0.28±0.02^{bc}	0.84±0.03^{c}	0.22±0.01^{bc}	2±0.07^{b}	3.82±0.01^{a}
	150	0.48±0.01^{d}	0.23±0.00^{cd}	0.71±0.01^{d}	0.2±0.01^{cd}	2.09±0.04^{ab}	3.55±0.02^{c}
	200	0.43±0.01^{e}	0.21±0.02^{d}	0.64±0.01^{e}	0.18±0.00^{d}	2.05±0.01^{ab}	3.56±0.02^{c}
NaCl		245.065**	62.931**	511.18**	91.789**	118.561**	278.454**
Varieties (V)		217.874**	47.847**	424.998**	42.906**	86.351**	159.678**
VxNaCl		3.692**	0.127NS	2.995**	0.179NS	11.296**	14.554**

Values are expressed as mean±S.E. (n=4). Means followed by a different letter within a column for each cashew variety are significantly different at P<0.05 according to the Duncan's Multiple Range Test (DMRT)

* and **, Significant at 1% and 5%, respectively; NS, not significant.

Chl a denotes Chlorophyll a (mg/g FW), Chl b, Chlorophyll b (mg/g FW), TChl, Total chlorophyll (mg/g FW), Caro, carotenoid (mg/g FW), Chla/Chlb, chlorophyll a/chlorophyll b, TChl/Caro, total chlorophyll/carotenoid

Biomass partitioning parameters

- The levels of 150 and 200mM reduced biomass allocation to leaf by 19.7% and 24.3% over control
- Biomass allocation to root increased by 11.2% and 22.5% at 150 and 200mM over control
- 1.5% and 2.2% reduction in biomass allocation to stem was observed at 150 and 200mM over control

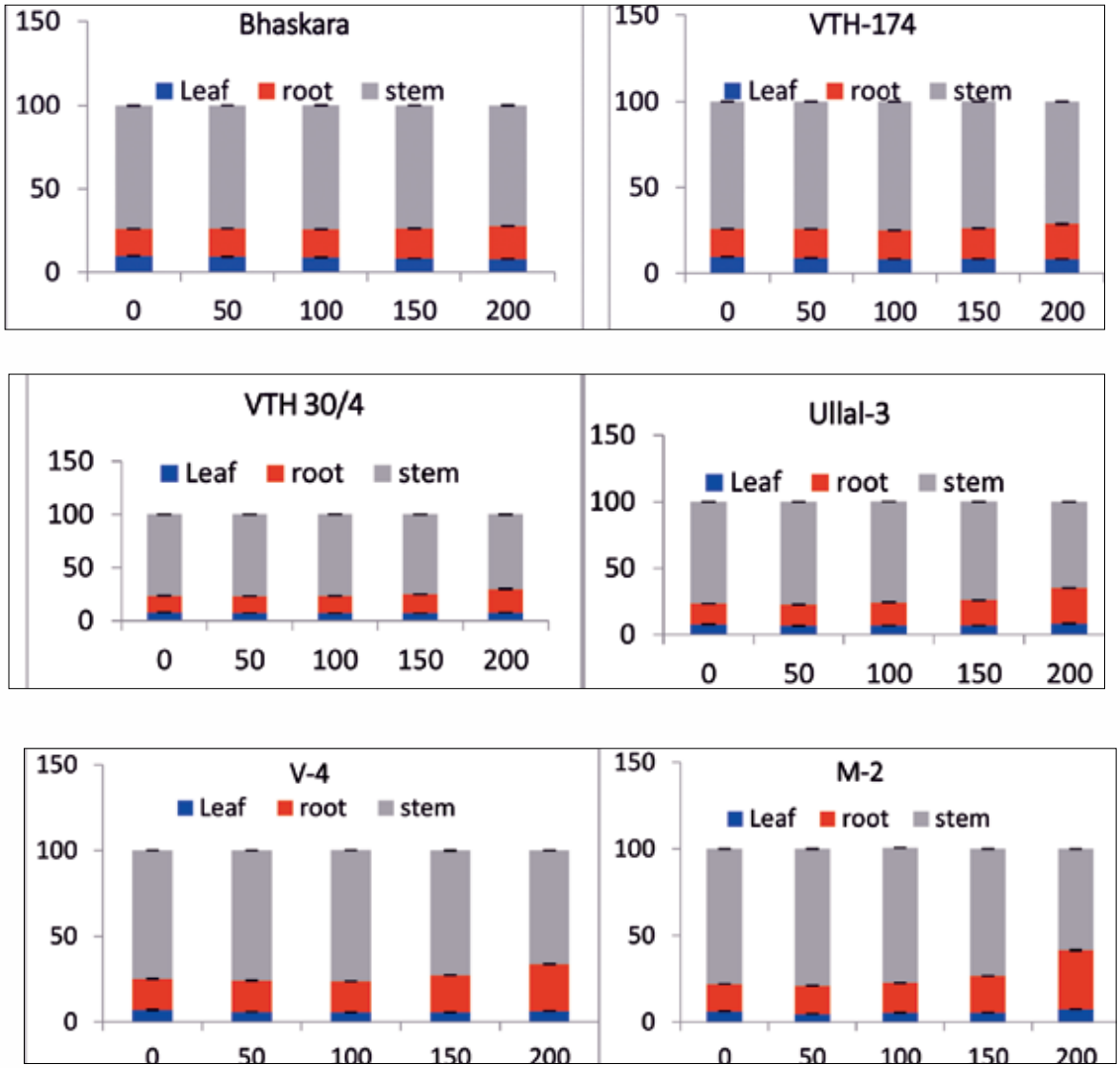


Fig 3.5.18: Influence of salinity stress on Biomass partitioning parameters of cashew cultivars

- Salt stress also led to decrease in relative growth rate (RGR). However, maximum reduction was observed at 150 mM (66.6%) and 200 mM (75%) over control
- Leaf area ratio (LAR) was not significantly affected by salinity where the reduction was only 5% at 200mM over control
- Specific leaf area (SLA) was also not significantly affected by salinity treatments where the reduction was 1.4% at 200mM

Table 3.5.11: Influence of different levels of salinity stress on relative growth rate, leaf area ratio and specific leaf area of cashew cultivars

Variety	NaCl	RGR	LAR	SLA
Bhaskara	0	0.152^{a}±0.0004	16.425^{a}±0.33	167.05^{a}±2.96
	50	0.134^{b}±0.0009	16.15^{a}±0.5	178.575^{cd}±5.18
	100	0.124^{c}±0.0004	16.325^{a}±0.32	188.375^{bc}±4.03
	150	0.107^{d}±0.0004	15.975^{a}±0.37	199.2^{ab}±4.02
	200	0.084^{e}±0.0009	16.9^{a}±0.41	213.4^{ab}±7.23
VTH-174	0	0.147^{a}±0.00091	16.6^{a}±0.34157	176.55^{b}±2.03899
	50	0.127^{b}±0.00071	16.275^{ab}±0.11087	184.35^{b}±3.89733
	100	0.12^{c}±0.00108	14.75^{c}±0.31754	182.3^{b}±6.76769
	150	0.1^{d}±0.00129	15.2^{bc}±0.5462	187.775^{b}±6.18363
	200	0.067^{e}±0.00108	16.75^{a}±0.39686	207.175^{a}±5.83529
VTH-30/4	0	0.142^{a}±0.00091	16.6^{b}±0.21213	204.5^{a}±4.15271
	50	0.126^{b}±0.00058	15.875^{b}±0.275	218^{a}±6.58268
	100	0.116^{c}±0.00108	14.675^{bc}±0.29545	211.225^{a}±7.31282
	150	0.089^{d}±0.00108	15.625^{c}±0.43277	223.25^{a}±15.70268
	200	0.052^{e}±0.00091	18.05^{a}±0.55151	242.6^{a}±19.8517
Ullal-3	0	0.139^{a}±0.00041	22.275^{a}±0.48713	287.575^{a}±5.65691
	50	0.127^{b}±0.00071	18.725^{b}±0.18875	283.625^{a}±8.15755
	100	0.104^{c}±0.00041	17.475^{bc}±0.50229	259.875^{ab}±9.44981
	150	0.077^{d}±0.00108	16.875^{c}±0.65368	247.675^{b}±11.17463
	200	0.031^{e}±0.00108	20.7^{a}±0.77996	248.45^{b}±10.05008
V-4	0	0.11^{a}±0.00108	20.925^{a}±0.2529	300.125^{a}±9.57378
	50	0.1^{b}±0.00041	16.975^{b}±0.23936	284.375^{a}±13.54925
	100	0.09^{c}±0.00108	15.075^{b}±0.53444	276.65^{a}±18.51317
	150	0.057^{d}±0.00091	15.0^{b}±1.14091	261.625^{a}±9.27859
	200	0.027^{e}±0.00108	16.025^{b}±0.7587	264.8^{a}±32.3311
M-2	0	0.111^{a}±0.00091	19.075^{a}±0.76526	305.4^{a}±17.70598
	50	0.103^{b}±0.00041	14.975^{b}±0.21747	309.5^{a}±18.63782
	100	0.083^{c}±0.00041	14.125^{b}±0.19311	291.3^{a}±17.678
	150	0.05^{d}±0.00108	14.275^{b}±0.60052	262.05^{a}±13.79822
	200	0.025^{e}±0.00091	18.025^{a}±0.9393	244.6^{a}±24.56369
NaCl		9220.963**	45.786**	0.88NS
Varieties (V)		2320.456**	29.106**	57.841**
VxNaCl		61.213**	5.099**	2.34**

Values are expressed as mean±S.E. (n=4). Means followed by a different letter within a column for each cashew variety are significantly different at P<0.05 according to the Duncan's Multiple Range Test (DMRT)

* and **, Significant at 1% and 5%, respectively; NS, not significant.

RGR denotes relative growth rate, LAR, leaf area ratio and SLA, specific leaf area

Salinity tolerance index (STI)

- Salinity tolerance index (STI), criteria for salt tolerance, was affected by salt stress. STI values were 93.3%, 83.8%, 71.2% and 53.7% at 50, 100, 150 and 200mM. Among accessions, Bhaskara recorded higher STI values (70.2%) and the same was minimum in M-2 (39%) at 200mM

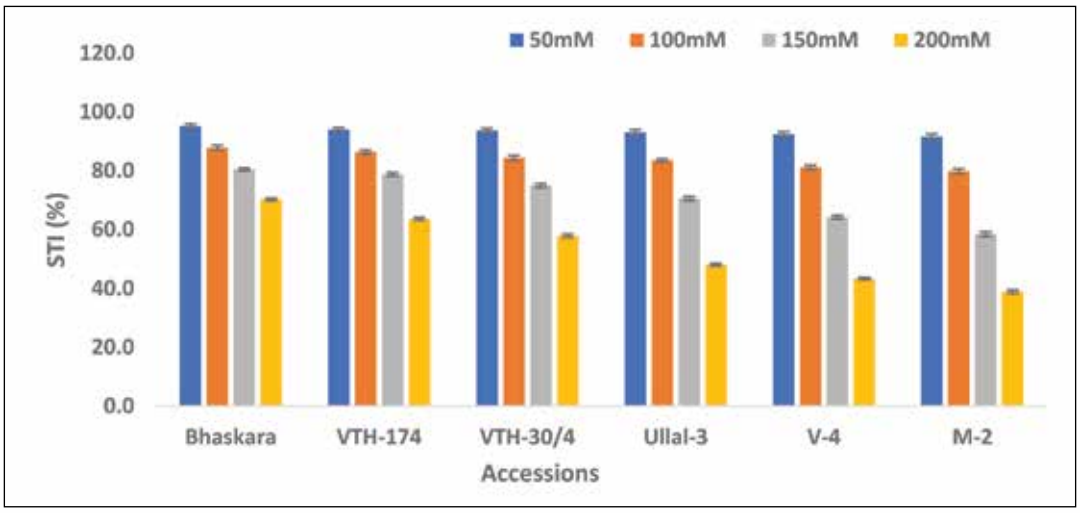


Fig 3.1.19: Salinity tolerance index values of cashew cultivars after imposition of different levels of salinity

Effect of deficit moisture stress on physiological and flowering parameters

Soil parameters

- Seventeen cashew cultivars were characterized for deficit moisture stress during February to April months of severe stress in existing cashew plantation (five-year-old) for field screening.
- The soil moisture content ranged from 10.2 to 12.0 %, 8.6 to 11.2% and 16.3 to 20.3% at 0-25 cm depth in un irrigated trees during stress periods of February, March and April months.
- Soil moisture deficit ranged from 88 to 89.5% in un irrigated trees during February month while it was in the range of 88.4 to 91.4% in the month of March. April month recorded soil moisture deficit in the range of 79.5 to 84% in un irrigated trees.

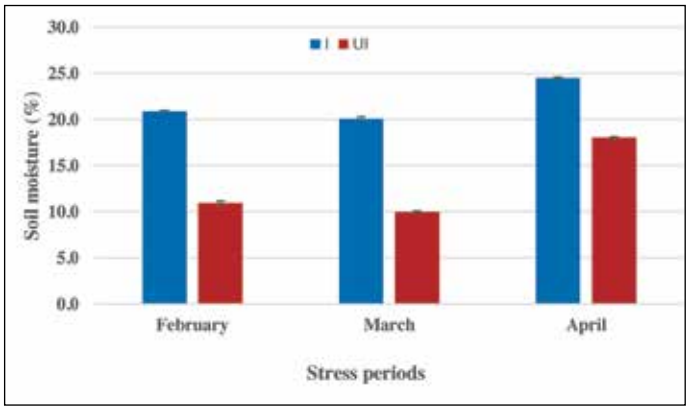


Fig. 3.5.20: Influence of moisture stress on soil moisture content in both irrigated and un irrigated trees during stress periods of February to April

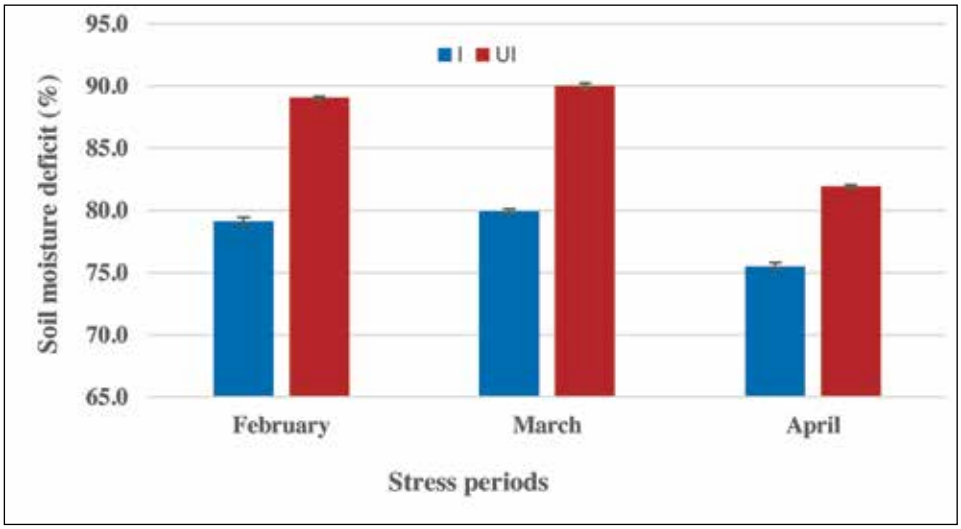


Fig. 3.5.21: Influence of moisture stress on soil moisture deficit in both irrigated and un irrigated trees during stress periods of February to April

Influence on relative water content (RWC):

- Relative water content ranged from 37.3 to 53.5%, 34.4 to 52.6% and 41.2 to 62.2% in un irrigated trees during stress periods of February, March and April months

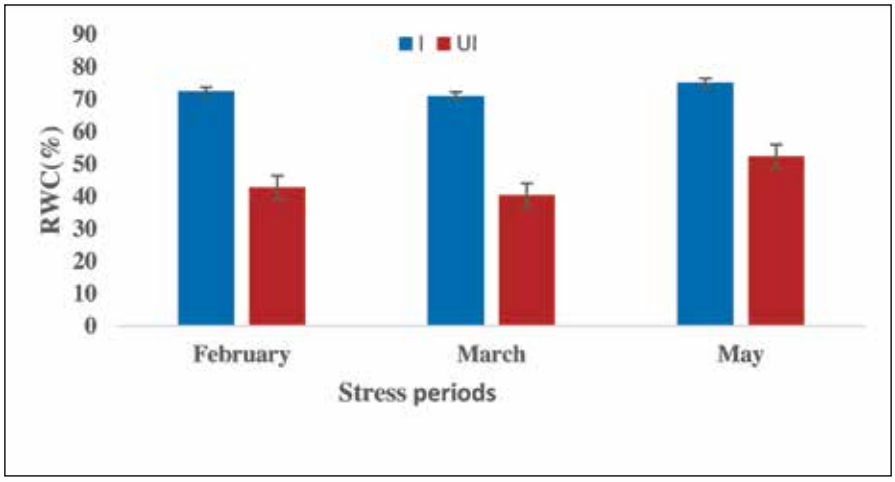


Figure 3.5.22: Influence of moisture stress on relative water content in both irrigated and un irrigated trees during stress periods of February to April

Influence on flowering parameters:

- Flowering parameters were recorded during flowering seasons coinciding the moisture stress periods starting from January to March. Male flower ranged from 91 to 108; hermaphrodite flower ranged from 8 to 18; total flower ranged from 101 to 122 and sex ratio ranged from 0.075 to 0.147 in un irrigated trees.

Table 3.5.12 Influence of deficit moisture stress on flowering parameters during January to March

Variety	PL(cm)		PW(mm)		MF(No)		HF(No)		TF(No)		SR	
	I	**UI**	**I**	**UI**	**I**	**UI**	**I**	**UI**	**I**	**UI**	**I**	**UI**
Ullal-2	17.1	16.1	5.12	4.81	100	97	11	8	110	105	0.095	0.075
VRI-1	15.3	12.5	4.60	3.33	101	98	12	10	113	108	0.109	0.088
V-1	15.8	16.9	4.67	3.84	101	99	14	10	116	109	0.125	0.090
V-7	14.3	13.0	4.39	4.04	104	100	15	13	119	113	0.128	0.118
V-2	15.8	13.7	3.57	2.95	100	99	12	8	112	107	0.106	0.078
Ullal-1	16.0	14.3	4.25	3.85	102	98	10	7	109	106	0.089	0.066
Bhaskara	18.5	17.1	5.10	4.36	110	105	19	17	129	118	0.151	0.140
VRI-3	18.0	17.7	4.19	3.65	111	108	20	18	132	122	0.153	0.147
Selection-2	17.8	14.5	4.42	3.69	112	106	18	15	130	121	0.136	0.122
VTH-174	19.1	18.3	4.60	4.09	107	102	16	14	123	114	0.127	0.124
M-1	18.3	14.3	5.53	3.82	101	96	14	10	115	106	0.119	0.099
V-3	17.0	14.9	5.08	4.40	103	99	15	11	118	110	0.128	0.096
V-4	17.1	18.7	4.27	4.06	109	102	19	16	128	118	0.146	0.135
VTH-30/2	18.4	15.6	4.09	3.89	100	91	16	10	116	101	0.135	0.101
Priyanka	18.9	17.5	4.05	3.26	111	103	16	13	126	116	0.123	0.112
M-2	19.4	15.4	4.74	3.87	106	101	18	14	125	115	0.147	0.124
Ullal-3	19.7	17.2	4.26	4.09	113	104	19	16	132	120	0.145	0.135
CD	2.26	2.39	0.89	0.84	8.94	6.80	3.64	2.60	8.65	7.09	0.031	0.022
CV(%)	11.29	13.24	17.15	18.82	7.39	5.92	20.47	18.35	6.24	5.50	21.107	17.561
SE(d)	1.14	1.20	0.45	0.42	4.49	3.42	1.83	1.31	4.35	3.56	0.015	0.011

I: Irrigated; UI: Un irrigated; PL: panicle length (cm); PW: panicle width (mm); MF: male flower (No); HF: hermaphrodite flower (No); TF: total flower (No) and SR: sex ratio

3. Conclusion

The critical salt concentration of 200mM was standardized for screening cashew varieties for salinity stress. Significant differences in soil parameters, physiological and flowering parameters were observed among seventeen cashew varieties. Varieties *viz.,* Bhaskara, Vengurla-4, Ullal-3 maintained performed better by maintaining higher relative water, membrane integrity and leaf pigment content after different months of stress periods.

4. TRANSFER OF TECHNOLOGY AND EDUCATION

4.1 Knowledge management and technology transfer in Cashew (2020-Long term)

The project was formulated with the broad objective of strengthening technology transfer in Cashew. Several capacity development programmes and demonstrations have been organized for the benefit of farmers and other stakeholders. A Radio talk series was also organized in collaboration with All India Radio, Mangalore on the topic *"Gerinu tirulu-tilivu Gerina samagra krishi kurita banulisarani"* to create awareness among the farmers on the technological interventions in Cashew for higher yield and income generation.

Information need analysis of Cashew farmers in non-traditional areas – a case analysis

A survey was carried out in Shimoga and Chitradurga districts of Karnataka considering the rapid expansion of this crop in these regions. Data were collected from 52 farmers using a pretested questionnaire prepared in Kannada. The data collected was subjected to several statistical analyses.

