

वार्षिक प्रतिवेदन ANNUAL REPORT 2021



भा. कृ. अनु. प. काजू अनुसंधान निदेशालय
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ICAR- Directorate of Cashew Research
(ISO 9001:2008)
Puttur-574202, Karnataka, India





Distribution of planting material under Poshan Vatika Mahabhiyan



On-farm training programme on Canopy Management in Cashew

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Front cover

Front Cover: From Bottom to top: Cashew pest database, Distribution of planting material under Poshan Vatika Mahabhiyan, Cashew Leaf spot disease and Nethra Jumbo (Cashew apple and Nut) a jumbo nut variety

Back cover

Images: Mobile-Apps developed: Cashew pest management; Water management website and Cashew Drip and fertigation calculator; Cashew site suitability; Cashew nutrient deficiency; Cashew diseases app.



प्रस्तावना

मुझे भाकृअनुप-काजू अनुसंधान निदेशालय (आईसीएआर-डीसीआर), पुत्तूर की वार्षिक रिपोर्ट-2021 प्रस्तुत करते हुए प्रसन्नता हो रही है। रिपोर्ट में फसल सुधार, फसल प्रबंधन, फसल संरक्षण, फसल कटाई के बाद प्रौद्योगिकी और प्रौद्योगिकी के हस्तांतरण के साथ-साथ अन्य संस्थागत गतिविधियों के क्षेत्रों में वर्ष के दौरान की गई गतिविधियों और उपलब्धियों को शामिल किया गया है।

फसल सुधार के तहत, नेत्रा जंबो-1 - एक नया काजू संकर एक बड़े आकार के बीज की किस्म के रूप में विमोचन किया गया है। यह जंबो नट एक विशेष चरित्र, असामयिक असर, गुच्छा धारक गुण, उच्च उपज, अधिक शेलिंग प्रतिशत और 3.4 ग्राम के औसत का कर्नेल वजन के साथ आशाजनक पाया गया जो W130 के कर्नेल ग्रेड में फिट बैठता है। यह कटाई पर श्रम को भी बचाता है और बड़े बीज के आकार के कारण किसानों के लिए उच्च कीमत सुनिश्चित करता है। वर्ष के दौरान 77 किस्मों की सीएनएसएल का अनुमान लगाया गया। 125 F1 संतानों की टैनिन का अनुमान लगाया गया और कम टैनिन प्रकारों की पहचान की गई। काजू स्क्रीनिंग के लिए 57 नॉवेल पॉलीमॉर्फिक एसएसआर मार्कर विकसित किए गए। काजू जीनोम से डिजाइन किए गए 100 एसएसआर प्राइमर और इनमें से लगभग 91% एसएसआर काजू के दो संबंधी अनाकार्डियं माइक्रोकार्पम और अनाकार्डियं ओर्थोनियं में क्रॉस एम्प्लीफाइड हुए हैं। वर्ष के दौरान, विस्तारित बीबीसीएच पैमाने के अनुसार काजू में आठ प्रमुख विकास चरणों की पहचान की गई। काजू में इन विट्रो पराग अंकुरण पद्धति को मानकीकृत किया गया। प्रारंभिक परीक्षण में काजू परागकों का क्रायोप्रिजर्वेशन भी किया गया। काजू सेब और बीज के इंजीनियरिंग गुणों पर विचार करके काजू फल और बीज विभाजक का एक कंसेप्टुयल (कल्पना का) डिजाइन तैयार किया गया।

वर्ष के दौरान भाकृअनुप-डीसीआर के विभिन्न भूखंडों में कीटों का प्रकोप 8-12 प्रतिशत था। काजू के पुष्पक्रम (इन्फ्लोरसेन्स) कीटों के खिलाफ वानस्पतिक कीटनाशकों की जैव प्रभावकारिता, पत्ती के जलयुक्त अर्क से बनाया आठ वानस्पतिक तैयारी / फ़ार्मुलेशन का अध्ययन



किया गया काजू के पत्तों के झुलसा रोग (लीफ़ ब्लाइट) पर अध्ययन किया गया और पहली बार रिपोर्ट किया गया। कच्चे काजू की नमी का आकलन करने के लिए एक डबल कैविटी नमी मीटर विकसित किया गया ।

RKVY-RAFTAAR द्वारा वित्त पोषित परियोजना के तहत, कर्नाटक के तीन तटीय जिलों में किसानों के खेतों में उनतालीस फ्रंट लाइन प्रदर्शन (FLDs) आयोजित किए गए। कुल 7 मोबाइल ऐप विकसित किए गए।

निदेशालय ने काजू दिवस, पोषण वाटिका महाभियान, प्राकृतिक खेती, कृषि शिक्षा दिवस, अंतर्राष्ट्रीय महिला दिवस, स्थापना दिवस, हिंदी पखवाडा, सतर्कता जागरूकता सप्ताह, स्वच्छता पखवाड़ा, संविधान दिवस और एआईसीआरपी की वार्षिक समूह बैठक जैसे विभिन्न कार्यक्रमों का आयोजन किया। काजू प्रशिक्षण और छंटाई पर प्रशिक्षण कार्यक्रम आयोजन किया।

मैं डॉ. टी. महापात्रा, महानिदेशक, भाकृअनुप; डॉ. ए.के. सिंह, उप महानिदेशक (बागवानी); और डॉ. बी.के. पांडे, एडीजी (बागवानी) को उनके निरंतर प्रोत्साहन, मार्गदर्शन और समर्थन के लिए आभारी हूँ। मैं निदेशालय द्वारा की गई प्रगति में अपने बहुमूल्य योगदान के लिए सभी वैज्ञानिकों और स्टाफ सदस्यों का आभारी हूँ। मैं इस रिपोर्ट के प्रभावी संकलन और संपादन के लिए संपादकीय और प्रकाशन समिति के सदस्यों द्वारा किए गए प्रयासों के लिए उन्हें धन्यवाद करता हूँ।

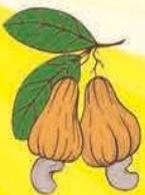


स्थान : आईसीएआर-डीसीआर पुत्तूर

दिनांक:30 एप्रिल, 2022

(टी एन रवीप्रसाद)

प्रभार निदेशक



PREFACE

I am happy to present the Annual Report-2021 of ICAR-Directorate of Cashew Research (ICAR-DCR), Puttur. The report covers the activities and achievements made during the year in the areas of crop improvement, crop management, crop protection, post-harvest technology and transfer of technology along with other institutional activities.

Under the crop improvement, the Nethra Jumbo-1 - a new cashew hybrid was released as a big size nut variety. It was found promising with a special character of jumbo nut, precocious bearing, cluster bearing habit, higher yield, with more of shelling per centage and the average kernel weight of 3.4 g which fits in to kernel grade of W130. It also saves the labor on harvesting and ensures higher price for the farmers due to bigger nut size. The CNSL content of 77 accessions was estimated during the year. The tannin content of 125F1 progenies was estimated and low tannin content types were identified. 57 novels polymorphic SSR markers were developed for cashew screening. 100 SSR primers designed from cashew genome and about 91% of these SSRs cross amplified in *A. microcarpum* and *A. othonianum*, two relatives of cashew. During the year eight principal growth stages were identified in cashew as per extended BBCH scale. *In vitro* pollen germination methodology in cashew was standardized. Cryopreservation of cashew pollen grains was also carried out on a preliminary trial. A conceptual design of a cashew fruit and nut separator was prepared by considering the engineering properties of cashew apple and nut.

The pest incidence was 8-12 % in different plots of ICAR-DCR during the year. The bio efficacy of botanical pesticides against inflorescence pests of cashew, eight botanical preparations /formulations comprising aqueous leaf extracts was studied. Study on cashew leaf blight disease was carried out and reported for the first time. A double cavity moisture meter was developed for assessing moisture content of raw cashewnuts.

Under the project funded by RKVY-RAFTAAR, fifty-nine front line demonstrations (FLDs) organized in farmers' fields in three coastal districts of Karnataka. A total of 7 mobile apps were developed.

The Directorate organized different programmes such as Annual Group Meeting of AICRP on Cashew, Cashew Day, Poshan Vatika Mahabhiyan, Natural Farming, Agricultural Education Day, International women's day, Foundation Day, Hindi week, Vigilance awareness week, Swacchata pakhwada, Constitution Day and a training programme on Cashew training and pruning.



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



Place : ICAR-DCR, Puttur
Date : 30th April, 2022

(T.N. Raviprasad)
Director (Acting)



CONTENTS

Preface		v viii
Contents		ix
1.	Executive Summary	1 6
2.	Introduction	11
3.	Research Achievements	16
3.1.	Crop Improvement	16
3.2.	Crop Management	38
3.3.	Crop Protection	48
3.4.	Post-Harvest Technology	59
3.5.	Concluded Projects	66
4.	Transfer of Technology and Education	76
5.	Implementation of STC/TSP and SCSP	84
6.	AICRP/ Co-ordination Unit	85
7.	Agri-Business Incubation Centre	88
8.	Awards / Recognitions	90
9.	Publications	95
10.	Linkages / Collaboration	102
11.	Human Resource Development / Training and Capacity Building	104
12.	Participation in Symposia / Conferences / Seminars / Meetings	106
13.	Ongoing and Concluded Research Projects	109
14.	Consultancy, Patents and Commercialization of Technology	117
15.	QRT/RAC/IRC/IMC/IJSC Meetings	118
16.	Workshops, Seminars, Training, Farmers Days and Other Events Organized	123
17.	Rajbhasha	134
18.	Distinguished Visitors	137
19.	Personnel	138
20.	Meteorological Data (2021)	141
21.	Publications for Sale	142



कार्यकारी सारांश

भाकृअनुप- काजू अनुसंधान निदेशालय, पुत्तूर काजू पर अनुसंधान और विस्तार गतिविधियों में शामिल है। वर्ष 2021 के दौरान फसल सुधार, फसल प्रबंधन, फसल सुरक्षा, कटाई उपरांत प्रौद्योगिकी और प्रौद्योगिकी हस्तांतरण और अन्य पहलुओं के तहत की गई अनुसंधान गतिविधियों का सारांश यहां दिया गया है। इस वर्ष, सात बाह्य वित्तपोषित परियोजनाओं सहित कुल 47 अनुसंधान परियोजनाएं प्रचालन में थीं।

फसल सुधार

एक नया काजू संकर नेत्रा जंबो-1 को इस वर्ष के दौरान एक बड़े आकार के बीज की किस्म के रूप में जारी किया गया है। जंबो बीज किस्मों को विकसित करने से प्रसंस्करणकर्ताओं से प्रीमियम मूल्य प्राप्त होगी क्योंकि इससे उच्च बाजार मूल्य के साथ प्रीमियम आकार के कर्नेल का उत्पादन होता है इस के अलावा नट्स की कटाई के लिए मानव शक्ति की आवश्यकता में काफी कमी आएगी। बड़े बीज कारखाने में प्रसंस्करण दक्षता में भी सुधार करते हैं क्योंकि यह उच्च उत्पादन प्राप्त करने के अलावा प्रसंस्करण में श्रम की बचत करता है। नेत्रा जंबो-1 को एनआरसीसी सेलक्षन-2 को स्त्री जनक के रूप में और भेड़ासी को पुरुष जनक के रूप में पार करके संकरण के माध्यम से विकसित किया गया है। यह जंबो बीज (12 ग्राम), असामयिक असर, क्लस्टर असर आदत, उच्च उपज, 29 प्रतिशत से अधिक शेल्लिंग पर्सेंट और 3.4 ग्राम के औसत का कर्नेल वजन के साथ आशाजनक पाया गया जो W130 के कर्नेल ग्रेड में फिट बैठता है। यह कटाई पर श्रम को भी बचाता है और बड़े बीज के आकार के कारण किसानों के लिए लगभग 10% अधिक कीमत सुनिश्चित करता है। इस संकर का अतिरिक्त लाभ बीज के आकार में एकरूपता है, जिस में 90% से अधिक बीज आकार में एक समान होते हैं।

टीएमबी सहिष्णु प्रजातियों का पता लगाने के लिए दक्षिण कन्नड़, उडुपी और उत्तर कन्नड़ जिलों के के.सी.डी.सी बागानों में जर्मप्लाज्म सर्वेक्षण और संग्रह किया गया। हालांकि, कोई सहिष्णु प्रकार नहीं मिला। कुंदापुर मंडल में डार्ले गुड्डा के पास केवल एक स्पष्ट रूप से बौना प्रकार देखा गया और यह पौधा निगरानी में है। काजू के जर्मप्लाज्म डेटाबेस (<https://cashew.icar.gov.in/dcr/>) को आज तक 4062 बार देखा गया है।

वर्ष के दौरान 77 काजू किस्मों की सीएनएसएल (Cashew Nut Shell Liquid) का अनुमान लगाया गया। अनाकर्डियम माइक्रोकार्पम और अनाकर्डियम अक्सिडन्टेल् के कल्चिवर जैसे उल्लाल -1,



उल्लाल -3, भास्कर, वेंगुर्ले -4 किस्मों के बीच के क्रॉस के 125 F1 पेड़ों से काजू फल में टैनिन का विश्लेषण किया गया, और कम टैनिनवाले प्रकारों की पहचान की गई। 36 इंटर स्पेसिफ़िक संततियों में (मुक्त चयन में 15, बिना किसी विकल्प में 21) परीक्षण की गई, इन में कोई भी टीएमबी(चाय मच्छर) के प्रति सहनशीलता नहीं पाया गया। चयनित किस्मों की टहनियों में पालिप्लाईडी उत्प्रेरण के लिए कोल्बेसिन ($C_{22}H_{25}NO_6$) से बीज, अंकुर और परिपक्व पेड़ों का उपचार किया गया है।

बौने और अर्ध बौने रोपण प्रणाली पर एक परीक्षण का गठन किया गया है। एच-126 और नेत्रा वामन किस्मों के पंजीकरण के लिए आवेदन पीपीवी-एफआरआई, नई दिल्ली को प्रस्तुत किए गए।

काजू स्क्रीनिंग के लिए 57 नोवेल पॉलीमॉर्फिक एसएसआर मार्कर विकसित किए गए। काजू जीनोम से डिजाइन किए गए 100 एसएसआर प्राइमर और इनमें से लगभग 91% एसएसआर काजू के दो रिश्तेदारों ए. माइक्रोकार्पम और ए। ओथोनियानम में क्रॉस एम्प्लीफाईड हैं। 20 सूचनात्मक एसएसआर मार्करों ने 96 काजू परिग्रहणों में आनुवंशिक विविधता और जनसंख्या संरचना विश्लेषण दिखाया, अर्थात्, तीन अलग आनुवंशिक समूह और मिश्रण। मॉलिक्यूलर वेरिएंस (AMOVA) के विश्लेषण से पता चला कि 12% आनुवंशिक विविधताएँ आबादी के बीच थीं जबकि 88%, आबादी के भीतर थीं। 71571 शूट ट्रांसक्रिप्ट में कुल 4271 एसएसआर की पहचान की गई थी। 414 शूट ट्रांसक्रिप्ट में, एक से अधिक एसएसआर पाए गए। डिनोवो असेंबल किए गए ट्रांसक्रिप्टोम में SSRs की आवृत्ति प्रति एक के लिए 12.2 Kb थी।

फसल प्रबंधन

वर्ष के दौरान विस्तारित बीबीसीएच पैमाने के अनुसार काजू में आठ प्रमुख विकास चरणों की पहचान की गई। कीटों के हमले की संवेदनशीलता के लिए महत्वपूर्ण चरणों की भी अध्ययन द्वारा पहचान की गयी जो काजू में बेहतर कीट प्रबंधन प्रथाओं में मदद करेंगे। प्रूनिंग के संबंध में, यह अनुशंसा की जाती है कि मध्य सितंबर के महीने में 25% पार्श्व प्ररोहों की छंटाई कर्नाटक के पश्चिमी तट की परिस्थितियों में काजू किस्म भास्कर में उच्च उपज प्राप्त करने के लिए आदर्श है।

काजू में इनविट्रो पराग अंकुरण पद्धति को मानकीकृत किया गया था। स्कैनिंग इलेक्ट्रॉन माइक्रोस्कोपी से पता चला कि भास्कर को छोड़कर जहां पराग का आकार विकृत था, अध्ययन किए गए काजू के पराग का आकार लम्बा था। प्रारंभिक परीक्षण में काजू परागकणों का क्रायोप्रिजर्वेशन भी किया गया।

काजू सेब और बीज के इंजीनियरिंग गुणों पर विचार करके काजू फल और बीज विभाजक (separator) का एक वैचारिक डिजाइन तैयार किया गया। प्रोटोटाइप काजू फल और बीज विभाजक में



एक मुख्य फ्रेम, इलेक्ट्रिक मोटर, चर आवृत्ति ड्राइव (वीएफडी), हॉपर, स्कू कन्वेयर, पहला रोटरी मॉड्यूल और माध्यमिक रोटरी मॉड्यूल शामिल था। काजू फल और पेड़ के छत्र के भौतिक और यांत्रिक गुणों के आधार पर एक प्रोटोटाइप हैंड-हेल्ड टेलीस्कोपिक काजू फ्रूट हार्वेस्टर विकसित किया गया था।

फसल सुरक्षा

वर्ष के दौरान भास्कर-अनुप-डीसीआर के विभिन्न भूखंडों में हाइपोसिड्रा एसपीपी, ओएनोस्पिला फ्लेविफुसाटा वॉकर, पेरिक्सेरा एसपी, बॉम्बोटेनिया जोकोसैट्रिक्स गुएन, अनार्सिया एसपी, एथोलिक्स फ्लेविबासालिस गुनी, नानागुना स्पी. के साथ, लैमिडा मोनकुसालिस वाकर, थायलोकोप्टिला पौरोसेमा एम, हाइपतिमा हलिग्रामा एम, हेलोपेल्टिस एसपीपी आदि की कीट घटनाएं 8-12% थीं। संक्रमित पुष्पक्रमों में विशेष रूप से (0-2 बीज/पुष्पक्रम) असंक्रमित (4-6/पुष्पक्रम) की तुलना में बहुत कम बीज थे। काजू के इन्फ्लोरेसेन्स कीटों के खिलाफ वानस्पतिक कीटनाशकों की जैव प्रभावकारिता को रिकॉर्ड करने के लिए, नीम के जलीय पत्तों के अर्क, विटेक्स नेगुंडो, अधातोदा वासिका (30 ग्राम/ली), नीम अजल 0.15% (5 मिली/ली), मल्टीनीम 0.03 % (3 मिली/लीटर), नीम का तेल (2 मिली/ली), नीम के बीज का अर्क (30 ग्राम/ली) और कैलोफिलम तेल (2 मिली/ली) को फरवरी 2021 के दौरान भास्कर किस्म पर इन्फ्लोरेसेन्स कैटरपिलर के खिलाफ परीक्षण किया गया। तीसरे स्प्रे के बाद सभी उपचारित इन्फ्लोरेसेन्स पीड़कों का संक्रमण स्तर (15 दिनों के अंतराल पर 3 छिड़काव के बाद) अनुपचारित के समान थे।

शांतिगोडु में भास्कर किस्म के काजू के बागानों में प्रति हेक्टेयर में चार की दर से रखी गई मधुमक्खी कॉलोनियों (ए. सेराना इंडिका) ने संकेत दिया कि इन मधुमक्खियों ने काजू के फूलों के परागण में सहायता की; लेकिन मधुमक्खी के दौरे और परिणामी बीज सेट की दर अन्य भूखंडों की तुलना में जहां मधुमक्खी कॉलोनियों को नहीं रखा गया था, महत्वपूर्ण रूप से भिन्न नहीं थी। यह, अन्य भूखंडों में जंगली कॉलोनियों की उपस्थिति के कारण हो सकता है। जंगली मधुमक्खियां पूरे चार महीनों के फूलों की अवधि के दौरान शुद्ध कारावास के तहत भी जीवित रह सकती हैं और काजू के फूलों को सफलतापूर्वक परागित कर सकती हैं। मधुमक्खियों से प्रभावित पेड़ में आस-पास के अन्य खुले परागण वाले पेड़ों की तुलना में तुलनात्मक रूप से अधिक बीज सेट दर्ज किए गए थे।

विभिन्न मधुमक्खी प्रजातियों द्वारा मधुमक्खी वनस्पतियों की वरीयता को समझने के लिए, काजू के फूलों के मौसम के दौरान मधुमक्खियों द्वारा एकत्र किए गए परागकणों को एस ई एम इमेजिंग का उपयोग करके सामान्य वनस्पतियों के परागकणों के साथ दर्ज किया गया था। सेराटीना हाइरोग्लिफिका और ब्राउनसेपिस मिक्स्टा की 'बी ब्रेड' ने मिमोसा पुडिका, अल्टरनेथेरा एसपी सहित पौधों की प्रजातियों के मिश्रण के पराग कणों की उपस्थिति का संकेत दिया। जबकि एक अन्य सेरेटिना स्पी. की 'बी ब्रेड' में



ज्यादातर अल्टरनेथेरा स्पी. शामिल हैं। एपिस सेराना पर परागकण इंडिका मधुमक्खियाँ काजू के भूखंडों में रखे अपने छत्ते में लौट रही थीं, मुख्य रूप से काजू के नहीं थे।

अप्रैल 2021 के दौरान भाकृअनुप-काजू अनुसंधान निदेशालय, पुत्तूर, कर्नाटक की दोनों नर्सरी से काजू की पत्ती झुलसा रोग के नमूने एकत्र किए गए थे। विशिष्ट लक्षण पत्ती, पत्ती मध्यशिरा और पत्ती के किनारों पर अनियमित परिगलित धब्बों के रूप में देखे गए थे। पत्ती का डंठल ये धब्बे बड़े हो जाते हैं, पत्ती के पटल के मुख्य भाग को ढककर भूरे-चांदी के रंग में बदल जाते हैं। गंभीर रूप से प्रभावित पत्तियों में झुलसा हुआ दिखाई दिया और समय से पहले पतझड़ हो गया। सांस्कृतिक, सूक्ष्म और आणविक लक्षण वर्णन के आधार पर रोगजनक की पुष्टि *Neopestalotiopsis clavispora* के रूप में की गई। जाहिर है, यह भारत से नियोपेस्टालोटिप्सिस क्लैविसपोरा के कारण होने वाले काजू के पत्ते के झुलसा रोग (सीएलबी) की पहली पुष्टि की गई रिपोर्ट है।

कटाई के बाद की तकनीक

एक ही इकाई में आरसीएन, यूपीके और सीके की नमी का आकलन करने के लिए एक डबल कैविटी नमी मीटर विकसित किया गया और बेहतर सटीकता की दिशा में अलग-अलग प्रभावित मापदंडों द्वारा परीक्षण किया गया। काजू सेब का सिंगुलेशन वाइब्रेटरी ट्रे और फ्लूटेड रोलर्स के माध्यम से हासिल किया गया और बेहतर प्रदर्शन के लिए काजू सेब के लिए मैकेनिकल स्लाइसर के साथ ब्रिज किया गया। उड़ीसा में स्थित काजू प्रसंस्करण इकाई के साथ नैदानिक जांच से संकेत मिलता है कि कच्चे काजू के 10/- रुपये प्रति किलोग्राम खर्च करके कर्नेल निष्कर्षण प्रक्रिया प्राप्त की जा सकते हैं।

प्रौद्योगिकी का हस्तांतरण

RKVY-RAFTAAR द्वारा वित्त पोषित परियोजना के तहत, कर्नाटक के तीन तटीय जिलों में किसानों के खेतों में उनतालीस फ्रंट लाइन प्रदर्शन (FLDs) आयोजित किए गए। तीन वर्मीकम्पोस्ट इकाइयों का निर्माण किया गया और चार ऑफलाइन और दो ऑनलाइन सॉफ्टवेयर विकसित किए गए। प्रौद्योगिकी के विस्तार और हस्तांतरण के लिए 8 वीडियो के अलावा वर्ष 2021 के दौरान कुल 7 मोबाइल ऐप विकसित किए गए। फलों और सब्जियों के मूल्यवर्धन में लोगों को सशक्त बनाने के लिए दो उद्यमिता प्रशिक्षण आयोजित किए गए। आरकेवीवाई-रफ़्तार, सरकार परियोजना के तहत ऑन-फार्म और ऑफ फार्म प्रदर्शन (59 सं.) कर्नाटक के काजू उत्पादकों को विशेष रूप से उच्च उपज और आय प्राप्त करने के लिए बेहतर प्रौद्योगिकियों की उपयोगिता दिखाने के लिए एक अत्याधुनिक प्रयोगशाला सुविधाओं और प्रदर्शन भूखंडों को बनाने की पहल करने के लिए किए गए। केंचुआ यूट्रिलस एसपी का उपयोग कर



काजू बायोमास से वर्मीकम्पोस्ट तैयार करना, डीसीआर, पुत्तूर द्वारा मानकीकृत किया गया है। 5.5 टन काजू बायोमास से वसूली की सूचना 3.5 टन खाद या वर्मीकम्पोस्ट है। शिवमोग्गा और चित्रदुर्ग जिलों में कुल 36 किसानों को वित्तीय सहायता और 117.65 एकड़ के लिए आरकेवीवाई क्षेत्र विस्तार कार्यक्रम दिया गया है। वर्ष के दौरान AI आधारित ऐप काजू प्रोटेक्टेड का एक विस्तृत स्टोरी बोर्ड लिखा गया है।

आईसीएआर-काजू अनुसंधान निदेशालय, पुत्तूर में काजू के लिए इंटरैक्टिव आईसीटी के साथ एक आधुनिक पादप स्वास्थ्य क्लिनिक संग्रहालय स्थापित किया गया है। संग्रहालय में उपलब्ध कराए गए कस्टम मेड सॉफ्टवेयर के साथ कियोस्क और टच स्क्रीन किसानों, छात्रों, शोधकर्ताओं और अन्य आगंतुकों को उनकी रुचि के क्षेत्रों का पता लगाने में मदद करते हैं। विभिन्न काजू उत्पादन पहलुओं पर कई मोबाइल एप और सॉफ्टवेयर विकसित किए गए। किसानों और अन्य हितधारकों के लिए प्रौद्योगिकियों के प्रसार के लिए खेती और पौधों की सुरक्षा का विवरण देने वाले वीडियो अंग्रेजी और कन्नड़ में विकसित किए गए।

सुविधा का उपयोग करने के लिए एग्री बिजनेस इनक्यूबेशन (एबीआई) के साथ पंजीकृत कुल 15 इनक्यूबेटियों और प्रत्येक इनक्यूबेटियों को तकनीकी प्रशिक्षण प्रदान किया गया और काजू प्रसंस्करण से संबंधित बाजार परिदृश्य और प्रबंधन पहलुओं पर सलाह दी गई। नेत्रा वामन और नेत्रा जंबो के व्यावसायीकरण के लिए टेक्नोलॉजी मीट का आयोजन किया गया।

एआईसीआरपी के वैज्ञानिकों की वार्षिक समूह बैठक, अनुसंधान सलाहकार समिति (आरएसी), और संस्थान अनुसंधान परिषद की बैठकें (आईआरसी) हाइब्रिड मोड में आयोजित की गईं। विभिन्न कार्यक्रम जैसे संविधान दिवस, काजू दिवस, आईसीएआर-डीसीआर स्थापना दिवस, एससीएसपी किसान सम्मेलन, हिंदी पखवाडा, सतर्कता जागरूकता सप्ताह, स्वच्छता पखवाड़ा, किसान दिवस और अन्य कार्यक्रम मनाए गए।



1. EXECUTIVE SUMMARY

ICAR- Directorate of Cashew Research, Puttur is involved in research and extension activities on cashew. The research activities carried out during the year 2021 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 47 research projects including seven externally funded projects were in operation.