Farmers focus on information related to cashew varieties suitable to their area and crop protection measures in cashew such as pest and disease management approaches. Among pests, farmers wanted information regarding the identification of Tea Mosquito Bug (TMB) damage and its control in cashew orchards. Studies have revealed that pests and diseases are a major hindrance to realising the potential yield in cashew and it is important to bridge the information gap for higher yields in this. Farmers also centered their interests in non-crop information needs like market availability, price of cashew and schemes and subsidies available for cultivating the crop. This is because for a cash crop like cashew there are no government announced prices for procurement and farmers are usually exploited by middle men. As a result, a huge variability exists in the market price leading to an information gap. The least preference was given to information related to modern planting systems like ultra density planting and high density planting which recommend a closer spacing such as 3m x 3m and 4m x 4m. This may be because farmers in this region prefer diversified cashew based cropping systems in which wider spacing between cashew trees (7.5m x 7.5m) helps a farmer to go for intercropping in the cashew orchards and gain more income. Also, wider spacing allows reducing production costs, especially in terms of labour when compared to high density and ultra density planting. Farmers' information needs with respect to standard agronomic and horticultural practices were found to be less important as most farmers prefer cashew due to its less labour intensive nature.

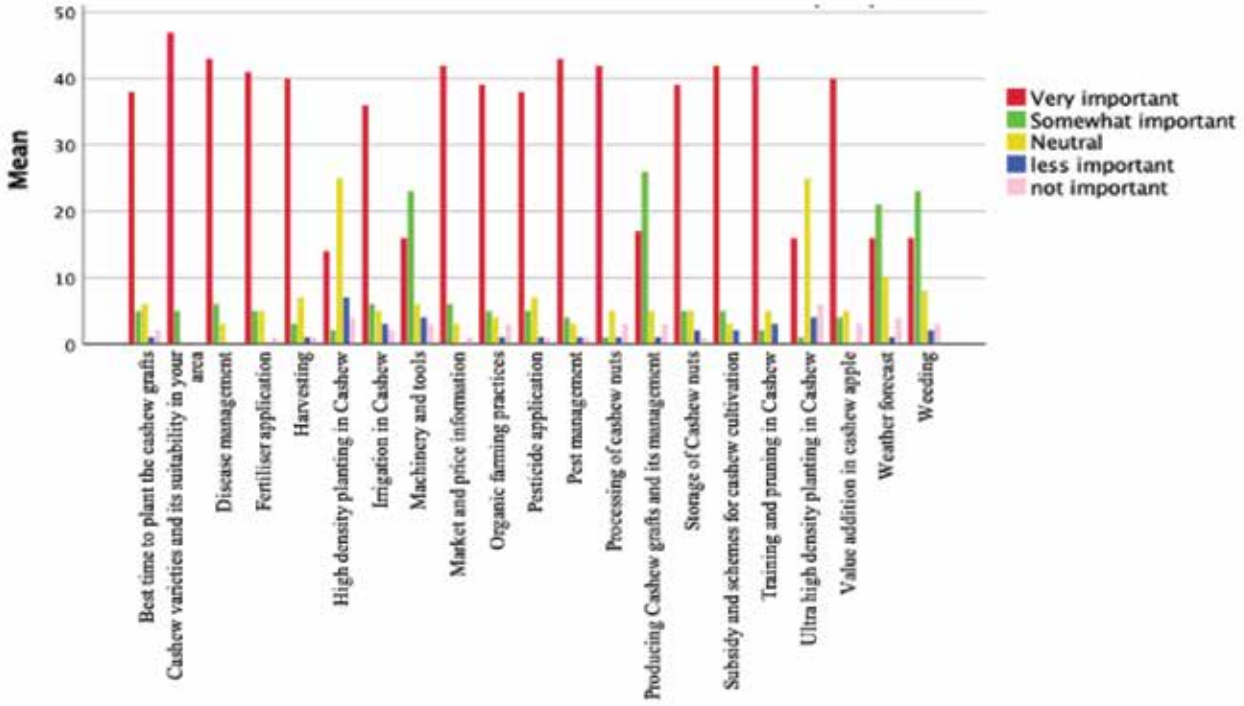


Fig. 4.1: Important information needs of Cashew farmers

Farmers' information needs also were found to be high which signifies the importance of tailor made extension strategies for improving the livelihood security of these farmers. The study results also illustrate that organisational communication channel was a prominent source of information in the study region and most farmers accessed public organisations followed by fellow farmers for information on cashew. The study suggests that farmers prefer personal contact and ICT based methods for information exchange.

4.2 Development of an exclusive android application for cashew cultivation

Earlier 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 centres on cashew.

The Google Play store rating of the app is 4.1 and the app is downloaded 3264 times. A total of 11,606 grafts have been booked via the app during 2020. During the year 2021, a total of 15,295 grafts have been booked via the app by 25 farmers.

Two

new

Modules in Cashew India app

The second version of the app is developed and is made available in Google Play Store. In this version, two new modules i.e Indigenous Technical Knowledge (ITK) and Pollination in cashew were introduced for all cashew growing states in respective languages. Further, under "Pest management' module, information on 'Minor pests' is included. The 'search' feature has been newly introduced. Registration process has been removed as users felt it difficult while using it for the first time. Moreover, the speed of the app is increased along with additional user-friendly features.

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

During the year 2021, twenty-one farmers have been given financial assistance as per MIDH guidelines for expanding the cashew area in 67.81 acres. In Shimoga district, 44.26 acres belonging to 16 farmers were covered. In Chitradurga district, 23.55 acres belonging to 5 farmers were covered. During the inspection, advisory for pruning, maintenance and fertilizer application was given.

So far, for the last two years, a total of 185.46 acres are covered involving 57 beneficiaries in both the districts.

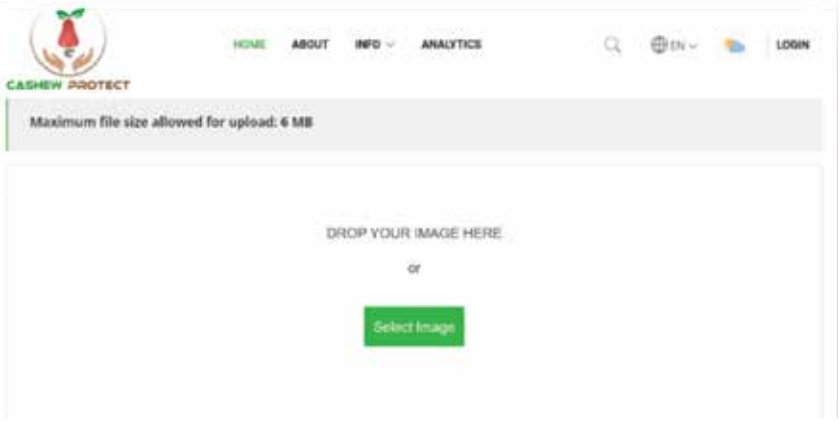
New farmers (top two) and farmers with two-year-old plants

4.4 Cashew Protect: An Artificial Intelligence (AI) based website and app for identification of pests, diseases and nutrient deficiencies in Cashew

Cashew farmers often need expert advice for proper management of pests and diseases in addition to nutrient deficiencies. However, due to remote nature of villages and farms, advice is not easily available when it is most required. Recent advances in mobile technologies can help to a greater extent in this connection. Apps and websites based on technologies such as artificial intelligence, visual recognition and deep learning are being developed worldwide for identification of plants/animals/insects including pests/diseases/ nutrient deficiencies. These tools have been found very useful and are regularly used by farmers in different parts of the world.

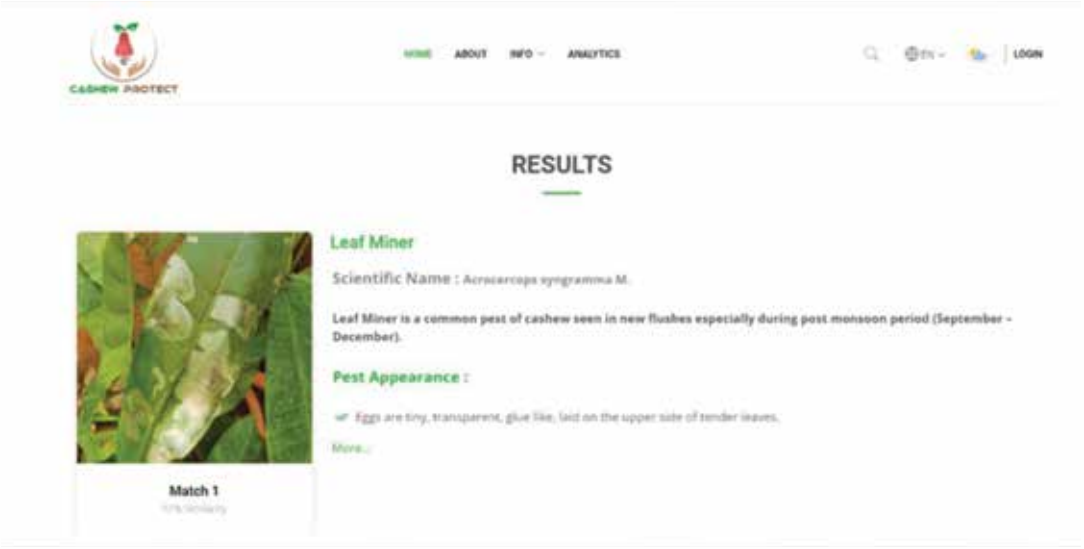
ICAR- Directorate of Cashew Research has developed the Cashew Protect website and app for identification of pests and diseases of cashew along with nutrient deficiencies (Website-https://cashewprotect.icar.gov.in/; App for android phones -https://play.google.com/store/apps/details?id=com.tosall.cashewprotect&pli=1 and app for iOS - https://apps.apple.com/us/app/cashew-protect/id1619732962). The website/app is targeted to diagnose about 60 cashew pests, 20 diseases and 10 nutrient deficiencies instantly from the uploaded images. However, as of now, in the first phase of the work, it can detect 6 pests and 1 disease.

Artificial Intelligence (AI) and computer vision-based techniques are deployed here. The website/app is constantly being trained with additional data and gets more accurate with time. In the backend application, PHP Laravel framework, MySQL, Windows OS, Apache/NGINX are deployed. React Native/Flutter is deployed in mobile phone application.



The AI machine learning system included Python, Windows OS, Tensor Flow as AI framework and GPU server for training. This website/app is available in 11 languages i.e., English, Hindi, Kannada, Gujarati, Marathi, Malayalam, Tamil, Telugu, Bengali, Odia and Garo to cater to the needs of farmers in the local language. Options for contacting experts and sharing photos in social media have been provided in case of no detection or unsatisfactory results.

Most interestingly, it is possible to capture data via users on the number and type of pests, diseases and nutrient deficiencies observed in different countries/regions/districts/taluks during different time periods through this website/app. This will eventually help in early forecasting of these problems and alert farmers in a particular region in time. Further, it also helps to channelize efforts and inputs required for management by the concerned agencies in an area/region of the country.



This is probably the first ever attempt of developing an AI based app/website in the world and in the ICAR system for cashew. The team behind developing this app/website included the scientists of ICAR- Directorate of Cashew Research, Puttur and the scientists of AICRP-Cashew centres spread across the country. This work is funded by the RKVY-RAFTAAR program of Government of Karnataka.

Screenshots of the Cashew Protect App

Further, during the year, text pertaining to insect morphology, management and precautionary measures is developed for 23 pests and 2 diseases. More than 3000 images of different pests, diseases and nutrient deficiencies are collated. The work is under progress.

4.5 Establishment of an exclusive 'Cashew Parlor' for creating awareness on value added products of cashew

During the year, architectural design of cashew parlour and cashew processing buildings is finalized. Both 2D and 3D designs are handed over to CPWD for further needful. First instalment of 30% of the total budget has been released to CPWD. The tender for procurement of cashew kernel and apple processing equipment along with other facilities for cashew parlour has been floated and the process is under progress to identify the firms for supply.

4.6 On-farm training and demonstration on "Training and pruning technique in Cashew": organized by ICAR-CPCRI, KVK, Kasaragod, and ICAR-DCR, Puttur on 26.07.2022

The Front-line demonstration of Cashew was laid out in Kasaragod District, initiated by ICAR-CPCRI, KVK adopted by 10 farmers. In this connection, as a part of the 75th Azadi Ka Amrit Mahotsav, ICAR-KVK organized On-farm training and demonstration of "Training and Pruning techniques in Cashew" on 26.07.2022. The KVK, Head Dr. Manoj Kumar and Dr. Saritha Hegde, along with ICAR-DCR Scientists Dr. Thondaiman, V., Dr. Manjesh, G.N., and Supporting staff Mr. Narayana Poojari visited 4 FLD plots (aged about 9 to 10 months) at Kudlu village, Kasargod. During the visit, Dr. Saritha Hegde introduced the farmers and briefed them about the technology adopted by farmers in the FLD plots. The farmers adopted the High-density planting technique with pruning responsive varieties (VRI-3, Sel-2, and Ullal-1). Dr. Thondaiman addressed the practical aspects of the initial care and maintenance

of cashew plants. Further Dr. Manjesh briefed about the technique of training and pruning, its advantages, and aftercare and carried out an on-farm demonstration on training and pruning techniques to be adopted in Cashew.

Fig. 4.2 FLD on Cashew: "Training and Pruning techniques" organized in collaboration with ICAR-CPCRI, KVK, Kasaragod, Kerala dated 31.10.2022

ICAR - Directorate of Cashew Research, Puttur organized a front-line demonstration in collaboration with ICAR-CPCRI KVK, Kasaragod, on 31.10.2022 with an aim to disseminate the knowledge on cashew pruning practices and farm advisory to be taken care of in the initially established cashew plantations of Kolathur, Kasaragod. Scientists (Horticulture) of this Directorate Dr. Manjesh, G.N., Dr. Veena, G.L., and Dr. Bhagya H.P. briefed and demonstrated practically the training and pruning techniques to be carried out at their cashew plantations. This activity was assisted by Sri. Narayana Pujari (Skilled Supporting staff). Dr. Saritha Hegde and Dr. Benjamin Mathew, SMS, ICAR-CPCRI, KVK coordinated the FLD plots and training program. A total of six plantations were visited and demonstrated the pruning practices. FLD farmers learned hands-on experience in training and pruning cashew and other management practices of cashew.

4.7 Consultancy/Advisories

Dr. D. Balasubramanian	• Provided technical consultancy to enhancing cultivation of cashew and improving cashewnut processing system in South Samara Mankachar district, Assam 14-18 February, 2022. • Provided technical consultancy to start up 'Cashewnut processing plant' at Hulikoti cluster, Gadag taluk, Karnataka funded by SPM RURBAN Mission on 27 July, 2022.
Dr. Mohana G S	• Visited AICRP, Cashew Hogalagere center on 16-07-2022 for monitoring of experiments • Visited AICRP- Cashew Bapatla, AP on 25-09-2022 for monitoring of the experiments
Dr. Eradasappa E	• Advised cashew farmers through whataspp and phone calls for their problems my side and through subject experts of the institute.
Dr. V. Thondaiman	• Deputed for field inspection of the Cashew plantation of DCCD-funded KCDC plantations in Karnataka on 9th March, 2022.
Dr. Manjesh G N	• Provided farm advisory to Mr. Krishnananda Kamath, 59/1c, Giregoudanahalli, Madhugiri in association with 20 farmers for "Possibility in the cultivation of Cashew". Dated 25.05.2022. (Dr. T.N. Raviprasad, Dr. J.D. Adiga and Dr. Manjesh, G.N.). • Deputed for field inspection of the Cashew plantation of DCCD-funded KCDC plantations in Karnataka during 10-11 March 2022.

4.8 Exposure visits

Several farmers, students and other officials have visited the Directorate during this period. They were taken to the museum, nursery and the showcase plots to appraise about the achievements and technologies developed by ICAR-DCR.

Sl. No.	Visitors category	Organization/Place	Number of participants	Date of visit
1.	Students	St. Philomena College, Darbe, Puttur	10	20.01.2022
2.	Students	College of Horticulture Engineering and Food Technology, Devihosur, Haveri, Karnataka	28	02.03.2022
3.	Farmers	Koppa taluk of Sringeri, Karnataka	10	16.03.2022

4.	Students	SDM Degree College, Ujire, Karnataka	39	26.03.2022
6.	Farmers	Maharashtra	20	19.04.2022
7.	Students	College of Sericulture, Chintamani, Karnataka	31	25.04.2022
8.	Students	JC Diwakar Reddy Horticultural College, Andhra Pradesh	32	27.04.2022
9.	Students	Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka	25	27.04.2022
10.	Students	College of Horticulture, Mudigere, Karnataka	43	05.05.2022
11.	Students	Jain University, Bengaluru, Karnataka	30	23.05.2022
12.	Students	College of Agriculture, Shivamogga, Karnataka	45	23.05.2022
13.	Students	College of Agriculture, Shivamogga, Karnataka	41	25.05.2022
14.	Farmers	Tamil Nadu	38	26.05.2022
15.	Students	Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shimoga	14	09.06.2022
16.	Farmers	Wayanad	25	17.06.2022
17.	Input dealers	DAESI programme participants from KVK, Mangalore	39	01.07.2022
18.	Technical Officers	Agriculture Department, Erode, Tamil Nadu	10	13.10.2022
19.	Students	Tamil Nadu Horticulture Management Institute	39	13.10.2022
20.	Students	BEST Innovation University Andhra Pradesh	130	25.10.2022
21.	Students	Dr. YSR Horticultural University, Andhra Pradesh	8	25.11.2022
22.	Students	Department of Agriculture, Mudibidre, Karnataka	25	26.11.2022
23.	Students	K.S.S College	10	10.12.2022

4.9 Exhibitions

ICAR-DCR, Puttur participated and exhibited cashew technologies at Mega Kisan Mela organized by ICAR-CPCRI, Kidu during 19th to 23rd November 2022.

Exhibited ICAR-DCR Stall in the Hort Fair held on 07.03.2022 at ICAR-CPCRI-RS, Vittal and disseminated cashew production technologies to farmers (Staff: Dr. Eradasappa, Sr. Scientist).

Technologies suitable for incubation and startup ecosystem in cashew viz, i) Nursery management and cashew grafting; ii) Value addition to cashew apples and iii) Cashewnut processing were exhibited during 'All India Agri Start-up Convention' conducted by National Agricultural Higher Education Project-Institutional Development Plan (NAHEP - IDP) and the University of Horticultural Sciences, Bagalkot (UHSB), Karnataka during 15-17, September, 2022 at UHSB, Bagalkot. Activities of ABI Centre narrated to visitors as it provides the effective platform to promote agribusiness and entrepreneurship developments in cashew with the concept of growth through innovation, upgradation of technology and skill development. Mentorship is being provided in the area of professional assistance and guidance to the entrepreneurs for better business insights; consultancy services to the Farmer/ Entrepreneur and Established units; incubation facilities and services to entrepreneurs to convert their innovative ideas into commercially viable products; training programs and workshops for capacity building of incubatees; preparation of business plan to the farmer/entrepreneur availability of incubation facility for potential entrepreneur etc., were briefed to 350 no. of visitors of farmers, students, entrepreneurs, business men and general public (Staff: Dr. D. Balasubramanian, Pr.Scientist).

4.10 Field Day Organized

ICAR-DCR, Puttur organized Filed Day on cashew as a part of DCCD sponsored one-day training on Cashew cultivation at Sagara in Shivamogga district during 16.03.2022.

ICAR-DCR, Puttur Field Day on cashew as a part of DCCD sponsored one-day training on Cashew cultivation at Chikkachelluru village in Challakere taluk of Chitradurga district during 17.03.2022.

4.11 Guiding of Students

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

Sl No.	Name	Institute	Project/Thesis / Internship report Title	Year of award
1.	Ms. Manju Manuel	St. Berchmans college, Chenganassery, Kerala	Assessment of Genetic Diversity in cashew using Novel microsatellite Markers	2022
2.	Mr. Gokul Mohan	St. Berchmans college, Chenganassery, Kerala	Screening of Novel Simple sequence repeat markers for Polymorphism and genetic diversity analysis in cashew	2022
3.	Mr. Ashuthosh R Pandith	Department of Biotechnology, College of Agriculture, Hassan	Biotechnology and horticultural aspects of cashew *(Anacardium occidentale L.*)	2022
4.	Mr. Kiran L			
5.	Mr. Shivanagouda Haranal			
6.	Mr.Thejus Prabhakar			

Dr. Veena G L guided the following students

Sl No.	Name	Institute	Project/Thesis / Internship report Title	Year of award
1.	Ms. Drishya K Msc (Food Science and Nutrition)	Mangalore University Department of Biosciences	Development of dehydrated products from cashew apple	2022
2.	Ms. Ashwini Msc (Food Science and Nutrition)	Mangalore University Department of Biosciences	Development and evaluation of nutritionally enriched cashew apple pomace powder extrudate	2022

5. IMPLEMENTATION OF STC/TSP AND SCSP

Training: The Directorate has supplied about 4000 cashew grafts to 25 farmers of Chikkamagaluru taluk and provided financial assistance for establishment of cashew plantation under SCSP programme during the year 2021-22. All the farmers have planted grafts and they expressed need for the training on cashew cultivation. Hence, one-day training programme on 'Cashew Cultivation' was organized on 23.03.2022 covering all aspects from different subject experts. All the participant farmers were given training kit and stipend and also transportation was arranged for them.