CROP IMPROVEMENT

Nethra Jumbo-1 - a new cashew hybrid was released as a big size nut variety during the year. Developing jumbo nut varieties would significantly reduce the man power requirement for harvesting of nuts apart from fetching premium price from processors as it leads to production of premium sized kernels with higher market price. The bigger nuts also improve processing efficiency in the factory as it saves labor in processing apart from getting higher outturn. Nethra Jumbo-1 was developed through hybridization by crossing NRCC Sel-2 as a female parent and Bhedasi as male parent. It was found promising with a special character of jumbo nut (12 g), precocious bearing, cluster bearing habit, higher yield, with more than 29 per centage of shelling and the average kernel weight of 3.4 g which fits in to kernel grade of W130. It also saves the labor on harvesting and ensures about 10% higher price for the farmers due to

bigger nut size. The added advantage of this hybrid is uniformity in nut size, wherein, more than 90 % of nuts are uniform in size.

Germplasm survey and collection was undertaken in KCDC plantations of Dakshina Kannada, Udupi and Uttara Kannada districts to locate TMB tolerant types. However, no tolerant types were found. Only one apparently dwarf type was sighted near Darle Gudda in Kundapur division and it is under observation. The germplasm database of cashew (<https://cashew.icar.gov.in/dcr/>) was visited 4062 times, as on date.

The CNSL content of 77 accessions was estimated during the year. Tannin content in cashew apples from 125 F₁ trees of crosses between *A. microcarpum* and cultivars of *A. occidentale* varieties viz., Ullal-1, Ullal-3, Bhaskara, Vengurle-4 was analyzed and low tannin content types were identified. Out of 36 interspecific progenies (15 in free choice, 21 in no choice) tested, none was found tolerant against TMB. Treatment of seeds, seedlings and mature trees with colchicine (C₂₂H₂₅NO₆) for inducing ploidy in shoot tips of selected varieties was accomplished.

A trial on dwarf and semidwarf planting system has been constituted. The application for registration of Nethra Jumbo-1 and Nethra Vaaman



varieties were submitted to PPV-FRA, New-Delhi.

57 novels polymorphic SSR markers were developed for cashew screening. 100 SSR primers designed from cashew genome and about 91% of these SSRs cross amplified in *A. microcarpum* and *A. othonianum*, two relatives of cashew. Twenty informative SSR markers showed the genetic diversity and population structure analysis in 96 cashew accessions, i.e., three distinct genetic groups and admixtures. Analysis of Molecular Variance (AMOVA) showed that 12% of genetic variations were attributable to among populations whereas 88% were within populations. A total of 4271 SSRs were identified in 71571 shoot transcripts. In 414 shoot transcripts, more than one SSR was found. The frequency of SSRs was 1 per 12.2 Kb in the de novo assembled transcriptome.

CROP MANAGEMENT

During the year eight principal growth stages were identified in cashew as per extended BBCH scale. The study also identified the critical stages for vulnerability to pest attack which will help in better pest management practices in cashew. With regard to pruning, it is recommended that the pruning of 25 % lateral shoots during in the month of mid-September is ideal for obtaining high yield in cashew variety Bhaskara under west coast conditions of Karnataka.

In vitro pollen germination methodology in cashew was standardized. The scanning electron microscopy showed that the shape of pollen of studied cashew accessions was prolate except Bhaskara where the pollen shape was perprolate. Cryopreservation of cashew pollen grains was also carried out on a preliminary trial.

A conceptual design of a cashew fruit and nut separator is prepared by considering the engineering properties of cashew apple and nut. The prototype cashew fruit and nut separator consisted of a main frame, electric motor, variable frequency drive (VFD), hopper, screw conveyor, first rotary module and secondary rotary module. A prototype hand-held telescopic cashew fruit harvester was developed based on the physical and mechanical properties of the cashew fruit and tree canopy.

CROP PROTECTION

During the year pest incidence was 8-12 % in different plots of ICAR-DCR with the insect species like *Hyposidra* spp., *Oenospila flavifusata* Walker, *Perixera* sp., *Bombotelia jocosatrix* Guen., *Anarsia* sp., *Aetholix flavibasalis* Guenee, *Nanaguna* sp., *Lamida moncusalis* Walker, *Thylocoptila paurosema* M., *Hypatima haligramma* M., *Helopeltis* spp. etc. Nut set was very less in the infested inflorescences especially (0-2 nuts/inflorescence) compared to the uninfected ones (4-6/inflorescence). To record the bio efficacy of botanical pesticides against



inflorescence pests of cashew, eight botanical preparations /formulations comprising aqueous leaf extracts of neem, *Vitex negundo*, *Adhatoda vasica* (30g/L), neem azal 0.15 % (5 ml/L), multineem 0.03 % (3 ml/L), neem oil (2 ml/L), neem seed extract (30 g/L) and Callophyllum oil (2 ml/L) were tested against inflorescence caterpillars during February 2021 on cv. Bhaskara. The infestation levels of inflorescence pests in all the treated inflorescences (3 sprays at 15 days intervals) after third spray were on par with the untreated ones. The maximum responses were observed in E-3 Hexenol followed by Z-3Nonanol and Z-3 Hexyl acetate. It was observed that the antennae of both sexes could respond to stimuli for a period of up to 20 minutes after excision.

The bee colonies (*A. cerana indica*) kept in the cashew plantations of Bhaskara variety at the rate of 4/ha at Shantigodu indicated that these bees aided in pollination of cashew flowers; but the rate of bee visits and resultant nut set were not significantly different compared to the other plots where no bee colonies were kept. This could be due to the presence of feral colonies in other plots. Wild bees could survive even under net confinement for the whole four months of flowering period observed and successfully pollinated the cashew flowers. Comparatively more nut set was recorded in the bees confined tree than the nearby open pollinated trees.

To understand the preference of bee flora by different bee species, the pollen grains collected by the bees during cashew flowering season were recorded along with pollen grains of common flora using SEM imaging. The bee bread of *Ceratina hieroglyphica* and *Braunsapis mixta* indicated presence of pollen grains of a mixture of plant species comprising *Mimosa pudica*, *Alternanthera sp.* etc, while the bee bread of another *Ceratina sp.* comprised mostly of *Alternanthera sp.* Pollen grains on *Apis cerana indica* bees returning to its hive kept in cashew plots were not primarily of cashew.

The cashew leaf blight disease samples were collected from both the nurseries of ICAR-Directorate of Cashew Research, Puttur, Karnataka during April 2021. The typical symptoms were observed in the form of minute to irregular necrotic spots at the margins of leaf, leaf midrib and leaf petiole. These spots enlarged, turn grey-silvery in colour by covering the major portion of the leaf lamina. Severely affected leaves showed blight appearance and premature defoliation. Based on cultural, microscopic and molecular characterization the pathogen was confirmed as *Neopestalotiopsis clavispora*. Apparently, this is first confirmed report of cashew leaf blight disease (CLB) caused by *Neopestalotiopsis clavispora* from India.



POST-HARVEST TECHNOLOGY

A double cavity moisture meter was developed for assessing moisture content of RCN, UPK and CK in the same unit and tested by varying influencing parameters towards better accuracy. Singulation of cashew apple achieved through vibratory tray and fluted rollers and bridged with mechanical slicer for cashew apple for better performance. Diagnostic investigation with cashew processing unit located in Orissa indicated that kernel extraction process could be achieved by incurring Rs 10/- per kg of raw cashew nuts. The bioavailability of minerals in cashew sprout and kernel was increased from 0 to 209 folds during germination.

TRANSFER OF TECHNOLOGY

Under the project funded by RKVY-RAFTAAR, fifty-nine front line demonstrations (FLDs) organized in farmers' fields in three coastal districts of Karnataka. Three vermicompost units were constructed and four offline and two online software were developed. A total of 7 mobile apps were developed during the year 2021 apart from 8 videos for extension and transfer of technologies. Two entrepreneurship training were organized for empowering people in value addition of fruits and vegetables. On-farm and off farm demonstrations (59 Nos) were carried out under the project RKVY-RAFTAAR, Govt. of Karnataka to initiate to create a state-of-the-art laboratory facilities and

demonstration plots to showcase the usefulness of improved technologies to realize higher yield and income to the cashew growers of Karnataka in particular. 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. A total of 36 farmers have been given financial assistance and RKVY Area expansion program for 117.65 acres in Shivamogga and Chitradurga districts. A detailed story board of the AI based app Cashew Protected was written during the year.

A modern plant health clinic museum with interactive ICTs have been set up for cashew at the ICAR-Directorate of Cashew Research, Puttur. Kiosks and touch screen with custom made software made available in the museum let the farmers, students, researchers and other visitors to explore areas of their interest. Number of mobile apps and software were developed on different cashew production aspects. Videos detailing the cultivation and plant protection was developed in English and Kannada for dissemination of technologies to the farmers and other stakeholders.

A total of 15 incubatees registered with Agri Business Incubation (ABI) to utilize the facility and each incubatees were provided hands on technical training and mentored on market scenario and management aspects pertinent to



cashewnut processing. Technology meet was organized to commercialize Nethra Vaaman and Nethra Jumbo.

The annual group meeting of scientists of AICRP, Research advisory Committee (RAC), and IRC Institute Research Council meetings were held in

hybrid mode. Different programmes like celebration of Constitution Day, Cashew Day, ICAR-DCR Foundation Day, SCSP farmers meet, Hindi week, Vigilance awareness week, Swachta Pakhwada, Kisan diwas and other programmes were celebrated.



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.

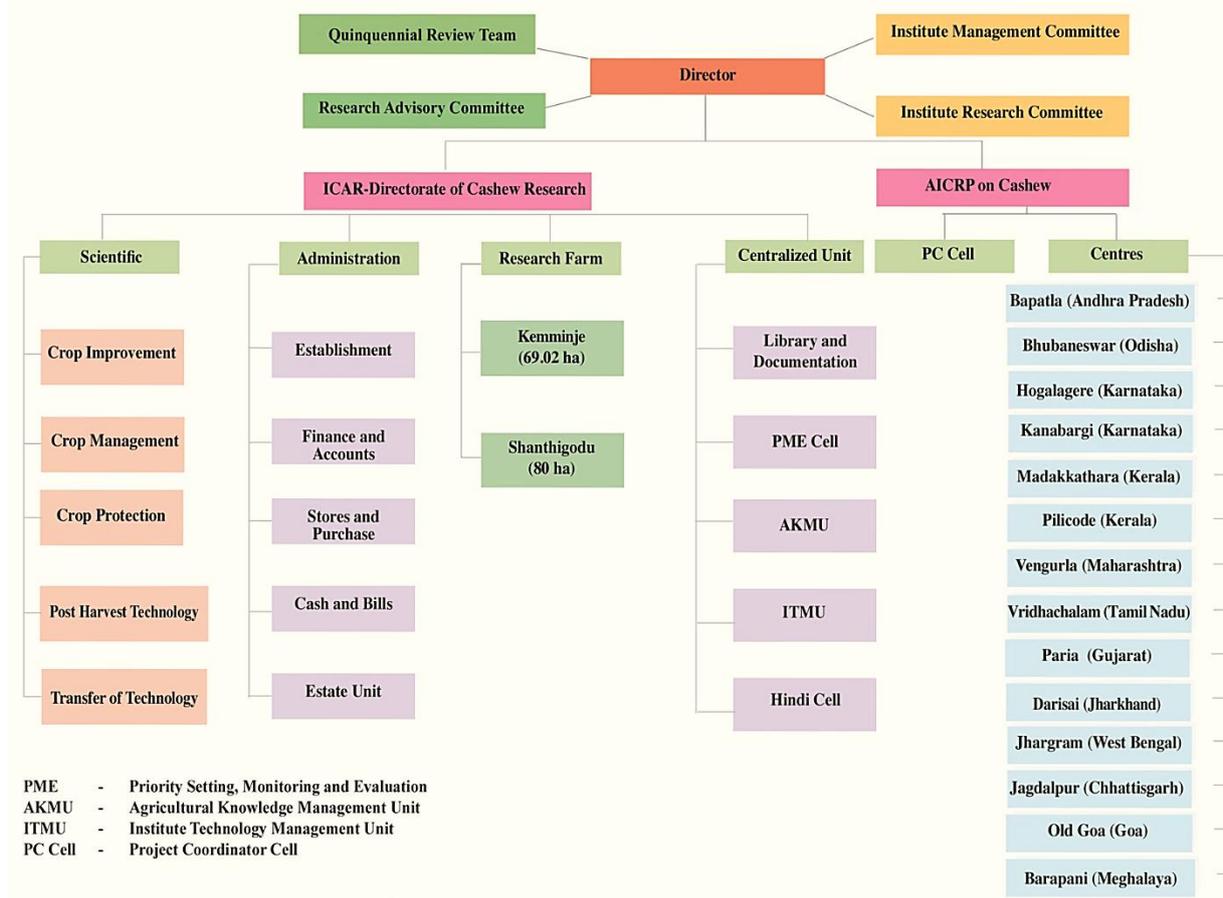
- To promote capacity building through the transfer of technology and consultancy services to stakeholders.

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.



ICAR-Directorate of Cashew Research



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	19	10	9
Administrative	16	7	9
Canteen staff	1	-	1
Skilled support staff	19	17	2
Total	78	49	29

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).

Table 2.2. Budget and expenditure details of DCR for FY 2020-21 (Rs. in Lakhs)

Particulars	Allocation	Utilization
GIA capital	10.00	10.00
GIA salary	649.45	649.40
Pension	143.25	110.77
GIA general	180.00	180.00
TSP	10.00	10.00
SCSP	25.00	25.00
NEH	14.00	13.96
Total	1031.70	999.13



Table 2.3. Receipts and expenditure under externally funded schemes at DCR for FY 2020-2021 (Rs. in Lakhs)

Particulars	Allocation	Utilization
RKVY-RAFTAAR, Govt. of Karnataka	236	34.49
PPV&FRA, New Delhi	5.950	5.800
DCCD, Cochin	0.993	0.889
DCCD (Training)	1.300	1.300
ABI	6.750	6.736
ITMU	7.590	7.389
Total	258.58	56.694

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-DCR during FY 2020-21 (Rs in Lakhs)

Revenue target (2020-21)	Revenue Generated (2020-21)
131.00	121.50

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 2020-21, a total of 1,08,455 cashew grafts (75000 from Kemminje campus and 33455 from Shantigodu campus) were supplied to farmers.



3. RESEARCH ACHIEVEMENTS

3.1 CROP IMPROVEMENT

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

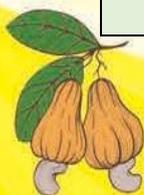
3.1.1 Nethra Jumbo-1 - A new cashew hybrid for higher income

Among the released varieties, more than 80 % are of medium (7g) to small nut (around 5 to 6g) type with a few exceptions of bold nut types weighing around 8 to 9g. The process of harvesting through picking of fallen nuts accounts to major share of expenditure to the tune of nearly 40 per cent in cashew cultivation. Developing jumbo nut varieties would significantly reduce the man power requirement for harvesting of nuts apart from fetching premium price from processors as it would lead to production of premium sized kernels with higher market price. The bigger nuts also improve processing efficiency in the factory as it would also save labor in processing apart from getting higher outturn. Hence, the research on this line was initiated at ICAR-Directorate of Cashew Research, Puttur during 1999-2000 as a result of which a new jumbo nut cashew hybrid Nethra jumbo-1 (H-126) was identified for release in 2021.

Nethra Jumbo-1 was developed through hybridization by crossing NRCC Sel-2 as a female parent and Bhedasi as male parent. It was found promising with a special character of Jumbo nut (12 g), precocious bearing, cluster bearing habit, higher yield, with more than 29 per centage of shelling and the average kernel weight of 3.4 g which fits in to kernel grade of W130. It also saves the labor on harvesting, ensures about 10% higher price for the farmers due to bigger nut size. The added advantage of this hybrid is uniformity in nut size, wherein, more than 90 % of nuts are uniform in size. As this hybrid is an early flowering type, the advantage of higher market price in the beginning of cashew season can be exploited. This hybrid can also escape severe pre monsoon moisture stress as compared to late varieties.

Table 3.1.1 Distinguish morphological characteristics of Nethra Jumbo-1

1.	Plant and leaf characters	
	Plant height (at the age of 9 years)	5.30 m
	Branching pattern	Extensive
	Canopy	Open, 5.40 m spread
	Leaf size and shape	Large, Obovate
	Young leaf color	Yellow red
2.	Flowering and fruiting characters	
	Number of flowering laterals/m ² canopy	14
	Panicle shape	Broadly Pyramidal



	Sex ratio (hermaphrodite to male)	High (0.21)
	Season of flowering	December-March
	Duration of peak flowering	64 days
	Season of harvest	January-April
3.	Nut characters	
	Nut weight (g)	12.0 g
	Number of nuts Kg ⁻¹	80-83 nuts /kg
	CNSL content	18.50%
4.	Kernel characters	
	Shelling percentage	29.10
	Whole kernel count lb ⁻¹	130 Whole kernels l ⁻¹
	Kernel sugars (%)	15.6
	Kernel protein (%)	21
	Total fat (%)	47
5.	Cashew apple characters	
	Apple color	Yellow red
	Apple shape	Conical to Obovate
	Apple weight (g)	104 grams
	Juice content (%)	72
	TSS of juice (°Brix)	13.0

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 large and dark green with obovate shape.



Flowering and fruit set: Flowers are produced from second year after planting. Nethra Jumbo is an early season bearer with short flowering duration. The flowering starts from December and continues up to March and the peak flowering will be in January and February. The panicles are broadly pyramidal in shape with large size. The hermaphrodite to male ratio is high (0.21) which helps to increase to fruit set and responsible for cluster bearing. The color of peduncle of tender nuts is purple and tender nuts are slightly purple.

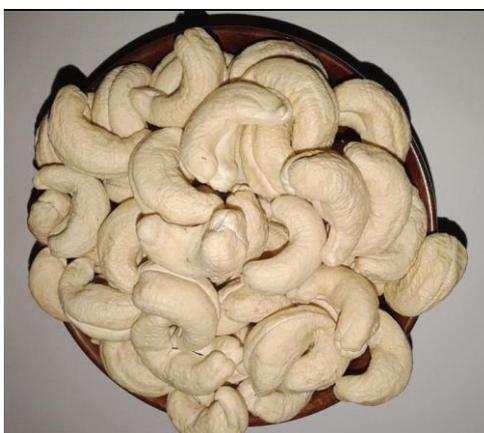
Nut and Kernels: The nut weight ranges from 11 to 13 g with an average nut weight of 12 g per nut. The nuts have high shelling percentage (29.1) with 3.66 cm nut length, 2.73 cm nut width and 2.41 cm nut thickness with 18.5 % of CNSL content in the shell. The kernels are bold with 3.4 g average weight and fits in to kernel grade W130. The



kernels contain good amount of proteins (21 %), sugars (15.6 %) and total fat content (47 %). The kernels are sweet in taste and uniform in size. The outturn of stored nuts is around 55 with a moisture content of 5.75%. The nut count of fresh nuts is 70 and the stored nuts are around 80-83.

Table 3.1.2: Improvement in nut weight and kernel weight (%) over check varieties (Bhaskara and NRCC Selection-2)

Hybrid/ variety	Cross combination	Nut weight (g) over Bhaskara	Nut weight (g) over NRCC Sel-2	Kernel weight (g) over Bhaskara	Kernel weight (g) over NRCC Sel-2
Nethra Jumbo-1	NRCC Sel-2 x Bhedasi	91.53	45.87	79.52	35.61
NRCC Sel-2 (check)	Check	31.30	-	32.38	-
Bhaskara (check)	Check	-	-23.84	-	-24.46



Cashew apple: It bears attractive red colored apples which weigh around 100g per apple with conical to obovate shape. The apples have TSS of 13° B with 72 per cent of juice content.



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. The early availability of raw nuts will help to catch higher market price prevailing during early part of cashew season. The cumulative nut yield of eight harvests under un-replicated trails were 42.44 kg/plant with average yield of 5.31kg per plant per year. A ten-year-old tree has a potential to yield around 10 kg per tree.

Table 3.1.3: Performance of H- 126 (Nethra Jumbo-1) under un-replicated trial

Hybrid	Cross combination	Annual Yield in 8 th Harvest (kg/tree)	Cumulative Yield for 8 Harvest (kg/tree)	Average Yield of eight harvest (kg/tree)	Mean nut weight (g)	Mean kernel weight (g)	Shelling (%)
H-126	NRCC Sel-2 x Bhedasi	8.00	42.44	5.31	12.00	3.40	30.76
NRCC Sel-2 (check)	-	1.97	25.14	3.14	9.2	2.63	28.60
Bhedasi (parent)	-	-	5.21 (over six harvests)	0.87	10.00	3.0	30.00

Table. 3.1.4: Bulk plot yield data of Nethra Jumbo-1 at Experimental Farm, Shantigodu

Year	Average yield (kg/plant)
2018(7 th year)	9.90
2019(8 th year)	10.10
2020(9 th year)	10.56
2021(10 th year)	10.86



Fig 3.1.1 Comparison of nut and apple size of Nethra Jumbo-1(Left and right) with Bhaskara (top and bottom)



Economics in terms of Profit: NethraJumbo-1 can save about Rs. 16,000 on labour cost (50% saving on man days) and fetch a premium price of Rs.10,000 for bigger size per ton of nut yield, giving an additional revenue of Rs. 26,000 for farmers on every ton of nut yield which can substantially make cashew cultivation a profitable venture under rainfed horticulture.

Cultural requirements: Nethra Jumbo-1 is suitable for wider density at a spacing of 7m x7m accommodating 200 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: As Nethra Jumbo-1 produces new shoots early in the season, the care from insect pests, especially, tea mosquito bug is very important. The timely spray of recommended insecticides during flushing, flowering and fruit set is essential to harvest good crop.

Striking/special features of Nethra jumbo-1: Jumbo sized nuts with uniform nut size, cluster bearing, W-130 kernel grade, higher market price, 50 % reduction in man power for harvest and easy peeling of testa.

Evaluation of promising varieties and bold nut hybrids in bulk trial

The seedling selection, No. 480 continued to perform as best promising type recording highest cumulative nut yield of 10.11 kg per tree from three harvests.

Genotype	Yield(kg/tree)	Cumulative yield of 2 harvests (kg/tree)
No.480	3.84	10.11
H 32/4	0.14	1.05
NRC 493	0.21	0.89
H 1616	0.16	0.65
Bhaskara	0.91	4.69
C.D @5%	0.59	
CV(%)	16.40	



Priority area : Management of genetic resources in cashew

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

Germplasm collection:

A survey for germplasm collection was undertaken in KCDC plantations Dakshina Kannada, Udupi and Uttara Kannada districts to locate TMB tolerant types. However, no tolerant types were found. However, one apparently dwarf type was sighted near Darle Gudda in Kundapur division and it is under observation. The planting material of H-130, BPP-10 and BPP-11 varieties was prepared for inclusion in NCFGB.

Further IC numbers for BPP-10, BPP-11, NRC-492 and NRC-546 (H-130) were obtained.

Germplasm maintenance:

A total of thirteen 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.

Germplasm database updation

A total of 82 images comprising of tree, bark, leaf, flower, inflorescence, fruit and nut belonging to 26 cashew germplasm accessions were uploaded in to the cashew germplasm database management system. This database site (<https://cashew.icar.gov.in/dcr/>) was visited 4062 times, as on date.

Cashew Nut Shell Liquid estimation in germplasm accessions

The CNSL extraction was carried out for 341 accessions during 2015-20. During 2021, the CNSL content of 77 accessions was estimated (Table 3.1.5). From the CNSL content of 418 accessions, it was observed that the range of CNSL content varied from zero per cent to 36.52%. Further, the total phenols, flavonoids and tannins have been estimated in 12 germplasm accessions (Table 3.1.5). The work of biochemical parameters and CNSL content estimation will be continued in the ensuing year.



Table 3.1.5: CNSL content of germplasm accessions assessed during 2021

NRC No.	CNSL %						
12	12.54	227	12.63	275	15.76	325	13.65
43	14.63	228	17.60	277	22.42	326	20.97
68	25.17	229	16.48	281	0.00	327	14.87
122	17.11	230	13.27	282	19.03	328	11.33
132	15.13	231	16.05	283	16.11	331	6.20
133	18.03	237	20.61	284	14.00	332	11.72
134	23.93	239	14.83	290	21.91	333	22.97
135	20.83	250	15.16	297	23.07	335	19.23
135	18.86	252	17.48	304	18.53	336	20.36
136	17.81	254	11.76	308	10.22	337	21.23
155	18.84	255	16.41	309	15.63	338	20.30
161	24.35	258	20.58	312	18.77	339	24.43
166	24.87	260	19.77	315	13.90	343	8.47
169	18.41	261	14.36	316	17.60	390	11.53
172	22.31	262	20.09	317	10.45	392	12.01
173	22.62	264	20.52	318	15.55	393	11.73
187	17.47	265	19.25	319	15.55	404	18.86
205	10.58	266	20.59	321	17.37		
216	17.35	268	22.12	322	9.80		
224	21.30	272	22.11	324	15.27		



**Fig. 3.1.2 CNSL free type NRC- 281
(Shell does not contain cashew nut shell liquid)**

Table 3.1.6: Biochemical parameters of some germplasm accessions

NRC #	Total phenols (mg/100g)	Total flavonoids (mg/100g)	Total tannins (mg/100g)
480	246.04	15.50	2.18
395	496.67	9.10	2.42
389	718.13	29.50	3.35



110	421.04	7.40	2.40
352	236.25	3.00	1.43
371	266.46	6.60	1.56
124	552.08	58.50	2.58
125	722.92	28.20	3.23
139	447.29	7.90	2.50
144	404.79	53.30	3.93
134	266.46	2.40	2.60
199	322.08	19.80	2.77

Development of polyclonal hybrids from core collections

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

Hence, it is planned to develop polyclonal hybrids from the core accessions. In quantitative genetics, it is a well-known fact that polygenic/oligogenic trait will follow normal distribution if the sample size is 30 and hence, it is planned to collect seeds (arising out of random mating among core accessions) 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 accessions. Accordingly, during the year 2021, we could collect 206 seeds from 15 accessions and these are sown in the nursery and the plants will be planted during next rainy season.