Distribution of water tanks: 165 water tanks of 500L capacity were distributed to 165 beneficiaries from Dakshina Kannada district.

Training: One Day Training Programme on Cashew Cultivation under SCSP Programme was organized on 23.03.2022

Distribution of Agriculture implements and Method demonstration on "Training and pruning in Cashew" to SCSP beneficiaries of Kasaragod, Kerala

As a part of the Scheduled caste Sub Plan (SCSP) scheme, a program was organized in collaboration with ICAR, CPCRI-KVK, Kasaragod to distribute agriculture implements viz., Pruning shear and Secateurs on 24th August 2022. The event was presided over by Dr. T. N. Raviprasad, Director, ICAR-DCR, Puttur, Dr. Ravi Bhat, Principal Scientist, ICAR-CPCRI, Kasaragod, Dr. Manoj Kumar, Principal Scientist, KVK, Kasaragod, Dr. Saritha Hegde, SMS, KVK, Kasaragod. During this program pruning shear and secateurs were distributed to the 11 beneficiaries. Further, Dr. Manjesh, G.N. Scientist, (Hort.), Nodal officer SCSP and Dr. Thondaiman, V., Scientist (Hort.) carried out a method demonstration on "Training and pruning of Cashew" to the beneficiaries at the front-line demonstration plots identified by KVK, Kasaragod. Further, the program was concluded with Director's remark.

Two-day training program on "Scientific Cashew cultivation" and distribution of Cashew grafts to SCSP beneficiaries of Chikkamagaluru District, Karnataka

A training cum distribution of Cashew grafts under the Scheduled Caste-Sub Plan (SCSP) program was organized by our Directorate for the beneficiaries of Chikkamagaluru, District held from 26th to 27th August 2022 with the support of ICAR-KVK, Chikkamagaluru, Karnataka. During this program, Dr. Manjesh, G.N. Scientist (SP&MAP), Nodal officer-SCSP, and Dr. Eradasappa E., Senior Scientist (Plant breeding), Former Nodal officer-SCSP, briefed about the implementation of the scheme to the beneficiaries. In this programme a total of 3788 (No's) of Cashew grafts were distributed to SCSP beneficiaries of Chikkamagaluru District of village Viz., Kanivehalli, Kythanabeedu, Sadarahalli, Shankarapura, Chikkakurubarahalli, Kamsagara, Banoor, Byadarahalli, Keresanthe. A total of 24 beneficiaries benefitted from the SCSP scheme belonging to Chikkamagaluru taluk (14) and Kadur taluk (10) farmers. Further resource person, Dr. J.D. Adiga, Principal Scientist, Horticulture, delivered a talk on practical aspects of "Scientific Cashew cultivation" to all the beneficiaries of the Scheme. Dr. Keerthishankar, Scientist (Horticulture), ICAR-KVK, Chikkamagaluru, assisted in our activities during the programme. Further, a monitoring visit was made to the previously benefitted farmers under the SCSP scheme to the villages viz., Devagondanahalli, Sadarahalli, Ishwarahalli, Baktharalli, Kythanabeedu belonging to Chikkamagaluru District. This program was Organised by Dr. Manjesh, G.N. Scientist (SP&MAP), Nodal officer-SCSP, and Co-organiser: Dr. Eradasappa, E. (Plant breeding), Former Nodal officer-SCSP.

Distribution of Cashew grafts and training program on "Scientific Cashew cultivation" to SCSP beneficiaries of Chikkamagaluru District, Karnataka on 3-4 November 2022.

A training cum distribution of Cashew grafts under the Scheduled Caste-Sub Plan (SCSP) program was organized by our Directorate for the beneficiaries of Chikkamagaluru, District held from 03rd to 04th November 2022. During this program, Director, Dr. T.N. Raviprasad, and Dr. Manjesh, G.N. Scientist (SP&MAP), Nodal officer-SCSP briefed about the implementation of the scheme to the beneficiaries. In this event, a total of 3750 (No's) of Cashew grafts were distributed to SCSP beneficiaries (31) of Chikkamagaluru District of village Viz Lakya, Bilikahalli, Gungarahalli, Karehalli, Gundasagara. The resource person Dr. J. D. Adiga and Dr. Thondaiman V. (SP&MAP), Member -SCSP briefed about the cultivation and aftercare of cashew. Monitoring visits of previously benefited farmers' plots [Villages: Devagondanahalli, Sadarahalli, Ishwarahalli, Baktharalli, Kythanabeedu] were also visited for effective implementation of the scheme.

Distribution of grafts to the SC beneficiaries of Chikkamagaluru District, Karnataka

Monitoring field visits to the previous beneficiaries under the SCSP scheme and distribution of Cashew grafts and Advisory on "Cashew cultivation" to SCSP beneficiaries of Hassan District, Karnataka, dated 16-17 November 2022.

As a part of the Scheduled caste Sub Plan, the distribution of planting material is a component. In this program, a total of 3200 (No's) Cashew grafts were distributed to 27 SC beneficiaries of K. Housur. Kalliborekaval, Mootikere, Koramangala, Bramadevarahalli villages of Hassan District. The Nodal officer SCSP, Dr. Manjesh G.N, and Dr. Veena G.L. Member SCSP advised about "good agricultural practices in Cashew." Monitoring visits of previously benefited farmer's plots of Chikkamagaluru district [Villages: Sadarahalli, Narsipura, Nagarahalli, Banur, Gunsagara, and Lakya] were covered for effective implementation of the scheme.

Distribution of Cashew grafts to the SC beneficiaries of Hassan District, Karnataka

Kisan Diwas was organized for the farmers under the SCSP and STC/TSP project

The "Kisan Diwas" was organized at this Directorate for the farmers under the SCSP & Tribal sub-plan programme on 23rd December 2022. As a part of the Kisan Diwas celebration, vegetable seed kit was distributed to the SC and ST farmers and a demonstration on "Weeding in cashew orchard by using brush cutter" was conducted at Kemminje farm followed by field exposure visits to the field of Sri Kadamajalu Subhash Rai to create awareness and motivate the farmers to take up scientific cashew cultivation. A total of 80 farmers from Bettampady, Kuriya, and Kemminje villages of Puttur, Karnataka, and Karadka village of Kasaragod, Kerala attended the "Kisan Diwas".

PM Kisan Samman Sammelan 17th October 2022: Farmers were invited to ICAR-DCR, Puttur

The "Skill Development training" on various aspects of Cashew production for SC and ST farmers was organized as a part of PM Kisan Samman Sammelan 2022 under SCSP and STC/ TSP. Technical sessions were organized for the farmers on cashew nursery production techniques which included preparation of the potting mixture, grafting and aftercare of cashew grafts, nutrient management, and pest and disease management. The hands-on training was also given to the farmers on softwood grafting in Cashew. A total of 71 farmers from Puttur, Chikkamagaluru, and Kasaragod and staff of ICAR-DCR, Puttur attended the program.

Training under SCSP-2022

Sl. No.	Title of training conducted	Place	Date
1	A Skill Development training (Nursery techniques in Cashew) during Agri-Startup Conclave and Kisan Sammelan	DCR Puttur	17 Oct 2022
2	Nutrient management in Cashew	DCR Puttur	17 Oct 2022
3	Importance of cashew grafts in realizing higher production and productivity	Farmer's field Chikkamagaluru District	3-4 Nov 2022
4	Cashew cultivation	Farmer's field Chikkamagaluru District	3-4 Nov 2022
5	Pest Management strategies in Cashew	Farmer's field Chikkamagaluru District	3-4 Nov 2022
6	Training cum advisory on Cashew cultivation	Farmers field Hassan District	16-17 Nov 2022

Demonstrations under SCSP-2022

Sl.No.	Title of a demonstration conducted	Place	Date
1	Weeding in cashew orchard by using a brush cutter as a part of Kisan Diwas 23.12.2022	ICAR-DCR Puttur	23.12.2022
2	Nursery management in Cashew and Softwood grafting techniques	ICAR-DCR Puttur	17.10.2022
3	A Skill Development training -Cashew production technology during Agri-Startup Conclave and Kisan Sammelan	ICAR-DCR Puttur	17.10. 2022
4	Nutrient management in Cashew	ICAR-DCR Puttur	17.10. 2022
5	A Skill Development training- Training and pruning in cashew	ICAR-DCR Puttur	17.10.2022

Distribution of inputs under the SCSP project 2022

Sl. No.	Inputs	Beneficiaries (No.)	Place
1	Cashew grafts	82	Chikkamagaluru and Hassan Districts-Karnataka
2	Vegetable seed kit	52	Dakshinakannada and Kerala
3	Pruning tools	11	Kasaragod, Kerala

Tribal Sub Plan- 2022

Various initiatives were taken up for the capacity building, empowerment and ensuring livelihood security of the Scheduled tribes of Dakshina Kannada, Chitradurga districts of Karnataka and Kasaragod district of Kerala. The activities taken up include-

Distribution of benefits

A total of 66 kitchen garden kits comprising of spade, shovel and pruning saw and 66 sprayers of 16L capacity were distributed to the beneficiaries of Nidpalli, Erde, Bettampady, Kemminje villages of Dakshina Kannada during this period. 41 soil health cards were distributed to farmers belonging to ST community in Puttur. Vegetable seed kits were also distributed to 40 ST beneficiaries of Kasaragod and Puttur.

Area expansion under Cashew

6305 cashew grafts of improved varieties of cashew like Ullal-3, Bhaskara, and Vengurla-4 were distributed to the farmers of Chitradurga district and Dakshina Kannada district.

Skill Development training

A Skill Development training was organized for 31 farmers under the Tribal Sub Plan programme of the Directorate on 17th October, 2022. Dr. T N Raviprasad, Director (Acting), ICAR-DCR, Puttur interacted with the farmers and highlighted on the importance of adopting proper management measures in Cashew orchards for better yields. Keeping in view of the demand for cashew grafts, the technical sessions focussed on cashew nursery production techniques.

Dr. J Dinakara Adiga, Principal Scientist (Horticulture) explained about grafting and important management measures to be taken for the maintenance of graft. Dr. Shamsudeen M, soil scientist, explained to the farmers about the importance of nutrient management in Cashew. Dr. T N Raviprasad, Director (Acting) and also Principal Scientist (Agrl. Entomology) took a class on important pests and their management. This was followed by a hands-on-training on soft wood grafting wherein Dr. Bhagya H, Scientist (SPM & AP) explained about the basics of softwood grafting and Dr. Thondaiman V, Scientist (SPM & AP), Dr. Manjesh G N, Scientist (SPM & AP) and Dr. Veena G L demonstrated softwood grafting techniques to the farmers. During this session, farmers were also given an opportunity to do softwood grafting for better understanding of the method. Farmers expressed that the training was very useful and created awareness about cashew productivity.

Organized soil health camp and distribution of soil health card to the farmers under TSP programme on 5.12.2022 at Bettampady village, Puttur taluk (Shamsudheen, M, Veena G L, Bhagya H P and Aswathy Chandra Kumar).

6. AGRIBUSINESS INCUBATION

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

A total of six incubates have registered with ABI and utilized 'State-of-the-Art' processing facility on the basis of 'Custom hiring' during the year 2022. Three days training on cashewnut processing conducted at ABI, ICAR-DCR, for incubatees to enhance knowledge on technical, management and financial aspects. At present, three incubatees (50%) have started small to medium scale processing units. Revenue generated to the tune of Rs.75,150/- through training for incubates and technical consultancy exclusively under ABI.

3-days trainings offered under ABI for registered incubates – 6 Nos. as detailed below

Sl. No	Name of the trainee / incubatee	Address	Time period
1	Mr Ranganathappa	Bangalore, Karnataka	4-6 April, 2022
2	Ms Lakshmi Nayak	Mangalore, Karnataka	10-12 October, 2022
3	Mr Manosh Gowda	Chikballapur, Karnataka	2-4 November, 2022
4	Mr M Amarendra	Bangalore, Karnataka	2-4 November, 2022
5	Mr Roshan Bidare	Pune, Madhya Pradesh	2-4 November, 2022
6	Mr Raghavendra Y Nayak	Mangalore, Karnatak	14-16 November, 2022

Ms Laksmi Nayak, Incubatee undergoing training in cashewnut processing

Hands on training on peeling cashew kernels to Mr Roshan Bidare, Incubatee in ABI

Training program for ATMA, Cannanore, Kerala

Agri Business Incubation – Exhibition at UHS, Bagalkot.

Learning by doing – Incabtees at ABI, ICAR-DCR

Operation of shelling machines – Training for incubatees – ABI, ICAR-DCR

Mr Manosh Gowda receiving ABI Incubatee certificate from Director, ICAR-DCR

7. AWARDS/RECOGNITIONS/RESOURCE PERSONS/LECTURE

7.1 Awards and Recognitions

ICAR-DCR	• ICAR-DCR, Puttur won the first prize for the Best Stall award in the Government category in the Mega Kisan Mela and Agri Expo organized by ICAR-CPCRI in Kidu during 19th – 23rd November, 2022
Dr. Mohana G S	• Recognized as PG guide recognition from Mangalore University on 10-10-2022 • Recognized as PG guide from UAHS, Shimoga on 19-10-2022 • Member of the assessment committee for Career Advancement Scheme of scientists at CPCRI, Kasaragod held on 01-06-2022 • Expert member of the Departmental Promotion Committee, ICAR - DCR, Puttur
Dr. Shamsudheen Mangalassery	• First prize for the oral presentation on role of online software and mobile apps in soil nutrient management in cashew during the National conference on Advancement of Science and Technology for the Environment, Society and People (NCASTESP-2022), Kozhikode, India on 28 August 2022. • Best Oral Presenter award secured for the presentation on "Information and Communication Technologies in Cashew Technology Dissemination" during the National Symposium on Horticultural Crops of Humid TYropics for Nutritional and Livelihood Security – 2022 at Madikeri, Karnataka during 2-3, December 2022 organised by CHES-ICAR-IIHR, Chettalli and Society for Promotion of Horticulture, IIHR, Bengaluru. • Passed Parangat Hindi Examination conducted by the Dept. of Official Language, Govt. of India during December 2022 with 76% marks.
Dr. K. Vanitha	• The research paper entitled 'Biological notes on nesting biology, development and natural enemies of *Braunsapis mixta,* a pollinator of cashew', published in Journal of Apicultural Research, 2022. DOI: 10.1080/00218839.2022.2028965 authored by Vanitha Kaliaperumal, Ankita Gupta, Venkatesan Thiruvengadam, Arati Pannure and Ashika Thotambailu Raghavendra was selected as 'Best Research Paper Award of DCR, Puttur conferred during the ICAR-DCR Foundation day -18.06.2022. • Received Best paper presentation award (third position) for the oral presentation on 'Influence of cashew flower eating caterpillars on cashewnut yield and their management measures' in the 'International Conference on advances in Agricultural, Veterinary and Allied sciences for improving livelihood and environmental security; conducted during September 28-30, 2022 organized by ICAR-Indian Grassland and Fodder research Institute, RRS, Srinagar, ICAR-NAHEP, Birsa Agricultural university and BADCL, Baramula at University of Kashmir, India.

	• Conferred upon 'Avvaru Seethamma Memorial Award-2021' for important contributions in the field of Entomology by Applied Zoologists Research Association, Bhubaneswar, conferred during the XVIII AZRA International Conference on "Advances in Applied Zoological Researches towards Food, Feed & Nutritional Security and Safer Environment" on 10-12 November, 2022 at Hotel Suryansh, Bhubaneswar, Odisha. • The article entitled ' Invasive ant species recorded in cashew plantations with reference to yellow crazy ant, a threat to ecosystem' authored by K. Vanitha, T.N. Raviprasad, K. Jayaprabhavathi and H. Rajashekara published in *Agriculture and Food: e-Newsletter,* 8 (4) was awarded with 'Best Article award' on 20.10.2022.
Dr. Veena G L	• Recognised as an editor for the Agriculture and Food e-newsletter magazine. • Awarded First place for Vahana and Sulekhan Pratiyogitha on occasion of Hindi Diwas at DCR, Puttur. • Awarded with Best article award for article Nutraceutical values of fruit crops in Agriculture and Food e- Newsletter • Acted as a reviewer for the National Academy science letters journal for the manuscript titled" Exploring the possibility of the best intercropping in juvenile cashew orchard of south Chhattisgarh India SCLE-D-22-00226R1 • Passed Praveen Hindi Examination conducted by the Dept. of Official Language, Govt. of India during December 2022 with 80% marks.
Dr. Siddanna Savadi	• Dr. Siddanna Savadi is recognized as the Research guide for supervising the research work leading to Ph.D. degree in the field of Applied Botany by the Department of Applied Botany, Mangalore University from 13.06.2022 • Dr. Siddanna Savadi is recognized as the Review Editor in the Editorial Board of Plant Pathogen Interactions, a specialty section of Frontiers in Plant Science and Frontiers in Microbiology journals from 28.05.2022 • Dr. Siddanna Savadi, Scientist (Biotechnology) received the DGCA-Certified Remote Pilot Certificate with a certificate No. PC11220000174 for the ROTORCRAFT Unmanned Aircraft System (UAS) to fly the Small class UAS in the Visible line of sight (VLOS) on 07 November 2022. • Ms. Manju Manuel, M.Sc. (Biotechnology), St. Berchmans college, Changanassery, Kerala received first prize in the Interdisciplinary seminars on Recent advances in technology held at Vimala College, Thrissur on 19 December 2022 for the oral presentation on the M.Sc. thesis research "Screening of novel SSR markers for polymorphism and genetic diversity analysis in cashew" carried out at the Biotechnology section of ICAR-DCR, Puttur under the guidance of Dr. Siddanna Savadi, Scientist (Biotechnology).

Dr. Bhagya H P	• Received Young scientist award in the International Scientist Awards on Engineering, Science and Medicine, held on 23-July-2022, online India, Organized by VDgood Professional Association. • Reviewed research article in the International Journal of Agricultural Research.

7.2. Resource person / Lecture delivered

Dr. Mohana G S	• Delivered a talk on 'Cashew Genetic resources in India' in national level training program on 'Cashew production and post-harvest technologies' organized by National Institute of Agricultural Extension Management (MANAGE), Hyderabad and ICAR- Directorate of Cashew Research, Puttur, Karnataka India on 16-02-2022. • Delivered a lecture on 'Is there any thing called Indian science?' at St. Philomina college, Puttur as part of the National Science Day celebration on 28-02-2022. • Delivered at lecture on "Cashew Genetic Resources "conservation and Utilization" during 24-03-2022 in ICAR Sponsored Winter School on Horticultural Biodiversity Conservation for Livelihood and Nutritional Security in the Era of Anthropocene and Climate change. ICAR-Indian Institute of Horticultural Research, Bengaluru-560089; 11 -31 March, 2022. • Delivered a talk on 'Cashew- crop with reliable future' during "Cashew Workshop" organized at College of Horticulture, Bangalore on 24-03-2022.
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 January 2022 at ICAR-CCARI, Goa, organized by DCCD, Kochi. • Delivered a lecture on Management of soil, water and nutrients in cashew for a training organized by DCR, Puttur in collaboration with MANAGE, Hyderabad on 18 February 2022. • Lecture in training programme on cashew cultivation under SCSP programme organized by DCR, Puttur on 23 March 2022. • Delivered a guest lecture on Macro-micronutrients and their deficiency symptoms for major crops grown in Dakshina Kannada and integrated nutrient management at ICAR-Krishi Vigyan Kendra, DK, Mangaluru to the participants of Diploma on Agriculture Extension Services for Input Dealers (DAESI) training programme on 08 April-2022. • Delivered a guest lecture on Macro-micronutrients and their deficiency symptoms for major crops grown in Dakshina Kannada and integrated nutrient management at ICAR-Krishi Vigyan Kendra, DK, Mangaluru to the

	participants of Diploma on Agriculture Extension Services for Input Dealers (DAESI) training programme on 23 April 2022. • Delivered lecture on Nutrient management in cashew during the Skill development training in cashew production for the SCSP/TSP farmers on the occasion of agri-Startup Conclave and PM Kissan Sammelan, 2022 on 17 October 2022. • Delivered lecture on Integrated nutrient management for cashew and value addition in Nari Shakthi Mela at Kannur, sponsored by DCCD, Kochi attended by 87 participants on 25 November 2022. • Delivered a lecture on Soil health management and use of soil health cards to the farmers under TSP programme at Bettampady, Dakshina Kannada on 05 December 2022.
Dr. K. Vanitha	• Participated as a resource person and delivered a talk on 'Management of TMB, minor pests and pollinators in cashew' in one-day training programme on 'Cashew cultivation' organised by ICAR-DCR under SCSP on 23.03.2022 for the farmers from Chikkamagaluru. • Participated as a resource person and delivered a talk on 'Management of TMB, minor pests and pollinators in cashew' in a three-days Collaborative online training programme on "Cashew Production and Post-harvest Technologies" jointly organized by ICAR-DCR and MANAGE during February, 16-18, 2022. • Participated as a resource person and delivered a talk on 'Management of major and minor pests in cashew' in 'One day training program on cashew cultivation' sponsored by Directorate of cashew and cocoa development, Cochin each in Sagar and Challakere of Karnataka during 16th and 17th March, 2022 respectively. • Acted as resource person and delivered a talk on 'Pest and disease management in cashew' for the Diploma in Agriculture Extension Services for Input dealers (DAESI) training programme for Batch-IV and Batch- V, organized by ICAR- KVK (D.K.), Mangaluru on 16.11.2022 and 28.12.2022, respectively. • Delivered a lecture on 'Pollinators in cashew: Species diversity and their importance' on 28th January, 2022 under 'Azadi Ka Amrit Mahotsav' webinar series organized by ICAR-DCR, Puttur.
Dr. Eradasappa E	• Delivered a lecture on 'Scientific Cashew Cultivation' in the one-day cashew seminar held on 11.02.2022 at Office of the SADH, Sullia to the farmers from Sullia taluk. • Delivered a lecture on 'Cashew Production and Processing Technology' in the Hort Fair held on 07.03.2022 at ICAR-CPCRI-RS, Vittal.

	• Delivered a lecture on 'Improved cashew varieties for Karnataka' in the one-day training Programme on Cashew Cultivation sponsored by DCCD held on 16.03.2022 at Sagara to the RKVY farmers from Shivamogga district. • Delivered a lecture on 'Improved cashew varieties for Karnataka' in the one-day training Programme on Cashew Cultivation sponsored by DCCD held on 17.03.2022 at Chikkachelluru village in Challakere taluk of Chitradurga district to the farmers from Chitradurga district. • Delivered a lecture on 'Improved cashew varieties for Karnataka' in the one-day training Programme on Cashew Cultivation under SCSP Programme held on 23.03. 2022 to the farmers from Chikkkamagaluru taluk. • Delivered a lectures on 'Crop production technology and value addition in cashewnut' at ICAR-Krishi Vigyan Kendra (D.K.), Mangaluru to the participants of Diploma in Agriculture Extension Services for Input Dealers (DAESI) training programme (Batch IV) on 10.11.2022. • Delivered a lectures on 'Crop production technology and value addition in cashewnut' at ICAR-Krishi Vigyan Kendra (D.K.), Mangaluru to the participants of Diploma in Agriculture Extension Services for Input Dealers (DAESI) training programme (Batch IV) on 30.11.2022.
Dr. Rajashekara H	• Delivered an invited talk on topic entitled as Race distribution pattern of *Pyricularia oryzae* Cavara causing rice blast from North-Western Himalayan region of India in 8th international conference (hybrid mode): Plant Pathology- Retrospect and Prospects from March 23-26th, 2022 at SKNAU, Jobner-Jaipur, Rajasthan. • Delivered a lead talk on topic entitled as race distribution pattern of *Pyricularia oryzae* Cavara causing rice blast from North-Western Himalayan region in 62nd Annual international conference of association of microbiologist of India (AMI): Microbes and Society: current trends and future prospects from September 21-23rd, 2022 at University of Mysore, Mysuru, Karnataka.
Dr. Veena G L	• A recorded talk was given on "Cashew Apple Processing prospects" in a training programme organized by ICAR-DCR Puttur at Sagara and Chitradurga on 16.03.2022. • Delivered a lecture on "Cashew apple utilization" in a training programme on cashew cultivation for farmers from Chikkamagaluru Taluk Under SCSP scheme, at ICAR_DCR, Puttur on 23.03.2022. • Delivered a talk on Generation of wealth from cashew waste on the occasion of swachta Pakhwada 2022 on 27012.2022. • Acted as resource person and delivered a lecture on Cashew apple handling commercial uses, products, and its other applications in a workshop on

	cashew Recent developments in cashew practices and its management, cashew nursery and cashew apple processing and other related aspects organized by Karnataka Cashew Development Corporation Limited Mangalore on 29.03.2022.
Dr. Siddanna Savadi	• Presented a lecture on ICAR-DCR technologies and the scope of commercialization in the 2nd Rural India Business Conclave (RIBC 2.0) organized by the Kalpa Agri-Business Incubator,ICAR-Central Plantation Crops Research Institute (CPCRI), Kasargod, Kerala jointly with Kerala Startup Mission on 12-06-2022.
Dr. Bhagya, H P	• Lecture delivered on nursery management techniques in cashew (kannada) to farmers of SC and ST in skill development training on cashew production on 8.09.2022.
Dr. Manjesh G N	• Therapeutic potential of Terpenoids from medicinal and aromatic plants as part of AZAM of ICAR-DCR webinar dated: 11.02.2022. • Commercial nursery management in cashew to SCSP farmers during a One-day training program on 23.03.2022. • Delivered a lecture on Nursery management in cashew and a demonstration on softwood grafting techniques during the "Skill development training in Cashew production" for the SCSP/TSP farmers on 17- 10-2022. • Delivered a lecture on the topic entitled "Commercial nursery management in Cashew" and Value addition in cashew apple to the DAESI program participants organized by KVK, Mangalore, Karnataka on 10-11-2022. • As a resource person delivered a lecture on the topic "Commercial nursery management in Cashew" and Value addition in cashew apple to the DAESI program participants organized by KVK, Mangalore, Karnataka on 30-11-2022.
Dr. K. Manjunatha	• Delivered the online guest lecture on Applications of UAV for crop protection on November 22 and November 29 as part of a three-day online training under IDP-NAHEP organized by the Department of Farm Machinery & Power Engineering, College of Agricultural Engineering & Technology, CCS HAU, Hisar. • Delivered a technical talk on "Status of Farm Mechanization in India: Challenges and Way Forward" on December 16, 2022, for B. Tech. (Ag. Engg.) students of ALVA's Institute of Engineering & Technology, Moodbidri. • Delivered a talk and demonstration on softwood grafting technique in Cashew and provided a package of practice for Commercial nursery management in cashew and cultivation aspects for farmers of Sringeri taluk on 16.03.2022.

8. PUBLICATIONS

8.1 RESEARCH PAPERS/ REVIEW ARTICLES

BabliMog, Adiga, J.D., Preethi, P. and Nayak, M.G.,2022. Changes in growth and developmental stages of nuts of selected cashew (*Anacardium occidentale* L.) varieties in west coast region of Karnataka Agric Res., https://doi.org/10. 1007/s40003-022-00620-z.

Chaithra K., Bhoomika H.R., Veena G.L., Dushyantha Kumar B.M., Shivaprasad M. and Ravi C.S. 2022. Correlation and path coefficient analysis for yield and yield attributing traits in cashew (*Anacardium occidnetale* L.) genotypes. *Biological Forum – An International Journal,* Issue No. 0975-1130.

Gajbhiye R.C., Khapare L.S., Zote V.K., Pawar S.N., Salvi S.P., Sawant B. N., Salvi B. R., Haldankar P. M., Mohana G. S. and Raviprasad T. N., 2022, Minimum descriptors of cashew germplasm accessions, Catalogue- II. AICRP on Cashew, Regional Fruit Research Station, Vengurla, Maharastra.

K Sethi, S Sahoo, M Dash, R Kumari, PK Panda, Mohanna GS and TN Raviprasad, 2022, Evaluation of Cashew germplasm based on morpho-economic traits. The Pharma Innovation, 11(10): 1025-1031.

Lata, C., Prasad, P., Gangwar, O. P., Adhikari, S., Thakur, R. K., Savadi, S., & Bhardwaj, S. C. (2022). Temporal behavior of wheat–*Puccinia striiformis* interaction prompted defense-responsive genes. Journal of Plant Interactions, 17(1), 674-684.

Prasad, P., Thakur, R. K., Savadi, S., Bhardwaj, S. C., Gangwar, O. P., Lata, C., ... & Kumar, S. (2022). Genetic Diversity and Population Structure Reveal Cryptic Genetic Variation and Long Distance Migration of *Puccinia graminis* f. sp. tritici in the Indian Subcontinent. Frontiers in Microbiology, 13.

Preethi, P., Shamsudheen, M., Thanushree, K., Vijay Rakesh Reddy, S., Ravi Pandiselvam, Ramesh, S.V., Sachin, A.J., Manikantan, M.R., and Veena, G.L. 2022. Synergistic effect of powdered cashew sprout cum cotyledon and cereals on improving the biochemical and physical properties of extrudates. Journal of Food processing and preservation 46(1)

Savadi, S., Muralidhara, B. M., Godwin, J., Adiga, J. D., Mohana, G. S., Eradasappa, E., ... & Karun, A. (2022). De novo assembly and characterization of the draft genome of the cashew (*Anacardium occidentale* L.). Scientific Reports, 12(1), 18187.

Savadi, S., Muralidhara, B. M., Venkataravanappa, V., Adiga, J. D., Manjunatha, K., & Patil, B. (2022). De novo transcriptome assembly and its utility in development and characterization of the first set of genic SSR markers in cashew. Industrial Crops and Products, 189, 115734.

Shameena Beegum, Ramesh S V, Pandiselvam R, Sugatha P, Arifa Nooh, Neenu S, Alka Gupta, Balasubramanian D, Eldho Varghese, Elain Apsara, Manikandan M R and K B Hebbar. 2022. Sensorial, textural, and nutritional attributes of coconut sugar and cocoa solids based "bean-to-bar" dark chocolate. Jl. of Textural Studies. 53(6): 870-882. https://doi.org/10.1111/jtxs.12698.

Subodh Kumar, Subhash Chander Bhardwaj, Om Prakash Gangwar, Pramod Prasad, Ranjana Chakrabarty Search author for Ranjana Chakrabarty, Prem Lal Kashyap, Hanif Khan, Siddanna Savadi, Baidya Nath Mahato, Paritosh Kumar Malaker (2022). Characterization of five new pathotypes of *Puccinia triticina* identified from Northeast India, Nepal, and Bangladesh. Australasian Plant Pathology, 51(3), 315-325.

V. Ramteke, P. Preethi, G.L. Veena and Y.S. Nirala. 2022 Impact of foliar application of primary nutrients on growth and yiled contributing traits in cashew (*Anacardium occidentale* L.) *Journal of Environmental Biology* Vol 43:477-483.

Vikas Ramteke, Padmakshi Thakur, Anurag Kerketta, V. Paramesh, Y. S., Nirala, R. S. Netam and J. D. Adiga. Assessment of Cashew Based Intercropping System in Chhattisgarh, India. Natl. Acad. Sci. Lett. https://doi.org/10.1007/s40009-022-01179-7.

8.2 PAPER PRESENTED IN SYMPOSIA/ WORKSHOPS/SEMINARS

Balasubramanian, D. 2022. Entrepreneurship development in cashew ecosystem – Opportunities through Agribusiness incubation centre. In. All India startup convention-2022 conducted by National Agricultural Higher Education Project-Institutional Development Plan (NAHEP - IDP) and the University of Horticultural Sciences, Bagalkot (UHSB), Karnataka at UHSB, Bagalkot from 15-17 September, 2022.

Balasubramanian, D., R. Pandiselvam, M. R. Manikantan and Narjas 2022. Optimization of composition and extrusion operating parameters for the production of cashew apple powder enriched extrudate using mixture-process design. In. International Symposium on India 2047: Agricultural Engineering Perspective, jointly organized by Indian Society of Agricultural Engineers (ISAE), New Delhi and Tamil Nadu Agricultural University (TNAU), Tamil Nadu during 9-11 November, 2022.

Balasubramanian, D. 2022. Innovative engineering technologies – A boon for cashew system in India. In. National conference on 'Enhancing competitiveness of horticulture through technology innovation, during 17-18 November, 2022 conducted at ICAR-Central Plantation Crop Research Institute (CPCRI), Kasaragod, Kerala.

Balasubramanian, D. 2022. Agriprenuership-Scope and Opportunities. In. Workshop on Intellectual Property Rights and Management conducted at Vivekananda College of Engineering and Technology (VCET), Puttur, Karnataka on 9 December, 2022.

Manjunatha K., Ravindra Naik and Adiga J. D. 2022. Performance evaluation of roller-type fruit collector. In: 56th Annual Convention of Indian Society of Agricultural Engineers (ISAE) on Agricultural Engineering Innovation for Global Food Security and International Symposium on India @2047: Agricultural Engineering Perspective held on November 9-11, 2022 at Tamil Nadu Agricultural University, Coimbatore.

Siddanna Savadi. 2022. Development and utilization of genomic resources in cashew. In: National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, ICAR-Indian Institute of Horticultural Research, Chettalli, Kodagu, Karnataka during December 02-03, 2022 topic.

8.3 ABSTRACT/ CHAPTER IN SYMPOSIA / WORKSHOPS/ SEMINARS

Eradasappa, E, Mohana, G.S. , Poduval, M., Sethi, K., Aneesa Rani, M.S., Lourdusamy, I.K., Velmurugan, S., Manjusha, M., Bhat, M.G. , Raviprasad, T.N. In Book of Abstracts (Eds. Rajesh, M.K., Ramesh, S.V., Muralikrishna, K.S., Neema, M. and Aparna, V.) National Conference on Enhancing Competitiveness in Horticulture Through Technology Innovations, 17-18 November 2022, ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala, 16p.

Eradasappa, E, Saroj, P.L., Meena, R.K., Preethi, P., Rajkumar Arjun, D, Vanitha, K., Janani,

P., Veena, G.L. and Chaitra, K. 2022. Selection of dual purpose cashew genotype suitable for nuts and apples. In abstracts of 'Advances in Agriculture and Food Systems Towards Sustainable Development Goals' at UAS GKVK, Bengaluru from 22-24 Aug 2022 (Eds: Prasad, S. R., Gowda, B., Nagaraj, K.H., Gowda, M., Mohan, K.M, Sanjay, M.T., Manjuantha, M., Thimmegowda, M.N., Srinivasappa, K.N., Nataraju, O.R., Jagadish, K.S., Gaddigangappa, M., Khandelwal, A., Saurabh, V., Prasad, M.B.P. Published by the New Delhi Publishers, New Delhi – 110059, India, pp.174.

G.L. Veena, Babli Mog, J.D. Adiga, Eradasappa, E., Anil Kumar Yadav, and Rajashekan, P.E. 2022. Cryopreservation in Cashew (*Anacardium Occidentale,* L.). National symposium on Horticultural crops of humid tropics for nutritional and livelihood security (NSHCT)-2022 from 02nd to 03rd December 2022 organized by ICAR-IIHR RS-Chettalli at Madikeri.

K. Vanitha and T.N. Raviprasad. 2022. Damage, seasonality and management of two species of thrips infesting cashew. In: Souvenir and abstracts of XVIII AZRA International Conference on 'Advances in applied Zoological Researches towards food, feed and nutritional Security and safer environment', during 10-12 November, 2022 at Hotel Suryansh, Bhubaneswar, Odisha. 141p.

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Shamsudheen, Mangalassery., Adiga, J.D., Preethi, P., Muralidhara, B.M. and Aswathy Chandrakumar. 2022. Information and communication technologies in cashew technology dissemination. Sovenir and book of abstracts (Eds: S. Rajendran, B.M., Muralidhara, A.T. Rani and G.S. Madu) National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT-2022) organised by IIHR-Central Horticultural Experiment Station (CHES), Chettalli & Society for Promotion of Horticulture (SPH), IIHR, Bengaluru at Hotel Crystal Court, Madikeri, Karnataka, India during 02-03 December 2022. P. 240.

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Veena, G.L., Babli Mog, Adiga, J.D., Eradasappa, E., Anil K Yadav, Rajashekaran, P.E., Shamsudheen, M., Manjesh, G.N. and Thondaiman, V. 2022. Cryopreservation in cashew (*Anacardium occidentale* L.). (Eds: S. Rajendran, B.M., Muralidhara, A.T. Rani and G.S. Madu) Sovenir and book of abstracts. National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT-2022) organised by IIHR-Central Horticultural Experiment Station (CHES), Chettalli & Society for Promotion of Horticulture (SPH), IIHR, Bengaluru at Hotel Crystal Court, Madikeri, Karnataka, India during 02-03 December 2022. P. 84.

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8.4 BOOKS/BOOK CHAPTERS / LECTURE NOTES

Amrutha Lakshmi, H. Rajashekara, K. Vanitha, B.R. Ajesh, Haritha Mohan and Madem Gurivi Reddy. 2022. Major diseases of cashews and oil palms. *In:* Diseases of fruit and plantation crops and their sustainable management. (Eds.) Mujeebur Rahman Khan and Ziaul Haque. Published by Nova Science Publishers, Inc. New York: ISBN: 978-1-68507-978-9. 387-418pp.

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Balasubramanian, D. 2022. 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. P: 102-109.

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Thakur, R. K., Prasad, P., Savadi, S., Bhardwaj, S. C., Gangwar, O. P., & Kumar, S. (2022). Nanotechnology for agricultural and environmental sustainability. Survival Strategies in Cold-adapted Microorganisms, 413-424.

8.5 TECHNICAL REPORTS / COMPENDIA

A technical report on 'Standard formulation for raw cashewnuts' is prepared for Food Safety and Standards Authority if India, Division of Science and Standard, FDA Bhawan, New Delhi (Ref: Letter from Ms Pushp Vanam, Joint Director (FSSAI) No. Std/Fruits and vegetables-12/A-1.21 dated 30.12.2021).

Technical report on 'Status and strategies for enhancing cultivation of cashew and improvising the cashewnut processing system in South Salmara Mankachar district of Assam' for Director of Horticulture and FP, Goa, Assam (Ref. Hort FP/629/Misc/2020-21 dated 3 January, 2022 and DC/PA/INDS/2019/10 dated 15 December, 2021).

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Savadi, S; Shamsudheen M., Manjunath K., Vijetha K., Patil B (2022) Report on STC/TSP programme-2020-21: Improving livelihood of ST population through Agri-Input supply and Improved technology dissemination. ICAR-Directorate of cashew research, Puttur, Karnataka, India, pp-1-10

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8.6 TECHNICAL BULLETINS

E. Eradasappa, J.D. Adiga, Mohana, G.S., B.M. Muralidhara, Siddanna Savadi and Manjesh G.N. Nethra Jumbo – 1 a new cashew hybrid for higher income (English and Kannada).

E. Eradasappa, Mohana, G.S., Adiga J.D., Siddanna Savadi, Manjesh G.N. and Veena G.L. 2022. Nethra Ganga (H-130) A new cashew hybrid with bold nut (English and Kannada).

Manjesh, G.N., Adiga, J.D., Aswathy, C., Veena, G.L., Thondaiman, V., Manjunatha, K., Babli, M., and Muralikrishna, K. Ka?uva??iyile v??ijya na?sa?i m?n?jmen?. Technical Bulletin, Malayalam version. ICAR-Directorate of Cashew Research, Puttur, Karnataka, India.

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Manjesh, G.N., Adiga, J.D., Veena, G.L., Thondaiman, V., Manjunatha, K., Babli, M Aswathy, C. Rajkumar A.D and Praksh Bhat. 2022. Kaajoo mein vaanijyik narsaree prabandhan. Technical Bulletin, Hindi version. ICAR-Directorate of Cashew Research, Puttur, Karnataka, India.

Mohana, G.S. and E. Eradasappa. 2022. Sudharita Geru Taligalu (Improved cashew varieties) published in Kannada.

Mohana, G.S., Eradasappa, E. and Nayak M.G. 2022. Nethra Vaaman: A dwarf variety of cashew (English and Kannada).

Rajkumar A.D. and Preethi P. Mohana, G.S. and Eradasappa, E. 2022. Geru hannina samskarane (Cashew Fruit processing).

8.7 EXTENSION BULLETINS /PAMPHLETS

Dinakara Adiga, G.S. Mohana, Muralidhara, B. M., Eradasappa, E., Siddanna, S. Manjesh, G.N. Aswathy, C and Babli Mog. Nethra Jumbo-1, Version: Malayalam. ICAR-DCR, Puttur.

Dinakara Adiga, G.S. Mohana, Muralidhara, B. M., Eradasappa, E., Siddanna, S. Manjesh, G.N. Babli Mog and Rajkumar, A.D. Nethra Jumbo-1, Version: Hindi. ICAR-DCR, Puttur.

Eradasappa, E., J.D. Adiga, Mohana, G.S., B.M. Muralidhara, Siddanna Savadi and Manjesh G.N. 2022. Nethra Jumbo – 1 a new cashew hybrid for higher income. ICAR-DCR, Puttur, Karnataka, India, [Extension Leaflet-Kannada]. July 2022.

Eradasappa, E., J.D. Adiga, Mohana, G.S., B.M. Muralidhara, Siddanna Savadi and Manjesh G.N. 2022. Nethra Jumbo – 1 a new cashew hybrid for higher income. ICAR-DCR, Puttur, Karnataka, India, [Extension Leaflet-English]. July 2022.

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K. Vanitha, Dr. T.N. Raviprasad and Rajashekara. H. Kannada Translation by Mr. Ravishankar Prasad. 2022. Tea mosquito bug and its management in cashew (in Kannada). ICAR-DCR, Puttur.