Fig: 3.1.3 Core collection Block





Fig:3.1.4 Polyclonal hybrid progenies from core accessions

Breeding approaches for developing TMB tolerance

One hundred and thirteen M_1 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 and excessive branching was observed in some seedlings as in the last year. The next generation seedlings (M_2) from all these trees will be screened for TMB tolerance in the nursery. As far as interspecific progenies are concerned, during the year 2020, out of 36 progenies (15 in free choice, 21 in no choice) tested, none was found tolerant. During the year 2021, 57 interspecific progenies were screened but none of them were found tolerant.

Table 3.1.7: TMB scoring on parents (progeny of the *A. microcarpum* used as parents for obtaining interspecific progenies)

Date	TMBT 1	TMBT 2
09.01.2021	1.60	1.17
20.02.2021	1.78	1.73
25.03.2021	1.97	2.06

Table 3.1.8: TMB scoring in interspecific progenies and popular varieties (No choice test - 2 numbers of 4th instar TMB were released / seedling - 48 hrs feeding during 1st week of January)

Cross	No. of plants	Grade
Vengurla 4 x TMBT	4	3.0
	48	4.0
Ullal-3 x TMBT	5	4.0
Bhaskara	8	4.0
	1	3.0



Ullal-3	3	4.0
	1	3.0

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

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. 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 (Table 3.1.9). However, duration of treatment showed a corresponding decrease in germination percentage. These plants will be subsequently field planted and evaluated. It may be expected that some plants/progenies may have advantages such as high yield, improved nut and apple size etc.

Table 3.1.9: Different concentrations of colchicine and the duration of treatment

Method	Colchicine Concentration (%)	Duration of treatment (hrs)
a) Seeds (soaking) 10 seeds of each variety are soaked under each treatment	Control	-
	0.4%	12, 24, 36, 48
	0.8%	12, 24, 36, 48
	1.0%	12, 24, 36, 48
a) Seedling apex dip method (10 seedlings of each variety)	Control	-
	0.2%	12, 24, 36, 48
	0.4%	12, 24, 36, 48
b) Cotton Plug method (10 young growing branch of each variety)	0.6%	12, 24, 36, 48





Fig 3.1.5 Colchicine treatment of seeds of two varieties



Fig 3.1.6 Seedlings from seeds treated with Colchicine

Table 3.1.10: Germination percentage in Colchicine treated seeds

Variety	Concentration	Duration (hrs) and Germination (%)				
		12	24	36	48	Mean
Nethra Vaaman	0.40 %	80	80	80	80	80
	0.80%	90	90	40	90	77.5
	1%	100	70	90	100	90
	Mean	90	80	70	90	82.5
	Control	100	70	60	60	72.5
Bhaskara	0.40%	100	100	80	80	90
	0.80%	90	100	90	100	95
	1%	90	100	100	100	97.5
	Mean	93.33	100	90	93.33	94.16
	Control	100	90	100	70	90



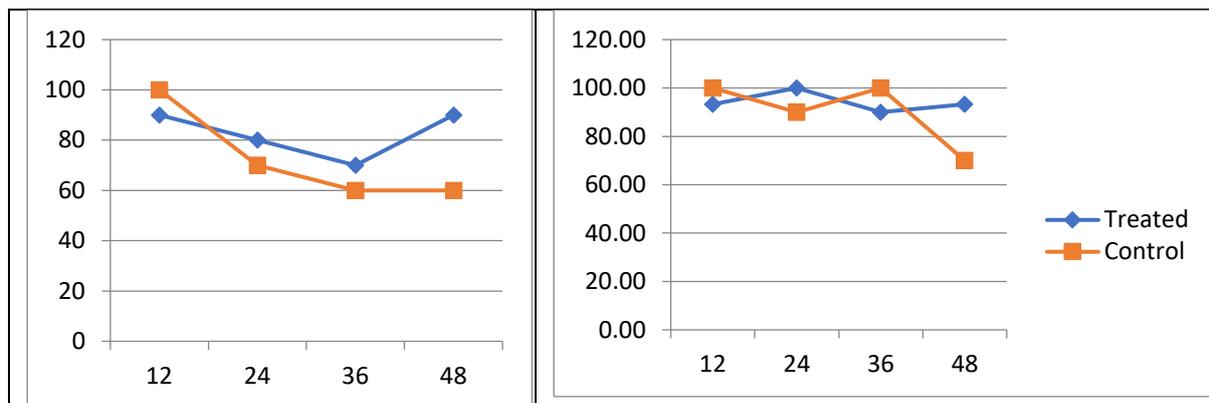


Fig 3.1.7 Germination percentage in Nethra Vaaman and Bhaskara varieties

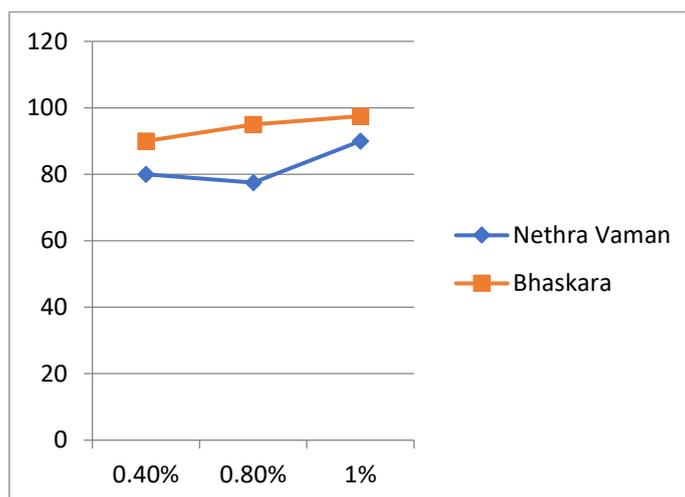


Fig 3.1.8 Germination percentage with respect to concentration of Colchicine (Germination Percentage on Y axis and, Duration and Colchicine concentration on X axis)

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

Dwarf and high yielding clones of cashew such as CPC 06, CPC 09, CPC 76 and CPC 1001, Embrapa 50, Embrapa 51, BRS 189, 226, 265, 274 and 275 are available in Brazil which have the yield potential of about 1.0 ton/ha under rainfed and 3.8 tones/ha under irrigated conditions.

However, in India, there are no dwarf and high yielding varieties are currently under cultivation. The varieties under cultivation are mostly tall and high yielding in nature. Though there are two dwarf varieties viz., KAU- Nihara (released from Pilicode center in Kerala) and Nethra Vaaman (released by ICAR- Directorate of Cashew Research, Puttur), their yield potential is low (about 1.5 to 2.0 kg/plant) to realize any substantial gain under normal density planting system. Though under ultra-high density planting system, they can yield about 2 tonnes/ha (with 1096 plants per hectare), farmers are yet to take up planting of these varieties.



With this background, the requirement for dwarf and high yielding varieties was realized and the trial has been constituted (Table 3.1.11). It is planned to go for seedling selection while evaluating these accessions *per se* for dwarf and high yield through a) Open pollinated seeds b) Geitonogamous seeds produced through artificial pollination from these accessions. This is to uncover the variability present in the genotypes. Evaluation of large number of plants may lead to identification of dwarf hybrids with high yield that are suitable for high density planting systems

Table 3.1.11: Details of the dwarf variety trial

Title of the trial	Evaluation of dwarf and semi dwarf accessions and their seedling progenies for high density planting system
Genotypes (16)	NRC 214, 314, 315, 312, 313, 306, 415, BDB 58, DB 626, TR8, Taliparamba, NRC 492, HC-6, H-3831, JGM-282 and local check (VRI-3)
Spacing (3)	3m x 3m, 4m x 4m and 5m x 5m
Replications	Three
Parameters to be recorded	Tree height, Tree spread, Girth, Canopy coverage (% of the allotted area), Number of flowering laterals, Nut weight, Yield (kg/tree) and Cumulative Yield (kg/tree)
Pruning	Need based
Required number of plants/accessions	About 36 grafts per accession
Design	Split Plot (Spacing as main plot and varieties as sub plots)

3.1.4 Evaluation of cashew apple genotypes for apple yield and quality

This project was initiated in 2013 with 14 cashew germplasm accessions having big cashew apples to evaluate them for cashew apple yield and quality. They were selected from the germplasm maintained in the National Cashew Field Gene Bank based on apple weight. These 14 accessions were planted at a spacing of 7.5 m x 7.5 m in RBD with three replications along with check Vengurla-8. 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 width, cashew apple yield, cashew nut weight, cashew nut yield and TMB incidence were recorded since 2015-16. The results of analysis carried out for the data of 2021 is presented here (Table 3.1.12). It was found that NRC 144 had maximum stem girth (78.57 cm). For plant height, NRC 176 was tallest (5.38 m) and Vengurla-8 was shortest (3.80 m). For canopy spread, NRC 175 showed maximum across E-W direction (7.60 m) while NRC 389 presented maximum in N-S direction (8.72 m). NRC 301 had heaviest (203.35 g), lengthy (10.56 cm) and broadest (6.07 cm) apples. For nut weight, NRC



493 recorded the maximum nut weight (12.41 g) and minimum was in NRC 175 with 7.97 g. NRC 301 recorded maximum cashew apple yield (34.81 kg / tree) as well as nut yield (2.04 kg /tree). It also gave maximum apple to nut ratio (17.08).

The cumulative yield analysis for five years revealed that NRC 175 has recorded highest cumulative cashew apple yield of 176.83 kg / tree and nut yield of 15.13 kg / tree. This was followed by NRC 140 with cumulative cashew apple yield of 100.04 kg / tree and nut yield of 7.17 kg / tree. Further, NRC 301 recorded cumulative cashew apple yield of 87.32 kg / tree and nut yield of 5.5 kg / tree. It can be observed that NRC 175 holds promise as a dual-purpose cashew genotype and NRC 301 holds potential as a cashew apple genotype.



NRC 175



NRC 301

Table 3.1.12: Performance of growth parameters and yield during 2021 and cumulative yield (over 5yrs)

Genotype	Stem Girth (cm)	Plant height (m)	Canopy spread (m)		Apple wt (g)	Apple length (cm)	Apple breadth (cm)	Nut wt (g)	Apple yield (kg/tr)	Nut yield (kg/tr)	ANR	Cumulative Yield (5 years)	
			E-W	N-S								Apple yield	Nut yield
NRC 301	61.61	4.35	6.88	7.26	203.35	10.56	6.07	11.91	34.81	2.04	17.08	87.32	5.5
NRC 493	76.16	5.19	6.31	6.72	87.62	9.03	4.61	12.41	4.88	0.69	7.10	37.74	5.18
NRC 140	66.46	4.69	7.42	7.03	127.68	8.95	4.99	9.69	15.06	1.14	13.17	100.04	7.17
NRC 389	73.89	5.30	7.73	8.72	87.70	7.12	5.05	9.92	12.28	1.39	8.81	57.02	5.77
NRC 176	72.89	5.38	6.63	7.15	60.88	5.37	4.45	8.18	9.63	1.29	7.31	69.37	6.57
NRC 270	71.76	5.02	6.81	7.31	118.40	7.95	5.45	11.11	16.48	1.55	10.68	53.43	5.57
NRC 189	69.94	4.56	6.60	8.51	75.14	5.56	5.09	10.26	10.42	1.42	7.35	55.8	6.46
NRC 144	78.57	5.11	7.13	7.69	113.41	8.58	4.53	9.40	6.94	0.57	12.07	42.66	3.73
NRC 175	70.53	5.36	7.60	7.69	81.58	5.97	4.70	7.97	16.38	1.60	10.23	176.83	15.13
V-8	53.83	3.80	5.64	5.09	65.64	5.82	4.32	9.66	8.82	1.30	6.80	28.81	3.71
Mean	69.56	4.88	6.88	7.32	102.14	7.49	4.93	10.05	13.57	1.30	10.06	-	-
SEm	2.31	0.16	0.20	0.32	13.29	0.57	0.17	0.46	2.66	0.14	1.05	-	-
CD (P=0.05)	7.83	NS	NS	NS	33.75	1.26	0.63	1.24	6.30	0.55	3.27	-	-

Note: Data analysis was carried out for 10 accessions due to death of some trees in replications



3.1.5 Breeding in Cashew for Special Traits

Development of dwarf and compact cashew hybrids

Direct and reciprocal crosses

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 10 selected trees. The data recorded for nut yield and growth characters is presented in Table 3.1.13. There was severe outbreak of TMB incidence during this year and yield levels were very low. Tree No.3 of Priyanka x NRC 492 recorded highest annual nut yield of 3.79 kg and presented highest cumulative nut yield of 16.60 kg over 6 harvest years. Tree No.149 of NRC 492 x Madakkathara 2 recorded 2nd highest annual nut yield of 3.08 kg and second highest cumulative nut yield of 15.03 kg over 6 harvest years. Tree No.13 of NRC 492 x Madakkathara 2 recorded 2nd highest annual nut yield of 3.08 kg. Tree No.8 belonging to Dhana x NRC-492 a semi-tall selection was died due to CSRB but its grafts were made. Grafting of top ten selections was carried out and grafts are maintained in the nursery. These selections will be planted along with checks in the field in replicated trial and evaluated for growth and yield.



Backcrosses

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 16 selected trees. The data recorded for nut yield and growth characters is presented in Table 2. Tree No.BDB-626-58 recorded highest annual nut yield of 1.86 kg and gave cumulative nut yield of 10.34 kg over 5 years. It is semi-tall with height of 4.75m and 5.5m average tree spread. Tree No.BDB-626 -97 recorded the second highest cumulative nut yield of 8.64 kg over 5 years. The top ranking six selections were grafted and maintained in the nursery. These selections will be planted along with checks in the field in replicated trial and evaluated for growth and yield.



Table 3.1.13. Growth parameters and nut yield in promising selections (Jan –Dec 2021)

Sl.No.	Cross	T.No.	Girth (cm)	Ht (m)	Spread (m)		Nut wt (g)	Nut Yield (kg/tree)	Cum. nut yield (5 yrs) (kg/tree)
					E-W	N-W			
Selections in 2018									
1	Vengurle-4 x	28	83.0	8.50	7.50	7.50	5.50	0.12	10.60
2	NRC-492	65	76.0	6.50	7.50	7.25	7.50	0.37	11.54
3	Vengurle- 4 x Taliparamba -1	122	84.0	6.00	6.24	7.25	6.00	1.28	12.36
4	Priyanka x NRC-492	3	89.0	6.25	6.50	7.50	6.50	3.79	16.60
5	Madakkathara-2 x NRC-492	102	88.5	6.75	8.50	7.50	6.20	1.60	9.89
6	Madakkathara- 2 x NRC-492	149	85.0	7.30	8.00	9.25	7.00	2.13	15.03
Selections in 2019									
7	NRC 492 X	49	72.0	5.25	7.50	6.75	8.04	0.90	7.94
8	Dhana	53	75.0	6.00	7.50	7.00	5.90	1.69	9.96
9	Madakkathara-2 x NRC- 492	117	104.0	7.50	8.25	7.75	5.00	2.32	11.67
10	NRC- 492 x Madakkathara-2	13	102.0	7.25	7.50	8.75	6.00	3.08	11.71

Table 3.1.14: Promising progenies identified in back cross population (Jan –Dec 2021)

Plant No.	Height (m)	Spread (m)		Girth (cm)	Nut wt (g)	Nut Yield (kg/tree)	Cumulative Nut Yield (kg/tree)-5
		EW	NS				
BDB-372 -4	48	5.1	5.25	4.50	4	0.66	4.22
BDB-372 -23	72	5.75	5.25	7.50	8	1.03	7.13
BDB-372 -36	50	4.25	5.25	6.00	6	0.44	4.04
BDB-372 -37	71	6.25	5.00	5.25	6	0.16	6.69
BDB-372 -46	56	5.00	4.75	3.10	6	0.27	4.52
BDB-372 -60	52	4.25	4.5	5.50	8	0.18	8.53
BDB-372 -61	71	4.25	7.25	7.50	8	0.30	7.14
BDB-372 -84	82	5.75	6.75	7.25	9	0.48	8.61
BDB-372 -90	71	6.00	7.25	6.75	7	0.09	5.18
BDB-626 -49	77	6.25	7.00	7.75	5	0.42	6.44
BDB-626-58	51	3.25	6.75	4.25	8	1.86	10.34
BDB-626 -97	61	5.25	5.25	6.25	7	1.00	9.65
BDB-626 -113	59	5.5	5.00	6.50	5	1.80	8.56
BDB-626 -114	63	4.00	6.00	6.25	6	1.60	4.52
BDB-626 -122	68	6.00	5.25	5.00	7	1.64	7.80



Breeding for improvement of nut size in cluster bearing genotypes

In an effort to improve nut size of cluster bearing genotypes, they were crossed with bold nut types and 408 seedlings of 15 crosses were planted in the year 2018. During this year, all the seedlings of these crosses were given shape pruning and maintained with plant protection measures. Gaps caused due to death of few seedlings in the previous year were planted with check varieties. Growth observations such as stem girth (cm), tree height (m) and tree spread were also recorded. Besides, flowering and fruiting in precocious types was recorded (Fig.3.1.9).



Fig 3.1.9 Growth observations in F₁ seedlings of small nut x bold nut types

Breeding for reduced tannin content in cashew apples of popular cultivars

Tannin contents in cashew apples from 125 F₁ trees of crosses between *A. microcarpum* and cultivars of *A. occidentale* varieties Ullal-1, Ullal-3, Bhaskara, Vengurle-4 was analyzed. T.Nos.820, 834, 829, 822, 830 of the cross Bhaskara x *A. microcarpum* were the top five with lowest tannin contents of 0.35, 0.43, 0.44, 0.46, 0.54 mg/g fresh wt. corresponding to 0.04, 0.04, 0.04, 0.05, 0.05%. Tannin contents of Ullal-1, Ullal-3, Bhaskara, Vengurle-4 are 3.83, 0.85, 1.09, 2.34 mg/g fresh wt. with 0.38, 0.09, 0.11 and 0.23% respectively. Tannin content was estimated in *A. microcarpum* and it presented 0.003% (Table 3.1.15).

Table 3.1.15: Mean tannin content in cashew apples from F₁ trees of crosses between *A. microcarpum* and cultivars of *A. occidentale* varieties Ullal-1, Ullal-3, Bhaskara, Vengurle-4

Tree No.	Mean tannin content (mg/g fresh wt)	Tannin content (%)	Tree No.	Mean tannin content (mg/g fresh wt)	Tannin content (%)	Tree No.	Mean tannin content (mg/g fresh wt)	Tannin content (%)
488	1.55	0.16	753	4.51	0.45	836	1.35	0.13
665	3.44	0.34	755	3.51	0.35	837	1.87	0.19
666	4.53	0.45	756	1.32	0.13	838	0.73	0.07
667	2.84	0.28	757	1.15	0.11	840	0.91	0.09
669	4.71	0.47	758	2.35	0.24	841	1.62	0.16



670	4.94	0.49	761	1.23	0.12	842	2.42	0.24
671	4.52	0.45	762	2.38	0.24	843	1.16	0.12
672	2.97	0.30	763	1.97	0.20	845	1.31	0.13
673	3.96	0.40	764	1.22	0.12	846	1.13	0.11
674	4.62	0.46	765	1.12	0.11	847	0.87	0.09
677	3.97	0.40	769	2.57	0.26	848	0.73	0.07
680	3.99	0.40	771	1.31	0.13	851	1.04	0.10
681	4.57	0.46	773	0.95	0.10	854	1.09	0.11
682	4.07	0.41	774	3.21	0.32	855	1.19	0.12
683	3.72	0.37	775	2.62	0.26	857	1.26	0.13
688	3.87	0.39	777	1.06	0.11	778	1.15	0.11
691	4.05	0.41	781	0.58	0.06	779	1.15	0.11
697	3.00	0.30	782	3.70	0.37	780	2.00	0.20
698	2.88	0.29	787	2.31	0.23	783	3.26	0.33
703	3.24	0.32	792	3.77	0.38	785	1.67	0.17
706	2.85	0.28	794	3.56	0.36	788	1.07	0.11
707	3.77	0.38	796	1.00	0.10	789	2.01	0.20
708	3.39	0.34	801	4.19	0.42	790	1.49	0.15
720	4.37	0.44	802	1.58	0.16	791	1.42	0.14
722	3.66	0.37	805	1.15	0.12	793	2.33	0.23
723	4.33	0.43	806	3.04	0.30	799	1.80	0.18
726	4.91	0.49	807	0.58	0.06	800	1.37	0.14
727	3.61	0.36	808	0.80	0.08	803	1.56	0.16
731	1.71	0.17	809	1.69	0.17	866	2.79	0.28
732	0.97	0.10	811	2.21	0.22	Bhaskara	1.09	0.11
733	1.60	0.16	812	1.54	0.15	Ullal-1	3.83	0.38
734	1.56	0.16	813	2.08	0.21	Ullal-3	0.85	0.09
735	3.73	0.37	814	0.94	0.09	Vengurla-4	2.35	0.23
736	1.01	0.10	815	1.94	0.19			
737	3.53	0.35	816	1.29	0.13			
738	3.51	0.35	819	0.99	0.10			
739	0.84	0.08	820	0.35	0.04			
740	1.22	0.12	822	0.46	0.05			
742	1.02	0.10	823	1.73	0.17			
743	2.10	0.21	827	2.58	0.26			
744	1.60	0.16	828	0.60	0.06			
745	1.61	0.16	829	0.44	0.04			
746	1.54	0.15	830	0.54	0.05			
747	1.36	0.14	831	1.62	0.16			
748	1.84	0.18	832	1.89	0.19			
749	2.38	0.24	833	0.97	0.10			
751	1.91	0.19	834	0.43	0.04			
752	2.03	0.20	835	0.84	0.08			



3.1.6 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.*, P₁, P₂, F₁, F₂, BC₁, BC₂. The status of plants available in these six generations is presented in the Table 1 and all these plants are maintained in the nursery (Fig 3.1.10). Planting will be taken up during 2022.



Fig 3.1.10 Seedlings of F₂ (top left), BC₂ (top right) and P₁, P₂, F₁, BC₁ (below) generations

Table 3.1.16. Status of grafts / seedlings available in six generations

Sl.No.	Generation	Parentage	# Grafts
1	P ₁	Bhaskara	18
2	P ₂	NRC-492	16
3	F ₁	Bhaskara x NRC-492	17
4	BC ₁	F ₁ x Bhaskara	77
	Generation	Parentage	# Seedlings
5	F ₂	Selfing of F ₁	77
6	BC ₂	F ₁ x NRC-492	39



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

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

Development of novel SSRs from the draft genome sequences:

Fifty-seven novel polymorphic SSR markers were developed for cashew by screening 100 SSR primers designed from cashew genome and about 91% of these SSRs cross amplified in two wild relatives *A. microcarpum* and *A. othonianum*, two relatives of cashew. PIC values of assayed SSRs ranged from 0.19 to 0.85 with a mean of 0.58 and forty-three of the markers developed in this study were highly polymorphic. The novel SSR markers were named with prefix DCR representing this directorate's name. Polymorphism detection by a novel SSR marker DCR S1-41 is shown in the Fig. 3.1.11.

Genetic Diversity analysis in germplasm accessions:

For genetic diversity and Population structure analysis in 96 cashew accessions a total of 20 informative SSR markers were used. A total of 180 alleles were detected by the 20 SSRs in 96 accessions. The number of alleles per SSR locus ranged from 5 to 17 with a mean of 9. Clustering by Neighbor-joining (NJ) method with the Dice genetic distances grouped the accessions into three major clusters. STRUCTURE analysis of accessions showed the existence of three distinct genetic groups and admixtures. Analysis of Molecular Variance (AMOVA) analysis showed that 12% of genetic variations were attributable among populations whereas 88% were within populations.

Mining and designing of SSRs from transcriptomes data:

The *de novo* assembled shoot transcriptome of giant cultivar Bhaskara was used for mining of SSRs. A total of 4271 SSRs were identified in 71571 shoot transcripts. In 414 shoot transcripts, more than one SSR was found. The frequency of SSRs was 1 per 12.2 Kb in the *de novo* assembled transcriptome. The identified SSRs were dominated by tri-nucleotide (49.12%). Primers were designed for all the detected SSRs.

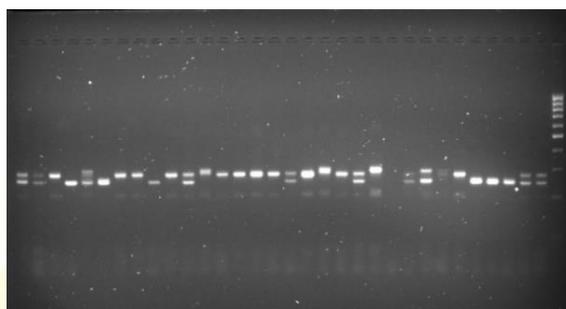


Fig. 3.1.11: Polymorphism detection by novel SSR marker DCR S1-41



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

1. **Field planting of mapping populations:** The two mapping populations (Bhaskara×NRC-188 and Vengurla-7×NRC-116) developed and planted in the field at a spacing of 5×5 m and 3×3 m in the previous year were maintained well by weeding and necessary plant protection measures.



Fig. 3.1.12 Mapping populations planted in augmented block design

2. **Identification of SSR markers detecting parental polymorphism:** Eighteen (18) SSR markers showing polymorphism between the parents of mapping population Bhaskara and NRC-188 were identified by screening 57 polymorphic markers.
3. **Crossing and generation of F₁ seedlings of interspecific hybrids in the nursery:** Seedlings of NRC-392 (*A. microcarpum*) × Bhaskara (*A. occidentale*), NRC-142 (*A. microcarpum*) × NRC-153 (*A. othonianum*) crosses produced in the previous year were raised in the nursery. These crosses were made to develop markers for interspecific hybrids



Fig. 3.1.13 Interspecific hybrids produced of NRC-392 (*A. microcarpum*) × Bhaskara (*A. occidentale*)



Externally funded Projects:

3.1.9 Development of morphological descriptors and DUS test guidelines for cashew

In order to arrive at the DUS test guidelines for cashew, a project was funded by Protection of Plant Varieties and Farmers Rights Authority, New Delhi. Accordingly, the DUS test guidelines for cashew were finalized and published during 2017. Thirty reference varieties for the purpose of DUS testing have been established at a spacing of 6 m x 6 m with four plants/variety and these were maintained in the field. During the year 2020-21, the application for registration of H-130 was submitted to the PPV-FRA, New Delhi and twelve plants of this variety have been planted adjacent to reference block for DUS testing.