K. Vanitha, T.N. Raviprasad and Veena, G.L. 2022. Pollinators of cashew and their importance. ICAR-DCR, Puttur.

Mangalassery, S., J.D. Adiga, Aswathy Chandra Kumar and T.N. Raviprasad. 2022. Cashew Plant Health Clinic Museum, ICAR-DCR, Puttur. ICAR-Directorate of Cashew Research, Puttur, Karnataka, India, [Extension leaflet-English]. 25 April 2022.

Mangalassery, S., J.D. Adiga, Babli Mog, Siddanna Savadi, K. Vanitha, T.N. Raviprasadand H. Rajasekhara. 2022 Software and Mobile Apps on cashew developed under RKVY project, ICAR-DCR, Puttur. ICAR-Directorate of Cashew Research, Puttur, Karnataka, India, [Extension leaflet-English]. 25 April 2022.

Mohana, G.S. and Eradasappa, E. 2022. Geru hannina samskarane (Cashew Fruit processing). ICAR-DCR, Puttur, Karnataka, India, [Extension Leaflet-Kannada]. July 2022. (Translation of English leaflet –cashew apple processing by Rajkumar A.D. and Preethi P.)

Mohana, G.S. and Eradasappa, E. 2022. Sudharita Geru Taligalu (Improved cashew varieties). ICAR-DCR, Puttur, Karnataka, India, [Extension Leaflet-Kannada]. July 2022.

Mohana, G.S. Eradasappa, E. and Nayak, M.G.2022. Nethra Vaaman: A dwarf variety of cashew. ICAR-DCR, Puttur, Karnataka, India, [Extension Leaflet-Kannada]. July 2022.

Mohana, G.S. Eradasappa, E. and Nayak, M.G.2022. Nethra Vaaman: A dwarf variety of cashew. ICAR-DCR, Puttur, Karnataka, India, [Extension Leaflet-English]. July 2022.

V. Thondaiman and K. Vanitha. 2022. Nethra Jumbo - 1 adhiga varumaanam tharum oru kalapina mundiri ragam (in Tamil). ICAR-DCR, Puttur.

8.8 POPULAR ARTICLES

Babli Mog, Eradasappa. E, J. D. Adiga, Mohana G. S, Shamsudheen M, Veena G.L, Thondaiman V, Vanitha K, Manjesh, G.N. Manjunatha K, Aswathy Chandra Kumar. The Cashew, a Golden Tree Crop, for Doubling Farmer's Income: Pollination as an Approach to Enhance Productivity. Agriculture and Food: E-newsletter. February 2022.

Babli Mog, J.D. Adiga, Mohana G.S, Eradasappa. E. Shamsudheen M, Siddanna Savadi, Veena G.L, Thondaiman V, Manjesh G.N, Manjunatha K. The impact of climate variability and change on cashew cultivation in India. KKE- e-journal. March 2022.

G. L. Veena, J. D. Adiga, B. M. Muralidhara, Babli Mog, V. Thondaiman, K. Manjunath, Shamsudeen M., Siddanna Savadi, G. N. Manjesh. Nutraceutical Values of Fruit Crops in Agriculture and Food: E-newsletter. March 2022.

K. Vanitha and T.N. Raviprasad. 2022. Cashew flower drying results upon caterpillar damage too. Cashew News, January - June 2022, published by ICAR-DCR, Puttur: 3-4p.

K. Vanitha, T.N. Raviprasad and Rajashekara, H. 2022. Notes on an Ant mimicking mantid, Euantissa pulchra Recorded in Cashew Plantations. Agriculture and food e-newsletter, 4 (8): 409-411.

K. Vanitha, T.N. Raviprasad and Veena, G.L. 2022. Bee pollinators of cashew lowers recorded at Puttur, Karnataka. Kerala Karshakan e-journal, 10: 31-34.

K. Vanitha1, T. N. Raviprasad1, K. Jayaprabhavathi, H. Rajashekara. 2022. Invasive Ant Species Recorded in Cashew Plantations with Reference to Yellow Crazy Ant, A Threat to Ecosystem. Agriculture and food e-newsletter, 4 (8): 406-408.

Muralidhara, BM., Shivaprasad M.K., Venkataravanappa V., Savadi, S., V.S. Karthik Nayak (2022). Bahu Bedikeya Benne Hannu. Magazine Negila Miditha, UAHS, Shimoga, April-June: 16-17.

8.9. Website/e Publication

Dr. Mohana G S	Maintained the webpage of AICRP www.cashew.icar.gov.in/aicrpc Maintained the Cashew phenology webpage www.cashew.icar.gov.in/phenology Maintained the website of Directorate of Cashew Research https://cashew.icar.gov.in/ Maintained the Cashew India android app in Google Play Store.

8.10 CDs for video extension

1. Shamsudheen. M., Adiga, J.D., Aswathy Chandrakumar and Veena, G.L., 2022. Video Cds for cashew extension (No. of video films: 9 & Language: English), ICAR-Directorate of Cashew Research, Puttur, Karnataka, India (18 June 2022).

2. Shamsudheen. M., Adiga, J.D., Aswathy Chandrakumar and Veena, G.L., 2022. ಗೇರು ವಿಸ್ತರಣೆಗಾಗಿ ವಿಡಿಯೋಗಳು [Video Cds for cashew extension] (No. of video films: 9 & Language: Kannada), ICAR-Directorate of Cashew Research, Puttur, Karnataka, India (18 June 2022).

8.11 Production of educational videos

Videos detailing the cultivation and plant protection was developed in English and Kannada for dissemination of technologies to the farmers and other stake holders.

S. No	Title
1.	ಗೇರು ಉತ್ಪಾದನಾ ತಂತ್ರಜ್ಞಾನ (Geru uthpadana tanthrajnana)
2.	ಗೇರಿನಲ್ಲಿ ಸಾಂದ್ರ ಬೇಸಾಯ ಹಾಗೂ ಅತಿ ಸಾಂದ್ರ ಬೇಸಾಯ (Gerinalli Sandra besaya hagu athi sandra besaya)
3.	ಗೇರು ಬೆಳೆಯಲ್ಲಿ ಪೋಷಕಾಂಶಗಳ ನಿರ್ವಹಣೆ (Geru beleyalli poshkamshagala nirvahane)
4.	ಗೇರು ಬೆಳೆಯಲ್ಲಿ ನೀರಿನ ನಿರ್ವಹಣೆ (Geru beleyalli neerina nirvahane)
5.	ಗೇರಿನಲ್ಲಿ ಚಹಾ ಸೊಳ್ಳೆ (ಟಿಎಂಬಿ)ಯ ನಿರ್ವಹಣೆ (Gerinalli chaha sole(TMB)ya nirvahane)
6.	ಗೇರಿನಲ್ಲಿ ಗೇರು ಕಾಂಡ ಮತ್ತು ಬೇರು ಕೊರಕ (ಸಿಎಸ್‌ಆರ್ ಬಿ) ದ ನಿರ್ವಹಣೆ (Gerinalli Geru kanda mattu beru koraka(CSRB)ya nirvahane)
7.	ಐ.ಸಿ.ಎ.ಆರ್ - ಗೇರು ಸಂಶೋಧನಾ ನಿರ್ದೇಶನಾಲಯ, ಪುತ್ತೂರು (ICAR-Geru samshodhana Nirdeshanalaya, Puttur)
8.	ಗೇರು ಮರಗಳಿಗೆ ಆಕಾರ ನೀಡುವಿಕೆ ಮತ್ತು ಸವರುವಿಕೆ (Geru maragalige akara needuvike mattu savaruvike)
9.	ಗೇರು ಸಸ್ಯ ಆರೋಗ್ಯ ಚಿಕಿತ್ಸಾಲಯ- ವಸ್ತು ಸಂಗ್ರಹಾಲಯ (Geru sasya arogya chikithsalaya- Vasthu Sangrahalaya)

8.12. Extension Teaching aids developed

Three posters were developed as extension teaching aids for supplementing the training activities and for the purpose of display during exhibitions. Posters developed include-

Sl. No.	Title of the Poster	Prepared by
1.	Farm level cashewnut processing	1. Dr. D Balasubramanian, Principal Scientist (AS &PE), ICAR-DCR, Puttur 2. Dr. Aswathy Chandrakumar Scientist (Agrl. Extension), ICAR-DCR, Puttur 3. Dr. T N Raviprasad Director (Acting), ICAR-DCR, Puttur
2.	Popular cashew varieties in India	1. Dr. Aswathy Chandrakumar Scientist (Agrl. Extension), ICAR-DCR, Puttur 2. Dr. J Dinakara Adiga, Principal Scientist (Horticulture), ICAR-DCR, Puttur 3. Dr. T N Raviprasad, Director (Acting), ICAR-DCR, Puttur
3.	Value addition of Cashew apple	1. Dr. Rajkumar A D, Scientist (Food Processing), ICAR- DOGR 2. Dr. Veena G L Scientist (Fruit Science), ICAR-DCR, Puttur 3. Dr. Aswathy Chandrakumar, Scientist (Agrl. Extension), ICAR-DCR, Puttur 4. Dr. T N Raviprasad, Director (Acting), ICAR-DCR, Puttur

9. LINKAGES / COLLABORATION

Dr. D. Balasubramanian	• ICAR-Central Institute of Agricultural engineering (Regional Centre), Coimbatore, Tamil Nadu. • M/s Environmental Control, Cochin, Kerala

10. HUMAN RESOURCE DEVELOPMENT AND CAPACITY BUILDING

Dr. D. Balasubramanian	• Training on 'Intellectual Property Awareness' conducted by National Intellectual Property Awareness mission (NIAPM), Kolkatta in association with Intellectual Property and technology Management (IP&TM), Indian Council of Agricultural Research, New Delhi during 1-5 August, 2022 (Webinar series).
Dr. Mohana G S	• Participated as resource person in International ITEC Training Programme on 'Computer Applications in Agricultural Extension' held during 13– 27th September, 2022 at MANAGE, Hyderabad and delivered a talk on 'Useful applications and websites for agricultural extension professionals' on 24-09-2022. • Attended a national workshop on 'Smart management of Agricultural Resources for transforming Indian farms at CTCRI Trivandrum on 15-12-2022 and presented an invited paper on "Cashew Protect: An Artificial Intelligence (AI) based website and app for identification of pests, diseases and nutrient deficiencies in Cashew".
Dr. Shamsudheen M	• Attended the Khajane-2, PFMS training organized by Office of Commissioner of Treasuries, 5th floor, KPCL green building, Palace Road, Bengaluru & RKVY Cell, Govt. of Karnataka at Office of Commissioner of Treasuries, 5th floor, KPCL green building, Palace Road, Bengaluru for implementation of RKVY Scheme through PFMS K2 on 20 Aug 2022.
Dr. K. Vanitha, Dr. Veena GL, Dr. Bhagya, H.P and Dr. Aswathy Chandrakumar	• Participated in the Mega Kisan Mela and Agri Expo conducted during 19-23 November, 2022 at Kidu, CPCRI regional station and involved in demonstration of DCR technologies in the stall. The stall of ICAR-DCR received *'First best stall award'* during the programme.
Dr. Siddanna Savadi	• Participated in the DBT sponsored Training on Biosecurity and Biosafety: Policies, Diagnostics, Phytosanitary Treatments and Issues organized by the ICAR-NBPGR during August 2-11, 2022 in virtual mode. • Participated in the talk by Dr. T. Ramasami on Science and Technology: For Low Resource Setting and Coping with Diversity Challenges organized by Tata Institute for Genetics and Society (TIGS), Bengaluru on August 22, 2022.

	• Participated in the DGCA-Certified Remotely Piloted Aircraft System (RPAS) Training Course for the RPAS flying training and pilot license scheduled during 10–11 October 2022 (online) and 17–22 October 2022 (offline) at Drone Destination Pvt. Ltd., Pyramid Meditation Room, Om Shanti Retreat Centre Road, Patti Kawan, Bhora Kalan, Haryana-122 414. • Participated in the online training on RNA world: Advanced bioinformatics for deciphering regulatory molecules organized by Division of Agricultural Bioinformatics, ICAR-Indian Agricultural Statistics Research Institute, New Delhi-110012 during November 3-9, 2022 online mode.
Dr. Bhagya H P	• Undergone orientation training program at ICAR-DCR, Puttur from 22.08.2022 to 21.09. 2022.
Dr. Manjesh G N	• Online training on Cashew production and post-harvest technologies. ICAR-DCR and MANAGE, Hyderabad. dated:16-18 February 2022. • Hands-on Training Program on "Advances in Biochemical Techniques and applications" organized at the Department of Biochemistry North-Eastern Hill University Shillong, Meghalaya, India Under the aegis of the Department of Science & Technology (DST), Government of India, from 01st to 8th September 2022.
Dr. K. Manjunatha	• Attended the Remotely Piloted Aircraft System (RPAS) Training Course (pilot training) from October 10–11, 2022 (online classes) and October 17–19, 2022 (hands-on training) at Drone Destination Pvt. Ltd., Gurugram's DGCA-approved RPTO Center, followed by product training at IoTechWorld Avigation Pvt. Ltd., Gurugram, from October 20–22, 2022.
Dr. Aswathy Chandrakumar	• Participated and demonstrated "Drone Technology" during Mega Kisan Mela and Agri Expo organized by ICAR-CPCRI at Kidu on 19th November, 2022. • Advances in Web and Mobile Application Development organised by ICAR-NAARM, Hyderabad from 02.08.2022 – 06.08.2022.

11. PARTICIPATION IN SYMPOSIA/ CONFERENCES/ SEMINARS/ WEBINARS / MEETINGS

Dr. D. Balasubramanian	• Participated in 'National level training programme' on "Recent Advances in Cashew Production Processing & Post-Harvest Management" conducted by ICAR-Central Coastal Agricultural Research Institute (CCARI), Goa in collaboration with the Directorate of Cashewnut & Cocoa Development (DCCD), Cochin, Kerala organized the at Krishi Vigyan Kendra (KVK), North Goa during 6-8 January, 2022 and delivered a talk on 'Cashew processing and preparation of project report'. • Participated in in the 'Training program' on Cashew Production and Post-Harvest Technologies (Online) conducted by ICAR-Directorate of Cashew Research, (ICAR-DCR), Karnataka and National Institute of Agricultural Extension Management (MANAGE), Hyderabad on 15 February, 2022 and delivered a talk on 'Raw cashewnut processing'. • Participated in 'Training program' on Cashew cultivation under Scheduled Caste Sub Plan (SCSP) conducted by ICAR-Directorate of Cashew Research, Puttur on 23rd March, 2023 and delivered talk on 'Raw cashewnut processing'. • Participated in 'Caju Utsav', organized by Karnataka Cashew Manufacturers Association (KCMA), Karnataka, conducted at Dr T M A Pai International Convention Centre, Mangalore, Karnataka on 28-28 July, 2022. • Participated in 'All India startup convention-2022' conducted by National Agricultural Higher Education Project-Institutional Development Plan (NAHEP - IDP) and the University of Horticultural Sciences, Bagalkot (UHSB), Karnataka at UHSB, Bagalkot from 15-17 September, 2022 and delivered a talk on 'Entrepreneurship development in cashew ecosystem – Opportunities through Agribusiness incubation centre'. • Participated in 'International Symposium' on India 2047: Agricultural Engineering Perspective, jointly organized by Indian Society of Agricultural Engineers (ISAE), New Delhi and Tamil Nadu Agricultural University (TNAU), Tamil Nadu during 9-11 November, 2022 and delivered a talk on 'Optimization of composition and extrusion operating parameters for the production of cashew apple powder enriched extrudate using mixture-process design'.

Dr. Shamsudheen M.	• Participated the International Conference On Advancement of Science and Technology for Environment, Society and People (ICASTESP-2022), organized by Society for Technology, Environment, Science & People, Kerala, India from 28-29 Jan 2022. • National Conference on Advancement of Science and Technology for Environment, Society and People (NCASTESP-2022), organized by Society for Technology, Environment, Science & People, Kerala, India on 28th August 2022 • National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT)-2022 organised jointly by IIHR-Central Horticultural Experiment Station (CHES), Chettalli & Society for Promotion of Horticulture (SPH), IIHR, Bengaluru from 2-3 December 2022
Dr. K. Vanitha	• Participated online in three days International Conference on Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security (AAVASILES-2022) conducted during 28 to 30 September, 2022 organized jointly by ICAR-IGFRI, Janshi, NADCL, ICAR-NAHEP and BHU, Ranchi at Gandhi Bhawan, University of Kashmir. • Participated in XVIII AZRA International Conference on 'Advances in applied Zoological Researches towards food, feed and nutritional Security and safer environment', 10-12 November, 2022 organized jointly by OUAT, Bhubaneswar, BAU, Ranchi, Dr. YSRHU, A.P., IRRI, Philippines-IIRI, India, Bhubaneswar, ICAR-NRRI, Cuttack and AZRA, Bhubaneswar at Hotel Suryansh, Bhubaneswar, Odisha.
Dr. Siddanna Savadi	• Participated in the National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, ICAR-Indian Institute of Horticultural Research, Chettalli, Kodagu, Karnataka during December 02-03, 2022 and presented on the topic Development and utilization of genomic resources in cashew. • Participated in the Knowledge Series lecture on Intellectual Property Rights (IPR) in Biotechnology Prosecution of Biotech Patents by Ms. Chitra Sundar, Advocate & Patent Agent, in the webinar organized by BioNcube, WIPO-TISC and IPFC at AIP–ICRISAT on 13 December 2022.
Dr. Veena G L	• Participated and poster presented in 5th International conference on international conference on advances in agriculture technology and allied sciences (ICAATAS-2022) (In hybrid mode) from 4th to

	5th June, 2022. Organized by society of agriculture research and social development, NRRI, Odisha. • Participated in IVth International Web Conference on Innovative and Current Advances in Agriculture and allied sciences from 12th to 14th June 2022 organized by Society for Scientific development in Agriculture and Technology Meerut (U.P.) India and Delivered oral presentation on "Diversity of bioactive components in Cashew apple". • Participated in National symposium on Horticultural crops of humid tropics for nutritional and livelihood security (NSHCT)-2022 from 02nd to 03rd December 2022 organized by ICAR-IIHR RS-Chettalli at Madikeri & delivered oral presentation on Cryopreservation in cashew (*Anacardium occidentale* L.)
Dr. Bhagya H P	• Participated and oral presentation was given on "Identification and selection of promising oil palm genotypes for high FFB and oil yield traits" at National symposium on Horticultural crops of Humid Tropics for Nutritional and Livelihood security (NSHCHT) held from 02-03 December 2022 organized by ICAR-IIHR, Chettalli.
Manjunatha K	• Participated and delivered oral presentation on Performance evaluation of roller-type fruit collector authored by Manjunatha K., Ravindra Naik and Adiga J. D. in 56th Annual Convention of Indian Society of Agricultural Engineers (ISAE) on Agricultural Engineering Innovation for Global Food Security and International Symposium on India @2047: Agricultural Engineering Perspective held on November 9-11, 2022 at Tamil Nadu Agricultural University, Coimbatore.
Dr. Raghurama Kukkude	• Attended an International Conference of Agricultural Librarians & User Community (ICALUC-2022) on theme "Innovation, Growth and Sustainability of Agricultural Libraries " jointly organised by University Library, Assam Agricultural University, Jorhat and Association of Agricultural Librarians and Documentalists (AALDI) from 28th to 29th April, 2022 held at Assam Agricultural University, Jorhat and presented a paper entitled "Use of Social Media Tools by Agricultural Library Users: A Study of ICAR Institute of South India".

12. 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. Siddanna Savadi Veena. G.L. 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. J.D. Adiga Veena. G.L.
4.	4.	Breeding approaches for developing TMB tolerance [09/2017-8/2030] **PIMS Number: IXX13687**	Mohana, G.S.	Eradasappa, E. K. Vanitha
5.	5.	Genetics of traits in cashew [05/2019 – 04/2025]	Eradasappa, E.	Mohana, G.S. Siddanna Savadi

		PIMS Number: IXX15237		
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
	Priority area III. Development, refinement and use of biotechnological approaches in cashew (Leader: Dr. Siddanna Savadi)			
8.	8	Genetic dissection of QTLs governing nut yield and cashew nut shell liquid (CNSL) content in cashew [06/2018-5/2025] **PIMS Number: IXX14347**	Siddanna Savadi	Eradasappa, E Mohana, G.S. Manjunatha. K Manjesh. G.N
9.	9	Deciphering the molecular basis of Cashew-Tea Mosquito Bug (TMB) interactions to understand host response and TMB effectors (4 years: 09/2022-09/2026) **PIMS Number: IXX17066**	Siddanna Savadi	T.N. Raviprasad K. Vanitha
10.	**10**	***Externally Funded Project:*** Development of morphological descriptors and	Mohana, G.S.	-

		DUS test guidelines for cashew Funded by: Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), New Delhi Budget: Rs. 10 Lakhs [04/2015-3/2022] **PIMS Number: OXX03473**		
	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 [10/2020-9/2023] **PIMS Number: IXX16218**	Shamsudheen Mangalassery	V. Thondaiman Babli Mog J.D. Adiga Manjesh. G.N Aswathy Chandrakumar
12.	2.	Carbon cycling, sequestration and nutrient dynamics in cashew orchards [10/2020-9/2023] **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]	Babli Mog	Eradasappa, E. Veena. G.L. V. Thondaiman Manjesh. G.N K.B. Hebbar (ICAR-CPCRI)

		PIMS Number: IXX15130		
14.	4.	Physiological and biochemical basis of salinity tolerance in cashew rootstocks [09/2021-08/2026] **PIMS Number: IXX16223**	Babli Mog	J.D. Adiga, Shamsudheen M Manjesh. G.N. Veena. G.L. V. Thondaiman Bhagya. H.P. K.B.Hebbar (ICAR-CPCRI)
	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.) [10/2020-9/2022] **PIMS Number: IXX16215**	V. Thondaiman	J.D. Adiga 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 [10/2020-9/2025] **PIMS Number: IXX16363**	V. Thondaiman	J.D. Adiga Shamsudheen Mangalassery K. Vanitha Babli Mog H. Rajashekhara
17.	7	Design, development and performance evaluation of Cashew fruit and nut separator [10/2020-9/2024] **PIMS Number: IXX15634**	Manjunatha. K	D. Balasubramanian Ravindra Naik
18.	8	Design and development of gadgets for	Manjunatha. K	D. Balasubramania n

		cashew fruit harvesting and collection [10/2020-9/2024] **PIMS Number: IXX15635**		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.	J.D. Adiga Babli Mog K. Vanitha Siddanna Savadi Bhagya. H.P.
20.	10	Effect of inter-stocks in Cashew (*Anacardium occidentale*) [09/2021-8/2024] **PIMS Number: IXX16474**	H.P. Bhagya	V. Thondaiman J.D. Adiga Veena. G.L. Manjesh. G.N.
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 J.D. Adiga Shamsudheen M Manjesh. G.N Manjunatha. K Bhagya. H.P.
22.	12	***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

	CROP PROTECTION			
	Priority area VIII: Integrated management of pests and diseases & ecosystem services in cashew (Leader: Dr. T.N. Raviprasad)			
23.	**1**	Cashew tea mosquito bug interactions and the defensive responses [05/2019-4/2023] **PIMS Number: IXX14975**	K. Vanitha	T.N. Raviprasad V. Thondaiman Shamsudheen Mangalassery Veena. G.L.
24.	**2**	Characterization and synthesis of female sex pheromone of Tea Mosquito Bug; (*Helopeltis antonii*) and its bioassay [10/2020-9/2025] **PIMS Number: IXX16224**	T N Raviprasad	K. Subaharan (ICAR-NBAIR) K.Vanitha
25.	**3**	Influence of *Apis cerana indica* and *Braunsapis* spp. on pollination and fruit set of cashew [05/2019-4/2023] **PIMS Number: IXX14974**	K. Vanitha	Veena. G.L
26.	**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*	T.N. Raviprasad	K.Vanitha Rajkumar (ICAR-CPCRI)

		obesus) [09/2021-8/2026] **PIMS Number: IXX16225**		
27.	**5**	Survey and diagnosis of diseases occurring in cashew crop and their morphological and molecular characterization [09/2021-8/2024] **PIMS Number: IXX17045**	H. Rajashekara	T N Raviprasad Siddanna Savadi RTP Pandian (ICAR-CPCRI, RS, Vittal)
28.	**6**	Species complex of thrips infesting cashew, their role and management measures (3 years, 2022-25) **PIMS Number: IXX17067**	K. Vanitha	T.N. Raviprasad Rachana, R (ICAR-NBAIR) Rajashekara, H Mohana, G.S.
	POST HARVEST TECHNOLOGY			
	Priority area VIII: Post-Harvest Technology (Leader: Dr. D. Balasubramanian)			
29.	**1**	Design and development of mechanized slicer for cashew apple [10/2014-6/2023] **PIMS Number: IXX11563**	D. Balasubramanian	Ravindra Naik (ICAR-CIAE)
30.	**2**	Studying comparative performance of cashewnut processing systems in India [10/2017-09/2023] IXX13902 IXX13683	D. Balasubramanian	-
31.	**3**	Design and development of moisture meter for	D. Balasubramanian	Sreejith (M/s EMCON)

		raw cashewnuts [07/2018-6/2023] IXX13901 IXX13682		
32.	**4**	Development of value added products from cashew apple and sprouts [06/2018-05/2024] **PIMS Number: IXX14346**	Veena. G.L.	Shamsudheen Mangalassery
33.	**5**	Optimizing processing parameters in cashew for enhancing whole kernel recovery [10/2020-9/2023] **PIMS Number: IXX17068**	D. Balasubramanian	-
34.	**6**	Development of ready to eat alternate snack food using cashew apple - extrusion and vacuum frying approach [09/2021-8/2024] **PIMS Number: IXX17069**	D. Balasubramanian	M R Manikandan (ICAR-CPCRI)
35.	**7**	Development of probiotic food products from cashew apple [09/2021-08/2024] **PIMS Number: IXX16226**	Veena. G.L.	H. Rajashekara Manjesh. G.N K. Renjitha (ICAR-IIHR)
36.	**8**	Phytochemical characterization of cashew (leaf and apple) nutraceuticals for its utilization in development of functional foods	Manjesh. G.N.	Veena. G.L. Bhagya. H.P Shabbir A (ICAR-NRCG) Rajkumar. A.D, (ICAR-DOGR)

		[09/2021-08/2025] [09/2021-08/2025] **PIMS Number: IXX16286**		
	TRANSFER OF TECHNOLOGY			
	Priority area IX: Transfer of technology and knowledge management (Leader: Dr. Aswathy Chandrakumar)			
37.	**1**	Knowledge management and technology transfer in cashew [09/2021-Long term] **PIMS Number: IXX17070**	Aswathy Chandrakumar	T N Raviprasad J D Adiga Mohana G S Manjesh. G.N Bhagya. H.P
38.	**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)
39.	**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 Karnataka Budget: Rs. 57.0 lakhs [04/2020 to 03/2023]	Veena. G.L.	Shamsudheen Mangalassery Manjunatha. K Aswathy Chandrakumar

		PIMS Number: OXX5068		
40.	**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 03/2023] **PIMS Number: OXX5458**	Mohana, G.S.	E. Eradasappa
41.	**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- 03/2023] **PIMS Number: OXX5459**	Mohana, G.S.	K. Vanitha Shamsudheen Mangalassery H Rajashekara
42.	**6**	***Externally Funded Project:*** Establishment of an exclusive 'Cashew Parlour' for creating awareness on value added	Mohana, G.S.	Manjunatha K

		products of cashew Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 2.2 Crores [04/2020 to 03/2023]		

List of projects concluded in 35th IRC

Continuous No.	Division-wise No.	Title, duration, Number	Project workers	Level and Duration of involvement
CROP IMPROVEMENT				
1.	1.	Evaluation of big cashew apple genotypes for apple yield and quality [10/2013-06/2022] IXX10492 IXX10491	Saroj. P.L.	PI from 10/2013 till 10/2016
			Janani	PI from 10/2016 to 06/2018
			Preethi. P	PI from 06/2018 to 10-08-2020
			Eradasappa, E.	PI from 10-08-20 to 06/2022 Co-PI from 10/2013 till 10/2015; & 06/2018 to 09-08-2020
			K. Vanitha	Co-PI from 10/2013 to 06/2022
			M.G. Nayak	Co-PI from 10/2013 to 07/2021
			Ramkesh Meena	Co-PI from 10/2013 to 12/2015
			M. Loganathan	Co-PI from 10/2015 to 03/2017
			Rajkumar AD	10/2016 to 03/2018;

				09/2021 to 04-03-2022
			Veena. G.L.	12-10-2020 to 06/2022
2.	2	*De novo* genome assembly, linkage analysis and population structure studies in cashew (*Anacardium occidentale* L.) [09/2017 – 08/2022] OXX04051	Siddanna Savadi	PI from 09/2017 to 08/2022
			Mohana, G.S.	Co-PI from 09/2017 to 08/2022
			J.D. Adiga	Co-PI from 09/2017 to 08/2022
			B.M. Muralidhara	Co-PI from 09/2017 to 09/2018; 16-07-2021 to 07-10-2021
3.	3	***Externally Funded Project:*** Establishment of a Centre of Excellence for Biotechnology Needed for Genomics Assisted Breeding in Cashew Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 75 lakhs [04/2020 to 03/2022]	Siddanna Savadi	PI from 04/2020 to 03/2022
			Mohana, G.S.	Co-PI from 04/2020 to 03/2022
			V. Thondaiman	Co-PI from 11-01-2021 to 03/2022
			Shamsudheen Mangalassery	Co-PI from 11-01-2021 to 03/2022
			Anitha Karun	Co-PI from 11-01-2021 to 27-09-2021
CROP MANAGEMENT				
4.	1	Characterization of physiological responses of cashew (*A. occidentale* L.) accessions to salt and drought stresses [10/2015-09/2022] IXX11537 IXX11536	Babli Mog	PI from 10/2015 to 09/2022
			T.R. Rupa	Co-PI from 10/2015 to 02/2016
			Prabha S. Philip	Co-PI from 02/2016 to 07/2017
			Veena. G.L	Co-PI from 12-10-2020 to 09/2022

			V. Thondaiman	Co-PI from 12-10-2020 to 09/2022
CROP PROTECTION				
5.	1	Investigations on inflorescence insect pests of cashew and their management [10/2016-05/2022] ICC13176	K. Vanitha T.N. Raviprasad	PI from 10/2016 to 05/2022 Co-PI from 10/2016 to 05/2022
TRANSFER OF TECHNOLOGY				
6.	1	Development of an exclusive android application for cashew cultivation Funding: Directorate of Cashewnut and Cocoa Development (DCCD), Kochi Budget: Rs. 5.0 Lakhs [09/2017-03/2022] OXX04052 OXX03985 OXX03984	Mohana G.S. M.G. Nayak	PI from 09/2017 to 03/2022 Co-PI from 09/2017 to 07/2021
NEW EXTERNALLY FUNDED PROJECTS BY RKVY				
7	1	Establishment of Farmer-Centric Pest Diagnostic and Bio-Control Laboratory to Achieve Sustainable Cashew Health Management (KA/RKVY-AGRE/2022/1345) Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: 100 lakhs	H. Rajashekara T. N. Raviprasad K. Vanitha Siddanna, S.	PI from 10/2022 till 09/2024 Co-PI from 10/2022 till 09/2024 Co-PI from 10/2022 till 09/2024 Co-PI from 10/2022 till 09/2024
	2	Establishment of Centre of Excellence for profiling of bioactive components in Cashew apple and nut (KA/RKVY-AGRE/2022/1344) Budget: Rs. 95 lakhs	Veena, G. L. J. D. Adiga Shamsudheen, M. Siddanna, S.	PI from 04/2021 till 03/2023 Co-PI from 04/2021 till 03/2023 Co-PI from 04/2021 till 03/2023 Co-PI from 04/2021 till 03/2023
	3	Mechanization of pesticide and nutrient sprays in cashew orchards through drones. Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 83.0 lakhs	Manjunatha, K. J. D. Adiga Shamsudheen, M. K. Vanitha	PI from 04/2021 till 03/2023 Co-PI from 04/2021 till 03/2023 Co-PI from 04/2021 till 03/2023 Co-PI from 04/2021 till 03/2023

13. CONSULTANCY, PATENTS AND COMMERCIALIZATION OF TECHNOLOGY

13.1 Commercialization of ICAR-DCR technologies: Licensing of Nethra Jumbo-1

Signing of Memorandum of Understanding (MoU) with M/s Yashaswi Nursery, Puttur to license Nethra Jumbo-1 hybrid for commercial multiplication and sale was done on 20th June 2022. The terms and clauses of the MoU were discussed with the proprietor of the M/s Yasaswi Nursery before signing of the MoU.

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

- ICAR-DCR filed application for registration of 'H-126: cashew hybrid' with PPV&FRA, New Delhi under PPV&FR act 2001 with PVP no. DL1012210001on 11 February 2022.
- A total of four copyrights were granted to ICAR-DCR, Puttur for the apps/software i). Cashew leaf diagnosis (https://cashew.icar.gov.in/leafanalysis/) SW-15715/2022 on 12-08-2022, ii). DCR-Cashew Drip / Fertigation Calculator (https://cashew.icar.gov.in/water/) SW-15535/2022 on 30-06-2022, iii). DCR-Cashew Nutrient Manager – Offline [SW 15864/2022-CO/SW] on 3/10/2022 and iv). Cashew diseases [SW-15907/2022] on 9/11/2022.

Copy rights obtained

Sl. No.	Details of software / mobile app	Copyright DiaryNo.	Filing Date	Registration No.	Issue date
1	Cashew leaf diagnosis (https://cashew.icar.gov.in/leafanalysis/)	347/2022-CO/SW	06/01/22	SW-15715/2022	12-08-22
2	DCR- Cashew Drip/Fertigation Calculator (https://cashew.icar.gov.in/water/)	138/2022-CO/SW	03/01/22	SW-15535/2022	30-06-22
3	DCR-Cashew Nutrient Manager – Offline	8062/2022-CO/SW	16/04/22	SW-15864/2022	03-10-22
4	Cashew diseases (Mobile app)	8073/2022-CO/SW	16/04/22	SW-15907/2022	09-11-22

14. RAC/ IRC/ IMC/ IJSC MEETINGS

14.1. Research Advisory Committee (RAC)

The second meeting of 9th Research Advisory Committee (26th RAC) of ICAR-DCR, Puttur was held during 7 and 8 June, 2022 at video Conference Hall of ICAR-DCR, Puttur on hybrid mode. The meeting started on 07.06.2022 at 9.30 am with the welcome address by Dr. T.N. Raviprasad, Director (A), ICAR-DCR. This was followed by the introductory remarks of the Chairman, Dr. N.K. Krishna Kumar. After the brief introductory remarks by the RAC members, Dr. Anandprakash, Dr. Pravu Charan Lenka, Dr. George V. Thomas, Dr. R. Muraleedhara Prasad and Dr. N. Basavaraj. Action taken report on the recommendations of 1st meeting of 9 RAC was presented by Dr. K. Vanitha, Member Secretary (9 RAC). During the remarks, RAC opined to take up the studies on influence of climate change on crop phenology; research interventions to enhance productivity of cashew and also market analysis. The IMC members, Mr. K Subash Rai and Mr. Udaya Kumar also participated in the meeting and shared their opinions about cashew farming and the problems faced by the farmers in recent years. Subsequently, there were presentations by the scientists of ICAR-DCR on their ongoing research projects under crop improvement, crop management and farm machinery, crop protection, post-harvest technology and transfer of technology sections. The research progress and the accomplishments of 47 research projects including seven external projects were presented during the meeting under nine mega projects. There were critical observations by the RAC on the research outcomes, and the suggestions to proceed further were discussed at length. Following the concluding remarks by the RAC Chairman and members, the recommendations were finalized. On the second day of the meeting, cashew nurseries and farmers' field in and around Puttur, Brahmavara and Udupi regions of Karnataka were visited by the RAC.

14.2 Institute Research Council (IRC)

The meeting of the 35th Institute Research Committee (IRC) was held during 27-28, September 2022 under the Chairmanship of Dr. T.N. Raviprasad, Director (Acting), 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. T.N. Raviprasad welcomed the scientists and appreciated the

efforts of the scientists. Dr. G.S. Prakash, Former Head, Fruit Crops, IIHR, Bengaluru said that scientists should work in close association with farmers. Dr. M.G. Bhat, Former Director, DCR, Puttur indicated the need to enhance the productivity and thereby the production in cashew. The scientists should closely observe the cashew plants and the experimental material. He also suggested that the Vision document of DCR and ICAR (Vision 2030 and 2050) need to be kept in mind while formulating new projects and while implementing ongoing projects. The scientists presented the achievements made under various ongoing projects and presented some new project proposals also. The summary of projects presented in IRC is given below.

Division	Institute projects				External projects				Total Projects
	Concluded	Ongoing	New projects	Total ongoing institute projects 2022-23	Concluded	Ongoing	New projects	Total ongoing external projects 2022-23	
Crop Improvement	2	8	1	9	1	1		1	10
Crop Management	1	11		11			1		12
Crop Protection	1	5	1	6					6
Post Harvest Technology		8		8					8
Transfer of Technology		2		2	1	4		4	6
Total	4	34	2	36	2	5	1	6	42

14.3 Technology meet-2022

Technology Meet-2022 of DCR was held on 21.02.2022 at 2.30 PM at ICAR-DCR, Puttur in hybrid mode under the Chairmanship of Dr. T.N. Raviprasad Director (Acting), ICAR-DCR, Puttur for commercialization of two technologies i.e., Nethra Vaman and Nethra Jumbo 1. Participants from various parts of Karnataka, Kerala and Tamil Nadu namely; Nursery owners and officials of Farmer Producer Organizations (FPOs) participated in the technology meet. The project investigators (PIs) briefed about the technologies

being commercialized: Nethra Vaman and Nethra Jumbo-1. At first, Dr. Mohana G. S., Principal Scientist (Genetics & Cytogenetics), presented about the unique features of dwarf variety Nethra Vaman. Later on Dr. J.D. Adiga, Principal Scientist (Horticulture), presented about Nethra Jumbo 1, the second jumbo nut hybrid from the Directorate, which yields big and uniform size nuts. At last Dr. Siddanna Savadi, Officer in-charge, ITMU & Coordinator of the Technology Meet-2022, presented the process for licensing DCR technologies and also the pricing details of the technologies. The interested buyers were invited for the price negotiation.

14.4 ITMC meetings

Two ITMC meetings 19th and 20th were conducted on18.02.2022 and 17.06.22 respectively under chairmanship of the Director Dr. T. N. Raviprasad (Acting). In 19th meeting conducted on 18.02.22, TDFs of Nethra Jumbo-1 and Nethra Vaaman varieties were discussed and

recognized as commercializable technologies and licensing fees were fixed for both the varieties. In 20th meeting conducted on 17.06.22, the licensing fee for Nethra Jumbo-1 variety was reduced after negotiation with the potential licensees. With respect to royalty fixation for the Nethra Jumbo 1 variety, it was decided to discuss with Agrinnovate. It was decided to make correspondence with the Vice Chancellors of UHS, Bagalkot and UAHS, Shimoga.

14.5 Institute Joint Staff Council (IJSC)

IJSC Meeting held on 22.06.2022

1.	Director	Chairman
2.	Dr. Mohana G.S. Senior Scientist	Member, Official side
3.	Dr. K. Vanitha, Scientist	Member, Official side
4.	Sri. Muralikrishna K, Chief Technical Officer	Member, Official side
5.	Administrative Officer	Member, Official side
6.	Asst. Finance & Accounts Officer	Member, Official side
7.	Asst. Administrative Officer	Secretary Official side
8.	Smt. Reshma K, PA	Member, Staff side
9.	Ms. Winnie Lobo, Asst.	Secretary Staff side
10.	Sri Bojappa Gowda. Technical Officer	CJSC Member
11.	Sri. Honnappa Naik P, Sr. Technician	Member, Staff side
12.	Sri. Vijaya Achary, Skilled Support Staff	Member, Staff side
13	Sri T. Padmanabha, Skilled Support Staff	Member Staff side

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

International Women's day, 2022

International Women's Day was celebrated at the Directorate on 8th March, 2022. The function was presided by Dr. T N Raviprasad, Director (Acting). Dr. Babli Mog, chairman of Women's cell welcomed the gathering. Following this, Dr. Aswathy Chandrakumar, scientist (Agrl. Extension), delivered a presentation on "Developmental programmes for women in India". The programme concluded with a brief interaction among the staff on the importance of empowerment of women. Dr. Vanitha K, member secretary, Women's cell gave the vote of thanks.

Inauguration of Silver Jubilee building

The honourable Shri. Narendra Singh Tomar, Union Minister of Agriculture & Farmers' Welfare virtually inaugurated the Silver Jubilee Building of the ICAR-Directorate of Cashew Research, Puttur, Karnataka on 31.03.2022.

The Union Minister regarded the New Silver Jubilee Building as a new dimension in the council's vision of empowering and benefiting the agricultural community which will help in advancing the research on the cashew crop. He stated about the council's efforts of enabling the farmers to connect with it through technological advancements.

Kisan Bhagidari Prathmikta Hamari campaign

The Government of India had launched a nation-wide campaign on the theme *"Kisan Bhagidari Prathmikta Hamari"* as a part of the *Azadi ka Amrut Mahotsav*. This campaign has been organized throughout the country from 25th April – 30th April, 2022 and a series of activities have been undertaken by various ministries and departments to support the farming community of the country.

As a part of this campaign, ICAR-Directorate of Cashew Research, Puttur also organized a webinar on the theme "Nutritional Security through Biofortification for the benefit of agriculture stakeholders" on 28th April, 2022. Dr. Rajkumar A Dagadhkhair, Scientist (Food Technology), ICAR-Directorate of Onion and Garlic Research, Pune gave a talk on this topic. In his talk, he explained about the need for biofortification, the means to achieve it, how it can address food security issues and shared some of the success stories. A total of 25 participants had attended the webinar.