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, twelve plants of this variety also have been 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.



3.2 CROP MANAGEMENT

Priority area: Horticulture production technologies

3.2.1 Studies on pruning and phenology in cashew

Understanding the phenological stages and assigning specific codes will help in adopting timely crop management practices suitable to various production systems such as high-density planting, rainfed agriculture etc. around the world. Also, it allows exchange of scientific information obtained from experiments in different environmental conditions by cashew researchers. The study, being first of its kind at global level could identify 8 principal growth stages in cashew as per extended BBCH scale. The proposed scale and descriptions of phenological stages will have broader implications for cashew improvement and management.

Further, the proposed scale could also be applied for assigning codes and describing phenological growth stages in the related species with similar physical and growth features like *A. pumilum*, *A. microcarpum* etc. with few minor modifications. The study also identified the critical stages for vulnerability to pest attack which will help in better pest management practices in cashew. With regard to pruning, it is recommended that the pruning of 25 % lateral shoots during in the month of mid-September is ideal for obtaining high yield in cashew variety Bhaskara under west coast conditions of Karnataka

Priority area: Enhancing input use efficiency and productivity

3.2.2 Optimization of mineral nutrition to cashew under ultra-density planting

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, P₂O₅ and K₂O were imposed. During the year 2020-21, the yield ranged from 1.05 to 3.20 kg/tree. The recommended optimum dose for Ultra Density Planting system found to be 70: 22.5: 40 g/tree [112: 36: 64 kg NPK/ha].

3.2.3 Carbon cycling, sequestration and nutrient dynamics in cashew orchards

To estimate the carbon sequestration, sample trees of cashew varieties Ullal-3 and NRCC-Sel-2, under different age group was felled and partitioned into components such as trunk, bark, main branches, sub branches, twigs and leaves. The total biomass accumulated by a 20-year tree was 345.7 kg/tree in case of variety Ullal-3 and 391.3



kg/tree in case of NRCC-Sel-2. The tree trunk contributed most to the total above ground biomass throughout different age of the plantation. The total biomass carbon by 20-year-old cashew tree ranged from 42.9 to 50.4 t ha⁻¹ with the CO₂ equivalent ranging from 157.5 to 185.0 t ha⁻¹.

Priority area: Physiological and basic studies

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

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.

Influence on soil moisture content (SM) and soil moisture deficit (SMD): 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 (Fig 3.2.1).

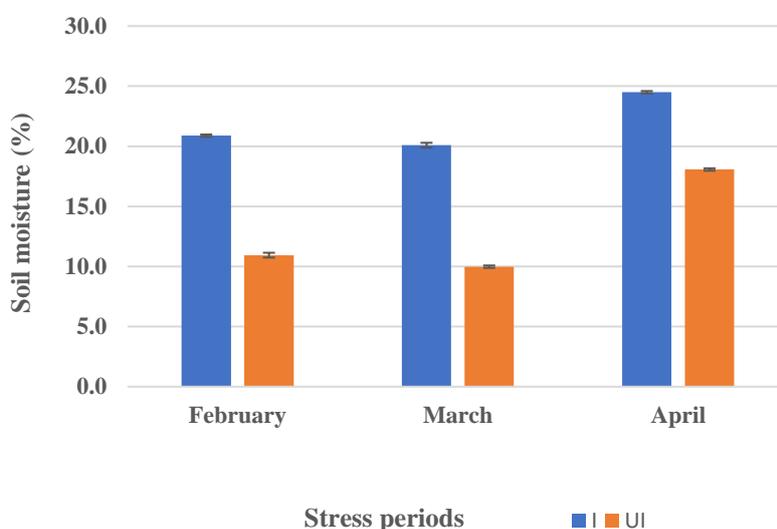


Fig. 3.2.1: Influence of moisture stress on soil moisture content in both irrigated and un irrigated trees during stress periods of February to April

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 3.2.2).



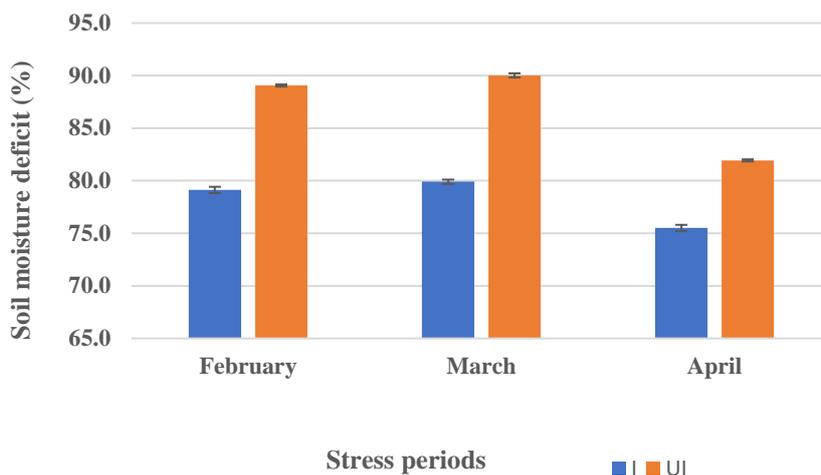


Fig 3.2.2: Influence of moisture stress on soil moisture deficit in both irrigated and un irrigated trees during stress periods of February to April

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 3.2.3).

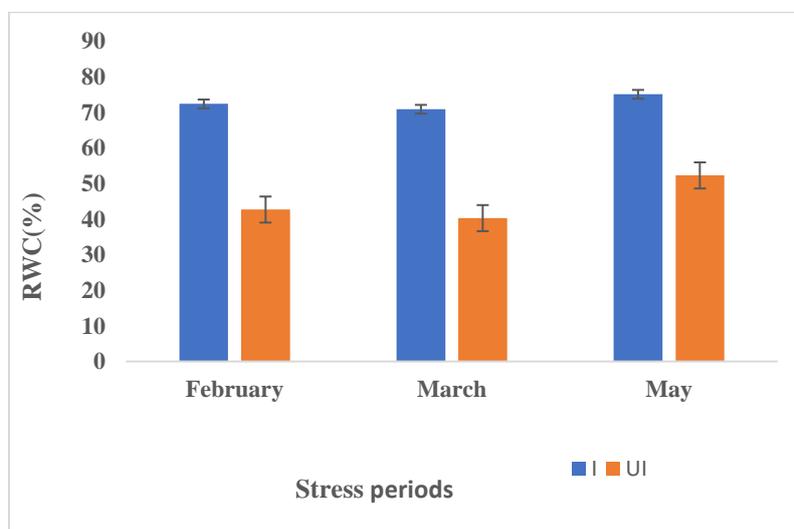


Fig 3.2.3: Influence of moisture stress on relative water content in both irrigated and un irrigated trees during stress periods of February to April

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 3.2.1).



Table 3.2.1 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

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

Standardization of pollen collection time and pollen growth media:

An attempt has been made to standardize the media as well as time for in vitro pollen germination in cashew. Two different media were tried i.e., Sucrose (5, 10 and 30%) and PEG with Boric acid, Calcium Nitrite and Magnesium sulphate. Pollen grains were collected from 9:30 am to 11:30. am. The pollen germination was observed with PEG (Polyethylene glycol) media when the pollens were collected between 9:30 to 11: 30 am (Fig.3.2.4).

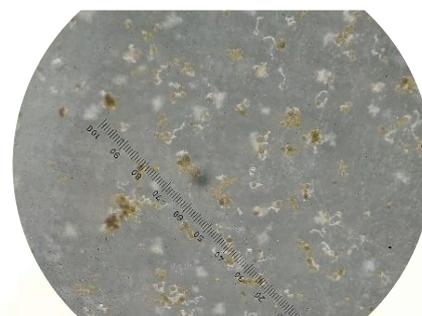


Fig.3.2.4: Pollen germination viewed under microscope



Electron microscopy of cashew pollen

Pollen grains of ten cashew accessions (*Anacardium Microcarpum*, *Anacardium pumilum*, Bhaskara, Ullal-3, Purple local, Madakkathara-2, H-130, VRI-3, Dhana and Ullal-2) were morphologically characterized under scanning electron microscope. The Polar length (μm) ranged from 36.73 μm (Ullal-2) to 48.53 μm (VRI-3). The Equatorial width (μm) ranged from 22.49 μm (Bhaskara) to 29.15 μm (H-130). The P/E for most of the studied accessions were less than 2 (in the range of 1.30-1.98), however, only one variety, Bhaskara exhibited higher P/E ratio (2.08). The shape of pollen of studied in the cashew accessions was prolate except Bhaskara where the pollen shape was perprolate (Table 3.2.2 and Fig.3.2.5).

Table 3.2.2: Scanning electron microscopy of cashew pollen

S No	Genotypes	Polar length (μm)	Equatorial width (μm)	P/E	Shape of the pollen
1	<i>Anacardium microcarpum</i>	36.73	28.27	1.30	Prolate
2	<i>Anacardium pumilum</i>	42.31	25.18	1.68	Prolate
3	Bhaskara	46.67	22.49	2.08	Perprolate
4	Ullal-3	46.39	27.68	1.68	Prolate
5	Purple local	42.34	24.41	1.73	Prolate
6	Madakkathara-2	47.91	24.27	1.97	Prolate
7	H-130	42.00	29.15	1.44	Prolate
8	VRI-3	48.53	24.45	1.98	Prolate
9	Dhana	43.61	25.93	1.68	Prolate
10	Ullal-2	36.73	28.27	1.30	Prolate

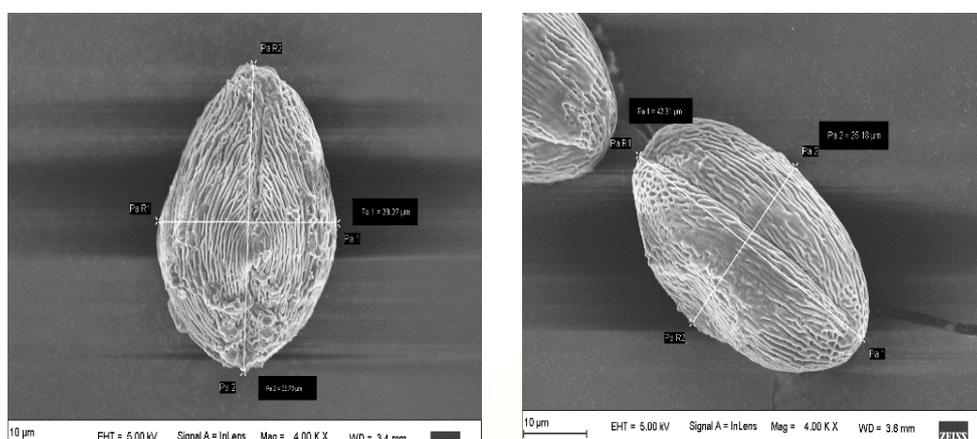


Fig. 3.2.5: Shape of cashew pollen under scanning electron microscope



Cryopreservation in Cashew



Freshly collected anthers were dehisced and cryopreserved for more than two months in liquid nitrogen cryocan. Later, the pollens were tested for its viability under *in vitro* and *in vivo* conditions. The



cryopreserved pollens were germinated successfully at *in vitro* condition using hanging drop technique in PEG media. The per cent of germinated pollens was less in comparison to fresh pollens. The cryopreserved pollens were also used for crossing at field condition and successful fruit set was noticed.

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

In India, cashew is habitually grown as a rainfed crop in ecologically sensitive areas for example coastal belts, hilly areas and areas with high rainfall and humidity and therefore its performance is primarily influenced by climate. Cashew has been adapted well in west and east coast regions and subsequently spread to hilly and plain regions of Karnataka, Tamil Nadu, Gujarat, Chhattisgarh, Andhra Pradesh and NEH States where part of areas is under salinity and alkalinity. In saline soil, the available moisture range is low and crop has to spend extra energy to extract water from the soil because of high osmotic potential of the soil solution. These also adversely affect water and nutrient availability which ultimately affect the crop yield. Hence, the challenge for cashew crop is to improve yields in marginal lands under rainfed conditions where the harsh environment with high soil salinity strongly limits crop growth, productivity and quality of the produce.

Generally, Cashew (*Anacardium occidentale* L.) is considered as hardy tree crop with greater adaptability in varied environments. Thus, introduction of cashew as salinity tolerant species could be an important strategy in improving the productivity in salt affected areas. In the light of aforementioned, in order to evaluate the cashew rootstocks with two goals of identifying the most important physiological traits associated with salinity tolerance (assessed through yield due to salinity) and to test the reliability of these traits when compared to salinity tolerance, an initial screening experiment has been initiated to fix the optimum salt concentration in order to screen the popular varieties of Directorate of Cashew Research, Puttur as well as All India Co-



ordinated Research Project centers for identification of contrast cashew rootstocks for salinity tolerance.

Experimental details:



Fig.3.2.6: General over view of plants maintained in the poly house for salinity treatments

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.

Priority area: Horticulture production technologies

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

The cashew varieties Vengurla-4, Vridhachalam-3, Vengurla-7, Selection-2, Bhaskara, and Madakathara-2 were selected and the observations were recorded based on principal growth stages following the extended BBCH scale. The weather parameters rainfall, relative humidity, minimum temperature, the maximum temperature was recorded. It was observed that the flowering was affected in early varieties in the initial flushing and flowering periods due to cloudy conditions (December 2021 to January 2022). Further, the relation of weather factors to the development of apple and nut is in progress. The principal growth stage; Nut and apple development and maturity stages are shown in the figure. The apple and nut weight in respect of principal growth stages was varied (Fig. 3.2.7)



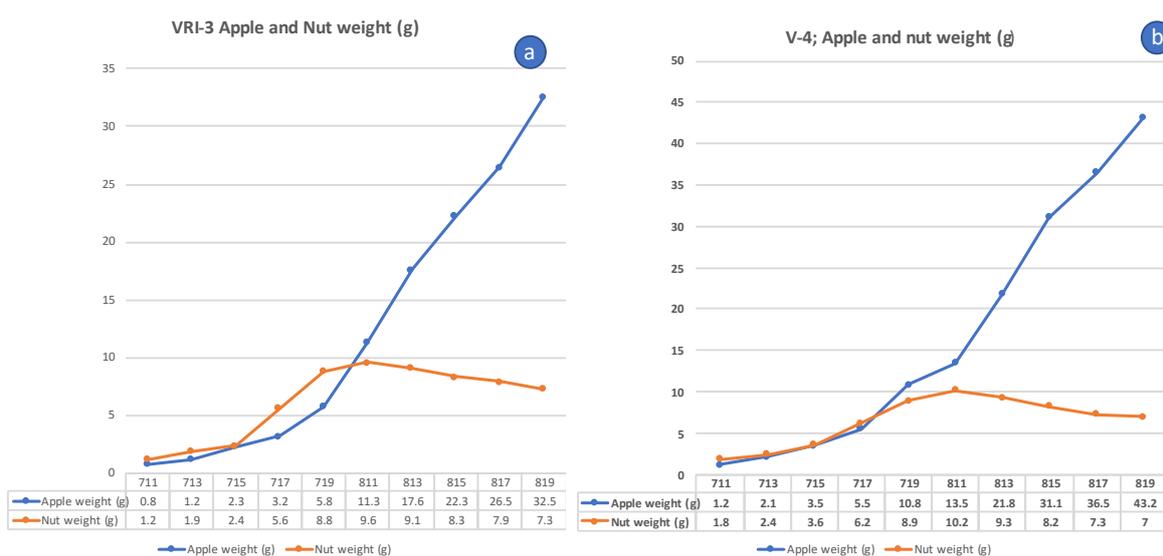
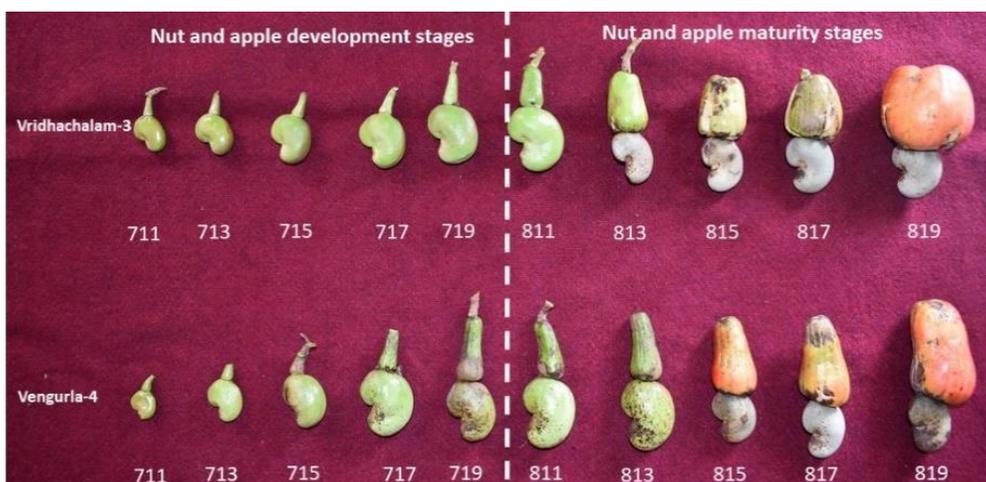


Fig. 3.2.7: Apple and nut weight with respect to principal growth stages (BBCH scale) in varieties; a) VRI-3 and b) V-4

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

The various engineering properties such as physical characteristics, mechanical and frictional properties of cashew apple and nut for six varieties *viz.*, Bhaskara, H-130, Ullal-3, Vengurla-7, Vengurla-4 and Dhana were determined and compared using Duncan's multiple ranges test. The results showed that the average length, width and thickness of the freshly harvested cashew apple and nut ranged from 54.15 to 60.74 mm, 40.62 to 50.77 mm, 35.63 to 44.81 mm and 32.88 to 38.27 mm, 23.97 to 27.22 mm, 16.83 to 23.93 mm respectively. The arithmetic and geometric mean diameters of the cashew apple and nuts were determined to be 44.58 to 52.11 mm, 43.41 to 51.41 mm and 24.96 to 28.81 mm, 23.89 to 28.11 mm respectively. The sphericity of the cashew apple was found to be in the range of 0.76 to 0.89 resembled a conical-obovate whereas the nut resembled as kidney shape having sphericity value ranged



between 0.71 to 0.80. The bulk density of cashew apple was found to be maximum for H-130 (581.50 kg m^{-3}) while it was minimum for Ullal-3 variety (495.15 kg m^{-3}).

The true density of the cashew apple ranged from 1013.33 to $1133.64 \text{ kg m}^{-3}$ whereas corresponding values of bulk density and true density of nuts ranged from 451.66 to 531.47 kg m^{-3} and 1108.60 to $1228.06 \text{ kg m}^{-3}$ respectively. The force required to detach nut from apple was determined using a torque sensor with a 0.5 % accuracy and the average force of fruit detachment was found to be 0.13 Nm. Static coefficient of friction of cashew apple and nuts varied on different base surfaces. Statistical analysis revealed that the factors considered under physical characteristics found to be significant ($p < 0.01$).

A conceptual design of a cashew fruit and nut separator is prepared by considering the engineering properties of cashew apple and nut. The detailed drawing of the machine is prepared using SolidWorks software (Fig. 3.2.7). The prototype cashew fruit and nut separator consisted of a main frame, electric motor, VFD (Variable Frequency Drive), hopper, screw conveyor, first rotary module and secondary rotary module. A bill of material (BOM) containing an extensive list of raw materials and components required for the fabrication of a prototype cashew fruit and nut separator has been worked out.

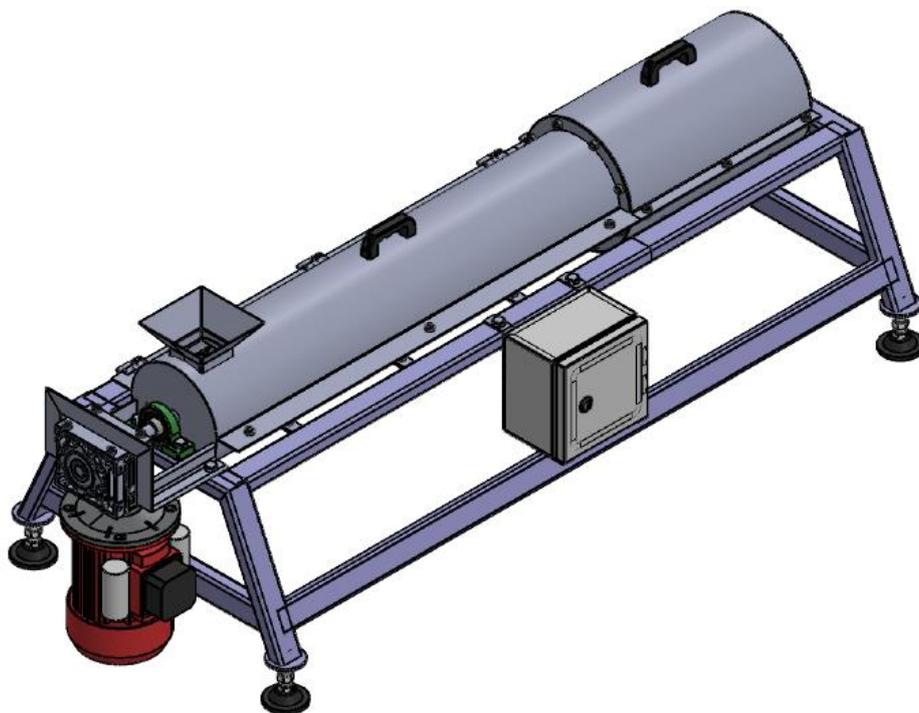


Fig. 3.2.8: A pictorial view of cashew fruit and nut separator



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

The preliminary trial was conducted to determine the fruit detachment force from the stalk by using load cell with computer interface. The force required to separate the fruit from the stalk ranged from 7.4 to 10.29 N. A prototype hand-held telescopic cashew fruit harvester was developed based on the physical and mechanical properties of the cashew fruit and tree canopy. The harvester consisted of a base pipe of 32 mm \varnothing and an extension pipe of 25 mm \varnothing , fruit receiving bowl and a flexible chute to convey the harvested fruits to the collection unit. The overall length of the harvester is \sim 20 ft and weighs 2.9 kg (Fig. 3.2.8).

The cashew fruit and nut collector has been designed 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 (Fig. 3.2.9). The prototype consisted of main handle, guiding handle, side covers and spring mechanisms.



Fig.3.2.9: A view of hand-held telescopic cashew fruit harvester

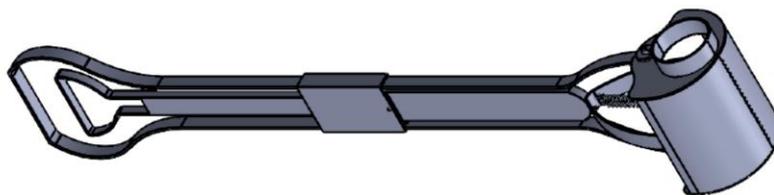


Fig. 3.2.10: A pictorial view of cashew fruit and nut collector



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

The primary EAG trials were done at ICAR-NBAIR, Bengaluru (Attur Campus) and were aimed at understanding the antennal longevity of both virgin females and unmated males of TMB and their effective responses to various solvents (without any pheromone volatile) at different durations after excision. This can provide a clue about the best timing for evaluation of responses to the sex pheromone volatile samples. The excised antennae were mounted onto the EAG electrodes using a conductive gel and the solvent were puffed over the antennae using standard operating conditions.

The antennae excised from lab reared virgin females and unmated males of TMB were tested for their EAG response to determine the responsive parameters using different solvents, di-chloromethane (DCM), Z-3 Nonanol, E-3 Hexenol, Z-3 Hexenol, Benzeneacetaldehyde and Z-3 Hexyl acetate.

The trials were done by puffing 10 μ L of 10 ppm of the test solvents. It was noticed that though DCM elicited considerable response from the antennae of both the males and females; maximum responses were observed in E-3 Hexenol followed by Z-3Nonanol and Z-3 Hexyl acetate. It was observed that the antennae of both sexes could respond to stimuli for a period of up to 20 minutes after excision.

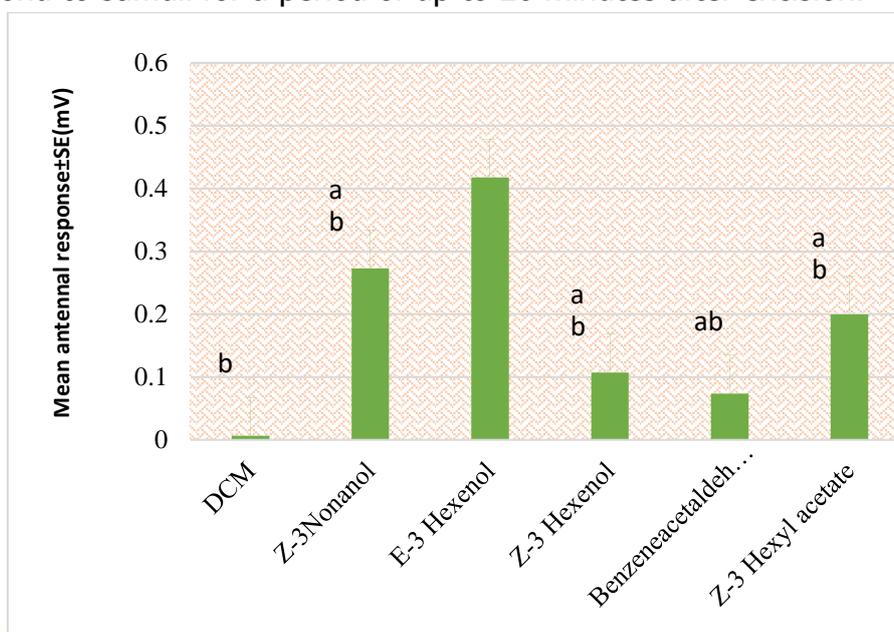


Fig. 3.3.1 EAG response to tested solvents in antennae of TMB males



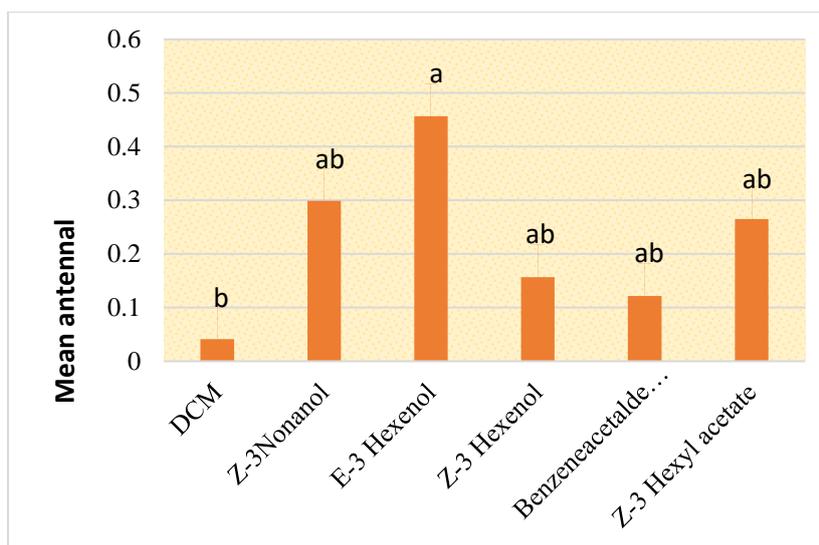


Fig. 3.3.2 EAG response to tested solvents in antennae of TMB females

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

In order to confirm the field survival of the entomopathogenic fungi, the trials on evaluation of EPN have been initiated in three locations of KCDC plantations at Koila, Alangaru and Sowthadka. The test solutions of the IJs of EPN of two different species viz., *Heterorhabditis indica* and *Steinernema carpocapsae*.