International Yoga Day celebration at ICAR-DCR, Puttur

International Yoga Day was celebrated at ICAR-Directorate of Cashew Research, Puttur on 21st June, 2022. Dr. Udayakumara K, Lecturer, Department of Yogic Science, Mangalore University, was invited for the function. The programme commenced with the introductory remarks by Dr. Udayakumara K wherein he briefed about the importance of inculcating yoga in our life. This was followed by a brief yoga session under his guidance in which the participants were taught about the basic yogasanas, the importance of each yogasana and meditation. A total of 35 participants attended the function which included scientists, technical staffs, skilled supporting staffs, contractual staffs, research associates and students.

PM Kisan Sammelan

On the occasion of PM Kisan Samman Sammelan, 2022 organised during the Agri-Startup Conclave and Kisan Sammelan at Mela ground in Delhi on 17th October, farmers were invited to ICAR-DCR, from Puttur, Chikkamagaluru and Kasaragod for the webcasting of the inaugural function of PM Kisan Samman Sammelan. During the inaugural function, Hon'ble Prime Minister, Shri Narendra Modi addressed the farmers throughout the country. He emphasized on the concept of "Ek Desh Ek Urvak" (One Nation One Fertiliser) while inaugurating 600 Pradhan Mantri Kisan Samrudhi Kendras and highlighted that Rs. 16,000 crores has been released as part of PM KISAN fund. A total of 71 farmers attended the programme.

World Soil day celebrations

Every year World Soil day is celebrated on 5th December, 2022 advocating the importance of healthy soils and the need for sustainable management of soil resources. The theme for this year is "Soils: Where Food begins". As a part of the World Soil day celebrations at the Directorate, a soil health camp was organized in the farmer's field in Bettampady village of Puttur.

The camp aimed at sensitizing the farmers on the importance of soil health in ensuring food and nutritional security and highlighted the need for soil health analysis for sustainable management

of soil resources. Soil health cards were distributed to the farmers during the soil health camp and farmers were given advisories on soil management based on the soil health analysis. The camp commenced with the lighting of the lamp by Dr. D Balasubramanian, Director-in-charge, ICAR-DCR, Puttur. In his opening remarks, he briefed about the soil health card programme of Govt. of India and he emphasized on the importance of judicious application of nutrients including micronutrients, based on soil test report. He highlighted the importance of soil in the production of quality food for human beings.

Following the distribution of soil health cards by Director-in-charge, Dr. Shamsudheen Mangalassery, Senior Scientist (Soil Science) delivered a talk on the theme "Soils: Where food begins." Dr. Bhagya H, Scientist (SPM and AP) and Dr. Veena G L, Scientist (Fruit science) of ICAR-Directorate of Cashew Research coordinated the event and assisted in giving advisories to the farmers. A total of 31 farmers attended the soil health camp and they opined that the camp was very fruitful.

Kisan Diwas

On 23/12/2022, Kisan Diwas was organised at ICAR-Directorate of Cashew Research, Puttur for the farmers under the SCSP and Tribal sub plan programme. The one of the chief guests of the function, Sri. Kadamajalu Subhash Rai, a progressive farmer delivered the speech by highlighting importance of farmers and agriculture. The other chief guest, Sri. Uday Kumar, M., who is also a progressive farmer addressed the gathering with his own agricultural success stories. Consequently, farmer and scientist interaction session was arranged in which farmers interacted with the scientists about nutrient, pest and disease management in cashew. Dr. T.N. Raviprasad, Principal Scientist (Agricultural Entomology) and Dr. Shamsudheen, Senior Scientist (Soil Science) addressed the queries received from the farmers. Farmers interacted well and they requested the Director for one day training programme on "Cultivation practices of Cashew" which was accepted by the Director, ICAR-DCR, Puttur.

The presidential address was delivered by Dr. J. Dinakara Adiga, Director, ICAR- DCR, Puttur. In his speech, he has narrated the objective of conducting Kisan Diwas and briefed about ICAR-DCR's achievements and schemes for the benefit of the cashew farmers. As a part of the Kisan Diwas celebration, seed kit was distributed to the farmers and a demonstration on "Weeding in cashew orchard by using brush cutter" was conducted in our Kemminje farm. This was followed by a field exposure visit for the farmers to the field of Sri Kadamajalu Subhash Rai to create awareness and motivate the farmers to take up scientific cashew cultivation. A total of 75 farmers from Bettampady, Kuriya and Kemminje villages of Puttur, Karnataka and Karadka village of Kasaragod, Kerala attended the "Kisan Diwas" function.

Cashew Day

Cashew Day, an annual event of ICAR-Directorate of Cashew Research, Puttur was organised on 22nd March, 2022 with an aim to create awareness about systematic cultivation of cashew among the farmers, providing an opportunity for mutually beneficial farmer-scientist interaction and show them the ways to increase

their income through value addition from cashew nuts and cashew apple. During the day long program, four progressive cashew farmers and two entrepreneurs in the field of value addition of cashew apple shared their experiences motivating the farmers gathered in large number.

Sri S N Bhat Khandige, President, All India Cashew Growers Association and Vice-president CAMPCO was invited as the Chief Guest. While delivering the remarks, he requested the farmers to come out of the old mindset that cashew was a "forest produce" and called for its systematic cultivation. Dr. T N Raviprasad, Director (Acting), ICAR-DCR, Puttur, in his introductory remarks, emphasized on the need for participatory research wherein the contributions of both the farmers and researchers are important in development of the sector. During the function, a new Cashew variety Netra Jumbo-1 and the improved and revised version of "Cashew India App-2" were released. Three technical bulletins and three extension folders (Kannada and English) were also released for the benefit of farmers.

Following the official inauguration, technical sessions were organised for the farmers, wherein progressive farmers and entrepreneurs were invited to share their experiences. Shri Brijith Krishna M C, CEO Eatery Malabarikas, Kannur shared his experience in venturing into cashew sprouts and explained its scope. Shri Chandrashekhara Udupa, a progressive farmer from Udupi explained about the activities of a Cashew based FPO while another progressive farmer Shri Ravichandra Amtange from Uppinangady spoke on how cashew farming can be made profitable with intercrops and bee keeping. Shri Canute Aranha, Kalpady progressive cashew farmer and entrepreneur from Mulky, gave a talk on the scope of value addition in Cashew apple and explicitly said how cashew apple value addition can bring 2-3 times the returns over raw nuts to farmers. He told there is great demand for products like cashew Halwa, Juice and Wine and anybody can venture with it. Technologies developed by ICAR-DCR, different varieties of cashew fruits and grades of cashew kernels and a few value-added products prepared from cashew apple and many food items prepared using cashew apple by the households were also exhibited on the occasion.

Vigilance Awareness Week

ICAR-Directorate of Cashew Research, Puttur celebrated the Vigilance Awareness Week -2022. A week-long programme was conducted by the Directorate from 31st October 2022 to 6th November 2022. The Vigilance Awareness week was started by taking the integrity pledge by staff members and general public on 31st October 2022. 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.

The valedictory function was held at the main conference hall of the Directorate on 07-11-202. Dr. Shamsudheen. M, Senior Scientist & Vigilance Officer, ICAR-DCR, Puttur welcomed the gathering. The programme was inaugurated by Sri. Gowda. R.P., Principal Senior Civil Judge and ACJM, Puttur & President, Puttur Taluk Legal Services Committee. He mentioned that greed is the basic cause of corruption. He stressed that individual must develop corruption opposition

mindset and protest the corruption. Sri. Manohar. K.V, President, Bar Association, Puttur also talked on the occasion and he indicated that it is the corrupt practices that facilitate corruption and stressed on the need to curb such practices. The resource person, Adv. Sudheer Tholpady, Puttur, delivered a special talk on the theme "Corruption free India for a developed Nation". He narrated in detail how the corruption comes in between the development of a nation and indicated that the least corrupt nations are highly developed and highly corrupt nations are extremely under developed and poor. The programme was presided over by Dr. T.N. Raviprasad, Director (Acting) of the Directorate. The programme was organized jointly by DCR, Puttur, Legal Cell, Puttur and Bar Association, Puttur. The programme was attended by 126 members including the students from Sandeepani School.

Sl No.	Programme details	Date	Male	Female	Total
1	Valedictory function of Vigilance Awareness Week 2022	07-11-2022	80	46	126

Swachhta Pakhwada - 2022

The ICAR- Directorate of Cashew Research, Puttur, Karnataka has observed "*Swachhta Pakhwada*" from 16.12.2022 to 31.12.2022 by conducting various day-wise activities as per the guidelines received from the Government of India. The day-wise activities like, pledge taking, display of banners in prominent places of the institute, cleaning of residential premises, celebration of kisan diwas, debate related to Swachhta,

VIP address on Importance of Swachhta, visit to waste management unit of Puttur, webinar on demonstration of composting technologies, lectures on rainwater harvesting, waste water recycling and generation of wealth from cashew apple waste has been conducted. The programme has increased the awareness about the Swachhta among the participants.

DEMONSTRATIONS

Drone Demonstration

Conducted forty-four 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. Shamsudheen M., Senior Scientist (Soil Science); 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	Convenor
1.	22.09.2022	Kemminje Farm, Puttur, D.K., Karnataka	1	2.0	Cashew	57	Dr. Manjunatha K, Dr. J. D. Adiga	Dr. Siddanna Savadi, Dr. Shamsudheen M, Dr. Veena G L, Dr. Manjesh G N
2.	23.09.2022	Shantigodu Farm, D.K., Karnataka	1	2.5	Cashew	32	Dr. Manjunatha K, Dr. J. D. Adiga	Dr. Siddanna Savadi, Dr. Shamsudheen M, Dr. Veena G L, Dr. Manjesh G N
3.	24.09.2022	Kemminje Farm, Puttur, D.K., Karnataka	1	1.5	Cashew	23	Dr. Manjunatha K,	Dr. Siddanna Savadi,
4.	04.11.2022	Kemminje Farm, Puttur, D.K., Karnataka	1	4.0	Cashew	18	Dr. Manjunatha K,	Dr. Siddanna Savadi,
5.	18.11.2022	CPCRI Research Centre and International Coconut Gene Bank for South Asia, KIDU, D.K., Karnataka	1	1.5	Coconut	27	Dr. Manjunatha K,	Dr. Siddanna Savadi,

6.	19.11.2022	**Kisan Mela** of CPCRI Research Centre and International Coconut Gene Bank for South Asia, KIDU, D.K., Karnataka.	8	7.0	Coconut	500	Dr. Manjunatha K,	Dr. Siddanna Savadi,
7.	06.12.2022	Kaddirampura, Hosapete (T), Vijayanagara (D)	2	1.5	Sugarcane	88	Dr. Manjunatha K Dr. Eradasappa, E. Dr. Siddanna Savadi	Dr. Babli Mog
8.	06.12.2022	Anegundi, Gangavati (T), Koppal (D)	2	2.5	Banana	90	Dr. Manjunatha K Dr. Eradasappa, E. Dr. Siddanna Savadi	Dr. Babli Mog
9.	06.12.2022	Chikka Jantakal, Gangavati (T), Koppal (D)	2	5	Banana	136	Dr. Manjunatha K Dr. Eradasappa, E. Dr. Siddanna Savadi	Dr. Babli Mog
10.	07.12.2022	Chikka Chelluru, Challakere (T), Chitradurga (D)	5	4.5	Cashew, Maize, Custard apple	229	Dr. Manjunatha K Dr. Eradasappa, E. Dr. Siddanna Savadi	Dr. Babli Mog
	08.12.2022	Siddeshwaranadurga, Challakere (T), Chitradurga (D)	2	1.75	Cashew	46	Dr. Manjunatha K Dr. Eradasappa, E. Dr. Siddanna Savadi	Dr. Babli Mog
11.	08.12.2022	Hariyabbe, Hiriyuru (T), Chitradurga	2	2	Cashew & Drum stick	28	Dr. Manjunatha K Dr. Eradasappa, E. Dr. Siddanna Savadi	Dr. Babli Mog
12.	20.12.2022	Govanakoppa, Bailhonga	2	2	Bengal gram & Maize	135	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya
13.	20.12.2022	Chikkabellikatti, Bailhongal	2	2.5	Bengal gram	93	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya
14.	20.12.2022	Mallammana Belavadi, Bailhongal	2	2	Maize	119	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya
15.	21.12.2022	Dodwada, Bailhongal	2	2	Bengal gram	210	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya
16.	21.12.2022	Kittur, Belgaum	3	3	Mango	239	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya
17.	22.12.2022	Khanapura, Belgaum	2	2	Cashew	40	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya
18.	22.12.2022	Karaguppi, Hukkeri (T), Belgaum	3	2	Cotton & Sugarcane	155	Dr. Manjunatha K Dr. Siddanna Savadi, Dr. Rajashekara, H.	Dr. H.P Bhagya






Demonstration on soil sampling

Soil sampling is an important step towards better soil health management. Soil health is important for achieving Honourable PM's vision of *Swasth Dharaa*. *Khet Haraa* and for ensuring food security in the country. With an aim to sensitise the farmers on the importance of soil sampling in soil health management, ICAR-Directorate of Cashew Research, Puttur organized a demonstration in Bettampady under the Tribal sub plan programme of the Directorate on 10th November, 2022.

A team of scientists comprising of Dr. Shamsudheen M, Senior Scientist (Soil Science), Dr. Bhagya H, P. Scientist (SP&MAP) and Dr. Veena G L, Scientist (Fruit Science) visited the farm of Smt. Anitha, who is a progressive farmer practicing integrated farming system in

Bettampady. The programme commenced with the introductory remarks by Dr. Bhagya H. P. and dr. Veena, G.L. who spoke about the importance of soil health in ensuring productivity of crops. Dr. Shamsudheen M who is a scientist in soil science sensitized the farmers about the soil health card initiative of Govt. of India and explained in detail the procedure of collecting soil samples for soil testing. He also highlighted, how the soil needs to be collected from their field and how the method varies for different crops. This was followed by a method demonstration by the scientists for enhancing the knowledge of the participants in arecanut plantation. Around 22 farmers from nearby villages attended the demonstration and they found the session very useful as many were not aware of the technique.

Monitoring of Demonstration plots under Cashew area expansion programme

A team of scientists comprising of Dr. Mohana G S, Principal Scientist (Genetics and Cytogenetics), Dr. Eradasappa E, Senior Scientist, (Plant Breeding), Dr. Rajashekhara H, Scientist (Plant Pathology) and Dr. Aswathy Chandrakumar, Scientist (Agrl. Extension) visited the demonstration plots laid under Cashew area expansion programme in Sagar and Chitradurga districts from 2nd February, 2022-5th February, 2022. Around 15 plots were visited and advisories were given to the farmers regarding pruning, management of ultra high-density plantations, application of fertilizers and control for tea mosquito bugs and thrips.

Webinars organised as a part of *"Azadi ka Amrut Mahotsav"* campaign

Azadi ka Amrut Mahotsav a flagship scheme of Govt. of India was launched to commemorate 75 years of India's independence. As a part of this campaign, weekly webinars were organised on various topics for the benefit of researchers, students, farmers and other stakeholders involved in agriculture. A total of 21 webinars were organised during this period, the details of which have been tabulated below.

Sl. No.	Title of webinar/activity	Resource person with contact details	Date	No. Of participants
1.	Clean milk production	Dr. D N Hegde Former Director (AH) Karnataka Milk Federation	06.01.2022	28
2.	An overview of Protected cultivation of horticultural crops	Dr. M S Biradar, Associate Professor (Hort.) and Head, Hi-tech Horticulture Unit, UAS, Dharwad	14.01.2022	58
3.	Indian sandalwood: A productive and profitable parasite	Dr. Sangram Chavan Scientist (Agroforestry) ICAR-NIASM,	21.01.2022	81
4.	Pollinators of Cashew: Species Diversity and their Importance	Dr. K Vanitha, Senior Scientist (Agrl. Entomology), ICAR-DCR, Puttur	28.01.2022	43
5.	Appemidi: An endangered treasure of Western Ghats of Karnataka	Dr. Veena G L, Scientist (Fruit Science), ICAR-DCR, Puttur	04.02.2022	48

6.	Therapeutic potentials of terpenoids from medicinal and aromatic plants	Dr. Manjesh G N Scientist (SPM & AP), ICAR-DCR, Puttur	11.02.2022	39
7.	Is Cashew Farming Profitable now?	Dr. Eradasappa E, Senior Scientist, (ICAR-DCR, Puttur	25.02.2022	37
8.	Do plants have brains? An Insight into Plant Intelligence	Dr. B N Sathyanarayana, Emeritus Scientist and Formerly Dean-Post Graduate studies	28.02.2022	59
9.	Is there anything called Indian Science	Dr. MohanG S, Principal Scientist (Genetics and Cytogenetics), ICAR-Directorate of Cashew Research, Puttur	11.03.2022	37
10.	Recent Developments in Blast Disease of Cereal Crops	Dr. Rajashekhar H, Scientist (Plant Pathology), ICAR-DCR, Puttur	19.03.2022	39
11.	Plant Health Management in Arecanut for Better Productivity	Dr. Bhavishya, Scientist (Horticulture) ICAR-CPCRI Regional Station Vittal	25.03.2022	47
12.	Achieving self sufficiency in Indian Pulse production: the way forward	Dr. H C Lohithaswa, Professor and Scheme Head, AICRP on Pulses, UAS, GKVK, Bengaluru	11.04.2022	31
13.	Useful and Unique Agricultural Websites and Apps for Stakeholders	Dr. MohanG S, Principal Scientist (Genetics and Cytogenetics), ICAR-Directorate of Cashew Research, Puttur	23.04.2022	39
14.	Forage Entomology	Dr. Narendra Kulkarni, Principal Scientist (Agrl. Entomology), ICAR-IGFRI, Dharwad Regional Station	29.04.2022	31
15.	Participatory Ecosystem Management and Biodiversity Conservation	Dr. Anil Kumar N, Senior Director, MSSRF, Wayanad	07.05.2022	36
16.	Increasing the visibility and impact of research	Dr. Sridhar Gutam, Senior Scientist (Plant Physiology), ICAR-IIHR, Bengaluru	12.05.2022	32
17.	Breeding for Plant type and earlines in cotton	Dr. Rajesh S Patil, Principal Scientist (GPB), UAS, ARS farm, Dharwad	19.05.2022	22
18.	Climate Change and Indian Cashew	Dr. Babli Mog, Scientist (Plant Pathology), ICAR-DCR, Puttur	17.06.2022	36
19.	Role of genetic engineering in crop improvement in the era of climate change and diversified food habits	Dr. Siddanna Savedi, Scientist (Plant Biotechnology), ICAR-DCR, Puttur	24.06.2022	37

Training/ Workshop

Three days Online Training Programme on "Cashew Production and Post Harvest Technologies" in collaboration with MANAGE, Hyderabad

A virtual training programme on "Cashew Production and Post Harvest Technologies sponsored by MANAGE, Hyderabad was organised by ICAR-Directorate of Cashew Research, Puttur from 16th February to 18th February, 2022.

The training received a good response from the participants from different parts of the country. A total of 140 participants had attended this training programme of which nearly 70 were students and the rest were faculty from State Agriculture Universities, KVKs, SAMETI, ATMA, NGO and private organisations. Training was imparted on various aspects such as nursery management, cashew varieties, breeding in cashew, canopy management, soil and nutrient management, protection measures and processing of Cashew. The participants expressed that the training was very useful in increasing their awareness and knowledge.

Training on Cashew Production technology

Two trainings were organised in Sagar taluk of Shimoga district and Challakere taluk of Chitradurga district on 16th and 17th of March, 2022 which were sponsored by DCCD, Kochi. Considering the rapid expansion of cashew cultivation in non-traditional areas like Sagar, Soraba, Hosanagar, Thirthahalli and drier parts of the state such as Challakere, Chitraduga, Hiriyur etc. the trainings were organised to impart knowledge on scientific cashew cultivation for the benefit of the cashew growers. Keeping in view of the low adoption of scientific management practices due to low awareness and the prospects of increasing the area under cashew cultivation in these areas, the trainings were planned to cover all aspects of cashew cultivation.

Training at Sagar on 16.03.2022

The training programme at Sagar commenced at 11.00 am with a brief inaugural session which was presided by Dr. J Dinakara Adiga, Principal Scientist (Horticulture), ICAR-DCR, Puttur. Two progressive farmers Shri. Prakash Naik and Shri. Vinayaka Maneghatte were also invited to share their views on the prospects of cashew cultivation during the function. This was followed by a lecture by Dr. Mohana G S, Principal Scientist (Gen. and Cytogen.) and coordinator of this training programme, in which he gave an overview of the Cashew scenario in India. Following this session, Dr. Eradasappa E, Senior Scientist (Plant Breeding), gave a lecture on different varieties of Cashew which are available for cultivation with a prime focus on the varieties suitable to that area. Since the introduction of Cashew Area Expansion programme in Neechadi village and other adjoining villages in Sagar, many farmers were attracted to this crop. However, scientific cultivation of cashew was adopted by very few. Keeping this in view, Dr. J Dinakara Adiga, Principal Scientist (Horticulture), ICAR-DCR, Puttur sensitized the farmers on the need to adopt scientific cultivation practices.

Ultra high density cashew planting system was gaining popularity in this region. In this system of planting, cashew trees were planted at a spacing of 2.5m x 2.5m and VRI-3 variety which is responsive for pruning was adopted for this kind of planting. Dr. Mohana G S, Principal Scientist (Gen. and Cytogen.), ICAR-DCR, Puttur gave a detailed presentation on the scope of Ultra high density planting and the management practices that need to be adopted for realizing the potential yield from this system of planting. After lunch, there were two sessions on crop protection and one recorded session on processing of Cashew apple. Dr Vanitha K, Senior Scientist (Agrl. Entomology), ICAR-DCR, Puttur during the lecture emphasized on management of tea mosquito bug and cashew stem and root borer

in Cashew while Dr. Rajashekhara H, Scientist, (Plant Pathology) created awareness among the farmers on the precautions to be taken to avoid the spread of diseases in cashew. The technical sessions concluded with a recorded talk by Dr. Veena G L, Scientist (Fruit Science), ICAR-DCR, Puttur in which she emphasized on the scope of value addition by explaining about the various value added products from cashew apple which were commercialized from ICAR-DCR, Puttur. A total of 51 participants had attended the training programme.

Training at Challakere, Chitradurga on 17.03.2022

The training programme commenced with the inaugural function presided by Dr. J DinakaraAdiga, Principal Scientist (Hort.), ICAR-DCR, Puttur. During the function, Shri B S Ragunath a progressive farmer from Hariyabbe, Hiriyur taluk shared his views on the scope of promoting this crop in the region and also he shared his insights on the way forward for promoting this crop. Shri Ramkumar from Siddeshwaranadurga and Shri Rajashekharappa from Challakere Taluk also shared their experiences.

Dr. Mohana G S, Principal Scientist (Gen. and Cytogen.) gave a brief overview of the cashew scenario in the country and shared his insights on why we should promote this crop. A detailed talk on varieties available in cashew was given by Dr. Eradasappa E, Senior scientist (Plant Breeding), ICAR-DCR, Puttur with emphasis on varieties suitable to Chitradurga district. Following this introductory session, Dr. J Dinakara Adiga briefed the farmers on the important crop management measures that need to be taken up in cashew which includes planting, nutrient management, water management, canopy management and growing of intercrops in cashew. The session on management of tea mosquito bug and cashew stem and root borer was handled by Dr. K Vanitha, Senior Scientist (Agrl. Entomology), ICAR-DCR, Puttur and Dr. Rajashekhara H explained to the farmers on the precautionary measures to be taken to control diseases. A total of 75 participants attended the training programme.

One day training programme on Cashew Processing

Dr. D. Balasubramanian organized one day training program on 'Cashewnut processing' for 30 nos. of farmers group from Chikkamagalur district, Karnataka on 22 March, 2022.

One day training programme on Startup for cashewnut processing and value addition

Dr. D. Balasubramanian organized 1-day training program for 30 nos. of Agriculture technology Management agency (ATMA), Cannanore, Kerala on 'Startup for cashewnut processing and value addition' on 23 March, 2022.

Research-Extension-Farmers-interface meeting on 16th and 17th March 2022

Research-Extension-Farmers-interface meeting were organized with the participants of both the training programmes organized at Sagar and Challakere on 16th and 17th March, 2022. Dr. J Dinakara Adiga, Principal Scientist (Horticulture), Dr. Mohana G S, Principal Scientist, (Genetics and Cytogenetics), Dr. Eradasappa E, Senior Scientist (Plant Breeding), Dr. Vanitha K, Senior Scientist (Agrl. Entomology), Dr. Rajashekhara H, Scientist (Plant Pathology) and Dr. Aswathy Chandrakumar, Scientist (Agrl. Extension) interacted with the farmers for better understanding of field level problems and other issues which they face in cashew cultivation. Farmers raised a number of queries like possibility of applying water soluble fertilizers in Cashew, broadcasting of fertilizers for reducing cost of cultivation, ideal time for pruning, fruit set issues in VRI-3 and regarding pest management and bee keeping in cashew orchards.

Scientist-Extension-Farmer Interface meeting on Cashew Production Technologies on 16th August, 2022

ICAR-DCR Puttur has been organising several events for the farmers, students and scientific community as a part of the *"Azadi ka Amrut Mahotsav campaign".* Under this initiative, a Scientist-Extension-Farmer interface meeting on Cashew Production technologies was organised on 16th August, 2022. The interface meeting commenced with the introductory remarks by Dr. T N Raviprasad, Director (Acting) wherein he emphasized on the need for scientific cultivation of cashew for better yield.

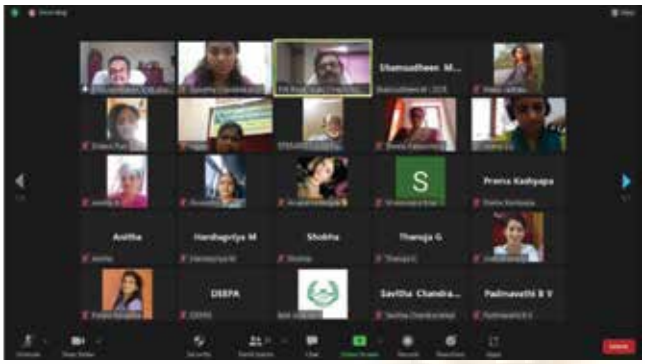
During the interface meeting farmers wanted information regarding the varieties suitable to this Karavali region, application of fertilisers as well as pest and disease management. Since few of the farmers were new to the crop, Dr. T N Raviprasad, Director (Acting) gave an overview of the scientific cultivation practices and about management of important pests in Cashew like Tea Mosquito Bug and Cashew Stem and Root Borer. Dr. J Dinakara Adiga, Principal Scientist (Horticulture) during his interaction with the farmers informed about the fertiliser recommendation for the crop while, Dr. Eradasappa E, Senior Scientist (Genetics and Plant breeding) explained about the varieties suitable to this region. Since farmers were not aware of the utilisation of cashew apple for value addition, Dr. Veena G L, Scientist (Fruit Science) briefly explained the scope of value addition of cashew apple. Dr. Rajashekara H, Scientist (Pathology) gave a brief orientation to the farmers on diseases like anthracnose in cashew and the application of Bordeaux paste as a control measure. An important concern raised by the farmers during the interface meeting was regarding the low price for raw cashewnuts which make cashew farming less profitable.

One day Training-cum-demonstration on cashew processing

A training cum demonstration programme on cashew processing was organised for 5 farmers from Badiadka panchayat of Kasaragod on 30th July 2022. The training programme was organised in collaboration with the Badiadka Krishi Bhavan, Kasaragod. The training session was handled by Dr. D Balasubramanian, Principal Scientist (AS & PE) and who is also heading the Agribusiness Incubation Centre of ICAR-DCR, Puttur. The training commenced with a theory class, in which the basic aspects of cashew processing and the steps involved was explained to the farmers. Following this, the participants were acquainted with machineries required for cashew processing. Shelling of raw cashew nuts with the hand-cum-pedal operated shelling machine and peeling were demonstrated to the participants, which were followed by hands on training session on shelling and peeling by them. The farmers opined that the training was very useful and the hands-on training session helped them to understand the process of shelling and peeling in a better way.

Entrepreneurship-cum-Skill Development Training Programme on "Value-added products from Fruits & Vegetables" *during 4 to 10 May 2022*

The ICAR-Directorate of Cashew Research, Puttur, Karnataka organized a five days virtual *Entrepreneurship-cum-Skill Development Training Programme on "Value-added*



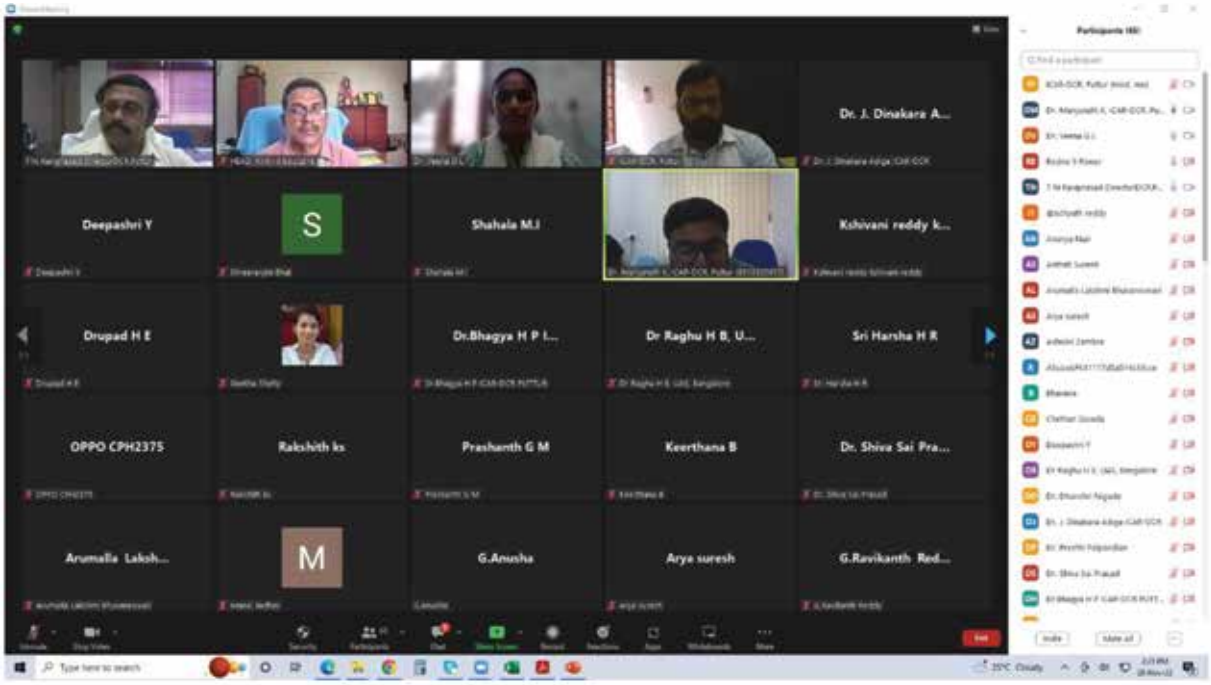
products from Fruits & Vegetables" during 4 to 10 May 2022.The virtual training programme commenced with the inaugural session. In his inaugural address, Dr. T.N. Raviprasad, Director (Acting), ICAR-DCR, Puttur highlighted the importance of value addition and the need for imparting the skills & knowledge and empowering the people for self-employment. Dr. P. Muralidharan, Head, ICAR-Krishi Vigyan Kendra, Alappuzha, Kerala briefed about the KVK's various activities and the impacts of the various training programmes. Around 30 participants attended the programme which covered various aspects such as value addition in vegetables and fruits like jackfruit, banana and cashew apple and coconut. Dr. Veena G.L and Dr. K. Manjunatha served as the convenor of this training.

Entrepreneurship-cum-Skill Development Training Programme on "Value-added products from Fruits & Vegetables" from 28 to 30 November 2022

The ICAR-Directorate of Cashew Research, Puttur, Karnataka organized three days virtual *Entrepreneurship-cum-Skill Development Training Programme on "Value-added products from Fruits & Vegetables"* from 28 to 30 November 2022. The training dealt with different aspects of processing covering the value addition of vegetables, fruits like banana, cashew apple, jackfruit and coconut.

In his inaugural address, Dr. T.N. Raviprasad, Director (Acting), ICAR-DCR, Puttur highlighted the importance of value addition, especially in the horticultural sector and the role of such training in generating employment opportunities.

Dr. P. Muralidharan, Head, ICAR-Krishi Vigyan Kendra, Alappuzha, Kerala briefed about the various activities of KVK and the impacts of their training programmes.



Around 100 participants attended the programme which included rural youth, entrepreneurs, students and farm women. Dr. Veena G.L served as the convenor of this training.

राजभाषा कार्यान्वयन समिति

1.	डा. टी.एन. रविप्रसाद (अगष्ट 2022 तक)	अध्यक्ष
2.	डा. जे. दिनांक अडिग (अगष्ट 2022 से)	अध्यक्ष
3.	डा. राजशेकर (प्र. अधिकारी प्रभार)	सदस्य
4.	डा. तोन्डाईमन	सदस्य
5.	डा. अश्वती चंद्रकुमार	सदस्य
6.	डा. रघुराम कुक्कडे	सदस्य
7.	श्रीमति रेष्मा के.	सदस्य
8.	श्रीमति लीला एम.	सदस्य
9.	श्री विजय आचारी	सदस्य
10.	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 राजभाषू कार्यान्वयन समिति की दो अर्ध वार्षिक बैठक और चार तिमाहि हैठकों 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 पखवाडा मनाया गया। पखावाडा के अवसर पर विध्यार्थियों और कर्मचारियों के लिए भाषण, निबंध लेखन और सामान्य ज्ञान प्रतियोगिता आदी आयोजन 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 जनेवरी 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 15 सदस्य कार्यालय सम्मिलित नगर राजभाषा कार्यान्वयन समिति (नराकास) का घटन किया गया है। पुत्तूर नराकास की 42वीं अर्धवार्षिक बैठक दिनांक 23.01.2022 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 2021) पूर्ण रूप से हिंदी में।
2. अखिल भारतीय समन्वित काजू अनुसंधान परियोजना की वार्षिक प्रतिवेदन सारांश (वर्ष 2021-22)।
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।

17. DISTINGUISHED VISITORS

Name	Address	Date of Visit
Mr. Sajeev, V.	Manager, Planataion Corporation of Kerala	29.01.2022
Dr. V Aravindan Nambi	Independent Expert On Biodiversity Chennai	19.02.2022
Mrs. Madhushree	Assistant Professor, Dept. of PG Studies, Ujire	26.03.2022
Dr. Anandprakash,	Member, RAC, ICAR-DCR, Puttur	08.06.2022
Dr. Geroge V. Thomas	Former Director, ICAR-CPCRI, Kasaragod	08.06.2022
Namitha N.V	BTM, ATMA, Kasaragod	10.06.2022
Anitha K	AGM, Karadka Block, Kasaragod	17.06.2022
Dr. Bhoomika H R	Assistant Professor, COH, Mudigere	18.06.2022
Dr. Narendra Kulkarni	Principal Scientist, IGFRI-Dharwad	19.06.2022
K. L. Raaghothama	Purdue University, USA	29.09.2022
P. Kumaresan	Horticulture Officer, TNHMI, Chennai	13.10.2022
Dr. S. Das	Best Innovative University	20.10.2022
Dr. Chinmaya	Best Innovative University	20.10.2022
Sr. Suresh Babu	Associate Dean, Best Innovative University	20.10.2022

18. 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. Shamsudheen Mangalassery	Senior Scientist (Soil Science)
5. Dr. Eradasappa, E.	Scientist (Plant Breeding)
6. Dr. K. Vanitha	Scientist (Agricultural Entomology)
7. Dr. Babli Mog	Scientist (Plant Physiology)
8. Dr. Siddanna Savadi	Scientist (Agricultural Biotechnology)
9. Dr. Thondaiman V	Scientist (Plantation medicinal spices and aromatic crops)
10. Dr. Rajashekara, H.	Scientist (Plant pathology)
11. Dr. Veena, G.L.	Scientist (Fruit Science)
12. Dr. Bhagya, H. P.	Scientist (Plantation medicinal spices and aromatic crops)
13. Dr. Manjesh G N	Scientist (Plantation medicinal spices and aromatic crops)
14. Dr. Manjunath, K	Scientist (Farm machinery and Agriculture Engineering)
15. Dr. Aswathy Chandrakumar	Scientist (Agriculture Extension)
Technical	
1. Shri. K. Muralikrishna	Chief Technical Officer
2. Shri. P. Abdulla	Chief Technical Officer
3. Shri. Prakash G. Bhat	Chief Technical Officer
4. Shri. N. Manikandan	Sr. Technical Officer
5. Shri. Raghurama Kukude	Sr. Technical Officer
6. Shri. M. Bhojappa Gowda	Technical Officer
7. Shri. Ravishankar Prasad	Sr. Technical Assistant
8. Shri. Honnappa Naik, P.	Sr. Technician

Administration		
1.	Smt. M. Leela	Upper Division Clerk
2.	Smt. Reshma, K	Assistant
3.	Ms. Winnie Lobo	Assistant
4.	Shri. Umashankar	Upper Division Clerk
5.	Smt. K. Padminikutty	Upper Division Clerk

Research Management Position

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 Sri Rajkumar Arjun Dagadkhair, Scientist (Food Technology) Transferred to Directorate of Onion & Garlic Research, Pune on 04.03.2022 (AN)

2 Sri R. Muthuraju, Asst Chief Technical Officer Transferred to ICAR- National Dairy Research Institute, Southern Regional Station, Adugodi, Bengaluru on 29.03.2022(AN)

3 Sri. K.V. Ramesh Babu, Asst Chief Technical Officer Transferred to ICAR-Indian Institute of Horticultural Research, Bangalore on 15.12.2022 (AN)

Inter- Institutional Transfers - Join

1. Dr. H.P. Bhagya., Scientist (Spices, Plantation, Medicinal and Aromatic Plants) from ICAR – Indian Institute of Oil Palm Research, Pedavegi, has reported for duty to this Directorate w.e.f 17.08.2022(FN).

Retirement

Sri. K. Umanath Shetty, (Messenger), Skilled Supporting Staff on superannuation w.e.f.31.03.2022(FN)

Smt. M. Rathna Ranjini, Administrative Officer retired on VRS w.e.f - 01.04.2022(FN).

Sri O.G. Varghese, PS retired on superannuation w.e.f.30.06.2022 (FN).

Appointment

1. Dr. J.Dinakara Adiga, Principal Scientist as appointed as Director w.e.f. 12.12.2022(FN).

Promotion

2. Dr. Shamsudheen. M, Senior Scientist (Soil Science), has been Promoted from the pay Matrix Level 12 to next higher grade pay Matrix Level – 13A w.e.f 08.01.2020.

3. Dr. Eradasappa.E, Senior Scientist (Plant Breeding), has been Promoted from the pay Matrix Level 12 to next higher grade pay Matrix Level – 13A w.e.f 26.02.2021.

4. Dr. Vanitha.K, Senior Scientist (Agriculture Entomology), has been Promoted from the pay Matrix Level 12 to next higher grade pay Matrix Level – 13A w.e.f 21.04.2021.

5. Dr. Manjesh. G. N., Scientist (Spices, Plantation, Medicinal and Aromatic Plants) has been Promoted from the pay Matrix 10 to next higher grade pay Matrix Level – 11 w.e.f 05.07.2021

6. Smt. M. Leela, Assistant has been promoted to AAO w.e.f -13.04.2022.

7. Smt. Reshma.K, Personal Assistant has been promoted to Private Secretary w.e.f 27.07.2022

19. WEATHER DATA (2022)

Month	Temperature		Humidity Pan (°C) velocity		Rainy (%) hours	Rainfall evaporation	Mean wind days	Sunshine (mm)	
	Max.	Min. (mm)	FN	AN			(km/h)	(h)	
January	33.55	19.80	71.06	35.09	0	0.00	2.34	256.30	5.82
February	34.20	20.96	64.31	38.57	0	0.00	2.28	244.60	3.91
March	35.58	21.46	70.60	43.14	0	0.00	2.80	221.50	4.44
April	34.90	23.91	83.20	50.14	5	43.70	2.48	227.90	4.37
May	33.55	24.13	85.21	64.80	15	493.10	2.56	122.50	4.84
June	27.46	21.57	88.75	86.14	30	1217.40	3.25	54.90	2.00
July	29.43	22.94	90.06	81.51	29	1239.30	3.22	56.90	1.90
August	28.38	22.36	88.75	80.61	29	842.90	3.48	56.10	2.50
September	30.34	22.18	86.82	57.93	7	161.90	2.91	135.10	2.80
October	31.43	21.36	85.60	56.60	11	187.20	2.4	245.00	2.60
November	31.73	20.15	77.04	51.86	3	57.10	1.70	212.80	3.20
December	33.17	21.18	76.97	48.66	1	3.30	1.77	188.30	3.50
Annual Average	**31.97**	**21.83**	**80.69**	**57.92**	**-**	**-**	**2.60**	**168.49**	**3.49**
Annual Total	**-**	**-**	**-**	**-**	**130**	**4246**	**-**	**-**	**-**

20. PUBLICATIONS FOR SALE

DETAILS OF SALE OF INSTITUTE PUBLICATIONS

Sl. No.	Name of the Publication sold	Qty.	Amount
1	Cashew production technology	4	240-00
2	Process catalogue on development of economically viable on -farm cashewnut processing	4	180-00
3	Pruning and canopy architecturing in cashew	3	120-00
4	Soil and water mgt. in cashew plantations	3	90-00
5	Softwood grafting and nursery mgt. in cashew	2	90-00
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
9	Biochemical characterization of released varieties of cashew	1	85-00
	Total	**22**	**1518-00**

FLD on Cashew: "Training and Pruning techniques" organized in collaboration with ICAR-CPCRI, KVK, Kasaragod, Kerala

Skill Development training programme on Nursery techniques in Cashew

Database on Beneficial Arthopods in Cashew Plantation

NRC-301

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