The test solution of 10 LE /L was used at different doses for treatment, and 2to 3 L of the suspension was sprinkled into the soil gently raked at the collar zone. The soil samples were collected after 45 days after treatment and the survival of the EPN and retention of their virulence was studied.

It was observed that; the test insects (*Galleria mellonella*- greater wax moth) used to trap / recover the applied EPN species surviving in soil of the cashew rhizosphere were wild cultures collected from infested honey hives and hence the infectivity of the was significantly lesser. It was also noticed that due to presence of saprophytic fungi in soil samples, majority of the cadavers of the EPN infected larvae of wax moth got partly decayed. However, substantial quantity of IJs could emerge from such cadavers; and the harvested IJs are being evaluated for their infectivity and virulence to CSRB grubs.



Fig. 3.3.3: Close up of webbing of IJs emerging from wax moth larvae cadavers



3.3.3 Inflorescence pests of cashew and their management

In the infested cashew trees, damaged flowers and rachis with webbing by the caterpillars and drying of floral branches were seen in clusters. Pest incidence was 8-12 % in different plots with the insect species like *Hyposidra* spp., *Oenospila flavifusata* Walker, *Perixera* sp., *Bombotelia jocosatrix* Guen., *Anarsia* sp., *Aetholix flavibasalis* Guenee, *Nanaguna* sp., *Lamida moncusalis* Walker, *Thylocoptila paurosema* M., *Hypatima haligramma* M., *Helopeltis* spp. etc. Nut set was very less in the infested inflorescences especially (0-2 nuts/inflorescence) compared to the uninfested ones (4-6/inflorescence). *Perixera* sp. was recorded in clusters (1-5 larvae/inflorescence) during January 2021, and nut set was almost nil in severely infested inflorescences of cashew accession VTH-174. In the subsequent flowering season, incidence of inflorescence pests was less (4-5 %) during November-December 2021 even in the early flowering types. To record the bio efficacy of botanical pesticides against inflorescence pests of cashew, eight botanical preparations /formulations comprising aqueous leaf extracts of neem, *Vitex negundo*, *Adhatoda vasica* (30g/L), neem azal 0.15 % (5 ml/L), multineem 0.03 % (3 ml/L), neem oil (2 ml/L), neem seed extract (30 g/L) and Callophyllum oil (2 ml/L) were tested against inflorescence caterpillars during February 2021 on cv. Bhaskara. None was found effective on tea mosquito bug and the infestation levels of inflorescence pests in all the treated inflorescences (3 sprays at 15 days intervals) after third spray were on par with the untreated ones.

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

Studies were continued to record the developmental duration and natural enemies of *Braunsapis mixta*, which is a abundant pollinating bee species in cashew and the artificial bee nests designed at ICAR-DCR, Puttur.

a. Developmental duration of *Braunsapis mixta*

Eggs of *B. mixta* were fully translucent when freshly laid and turns opaque towards hatching. Eggs are banana shaped and not glued to the nest wall. Periodical observations on fully translucent eggs indicated that eggs of *B. mixta* took maximum of 6 days to hatch with the mean incubation period of 5.32 ± 0.67 days in laboratory conditions (Table 3.3.1). Attempts made to feed the developing larvae with pollen using brush was not successful, and it was difficult to remove the pollen grains and the fecal pellets excreted by the larvae adhered over the body surface. Under laboratory conditions, the larvae after hatching remained alive up to 9 days without food, and the field collected medium sized and larger larvae remained active up to 15 and 25 days, respectively without any food. Feeding the larvae with pollen grains was not achieved in laboratory and hence, larval period could not be recorded. Considering the different stages and duration of larvae, total larval period of *B. mixta* probably



would be more than 50 days. The duration of post defecating larva lasted for 4-6 days (4.57 ± 0.68). The total pupal period ranged between 11 and 14 days, including duration of 3-5 days as pre adult. The laboratory observations with split opened sticks indicated that the adults after full development remained in the sticks for 2-3 days before started moving. Female and male bees survived up to 75 and 35 days, respectively under laboratory conditions when provided with bee flora (*Tridox procumbens*, *Wedalia trilobata*) and honey (10 %) soaked cotton swab.

Table 3.3.1 Developmental duration and adult longevity of *Braunsapis mixta*

Life stage of the bee	Mean duration (\pm SD) in days	Range duration (between days)
Egg	5.32 ± 0.67	4.00-6.00
Larvae	> 50.00	-
Post defecating larva (prepupa)	4.57 ± 0.68	4.00-6.00
Pupa		
Pupa with creamy eyes	1.07 ± 0.27	1.00-2.00
Pupa with light brown eyes	2.00 ± 0.00	2.00
Pupa with brown eyes	2.47 ± 0.52	2.00-3.00
Pupa with black eyes	3.56 ± 0.62	3.00-5.00
Body black with wing buds	3.42 ± 0.51	3.00-5.00
Total pupal period	12.51 ± 1.91	11.00-14.00
Adult longevity (with 10 % honey solution)	36.60 ± 10.49	20.00-75.00
Male	27.1 ± 4.70	20.00-35.00
Female	53.5 ± 12.38	32.00-75.00

b. Nest occupants in *B. mixta*

A highly significant positive relationship was found between the number of adults per nest and the number of eggs per nest ($r=0.61$, $p<0.001$). Similarly, highly significant positive relationships were found between number of adults and its corresponding number of larvae ($r=0.48$, $p<0.001$) as well as pupae ($r=0.39$, $p<0.001$). The positive trends of number of adults and its corresponding mean number of eggs, larvae and pupae per nest are noticeable in *B. mixta* (Figure 1). The maximum numbers of eggs, larvae and pupae found were 6, 12 and 6, respectively, in single-adult nests, and 10, 20 and 10, respectively, for the nests with four adults; but in the nests with 11 adults, the corresponding maxima recorded were only 8, 10 and 9, respectively.



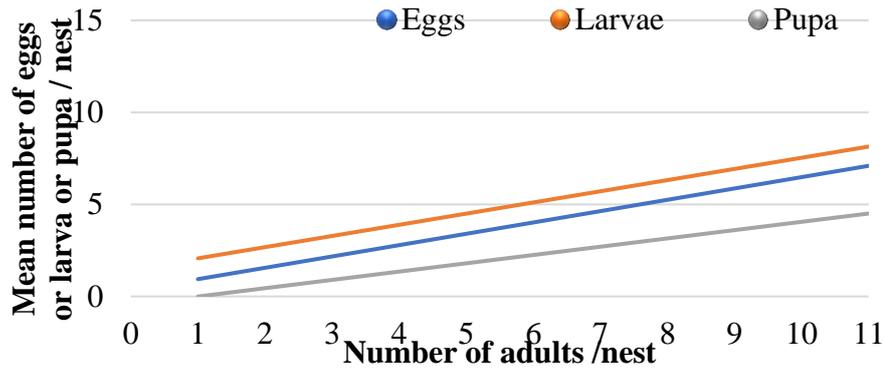


Fig. 3.3.4. Mean number of *Braunsapis mixta* eggs, larvae and pupae per nest against number of adults per nest (N=339)

c. Natural enemy - Parasitic Conopid fly on *B. mixta*

In the artificial bee nests developed for *B. mixta*, dead bees with its torn abdomen, and its body parts along with pupae of Conopid flies (Conopidae: Diptera) were noticed outside the nests during October-December, 2020. In three bees, a pupa of the conopid was seen inside the abdomen of each *B. mixta* adult confirming that the flies are parasitoids of adult *B. mixta*, which was not known earlier. Adult flies of this Conopid emerged after 12-16 days from its pupae under laboratory conditions. In general, these conopid flies are found to be prevalent endoparasitoids of many bees and wasps, often infecting high percentages of free flying individuals. Further during the observations, hyperparasitoids were also found on the pupa of these Conopid flies during October -November 2020. Both Conopid fly and its pupal hyperparasitoids were collected and preserved for their species level identification. From a single Conopid pupa, 8-13 hyperparasitoids have emerged. Developmental period of these hyperparasitoids (egg to adult emergence) varied from 15 to 17 days under laboratory conditions.



Fig. 3.3.5. A pupa of Conopid fly outside the nest and a dead *B. mixta* bee with intact conopid fly pupa.



d. Pollination efficiency studies in cashew: The bee colonies (*A. cerana indica*) kept in the cashew plantations of Bhaskara variety @ 4/ha at Shantigodu indicated that these bees aided in pollination of cashew flowers; but the rate of bee visits and resultant nut set were not significantly different compared to the other plots without bee colonies, which could be due to the presence of feral colonies in other plots. Besides in the plots where beehives were kept, honeybees moved to forage on other nearby flora also. Further observations and trials are under progress to record the pollination efficiency of *A. cerana indica* both under confined situation and open field condition.

Table 3.3.2. Honey bee visits and nut set in cashew

Details	Plot with Bee colony	Plot without bee hive
Mean number of honeybees/10 min in 10 inflorescences	1.63 (1-4)	1.54 (1-4)
Mean number of wild bees/10 min in 10 inflorescences	3.28 (2-6)	3.41 (2-7)
Mean number of nuts/inflorescences	4.75 (3-13)	4.58 (1-12)

(Mean of 20 observations, figures in parenthesis indicate minimum and maximum values)

To record the pollination efficiency of *Braunsapis* spp., fine mesh nylon net (30 M, UV stabilized) structure has been used to cover the whole cashew tree cv. VRI-3 in full bloom and the artificial bee nests of *B. mixta* were kept inside in an ant well structure. Observations indicated that these wild bees could survive even under net confinement for the whole four months flowering period observed and successfully pollinated the cashew flowers. Comparatively more nut set was recorded in the bees confined tree than the nearby open pollinated trees, and nut setting was recorded even at the end of flowering season *i.e.*, second fortnight of May month.

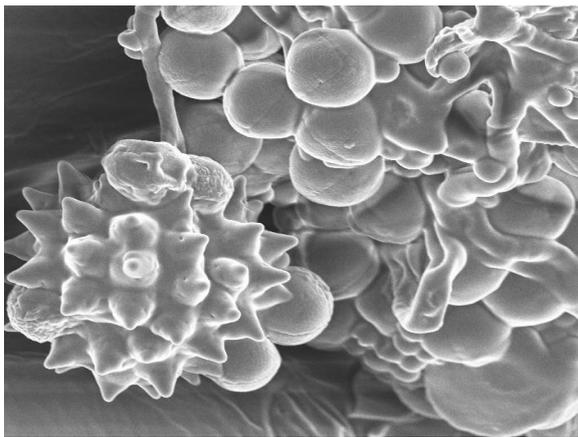


Fig. 3.3.6 A caged cashew tree with bee nests of *B. mixta* for pollination efficiency study

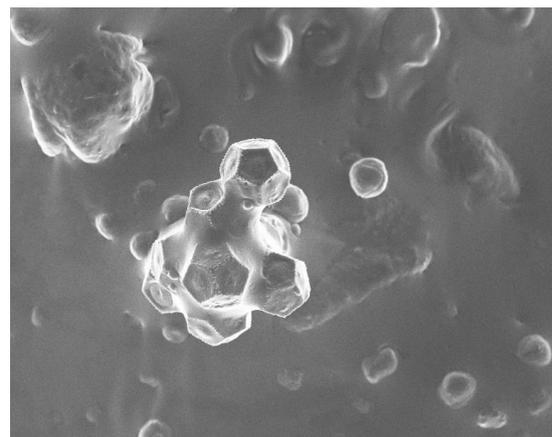


e. Bee flora

To understand the preference of bee flora by different bee species, the pollen grains collected by the bees during cashew flowering season were recorded along with pollen grains of common flora using SEM imaging. The bee bread of *Ceratina hieroglyphica* and *Braunsapis mixta* indicated presence of pollen grains of a mixture of plant species comprising *Mimosa pudica*, *Alternanthera* sp. etc, while the bee bread of another *Ceratina* sp. comprised mostly of *Alternanthera* sp. Pollen grains on *Apis cerana indica* bees returning to its hive kept in cashew plots were not primarily of cashew. But more samples during different period of a year are required to document the floral preference of different bee species.



Pollen grains inside nest of *B. mixta*



Pollen mass of *C. hieroglyphica*

3.3.5 Cashew - Tea Mosquito Bug interactions and the defensive responses

In six-years old trees of cashew varieties that were limb pruned during October first week at Shantigodu farm, flowering laterals were seen in Brazil dwarf (Nethra Vaaman) > V-7 > Dhana > Ullal-4 (very less) in the current season itself, but not in Bhaskara and Madakkathara 2. Observations indicated that spraying during initial Tea Mosquito Bug (TMB) population build-up (*i.e.*, November end or early December) was imperative to avoid yield loss in cashew and essential in early flowering varieties, as unsprayed trees yielded very less though sprays were given at later months compared to timely sprayed ones. Later sprays helped in protection against TMB in Bhaskara, Madakkathara 2 and Dhana as they again produced flowers. In another plot at Kemminje, continuous flowering and nut set even under TMB infestation was recorded in VRI-3 similar to previous years. The mean nut set/inflorescence varied from 0 to 3 in unsprayed trees (52-110 nuts/tree) compared to 1 to 6 nuts/ inflorescence in the sprayed ones (50-560 nuts/tree) in different cashew varieties. Early flowering in all varieties and unseasonal rainfall during flowering season hampered specific observations during 2020-21. Inflorescences with G2 and G3 damage grade of TMB produced 2 or 3 nuts each.



Different nutrient treatments involving KCl, Potassium silicate, calcium silicate, B, Zn and their combinations could not induce resistance to TMB in four months old cashew seedlings, as damage grade was almost 4 in all treatments under no choice test carried out with TMB nymphs. Field experiments with foliar sprays of different nutrients are under progress.

	Treatment	Dose	MeanTMB grade*
T1	Pot mixture alone	-	4.0
T2	Potassium chloride (KCl)	10 g/lit	4.0
T3	Potassium Silicate	5.0 g/pot	4.0
T4	Potassium Silicate spray 0.5 %	5 g/lit	4.0
T5	Calcium Silicate	0.5 g/pot	4.0
T6	Calcium Silicate	1.0 g/pot	4.0
T7	KCl+ Potassium Silicate spray	10 g/lit+5 g/lit	4.0
T8	KCl +Calcium Silicate	10 g/lit+ 5 g/pot	4.0
T9	Potassium Silicate spray 0.5 % +Ca Silicate	5 g/lit+ 5 g/pot	4.0
T10	Borax+ZnSO ₄ - foliar spray	2 g/lit+3 g/lit	4.0
T11	KCl+Borax+ZnSO ₄	10 g/lit+2 g/lit+3 g/lit	4.0
T12	Calcium Silicate	2.5 g/pot	4.0
T13	Calcium Silicate	5 g/pot	3.8
T14	Calcium Silicate	10 g/pot	3.8
	*Non-Significant		

Leaf samples from different nutrient treatments after 48 hours of TMB infestation were analysed for phenols, tannins and flavonoids. Significant increases in secondary metabolites were observed in all TMB infested plant leaf samples. However, the corresponding damage scores on infested shoots indicate that these secondary metabolites could not contribute to resistance against TMB. For the study on herbivore induced plant volatiles for TMB, trials have been initiated.



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

The periodical observation of different diseases was carried out in cashew nurseries and cashew farms of institute during the year 2021. The infected samples were collected along with the geographical coordinates and kept in refrigerator for isolation and confirmation of pathogen. In nursery, leaf blight symptoms were observed with different expression like irregular brown colour spots with yellow margin and later the lesions will coalesce leading to complete drying of leaf. The rotting symptoms were also observed on leaf lamina and petiole. The disease scoring was done based on percent area infected; it was found that Ullal-3 showed 40-50%, Priyanka exhibited 20-25% and Vengurla-7 with 15-20% and the remaining varieties (Bhaskara, H-130, VRI-3, Vengurla-4 and Ullal-1) showed <10% infection. During monsoon season regular monitoring of cashew germplasm was done, it was observed that high incidence of black mould and its severity in old trees as compared to young plants.

3.3.6.1 First report of Cashew leaf blight disease (CLB) in nursery

The cashew leaf blight disease samples were collected from both the nurseries of ICAR-Directorate of Cashew Research, Puttur, Karnataka during April 2021. The typical symptoms were observed in the form of minute to irregular necrotic spots at the margins of leaf, leaf midrib and leaf petiole. These spots enlarged, turn grey-silvery in colour by covering the major portion of the leaf lamina. Severely affected leaves showed blight appearance and premature defoliation (Fig 1A & B). The mycelial growth on potato dextrose agar media appeared whitish in colour. The growth pattern also had crenate margins and smooth margins, while others had smooth margins. Topography of the colonies was predominantly raised and fluffy, and zonations were also observed (Fig 1C). The conidia were fusiform, five-celled, versicoloured with three olivaceous brown median cells, two apical and basal hyaline cells. The apical cells had two to three flexuous, unbranched appendages, and basal appendage was solitary, tubular and unbranched (Fig 1D). Morphological and cultural characteristics confirmed the pathogen as *Neopestalotiopsis* sp.

Further, molecular characterization of multi genes viz., Internal Transcribed Spacer (ITS), Translation Elongation Factor (TEF), β tubulin and Large Subunit (LSU) was done to confirm the species identity. The ITS gene sequence was analysed using nucleotide BLAST in NCBI database and confirmed the species as *Neopestalotiopsis clavispora*. ITS gene sequence was submitted to NCBI with the GenBank accession No. OM679447. A phylogenetic tree was generated from the ITS sequences obtained from NCBI database. Based on cultural, microscopic and molecular characterization the pathogen was confirmed as *Neopestalotiopsis clavispora* (Fig 2). Apparently, this is



first confirmed report of cashew leaf blight disease (CLB) caused by *Neopestalotiopsis clavispora* from India

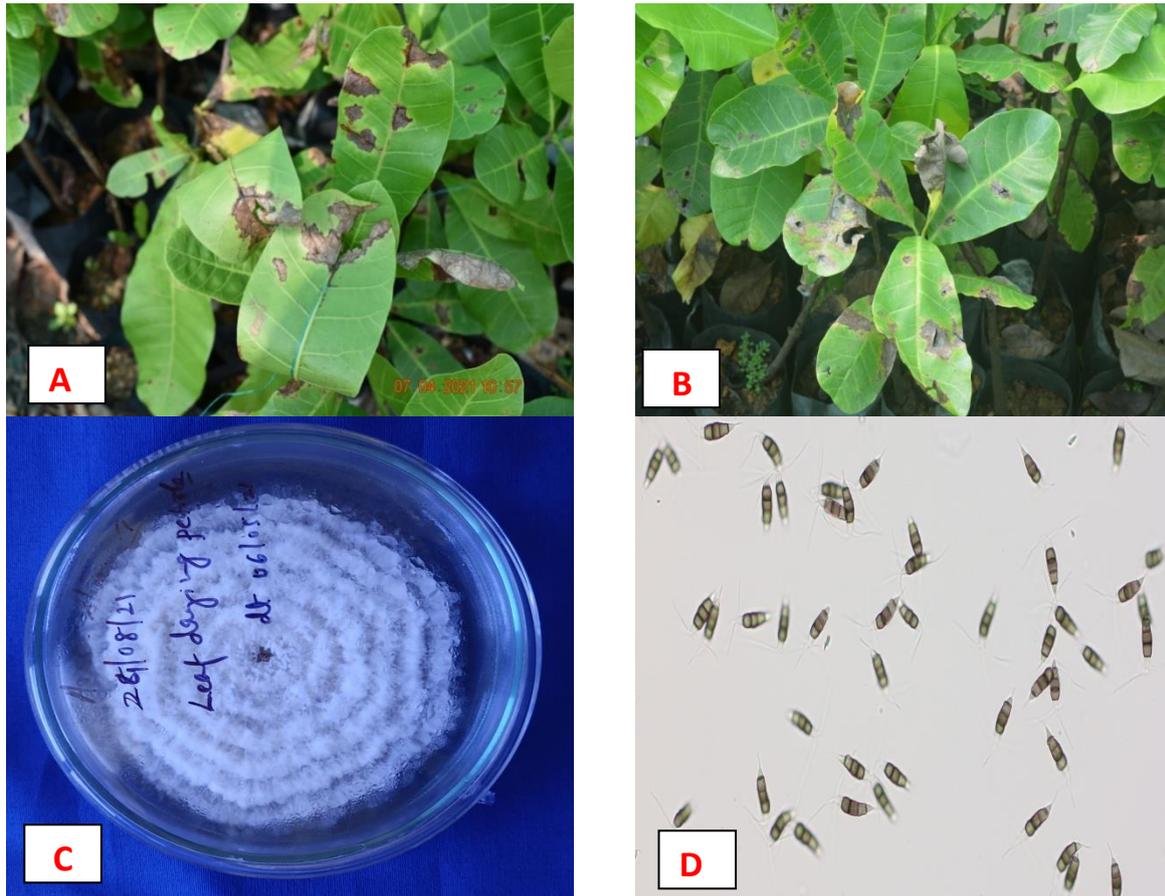
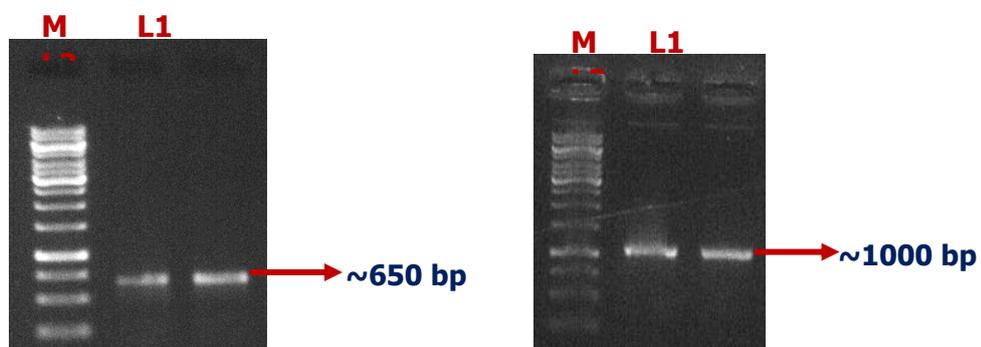


Fig. 3.3.7. (A) & (B)-Typical symptoms of cashew leaf blight disease, (C) - Pathogen growth on PDA media, (D) - Conidia of pathogen at 20x magnification



Internal transcribed spacer region

Transcription elongation factor

Fig 3.3.8: Gel picture of ITS region and TEF genes and their amplification (M- 1 Kb DNA ladder, L1- CLB pathogen from Shantigodu, L2-CLB pathogen from Kemminje)



Both Internal transcribed spacer (ITS) region and transcription elongation factor (TEF) genes were amplified in cashew leaf blight pathogen and obtained product size of approximately 650 bp and 1000 bp respectively

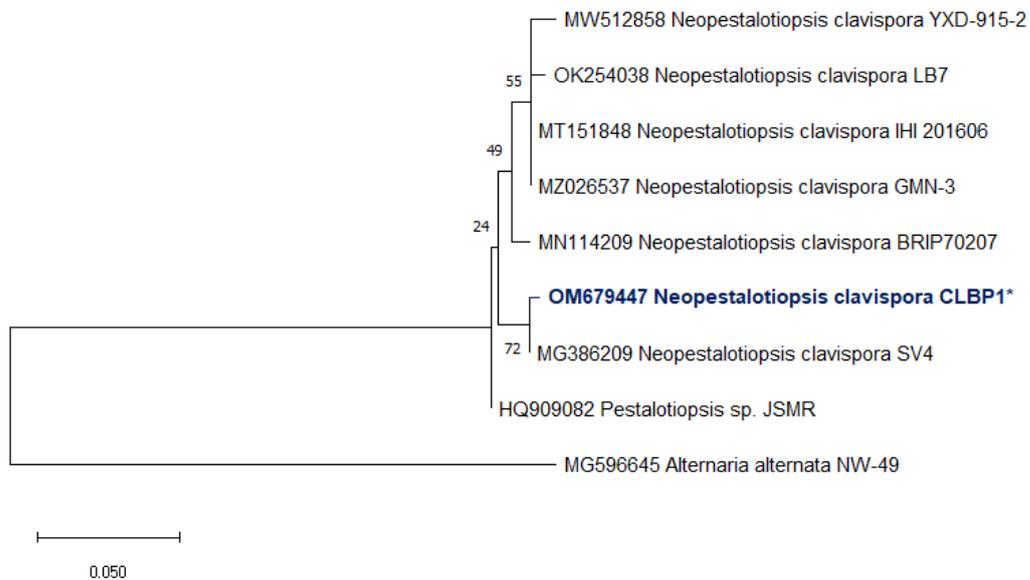


Fig.3.3.9 Phylogenetic tree showing the phylogenetic relationship of *Neopestalotiopsis clavispora* isolated from cashew (Bold with asterisk mark) with other *Neopestalotiopsis clavispora* isolates and *Alternaria alternata* as out-group retrieved from Gen Bank, using the Maximum-likelihood (ML) method.



3.4 POST-HARVEST MANAGEMENT

Priority area: Post-Harvest Technology

3.4.1 Design and development of mechanized slicer for cashew apple

A trapezoidal feed hopper with vibratory mechanism at discharge end was developed to singulate cashew apples based on dimensional analysis. Interlocking of pear-shaped fruits at outlet led to blockade. Alternatively, inclined belt conveyor was provided with trapezoidal shape buckets and attempted to lift cashew apples one by one, but it was not successful. Based on the failure analysis, a singulation system with fluted rollers conjunction with vibratory trays was designed and fabricated. In order to change the slope of the feed tray and conveying system, necessary adjustments were provided. Besides, DC power supply was given to vary conveyor speed. The improvised mechanical slicer for cashew apple consists of three sectors viz., feeding chute for bulk transfer, singulation through fluted and segmental belt conveyor and multi disc rotary slicer (Fig 3.4.1). Due to non-availability of cashew apples, it was tested with soft textured tomato fruits and minor adjustments made for better performance.



Fig. 3.4.1 Mechanical Cashew Apple Slicer



3.4.2 Design and development of moisture meter for raw cashew nuts

Calibration of moisture meter carried out with eight different varieties of freshly harvested raw cashew nuts (RCN) viz., Bhaskara, Ullal-3, Dhana, VTH-174, K-22/1, Madakkathara-2, NRCC Sel-1, Priyanka and mixed nuts. Change in the accuracy i.e., R^2 value observed between original moisture content and moisture meter value. Sensitivity of moisture meter is directly proportional to distance between the parallel plates i.e., width of the cavity resistance and surface



Fig. 3.4.2: Double cavity moisture meter

area of sensor. Increased width up to 26 mm showed erratic values and the correlation coefficient found to be 0.48. Double cavity designed primarily to increase the sensor area for better results i.e., from 420 cm² to 840 cm² (Fig 3.4.2). Size distribution of the nuts in a lot indicated that nuts having intermediate dimension of 24 mm contributes 78% and hence width of the moisture meter selected ≤ 24 mm.

Trials conducted with resistance value of 100K showed better results up to moisture content of 10% db. and beyond which it decreased correlation coefficient (Fig 3.4.3). In the case of resistance value 750K, the moisture range could be increased up to 15% db. with higher R^2 (Fig 3.4.4). Experiments with changed resistance indicated that lower resistance in the circuit results in better accuracy and higher resistance aids in longer range of moisture measurement. In the same manner, moisture meter tested for unpeeled and peeled cashew kernels with different circuit by varying resistance value from 100 to 750 K. Accuracy of moisture meter found to be better for the resistance value of 100K for both unpeeled (Fig 3.4.5) and peeled cashew kernels (Fig 3.4.6) with correlation coefficient of 0.985 (up to moisture content of 11.5% db. and 0.976 (up to the moisture content of 8.5% db.) respectively.



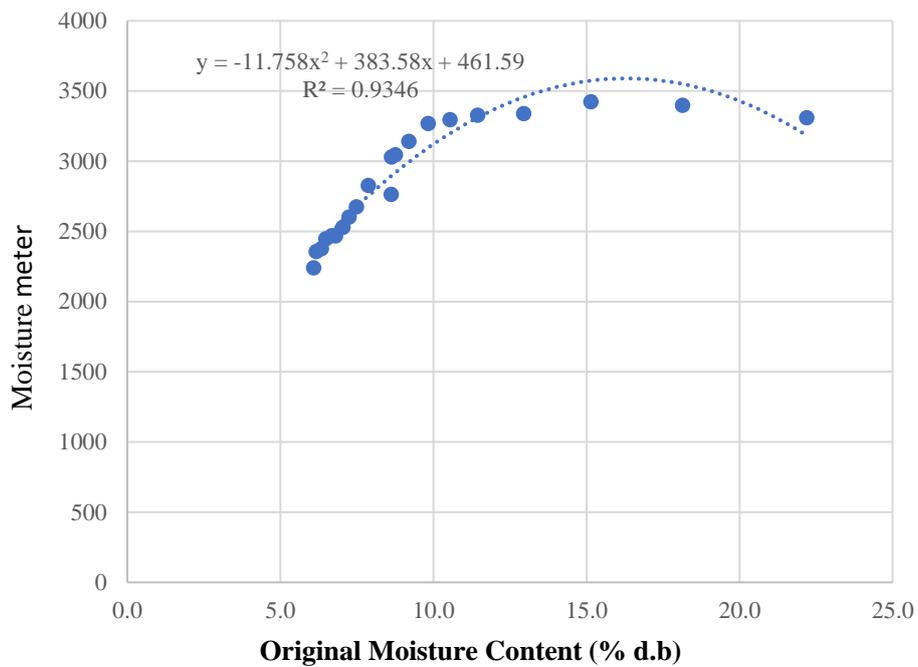


Fig 3.4.3. Response of moisture meter for raw cashewnut for the resistance value of 100K

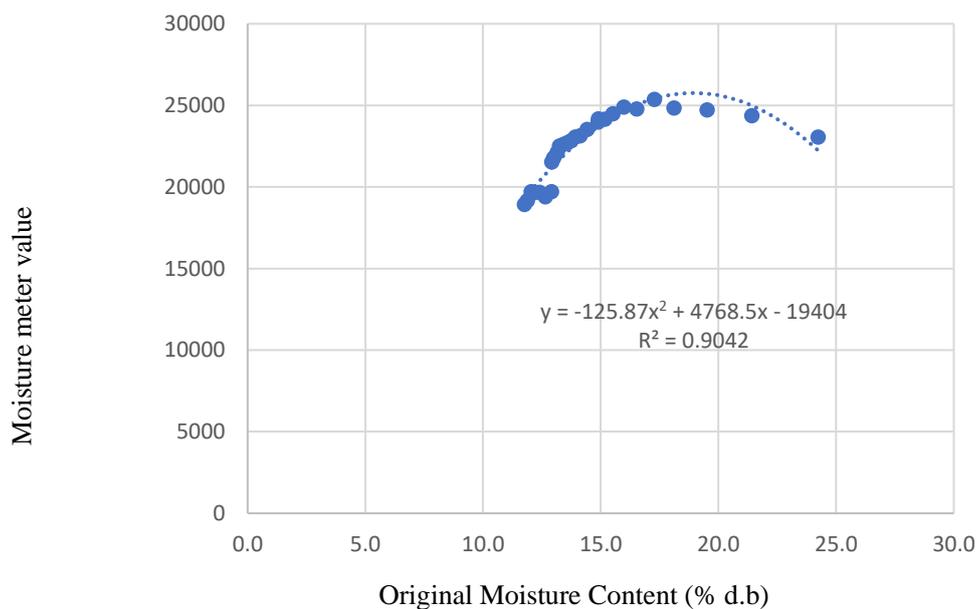


Fig 3.4.4. Response of moisture meter for raw cashewnut for the resistance value of 750K



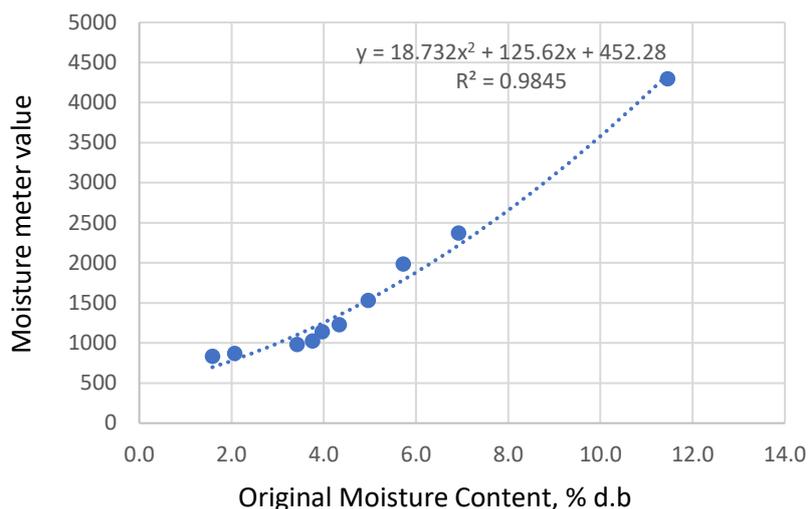


Fig 3.4.5. Response of moisture meter for unpeeled cashew kernels with resistance of 100 K

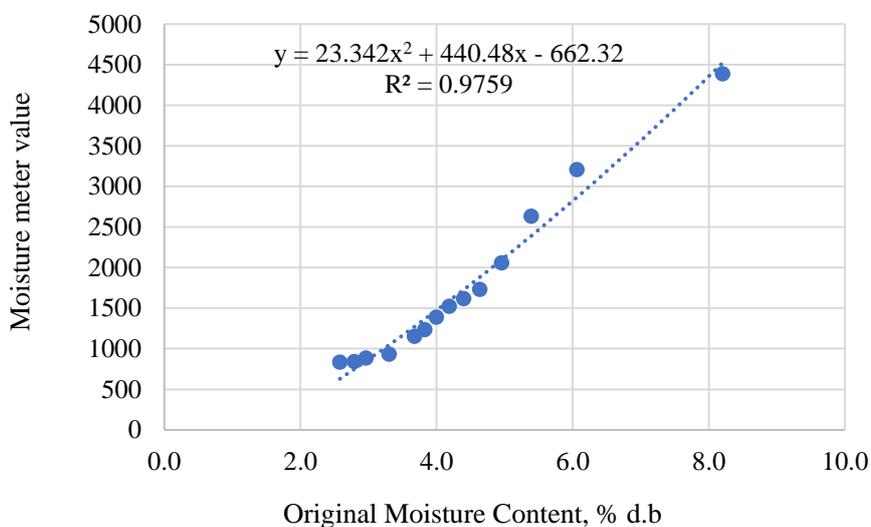


Fig 3.4.6. Response of Moisture meter for peeled cashew kernels with resistance of 100 K

3.4.3 Studying comparative performance of cashewnut processing systems in India

Diagnostic investigation carried out with processing units located in Orissa. Although annual production of cashew is around 0.93 lakh MT (14% of national annual production) from 1.83 lakh ha, demand from cashew processing units located is much more than internal production in the state and balanced quantity is derived by import from African countries to the tune of 0.35 lakh MT. There are about 400 registered units located in Rambha, Chhatrapur, Behrampur, Angargaon, Jaipur, Puri, Cuttack,



Dhenakal, Gajapathi, Angul, Mayurbanj, Koraput, Khurda etc., About 50 no. of units are operating with capacity > 5 TPD (Tonnes per day); 50 units with 3-5 TPD, 200 units between 1 and 3 TPD and 100 units < 1 TPD.

Major problem associated with highly mechanized units are i) Discoloration of cashew kernels due to various degree of thermal exposure at SB (Steam boiling) and KD (Kernel drying) ii) Higher breakage of kernels iii) No energy budget iv) Non-compliance of food quality v) Negligence on human safety vi) Improper flow of material from beginning to end (Plant layout) vii) Non-availability of skilled service for repair and maintenance viii) Improper packaging without inert gas flushing to increase shelf life ix) Inadequate supply of quality raw cashew nuts at reasonable price x) Non-compliance of quality assessment of raw cashew nuts due to large gap between demand and supply etc. On an average processing cost worked out to be less than Rs10 per kg of raw cashew nuts irrespective of location indicating an increase in volume of production proportionately reduces the cost incurred.



Processing cost in semi-mechanized system in this region, worked out to be in the range of Rs 12 to Rs 14 per kg of raw cashew nut due to labour wages per head i.e., Rs 300-350 per head per day. As there is an increase in the production of whole kernels, processors are continuing with the semi mechanized system and it out numbered other classification of cashew processing units i. e., fully mechanized and labour oriented. Discoloration and more breakage of kernels, and low degree of cleanliness are the primary problems identified with these units.

As such, there are no cashewnut processing units operating completely labour-oriented processing except conditioning the nuts with steam and kernel drying by hot air convection. This category processing units operating with ≤ 1 TPD and the women



work force deployed in all stages in the kernel extraction process. Processing cost worked out to be Rs 13-15 per kg of RCN depending on the location. These units are mostly depending on large scale units for supply of raw cashew nuts during lean period to operate the unit round the year.

A new concept of 'Cashew Cluster' is followed in the state supported by Govt. of Orissa which is followed by M/s Jaganath Cashew Cluster, Rambha and Kalpataru nut Pvt. Ltd., Ganjam. These clusters are cooperative unit linking over 20 units to utilize common facility of kernel grading and packaging. It has been certified with 'Organic Cashew Producer' having followed terms and condition of 'Organic certification' and operating under Farmer Producer Organization (FPO). It aids, processor to interact at common point about various aspects of processing and technical solutions for adoption.

In general, diagnostic investigation revealed that volume of production is inversely proportional to cost of processing. Quality and quantity of raw cashew nuts in the line of processing contributes 2/3rd of the total processing cost and decisive factor on profitability. Processors resort to mechanization due to scarcity of labour force, but due to increased realization, majority switched over to partial to full mechanization. Supply of efficient machinery and service provider become need of the hour.

3.4.4 New Optimizing processing parameters in cashew for enhancing whole kernel recovery

Moisture has strong bearing on shelf life of raw cashew nuts and its economic part, cashew kernel. Subjective method of assessing moisture content is in vogue i.e., sensation of metallic sound while rubbing raw nuts between palms of hand. Moisture meter aids in determining the moisture content accurately and in turn it enables safe storage of this seasonal crop without spoilage. Moisture content of raw cashew nuts is a decisive factor for conditioning by steam to extract whole kernels after shelling. Fixing various process parameters at various stages i.e., drying, humidification, peeling and packaging depends on moisture content.

Therefore, the whole process of cashew is orienting based on moisture and it is the need of the hour to optimize processing parameter influencing the white whole kernel recovery in cashewnut processing for higher economic returns. Optimization is an important tool in making decisions and in analysing physical systems. A project has been contemplated to maximize the profit by adopting appropriate optimization technique or methodology in conversion process to extract edible cashew kernels especially white whole kernels. In this regard, as per directives of council, a project proposal is submitted to Chhattisgarh State Minor Forest Produce (CGMFP) Federation, Chhattisgarh, seeking financial assistance.



3.4.5 Development of ready to eat alternate snack food using cashew apple – Extrusion and Vacuum frying approach

Economic utilization of cashew apple has not progressed to the desired level in spite of excellent qualities of cashew apple and the availability of technologies for its processing to various value-added products. Improving shelf life of perishable cashew apple is a challenging one and making it available during lean season is essential to operate cashew apple-based industry round the year and make it economically feasible. At this juncture, converting perishable cashew apple in to stable cashew apple powder or converting in to size reduced form to manufacture ready to serve snack food is the only solution to derive wealth from waste. In this regard, this project is proposed to utilize cashew apples in two different innovative approaches viz., extruded snack food using cashew apple powder and vacuum fried snack food utilizing cashew apple slices.

3.4.6. Development of dehydrated products from cashew apple and sprouts

The estimation of Bio-availability of minerals in cashew sprout was repeated in 2021-22. The mineral extract was done by the procedure suggested by Nagaraja (2010) and mineral components were analyzed through AAS. According to the results obtained (Fig. 3.4.7), the germination process enhanced the mineral content from 0 to 209 folds. This process enormously increased the phosphorous (114 folds) and selenium (209 folds) compared to cashew kernel. But the potassium content remains same in both cashew sprout and kernel.

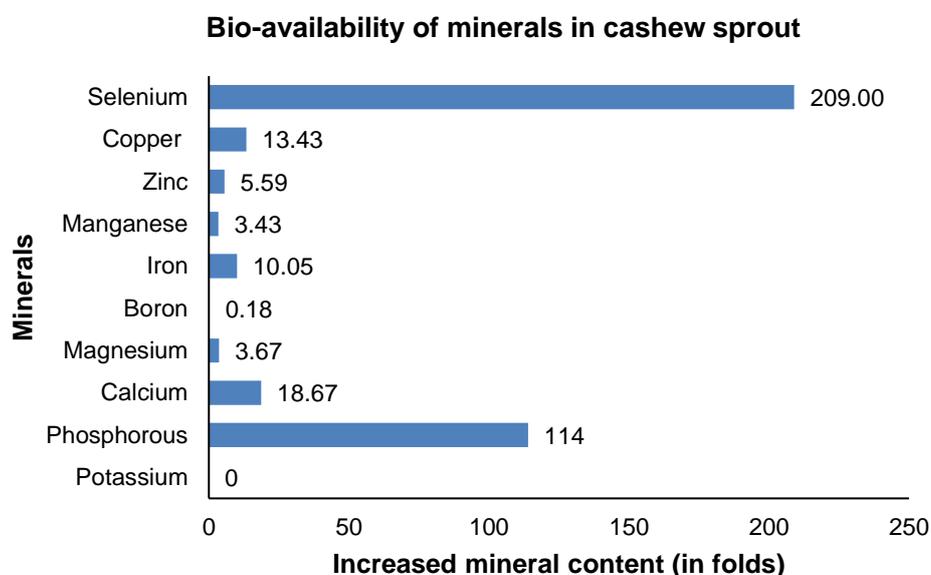


Fig. 3.4.7. Bioavailability of minerals in cashew sprouts



3.5 CONCLUDED PROJECTS

3.5.1 Studies on pruning and phenology in cashew

Project Leader : J. Dinakara Adiga
Project Associates : B. M. Muralidhara
Siddanna Savadi
Preethi, P.
V. Thondaiman

Project duration : 9/2018 to 10/2021

Introduction

Cashew (*Anacardium occidentale* L.), is one of the most important plantation crops of India. The major cashew growing states are Maharashtra, Kerala, Karnataka, and Goa, on West Coast and Tamil Nadu, Andhra Pradesh, Orissa, West Bengal on East coast. Presently, India has the largest area under cashew and also largest producer in the world. The cashew occupies 1.04 million ha in the country with 0.78 million tonnes production (2016-17). Nevertheless the productivity is still around 750 kg per hectare. It is mainly due to large area of old senile orchards, low plant population, poor canopy management and non-adoption of improved package of practices. Earlier works were attempted to standardize pruning techniques for improving nut yield (Mohan and Room Singh, 1988, Aneesa Rani *et al.*, 2011, Prasanna Kumar *et al.*, 2015 and Murali *et al.*, 2015). These studies proved that cashew will responds well for pruning and helps in improving productivity. However, no package of practice is available to advise farmers on pruning intensity and timing of pruning. The pruning response will also vary from variety to variety. Hence, a systematic study is required to standardize the intensity of pruning in different varieties which are commercially grown under coastal belts of Karnataka.

Identification of critical phenological stages is very much important for adopting better crop management practices such as pruning and training, nutrient management, irrigation, pest and disease management. The phenology studies also help in crop improvement programmes and characterization of germplasm. The phenological studies were carried out in mango, guava, bael, aonla, dragon fruit, sapota by using *Biologische Bundesantalt Bundessortenamt und Chemische Industrie* scale (BBCH) by different researchers (Rajan *et al.*, 2011). However, there is no work has been taken so far in cashew. Hence, present study is formulated to identify the critical phenological stages in cashew by using BBCH scale in pruned as well as unpruned trees.



Objectives

1. To study the effect of pruning intensity and time for on growth and yield of cashew and
2. To identify critical phenological stages in cashew under pruned and unpruned conditions (BBCH scale).

Results

The phenological studies were carried out in cashew cultivars Ullal-3 and Bhaskara by using Biologische Bundesantalt Bundessortenamt und Chemische Industrie (BBCH) scale. Hundred shoots were tagged in each cultivar during the month of August 2017 for recording observations. The observations were recorded twice weekly.

Principal growth stage 0: Vegetative bud development

After a quiescent phase, the vegetative buds start swelling and burst to form leaf primordia which differentiate into leaves through a series of developmental stages. The bud initiation starts in after the rainy season (September – October). However, the flushes occur two or more times during an annual growth of cashew.



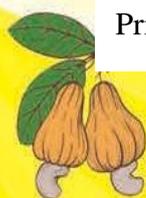
Principal growth stage 0: Vegetative bud development stages (000, 011 ,013, 017, 019 from L-R)

Principal growth stage 1: Leaf development

Leaf primordia visible after withering of bud scales will develop into leaves by passing through sequential developmental stages. Further, the leaf development occurs in parallel with the shoot development. Distinct shoot visibility occurs towards end of the leaf development (119).



Principal growth stage 1: Leaf development stages (110, 111 ,115, 117, 119 from L-R)



Principal growth stage 3: Shoot development

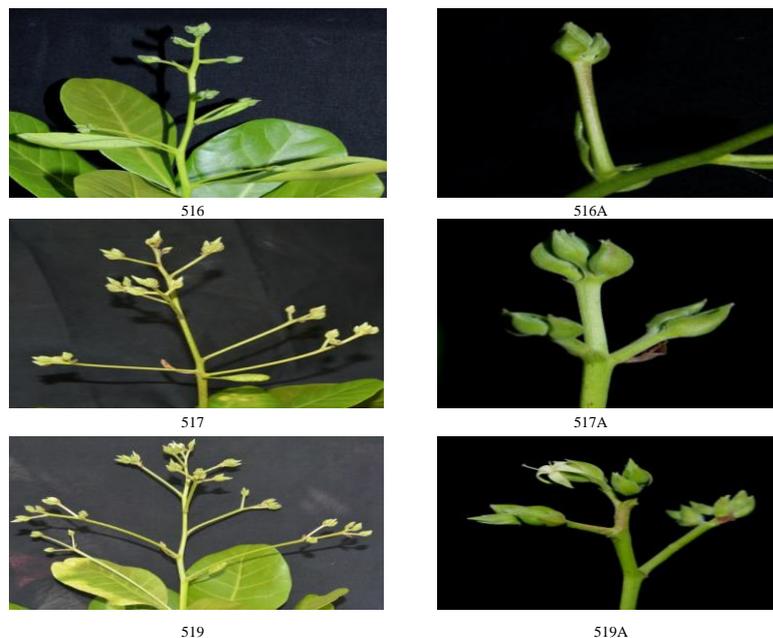
Shoot elongation and development continues along with the leaf development. Finally, the leaves turn into leathery green and shoots become woody in 5-7 weeks.



Principal growth stage 3: Shoot development stages (311,313,315,317,319 from L-R)

Principal growth stage 5: Inflorescence development

In cashew, inflorescence emerges terminally from current season shoots during winter. Reproductive buds develop into inflorescence. During inflorescence development, panicle expansion occurs with the formation of laterals and sub laterals in a sequential manner to form a complete panicle in 4-6 weeks. Shoot development continues in parallel with the inflorescence development (311-317). The inflorescence emergence begins in November and more than 80% inflorescences emerge between third week of November and third week of December. The inflorescence development stages were redefined with codes 516A, 517A and 519 A for better clarity in defining stages with codes.

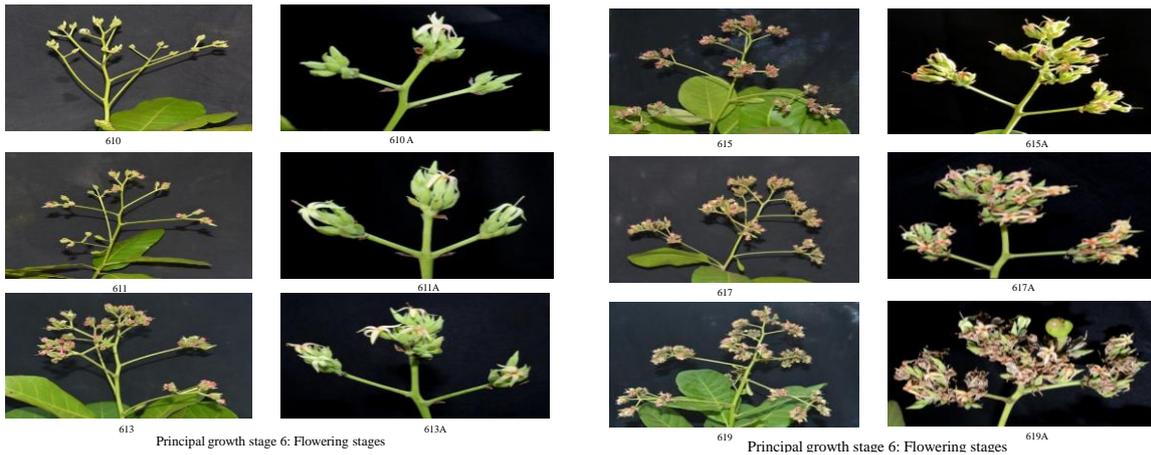


Principal growth stage 5: Inflorescence development stages



Principal growth stage 6: Flowering:

Flowering begins in the second week of November and the peak flowering occurs during January and February months. In cashew, two types of flowers are found viz. hermaphrodite and staminate flowers. The freshly opened flowers are white in color and turn into pink after few hours of opening. The Inflorescence development also continues with flowering and in a panicle, about 600-800 flower buds formed and opened sequentially. The secondary flowering stages were defined on the basis of percentage of flowers opened viz. 10% of flowers opened and so on till 90% flower opened. The flowering stages were redefined with codes 610A, 611A, 613 A, 615A, 617A and 619A for better clarity in defining stages with codes.



Principal growth stage 7: Nut and apple development

In cashew, along with true fruit (cashew nut), flower pedicel swells and develops into the false fruit called as 'cashew apple'. In the initial phase, nut develops at a faster rate and attains the maximum size whereas apple develops slowly and attains about 10% of its final size by the end of nut development. After fertilization, the nut develops slowly up to 30% of its final size (i.e. lag phase) and later grows rapidly (log phase of growth) to attain the maximum size. Both nut and apple developments follow a simple sigmoidal growth pattern. For describing the secondary stages, growth characteristics of both nut and apple (percentages of final size) were taken into account.



Principal growth stage 7: Fruit and Nut development stages (701,703,705,707 and 709, L-R)



Principal growth stage 8: Nut and apple maturity

After nut attaining the maximum size, nut undergoes desiccation and shrinks and colour changes from dark green to grey in 8-10 days. At the same time, apple rapidly develops to reach final size and undergoes maturity. The secondary stages of nut and apple maturity were assigned taking into account the growth (size in percentages) and maturity (colour changes) characteristics of both were taken into account.



Principal growth stage 8: Nut and apple maturity stages (811,813,815,817 and 819, L-R)

It was found that the tender shoots (110 to 313), developing panicles (511 to 519) and flowering (611 to 615) are highly susceptible to Tea Mosquito Bug (*Helopeltis antonii*), expanding tender leaves (119 to 313) are susceptible to leaf miner (*Acrocercops syngramma*) attack, and developing nuts and apples (715 to 811) are more susceptible to apple and nut borer (*Thylocoptila paurosema*).

Table 3.5.1. The phenological stages identified as critical for pest attack in cashew

Stage code	Pest
110-313 (tender shoots)	TMB
511-519 (developing panicles)	TMB
611-615 (flowering stages)	TMB
119-313 (expanding tender leaves)	Leaf miner
715-811 (Nut & apple development stages)	Apple & nut borer

The different phenological stages in cashew as per BBCH scale can be summarized as follows.

Principal Stages	Code	Description
Vegetative bud development	010	Dormant stage: buds covered with brown or brownish green scales
	011	Beginning of bud swelling: swollen bud, brownish scales are intact
	013	End of bud swelling: scales completely separated; light green bud visible
	017	Beginning of bud break: bud completely visible



	019	End of bud break: leaf tip visible above the bud scales
Leaf Development	110	Separation of leaf scales: leaves start emerging
	111	First pair of leaves separated: Leaf petiole visible
	115	More leaves separated: more number of leaves separated
	117	More leaves unfolded: slightly expanded, appearance of coppery shades on leaves
	119	All leaves unfolded: Leaves unfolded and expanded
Shoot Development	311	Beginning of shoot growth: 10% of final shoot maturity, axis of developing shoots visible, coppery brown leaves
	312	Shoots at 20% maturity: shoots about 20% of final maturity, light green colour, smooth texture, flexible shoots, leaf are dark copper green
	314	Shoots at 40% maturity: shoots about 40% of final maturity, upper leaves are copper green and smooth, lower leaves are green
	317	Shoots at 70% maturity: shoots about 70% of final maturity, brownish green and smooth shoots, leaves are dark green and leathery
	319	Shoots at 90% maturity: shoots completely matured, leaves are fully developed, dark green colour, leathery
Inflorescence development	511	Beginning of reproductive bud swelling: Inflorescence bud visible
	514	Elongation of panicle: panicle expands, separation of laterals begins, keel leaf clearly visible
	515	More laterals separated: laterals elongation continues
	516	Separation of sub laterals: sub laterals start separating from main laterals, keel leaf green in colour and intact
	517	More sub laterals separated: about 80% of sub laterals separated and elongated, keel leaf dried and withered
	519	End of panicle development: laterals fully developed, sub laterals elongation continues, swollen flower buds
Flowering stages	610	First flower opened: First flower opened
	611	Beginning of flowering: Up to 10% of flowers opened, newly opened flowers are white and older flowers are pink in colour
	613	Early flowering: About 30% flowers opened
	615	50% flowering: About 50% flowers opened
	617	70% flowering: About 70% flower opened and early opened flowers dry
	619	End of flowering: First nut set
	620	Barren panicles: Panicles without nut set
	701	Nut at 10% of final developmental stage: nut at about 10% of the final developmental size, soft and



Nut and Apple development		spongy, style is attached, 90% of the nut cavity is filled, mostly filled by whitish testa Apple: about 2.5% of final cultivar apple size
	703	Nut at 30% of final developmental stage: about 30% of the final developmental stage size, soft and spongy, about 50% of the nut cavity is filled, visible kernel, nut shell grows rapidly compared kernel and testa Apple: about 5% of final cultivar apple size
	705	Nut at 50% of final developmental stage: about 50% of the final developmental stage size, soft and spongy, about 50% of the nut cavity is filled, kernel about 10% of final size Apple: about 7.5% of final cultivar apple size
	707	Nut at 70% of final developmental stage: about 70% of the final developmental stage size, about 90% of the nut cavity is filled, whitish testa thickness attains maximum size, kernel about 80% of final size, nut surface colour is green Apple: about 10% of final cultivar apple size
	709	Nut at 90% of final developmental stage: about 90% of the final developmental stage size, about 100% of the nut cavity is filled, kernel about 90% of final size, testa thickness is drastically reduced and inside color turns brownish, nut surface color is green, inner shell colour turns olive green Apple: about 15% of final cultivar apple size
Nut and apple maturity	811	Physiological nut maturity: nut size reduced, physiologically mature, shell colour turns dark green, appearance of grey at suture region, inside shell colour turns brown, testa inner colour is brown, Kernel- slightly hard and ivory colour Apple- About 20% of final cultivar size, surface colour is green, pulp is white in colour
	813	Beginning of nut maturity: whole nut colour turns to greenish grey, inside shell colour turns to dark brown, hardening of nut Apple- about 30% of final cultivar size, surface colour is green, pulp is white in colour
	815	Advanced nut maturity: Nut colour turns to whitish grey Apple- about 50% of final cultivar size, surface colour is yellowish, pulp is white in colour
	817	Post advanced nut maturity: Nut colour turns to ash, Apple- about 70% of final cultivar size, shades of yellow or orange colour appear, pulp is slightly yellowish in colour
	819	Horticultural maturity: nuts and apple are fully mature



Apple- attains about final cultivar size, surface colour is cultivar dependent (yellow/red/orange), pulp is yellowish in color

Influence of time of fertilizer application on phenology of cashew cultivars Bhaskara and Ullal-3

The influence of time of recommended dose of fertilizer (RDF) application was carried out in cashew cultivars Ullal-3 and Bhaskara. The RDF of fertilizer was applied in the months of July, August and September and the observations for different phenological growth stages were recorded at fortnightly interval from October, 2019 onwards. The study showed that the buds were at 010 stage (dormant stage) till first fortnight of October, 2019 invariable to cultivar and time of fertilizer application. When the time of fertilizer application is considered, July application advanced the flowering and fruiting invariable to cultivars.

Nitrogen content was estimated for leaf and soil samples were collected from cashew varieties Bhaskara and Ullal-3 to study the influence of time of fertilizer application (recommended dose of fertilizer) in altering the phenology of cashew trees. In Bhaskara, based on time of fertilizer application, the average nitrogen content in leaves has increase from 0.777% to 1.034% in August application, indicated that the august application encourages maximum intake of nitrogen in Bhaskara. Whereas in Ullal-3, the maximum nitrogen intake was recorded in July application.

The time of application of fertilizers did not have any influence on yield of both cultivars

Effect of pruning on production of flower panicles and yield in cashew

The pruning of six years old cashew trees was carried out during the months of June, July, August and September with 25 and 50 % leader shoot pruning, 25 and 50 % lateral shoot pruning and trees without pruning served as control. The trees pruned with 25 % of the lateral shoots during mid-September recorded maximum number of panicles per tree (80.50) and nut yield per tree (6.80 kg/tree) compared to un-pruned trees (47.50 per tree and 2.99 kg/tree respectively). The results also revealed that pruning in the month of June has failed to produce any panicles and thereby no nut yield. Besides, the leader shoot pruning (both 25 and 50 %) was not effective as it resulted in the production of minimum number of panicles and nut yield per tree.





Fig 3.5.1: View of 6-year-old cashew tree after pruning



Fig 3.5.2: Fruit set in trees pruned in September to 25% lateral shoot level

Table 3.5.2. Effect of pruning on flowering and yield in Bhaskara variety

Treatment	No. of panicles/tree	Yield (kg/tree)
June @25% leader	0	0
June @50% leader	0	0
June@25% lateral	44.00	3.70
June@50%lateral	21.00	1.76
July @25% leader	29.50	2.48
July @50% leader	6.50	0.55
July @25% lateral	23.50	1.97
July @50%lateral	17.00	1.43
August @25% leader	18.00	1.51
August @50% leader	36.00	3.02
August @25% lateral	23.50	1.97



August @50%lateral	53.00	4.45
Sep @25% leader	38.00	3.19
Sep @50% leader	25.00	2.10
Sep @25% lateral	80.50	6.80
Sep @50%lateral	71.50	6.01
CONTROL	47.50	2.99
CD at 5%	37.07	3.11

Conclusion

Being an economically and nutritionally important nut crop, cashew is gaining popularity across the world. Understanding the phenological stages and assigning specific codes will help in adopting timely crop management practices suitable to various production systems such as high-density planting, rainfed agriculture etc. in different parts of world. Also, it allows exchange of scientific information obtained from experiments in different environmental conditions by cashew researchers.

The study, being first of its kind at global level could identify 8 principal growth stages in cashew as per extended BBCH scale. The proposed scale and descriptions of phenological stages will have broader implications for cashew improvement and management. Further, the proposed scale could also be applied for assigning codes and describing phenological growth stages in the related species with similar physical and growth features like *A. pumilum*, *A. microcarpum* etc. with few minor modifications. The study also identified the critical stages for vulnerability to pest attack which will help in better pest management practices in cashew. With regard to pruning, it is recommended that the pruning of 25 % lateral shoots during in the month of mid-September is ideal for obtaining high yield in cashew variety Bhaskara under west coast conditions of Karnataka



4. TRANSFER OF TECHNOLOGY AND EDUCATION

Priority area: Transfer of technology and knowledge management

4.1 Farmer-Scientists Interaction

Farmer participatory soil and plant health management – An attempt for improving the livelihood of cashew farmers of coastal Karnataka under RKVY-RAFTAAR

A project funded by Rashtriya Krishi Vikas Yojana - Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RKVY-RAFTAAR), Govt. of Karnataka was initiated to create a state-of-the-art laboratory facilities and demonstration plots to showcase the usefulness of improved technologies to realize higher yield and income to the cashew growers of Karnataka in particular and other regions in general. Under this project on-farm and off farm demonstrations (59 Nos) were carried out.

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.



4.2 E-Extension

An AI-based app for identification of pests and diseases in cashew

A detailed story board of the AI based app "Cashew Protect" was written. More than 800 images of various cashew pest and diseases and nutrient deficiencies were collated from scientists of ICAR- DCR, Puttur and AICRP centres for the purpose of database development. The logo of the 'Cashew Protect' was designed. The development of the app and the website is under progress.

Kiosk and software for cashew farming

A modern plant health clinic museum with interactive ICTs have been set up for cashew at the ICAR-Directorate of Cashew Research, Puttur. Kiosks and touch screen with custom made software made available in the museum let the farmers, students, researchers and other visitors to explore areas of their interest. Farmers can compare

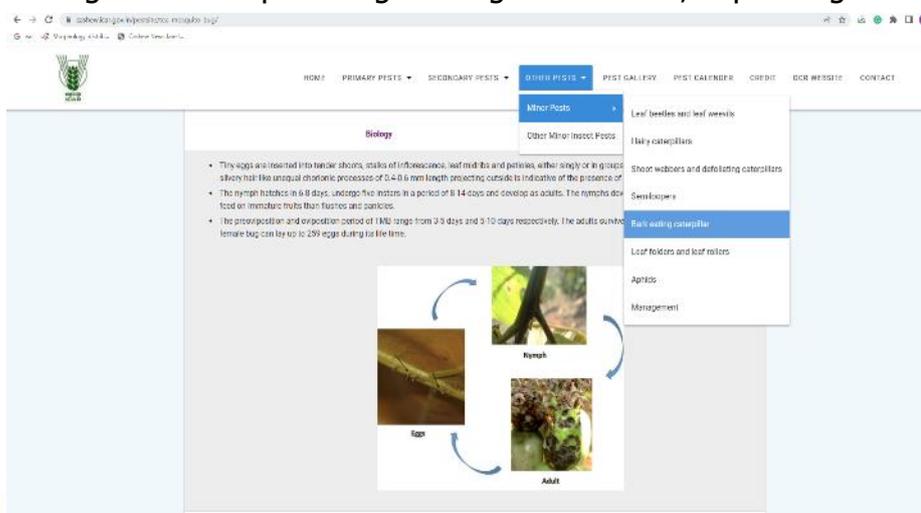


the symptoms of various diseases, disorders, pest damages, nutrient deficiencies and find out the remedial measures on their own. The following offline softwares were developed.

Sl. No.	Name of the offline Software	Details of the software
1	Cashew Site Suitability Evaluator	Many farmers in nontraditional areas are now-a-days switching to cashew, due to its drought hardiness and limited care requirements. In newer areas, the site suitability is important factor deciding the success of plantation. This calculator is aimed at identifying site suitability.
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 shall empower farmers to identify the diseases affecting cashew based on various symptoms and suggest remedial measures.

Cashew Pest Database

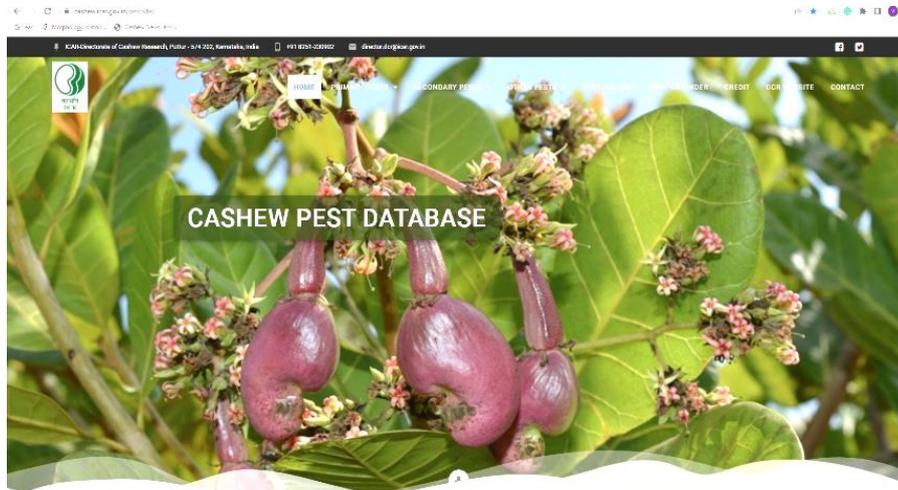
Cashew plantations are rich in biodiversity and globally, more than 400 species of arthropods are known to infest cashew. In India alone, there are about 200 insect pests infest cashew during its various phenological stages. However, depending on the climate, location and age of the plantation, each geographical region may have its own distinctive pest complex. Knowledge on insect species, pest status, season of occurrence,



symptoms of pest damage, natural enemies aid to plan suitable management measures. Cashew Pest Database developed at ICAR-DCR, Puttur gives access to all



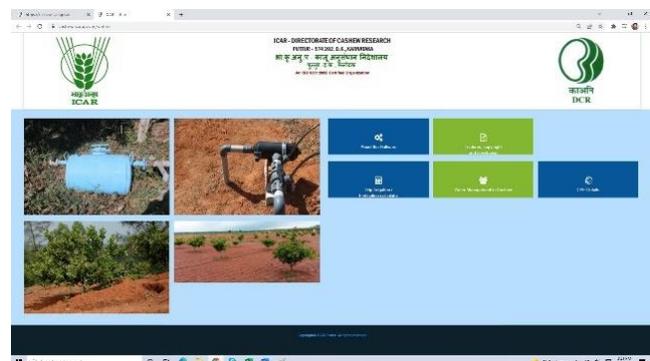
the above aspects of common pests infesting cashew at a single site under fields: primary pests (TMB and CSRB), secondary pests and other pests (minor pests). 'Pest gallery' consists several images of pests and their damage with a short description. 'Pest Calender' provides pictorial information on season of occurrence of important pests. This site will be helpful for those interested in cashew cultivation and its pest management in the country.



URL: <https://cashew.icar.gov.in/pestsites>

Water and leaf based nutrient management softwares

In India, the vegetative development of cashew occurs during the rainy season and the reproductive phase during the dry season. Although cashew is grown in high rainfall environment, it experiences severe moisture stress during January to May with the highest water deficit from March to May. Incidentally, the critical growth phases such as flushing, flowering and nut formation in cashew also occur during these periods. Any form of biotic and abiotic stresses during these periods adversely affects the flowering and fruit set and result in premature nut drop and finally reduces the yield and productivity of cashew. Lack of moisture availability during the fruiting season is one of the several factors associated with the low yield in cashew. Studies have shown that supplemental irrigation can significantly improve the productivity and yield of cashew. The software was developed with bilingual functionality shall help growers to schedule irrigation for their own fields themselves. Leaf nutrient status serve as quick diagnostic tool for nutrient management in cashew. A software was developed to help growers and decision makers to quickly assess the nutrient demand of cashew.

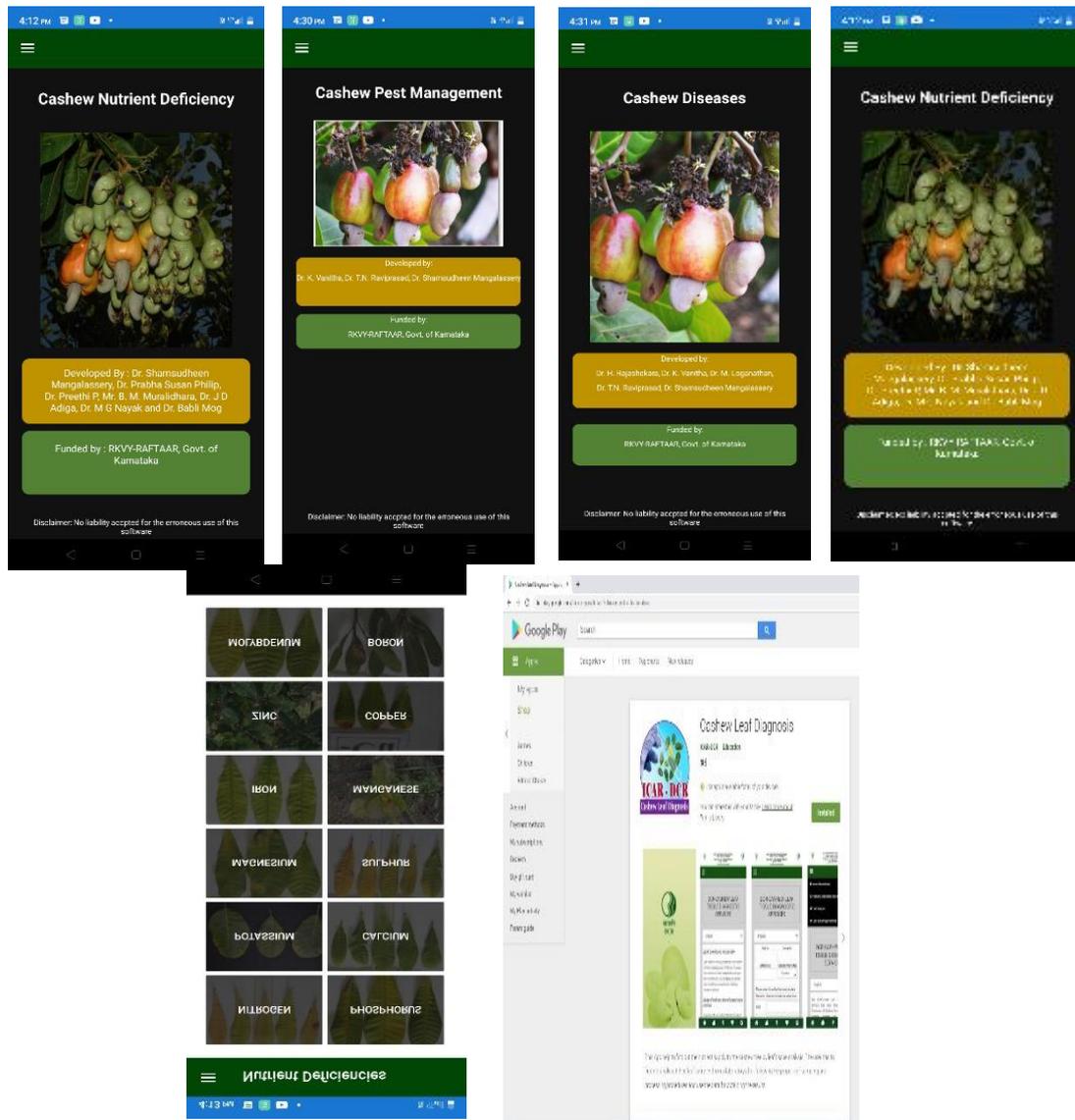


Sl. No.	Name of software	Short description
1	DCR- Cashew Drip/Fertigation Calculator	The scheduling of irrigation and application of correct doses of fertilizers through drip are important which depends on many factors. Under the actual field conditions, the no. of drippers, flow rate, availability of 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 resources
2.	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 4 th and 5 th 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 and afterwards it can be diagnosed with this software

The mobile versions of various software were also developed and the same are listed below.

Sl. No.	Details of mobile app
1.	DCR-Cashew Nutrient Manager – Offline
2.	DCR- Cashew Drip/Fertigation Calculator
3.	Cashew leaf diagnosis
4.	Cashew Site Suitability
5.	Cashew Nutrient Deficiency
6	Cashew pest management
7	Cashew diseases





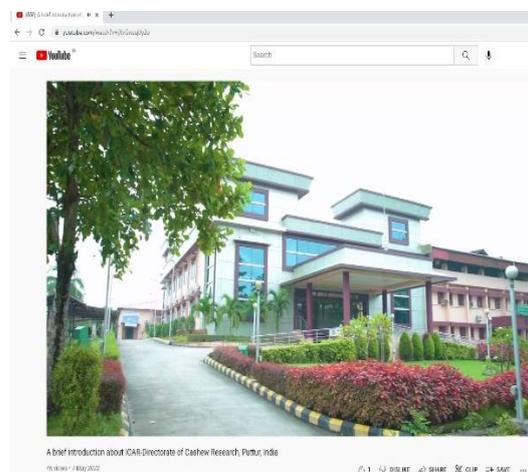
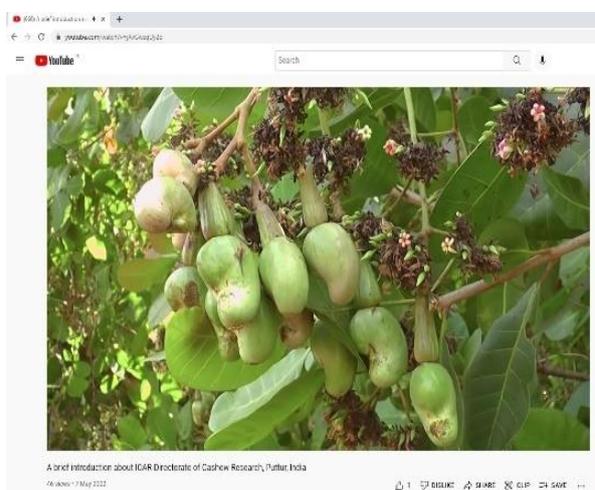
An exclusive android application for cashew cultivation

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 10 languages for 11 states with the inputs from AICRP centres on cashew. The app was saturated with data sets during the year. A total of 11,606 grafts have been booked via the app so far by farmers. The Google Play store rating of the app is 4.3 and the app is downloaded 2817 times. The work on development of second version of the app is under progress.



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 stakeholders.

Sl. No.	Title
1.	Cashew production technology
2.	High density and Ultra density planting in cashew
3.	Nutrient management in cashew
4.	Water management and soil and water conservation in cashew
5.	Management of TMB in cashew
6.	Management of CSRB in cashew
7.	About DCR
8.	Training and pruning in cashew



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

The designing of cashew parlour and establishment of processing unit is under progress.

4.3 Interaction with students on scope of agriculture education and job opportunities

As a part of Agriculture Education Day, students of classes 6, 7 and 8 were invited on 3rd December, 2021 for an orientation lecture on "Opportunities in Agriculture". Students of Narendra Pre University College and Government school in Mottethadka were invited for the talk. Dr. Eradasappa E, Senior Scientist, Genetics and Plant



Breeding gave a informative and detailed talk on the scope of agriculture education, pursuing higher studies and the job opportunities available.

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

During the year 2021, a total of 36 farmers have been given financial assistance as per MIDH guidelines for expanding the cashew area in 117.65 acres. In Shimoga district, 61.54 acres belonging to 25 farmers were covered. In Chitradugra district, 56.11 acres belonging to 11 farmers were covered. During the inspection, advisory for pruning, maintenance and fertilizer application was given.



4.4 Exhibitions

ICAR-DCR, Puttur participated in Krishi Mela, 2021 organised by University of Agricultural Sciences, Bengaluru during 11th -14th November, 2021 to impart awareness and knowledge on different aspects of Cashew.

4.5 Technical advice/consultancy provided

Dr. D. Balasubramanian

- Provided technical consultancy to M/s Tea Mech Pvt. Ltd., Kolkata to assess continuous convection type drying system for cashew kernels from 27th to 30th October, 2021 (Rs 12000/-).
- Provided technical consultancy 'Bakawand Cashewnut Processing Unit' located in Jagadapur, under Chhattisgarh Forest Minor Produce Federation Cooperative Unit (CFMPFCU) from 4th to 8th October, 2021 (Rs 15000/-).
- Provided technical consultancy to budding Entrepreneur Mr Bidwan Mohapatra, Bhubaneshwar to start cashewnut processing as per directives of DDG (Hort.), ICAR, New Delhi.



4.6 Others

Exposure visits and orientations organised for students and farmers

Sl. No.	Particulars	Date	Coordinators
1.	Practical exposure to Cashew cultivation through field visit to the showcase plot and Cashew Museum of ICAR-DCR for 30 farmers from KVK, Mudigere	18.03.2021	Dr. Aswathy Chandrakumar and Shri. Manikandan
2.	Practical exposure to Cashew cultivation through field visit to the showcase plot and Cashew Museum of ICAR-DCR for 52 farmers from KVK, Mudigere	26.03.2021	Dr. Eradasappa E and Dr. Aswathy Chandrakumar
3.	Coordinated two days Horticulture based Industrial (HBI) Placement programme of the final year B.Sc. students of College of Horticulture, Mudigere at ICAR-DCR, Puttur	16.04.2021-17.04.2021	Dr. Aswathy Chandrakumar and Dr. Veena G L
4.	Organised the field visit to showcase plot for 18 PG and PhD students from College of Horticulture UHS, Bagalkot as a part of their study tour	03.09.2021	Dr. Eradasappa E, and Dr. Aswathy Chandrakumar
5.	Coordinated the exposure visit of 13 Final year B.Sc. students from College of Horticulture, Mudigere to ICAR-DCR and Cashew Processing Unit as a part of their HBI placement training	21.09.2021	Dr. D Balasubramanian, Dr. Aswathy Chandrakumar
6.	Organized a visit to showcase demonstration plot and demonstration of softwood grafting for 9 students from Kittur Rani Channamma College of Horticulture, Arabhavi, under University of Horticultural Sciences, Bagalkot visited ICAR-DCR as a part of tour programme	29.09.2021	Dr. J Dinakara Adiga, Dr. Aswathy Chandrakumar and Shri Murali Krishna



5. IMPLEMENTATION OF STC/TSP AND SCSP

5.1 Tribal sub plan

STC/TSP project was implemented by this Directorate for the benefit of Scheduled tribe population from different parts of Dakshina Kannada. With an aim to improve their livelihood by supporting agricultural and self-employment activities, sewing machines and hand carts were procured and distributed to beneficiaries from Bettampady, Irde and Nidpally villages. A training programme was also organised for 30 tribal farmers on "Cashew Production Technologies" to give an orientation to the participants regarding production, management and protection of Cashew.



Programmes under SCSP

FLDs Initiated (under SCSP)

1. 25 FLDs on Scientific cashew cultivation in Chikkamagaluru district covering about 50 acres in 25 farmers with 4022 grafts.
2. 4 FLDs on Scientific cashew cultivation in Dakshina Kannada district covering about 5.8 acres in 4 farmers with 464 grafts.
3. One FLD on Arecanut plantation in 1.00 acre in one farmer's field with 450 plants in Shantigodu, Puttur taluk, D.K.

Inputs supplied (under SCSP)

1. Solar lights-65 No
2. Multi layered Laminated plastic sheets-52 No
3. Kitchen garden kits-100 No
4. Agri-implements kit-100 No
5. Cashew grafts-4486 No
6. Arecanut plants-450 No
7. Water tanks-160 No



6. AICRP/Co-ordination UNIT

6.1 Annual Group Meeting (AGM) of AICRP on Cashew

The Annual Group Meeting (AGM) of Scientists of AICRP on Cashew was organized on a virtual platform during 5th to 6th December 2021. Dr. T.N. Raviprasad, Director (Acting) presented the Project Coordinator's Report and welcomed all the delegates. In this Project Coordinator's report, Director presented the achievements of different AICRP centres on crop improvement, crop management and crop protection experiment during the last year and highlighted on graft production and extension activities executed by different AICRP centres.

The guest of honor of inaugural session Dr. B. K. Pandey, ADG (Hort.-II), ICAR, New Delhi, emphasized on how to increase the production and productivity of cashew through effective nutrient management by fertigation, drip irrigation and pest management etc, and also stressed upon proper survey and collection of good germplasm of cashew available in different cashew growing regions of India to avoid the duplication. He opined that organic cashew cultivation is a better option particularly in hilly and tribal regions. He urged upon the AICRP scientists not to use the banned pesticides in cashew and requested ICAR-DCR, Puttur to develop and design a template for uniform data presentation by the AICRP scientists. As large number of datasets have been generated, a common platform needs to be developed to host this data for easy access by individuals. He also requested cashew scientists to demonstrate and disseminate the developed technologies through KVKs and line departments to reach farmers.

Dr. A. K. Singh, DDG (Hort.) ICAR, New Delhi, Chief Guest of the session appreciated the efforts of scientists for developing technologies on various aspects viz., cashew cultivation, pest and disease management as well as preparation of different value-added products from cashew for the benefit of the farmers. He urged the scientists to identify the need of the country and accordingly develop suitable technologies which are economically viable and cost effective for achieving self-sufficiency in cashew production. He also emphasized on the following points for increasing the production and productivity of cashew in the country.

- a) Development of varieties responsive to climate change
- b) Production and distribution of quality planting material
- c) Good management practices for resource maximization
- d) Scientific management of water and nutrients etc.
- e) Development of apps to solve the problem of pest and diseases



- f) Effective control of pests and diseases by replacing the chemicals with biological means
- g) Proper checking and validation of the technologies
- h) Technologies should be more scientific and time bound
- i) Harnessing the vast knowledge of experts in the field

Dr. TN Raviprasad, Director (Acting) presented the Project Coordinator's report wherein he highlighted the research activities carried out by the 14 different AICRP C Centres on various aspects of crop improvement, crop management and crop protection during the last year and highlighted on graft production and extension activities executed by different AICRP centres. He mentioned that during the year 2021, 25 new accessions have been developed by the centres of different agro ecological regions and around 1461 accessions are being maintained at different AICRP Cashew centers. 92 accessions have been evaluated at various centres for their growth, yield and yield attributing characters. He also informed that a trial on CNSL free accessions is under progress at Vengurle center where tender cashewnuts are in demand for culinary purposes. Under crop management and crop protection trials achievements of different centres were reported with respect to intercrops, high density planting system, nutrient management, organic management, application of botanicals and chemicals. He also highlighted on the extension activities carried out by the different AICRP on Cashew centres including production of about 3.99 lakhs of cashew grafts supplied to the farmers, government and other non-government organizations. He also mentioned that the centres have taken up 50 training programmes on various aspects under TSP, SCSP and other programs wherein around 4000 farmers had participated and thereby disseminating the technologies in various regions. He also expressed his gratitude to the DDG, ADG from ICAR for continuous support, officials of different state universities for sincerely supporting AICRP on cashew and successfully implementing the technical programme.

Later, the technical session on 'Crop Improvement' was held chaired by Dr. M.R. Dinesh, Former Director, ICAR-IIHR followed by 'Crop Management' session which was chaired by Dr. Ravi Bhat, Principal Scientist, ICAR-CPCRI, Kasaragod.



The Crop Protection Session was held on 6th Dec. 2021 which was chaired by Dr. P.S. Bhat, Former Principal Scientist, ICAR-IIHR followed by Interactive Session chaired by Dr. Venkatesh Hubballi, Director, DCCD, Kochi wherein farmers, scientists, processors and officials from other development departments had participated. During the session the problems and suggestions of farmers regarding cashew was also discussed at length.

The Variety Release session was chaired by Dr. B.K. Pandey, ADG (Hort.-II), ICAR. A proposal for release of variety JGM-282 (Bonsai Kaju) received from RRS, Jhargram, West Bengal which was identified as a pruning responsive high yielding cashew variety suitable for high and ultra-high density planting systems was discussed at length. However, due to inconsistency in the yield data, it was suggested that the proposal needs to be revised with all necessary data required to be presented in the interim meeting for further recommendations. The AGM was concluded with the plenary session and with vote of thanks by Dr. Mohana G.S. Principal Scientist and Scientist-in-charge, PC Cell, ICAR-DCR.



7. Agribusiness Incubation

A total of 15 incubatees registered with Agri Business Incubation (ABI) to utilize the facility and each incubatees were provided hands on technical training and mentored on market scenario and management aspects pertinent to cashewnut processing. Out of which, 5 nos. of incubatees have started 'Small scale cashewnut processing/ value addition / cashew kernel trading' after training from ABI. It is learnt through incubatees that a total sum of 36 lakhs generated and offered employment for 46 workers in just two to three months before 2nd wave of COVID 19 and very recently their factory or business become operational. In order to procure raw cashewnut, these incubatees contacted 12 nos. of cashew growers for procuring RCN in their respective location. Fund generated through incubation training and consultancy related to cashew processing is around Rs, 1,78,900/- during the calendar year 2021.



ABI activities of this institute were spread through online program during 'Business Meet' conducted by ICAR-CPCRI and 'Webinar' program presented through UNDP (Karnataka chapter) and 'Agriculture information', Bangalore. Entrepreneur Development Programme (EDPs) organized for Tribal Women belonging to Jagdalpur and Raigar district of Chhattisgarh financially supported by CGMFP Federation, Chhattisgarh from 4-8 October, 2021 (Fig 7). Advisory cum Management Committee Meeting was conducted in

hybrid mode on 10.08.2021 and discussed various proposals from KIIT, Bhubaneshwar, Orissa, M/s Tea Mech Coy, Kolkata, West Bengal, M/s Ventures International, Chennai, Tamil Nadu, M/s Food Industry Capacity & Skill Initiative, New Delhi, Mr Shishir, Farmer, Kundapura, Karnataka and budding entrepreneurs to join as Incubatee of institute A MoU was signed with KIIT, Bhubaneshwar to include as Co-Incubation Centre of this institute on 08.11.2021.



3-days trainings conducted for registered 15 number of incubates under ABI

Sl. No	Name of the trainee / incubate	Address	Time period
1	Mr Vari Venkata Vamsi	Godavari, Andhara Pradesh	18 th to 20 th January, 2021
2	Mr Shubash Shaw	Kolkata, West Bengal	04 th to 06 th February, 2021
3	Mr Reavappa Halappa Nayakawadi	Belgaum, Karnatak	08 th to 10 th February, 2021
4	Mr Thejas Kumar M	Bangalore, Karnataka	25 th to 27 th February, 2021
5	Ms Nagajyothi	Madurai, Tamil Nadu	19 th to 21 st April, 2021
6	Mr Chakkaravarthi	Dindigul, Tamil Nadu	19 th to 21 st April, 2021
7	Ms Shradha Dhanwadkar	Bijapur, Karnataka	15 th to 17 th July, 2021
8	Mr Sudhir Kumar M	BC Road, Karnataka	27 th to 29 th August, 2021
9	Ms Revathy M Shetty	Puttur, Karnataka	30 th August to 1 st September, 2021
10	Ms Sharadha K	Puttur, Karnataka	02 nd to 04 th September, 2021
11	Mr Gururaj Kolathaya	Puttur, Karnataka	07 th to 09 th September, 2021
12	Mr Mohan K	KGF, Karnataka	16 th to 18 th November, 2021
13	Mr Pramod M P	Mysore, Karnataka	06 th to 08 th December, 2021
14	Mr M P Pradeep	Mysore, Karnataka	08 th to 10 th December, 2021
15	Mr Joswin Lasrado	Vittal, Karnataka	21 st to 23 rd December, 2021



8. AWARDS/RECOGNITIONS/RESOURCE PERSONS/LECTURE

8.1 Awards

Dr. J.D. Adiga

- Nominated for award of Fellow of ISNS-2020 by International Society of Noni Science

Dr. ShamsudheenMangalassery

- First position for the Poster presentation on "Soil and water conservation practices for improving sustainability in cashew plantations" presented during the online International Conference on Soil and Water Resources Management (ICSWRM2021) during 26-27 February 2021 organised by College of Technology & Engineering, MPUAT, Udaipur, Rajasthan.
- Secured second prize for the oral presentation on "Approaches for. sustainable cashew production in hilly areas" presented during the 5th International conference on advances in agriculture, environmental and biosciences for sustainable development, organized by Agro Environmental Development Society, Majhra Ghat, Rampur, UP, India, 05-07- August 2021.

Dr. K. Vanitha

- Conferred with 'Best paper Award' for the oral presentation on 'Bees are important for increasing nut yield in cashew' in 6th National Conference on Agricultural Scientific Tamil, conducted by Agricultural Scientific Tamil Society, New Delhi and others at International Institute of Tamil Studies at Chennai during 21-22, December, 2020 (Received in May, 2021).
- Bagged 'Best Oral Presentation Award' for the research paper "Nesting behaviour of three species of *Ceratina* pollinating cashew" during the National Web-symposium on Recent Advances in Beneficial Insects and Natural Resins & Gums held at ICAR-IINRG, Ranchi during February 25-26, 2021.

Dr. Preethi, P.

- DCR-Best Research Paper Award for the year 2021 was secured by the research paper entitled "Cashew apple pomace powder enriched the proximate, mineral, functional and structural properties of cereal based extrudates" published in the journal, *LWT-Food Science and Technology* authored by Preethi, P., Mangalassery, S., Shradha, K., Pandiselvam, R., Manikantan, M.R., Reddy, S.V.R., Ramyashree Devi, S. and Nayak, M.G.



Dr. Babli Mog

- Best Oral Presentation award in the International Web-seminar on Future of Food Agriculture: Trends and Challenges, VAKSANA organised by Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, Madhya Pradesh during 20-21 September, 2021
- Young Achiever Award-2021 by SADHNA (Society for Advancement of Human and Nature) Dr YS Parmar University of Horticulture and Forestry Nauni, Solan 173 230 Himachal Pradesh, India).

8.2 Recognitions

Dr. D Balasubramnian

- Equipment specifications for cashew processing system. Training of Master Trainers, organized by ICAR-CPCRI, Kerala and NEFTM (Erstwhile IIFPT), Tamil Nadu on 24.07.2021(Online).

Dr. Mohana G S

- Acted as a member of the selection committee - Walk-in Interview scheduled on 12-08-2021 at 10.00 am for selection of YP-II on contract basis under the project on "DUS Centre for Arecanut funded by PPV&FRA" at ICAR-CPCRI, Regional Station, Vittal.
- Served as a reviewer of Journal of plantation crops published by Society of Plantation crops CPCRI, Kasargod.

Dr. ShamsudheenMangalassery

- Served as external member in selection committee for screening the applications for inter-institutional transfer at ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala on 02-02-2021.
- Served as reviewer for the Indian Journal of Soil Conservation for the year 2021

Dr. Eradasappa E.

- Designed and organized online Training on Cashew Production and Post Harvest Technologies from 16-18 February 2022 sponsored by MANAGE, Hyderabad



Dr. Siddanna Savadi

- Recognized as the Research guide for supervising the research work leading to Ph.D. degree in the field of Biosciences by the Department of Biosciences, Mangalore University from 21.09.2021
- Recognized as the Research guide for three M.Sc. (Biotechnology) students from Mangalore University

Dr. Rajashekhara, H

- Editor for Indian Phytopath News, Newsletter published from Indian Phytopathological Society (IPS), New Delhi
- Judge for technical session-II for national e-conference on Recent Trends in Plant Pathology jointly organized by Indian Society of Plant Pathologists and Agricultural Research Station, ANGRAU, Vizianagaram, Andhra Pradesh on 4th May, 2021.
- Zonal councilor for MEZ of Indian Phytopathological Society (IPS).
- Nominated as Co-organizing secretary for organizing two days national symposium of Recent trends in phytopathology to address the emerging challenges for achieving food security from 21-22 February, 2022 at ICAR-VPKAS, Almora in association with Indian Phytopathological Society (IPS), New Delhi

G.L. Veena

- Recognised as an editor for the Agriculture and Food e-newsletter magazine.

8.3 Resource Person/ Lecture

G.S. Mohana	Presented a talk on "What is science? Epistemology of Ancient Indian Science and Modern Western Science" during Science Literature Workshop by Karnataka Sahitya Academy, Government of Karnataka	19 th February 2021
K. Vanitha	Served as Chairperson for a poster session in the (Theme 1) National Web-symposium on Recent Advances in Beneficial Insects and Natural Resins & Gums held at ICAR-IINRG, Ranchi during.	25 th -26 th , February 2021
E. Eradasappa	Delivered lecture on Breeding techniques in cashew to the Final year B.Sc. (Hort.) students of Horticulture college, Mudigere	16 th April 2021



	as part of their horticulture based industrial placement programme.	
M. Shamsudheen,	Delivered a lecture on Soil and water management in cashew on 17-04-2021 during the Horticulture Based Industrial Placement Programme of the final year B.Sc (Hort.) students of College of Horticulture, Mudigere.	16 th -17 th April 2021
G.S. Mohana	Resource person for Horticulture Based Industrial Training programme for the final year B.Sc. (Hort.) students from college of Horticulture, Mudigere. Gave talk on Cashew- A promising crop for the future	16 th to 17 th April, 2021-
	Shramajeevi TV interview on Cashew Production Technology	24 th May 2021
D. Balasubramanian	Delivered a lecture on Utilization of cashew apple and value addition during webinar organized by Agriculture information, Bangalore.	5 th July 2021
J.D. Adiga	Delivered an invited talk on "Canopy management in cashew" during national webinar on "Canopy architecture management in perennial commercial Horticulture Crops" organized by UHS, Bagalkot.	19 th -20 th , July,2021
E. Eradasappa	Delivered lecture via online mode on Cashew Research Activities of ICAR –DCR Puttur the students during Virtual All India Study Tour Programme of COH, Bidar, Bagalkot, Arabhavi and Sirsi (UHS, Bagalkot)	12 th August 2021
	Explained research activities of DCR to PG and Ph.D. students (18 No) of College of Horticulture, UHS Bagalkot	23 rd September 2021.
C. Aswathy	Invited as guest speaker to deliver a talk on the topic "sketching the path to JRF/ARS" during the online orientation module for final year B.Sc. RAWE students of College of Agriculture, Vellayani	24 th September 2021
K. Vanitha	Delivered a lecture on 'Advances in cashew pest Management and role of pollinators in cashew' in the 'Azadi ka Amrit Mahotsav' lecture series, through online mode which was organized by S.G College of Agriculture and Research	30 th September, 2021



	Station, IGKV, Bastar and AICRP on Cashew, Jagdalpur	
Eradasappa E	Delivered a talk on cashew cultivation for sustainable livelihood of farming community at ICAR-KVK, Mangaluru.	23 rd November 2021
G.L. Veena	Delivered lecture on pollen studies in cashew for newly joined scientist as a part of exposure training	24 th November 2020
E. Eradasappa	Delivered a lecture on 'Scope of Agriculture Education' on the occasion of Agriculture Education Day to the 1 st Year PUC students from Vivekananda College, Puttur.	03 rd December 2021
H. Rajashekara	Delivered a talk on Diseases of cashew in India: Status and challenges in Annual Group Meeting of AICRP on cashew	06 th December 2021
D. Balasubramanian	Over view of Cashew processing and Entrepreneurship Opportunities in Cashew. Entrepreneurship Development Training on Agriculture Food Processing, Packing and Marketing organized by College of Agricultural Engineering and Odisha University of Agricultura and Technology (OUAT), Bhubaneshwar	23 rd December 2021



9. PUBLICATIONS

9.1 RESEARCH PAPERS/ REVIEW ARTICLES

Krishnappa, G., Savadi, S., Tyagi, B. S., Singh, S. K., Mamrutha, H. M., Kumar, S. and Singh, G. P. 2021. Integrated genomic selection for rapid improvement of crops. *Genomics*, 113(3); 1070-1086.

Mangalassery, S., Nayak, M.G., Prabha Susan, P., Rupa, T.R., Behera, S.K., Srinivasan, V. 2021. Delineating the nutrient constraints and developing nutrient norms for cashew (*Anacardium occidentale* L.) in coastal India. *Journal of Plant Nutrition*. 44 (17); 2627-2639. (<https://doi.org/10.1080/01904167.2021.1921198>).

Nayak, M.G., Mohana, G.S. and Eradasappa, E., 2020, NRC-492 A novel dwarf cashew variety - *Cashew News*. July to December 2020.

Patil, S.V., Nagaraja, G., Manjunath, R., Rajkumar, G. R., and Adiga, J.D., 2021. Integrated nitrogen management strategy for growth and yield of cashew (*Anacardium occidentale* L.) *Biological Forum*, 13(3): 454-459.

Preethi, P., Shamsudheen Mangalassery, Shradha, K., Pandiselvam, R., Manikantan, M. R., S.V.R. Reddy, S. Ramyashree Devi, M. G. Nayak. 2021. Cashew apple pomace powder enriched the proximate, mineral, functional and structural properties of cereal based extrudates. *LWT-Food Science and Technology*, 139(7); 110539. doi: [10.1016/j.lwt.2020.110539](https://doi.org/10.1016/j.lwt.2020.110539).

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

Savadi, S., Mangalassery, S. and Sandesh, M.S., 2021. Advances in genomics and genome editing for breeding next generation of fruit and nut crops. *Genomics*. <https://doi.org/10.1016/j.ygeno.2021.09.001>

Vanitha, K., Raviprasad, T.N. 2021. Flower pests of cashew, their seasonal incidence, damage and natural enemies. *Int. J. Trop. Insect Sci.*, <https://doi.org/10.1007/s42690-021-00527-2>.

Vanitha, K. and Raviprasad T.N. 2021. Artificial nests conserve important native bees, *Braunsapis* spp. pollinating cashew. *Current Science*, 121 (1): 127-132.



9.2 ABSTRACT/ CHAPTER IN SYMPOSIA / WORKSHOPS/ SEMINARS

Babli Mog, J.D. Adiga, Veena G.L, Thondaimon V, Manjesh G.N and Shamsudheen M. 2021. Regulation of Vegetative and Reproductive Traits in Cashew through Paclobutrazol. In: International Web Conference on Future of Food Agriculture: Trends and Challenges, VAKSANA, 20th to 21st September, 2021, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore– Oral presentation

Mangalassery, S., Nayak. M.G., Preethi. P and Muralidhara, B.M. 2021. Soil and water conservation practices for improving sustainability in cashew plantations. Souvenir cum Abstract book of the international conference on soil and water resource management-2021 (Eds. Manjeet Singh, Yadav, K.k. and Urmila), organized by Department of Soil and Water Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan 313001, India, 26-27 February 2021. pp. 59.

Mangalassery, S. and Anitha Karun. 2021. Innovative and recent approaches for nutrient management in cashew. Souvenir and Conference Book of the International web conference on Innovative and current advances in agriculture and allied sciences (Eds. Singh, S.P. et al.), organized by Society of Scientific Development in Agriculture and Technology, Meerut, UP, India, 19th to 21st July 2021. pp. 63.

Mangalassery, S. 2021. Approaches for sustainable cashew production in hilly areas Souvenir of the 5th International conference on advances in agriculture, environmental and biosciences for sustainable development (Eds. Chhatarpal Singh, Sudhir Singh Bhadoria and Md. Nadeem Akhtar), organized by Agro Environmental Development Society, Majhra Ghat, Rampur, UP, India, 05th to 07th - August 2021. pp. 243-244.

Manjesh-National Webinar on Canopy Architecture Management in Perennial Commercial Horticultural Crops organized by College of Horticulture Bidar (UHS, Bagalkot) held on 19-20th July 2021. "Industrial Applications of Flow cytometry for the determination of Ploidy level, Genome Size and Pollen viability in Plants" organized by Sysmex held on 23rd July 2021.

Manjunatha, K., Ravindra Naik. and Adiga, J. D. 2021. Development of drudgery reducing hand held telescopic cashew fruit harvester. 2nd International web conference on the future of Food and Agriculture: Trends and Challenges (TFFA), Shri Vaishnav Vidyapeeth Vishwavidyalaya, Shri Vaishnava Institute of Agriculture, Indore (M.P), India. Pp: 46.

Manjunatha, K., Balasubramanian, D., Ravindra Naik. and Adiga, J. D. 2021. Determination of engineering properties of cashew apple and nut in relation to design of apple and nut separator. 24th Biennial Symposium on Plantation Crops,



14-16 December 2021, Indian Cardamom Research Institute, Spice Board India.
Pp: 255.

Mohana, G.S. 2021. "What is science? Epistemology of Ancient Indian Science and Modern Western Science" during Science Literature Workshop during 19th February, 2021 by Karnataka Sahitya Academy, Government of Karnataka.

Mohana G.S. 2021. "Recent IT initiatives at ICAR- DCR for management and dissemination of cashew information" at Goa DCCD conference during 26th to 27th of February 2021.

Mohana, G.S. 2021. AI based app – cashew protect an AI based app for identification of pests, diseases and nutrient deficiencies in cashew Horticulture Science Congress, 18th to 21st, November 2021.

Mohana, G.S., Vanitha, K., Shamsudheen, M. and Adiga, J.D. 2021. Recent IT initiatives for management and dissemination of cashew information. Souvenir of the National Conference on Cashew 2021 (Eds. Ravindra Kumar, Jayalakshmi, V.S., Nikhil, V.M., Shine, K.K. and Vinneth Lukose), organized by Directorate of Cashewnut and Cocoa Development, Kochi, India and Directorate of Agriculture, Govt. of Goa and Goa State Horticultural Corporation Ltd., Govt. of Goa at Panjim, Goa, 26-27 February 2021. pp. 27-30.

Mohana. G.S., Vanitha. K, Rajashekara, H. and Mangalassery, S. 2021. Cashew Protect: An artificial intelligence-based website and app for identification of pests, diseases and nutrient deficiencies in cashew. Souvenir and Conference Book of the 9th Indian Horticulture Congress (Eds.), organized by, India, 18th to 21st November 2021. pp. 69.

Muralidhara, B.M., Sakthivel, T., Karunakaran, G., Honnabyraiah, M.K., Shivashankara, K.S., Venugopalan. R., Lakshmana Reddy D.C., Venkatravanappa, V., Savadi S, Karthik Nayak, V.S. and Divya Vani Vaka, 2021. Collection and characterization of Indian avocado accessions using morphological descriptors. *In* In International Web Conference on Innovative and Current Advances in Agriculture and Allied Sciences, Society for Scientific Development in Agriculture and Technology, Meerut (UP), India during 19th to 21st July 2021.

Nayak, M.G., Preethi, P. and Mangalassery, S. 2021. Client needs and technologies for improved cashew cultivation. Souvenir of the National Conference on Cashew 2021 (Eds. Ravindra Kumar, Jayalakshmi, V.S., Nikhil, V.M., Shine, K.K. and Vinneth Lukose), organized by Directorate of Cashewnut and Cocoa Development, Kochi, India and Directorate of Agriculture, Govt. of Goa and Goa State Horticultural Corporation Ltd., Govt. of Goa at Panjim, Goa, 26th to 27th February, 2021. pp. 15-21.



Savadi S, Muralidhara B.M., Preethi P., Sandesh M.S., J.D. Adiga and Anitha Karun, 2021. Cashew fruit development and the biochemical characterization of CNSL free mutant. *In* International Web Conference on Innovative and Current Advances in Agriculture and Allied Sciences, Society for Scientific Development in Agriculture and Technology, Meerut (UP), India during 19th to 21st July 2021

Vanitha, K. – Participated in National Web-symposium on Recent Advances in Beneficial Insects and Natural Resins & Gums held at ICAR-IINRG, Ranchi during February 25th to 26th, 2021.

Vanitha, K. - Participated in national symposium - PLACROSYM-24 'Coping with the pandemic and beyond: research and innovations in the plantation crops sector' during 14th to 16th December, 2021, Kochi, Kerala.

Vanitha, K. 2021. Nesting behavior of three species of *Ceratina* pollinating cashew. Oral presentation made in the National Web-symposium on Recent Advances in Beneficial Insects and Natural Resins & Gums held at ICAR-IINRG, Ranchi during February 25th to 26th, 2021. 4-5p.

Vanitha. K., 2021. Deployment of wild bees, *Braunsapis mixta* for pollination in cashew and record of its natural enemies. In: PLACROSYM-24 'Coping with the pandemic and beyond: Research and innovations in the plantation crops sector' during 14th to 16th December, 2021, Kochi, Kerala.

Vanitha, K., T.N. Raviprasad and Veena, G.L. 2021. Species of wasps associated with the trap nests of bees, *Braunsapis spp.* In: 5th National Symposium on Plant Protection in Horticulture (NSPPH-2021): Challenges and a roadmap ahead during 27th to 29th December, 2021 at Indian Institute of Horticultural Research, Bengaluru.

Vanitha, K. – Participated in 5th National Symposium on plant protection in horticulture (NSPPH-2021): Challenges and a roadmap ahead during 27th to 29th December 2021 at IIHR, Bengaluru.

Veena G L. and Dinesh, M.R., 2021. Indigenous traditional knowledge on Appemidi Mango". In Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2021) scheduled to be held on 13th to 15th December, 2021 at SKRAU Bikaner, Rajasthan, India.

Veena, G.L., J.D. Adiga, Vanitha, K., Shamsudheen, M., Siddanna Savadi, Muralidhara, B.M. and Babli Mog. Purple cashew – a novel cashew. In 2nd International web conference on The future food and Agriculture: Trends and Challenges (TFFA), VAKSANA 2021, during 20th to 21st September, 2021.



9.3 BOOKS

Prasad, P., Khan, H., Bhardwaj, S.C., Savadi, S., Gangwar, O.P., Kumar, S. 2021. Practical Manual on Protocols and Methodologies in Wheat Rusts Research. ICAR-Directorate of Knowledge Management in Agriculture Vol.1, pp. 1-75

9.4 BOOK CHAPTERS / LECTURE NOTES

Anandakumar, T. M., Chethan, C. R., Shrinivasa, D. J. and Manjunatha K. 2021. Advances in Ocean Energy Technology. Seveda *et al.*, (Eds). Advances in Renewable Energy Engineering, Narendra Publishing House, Delhi, India. Pp: 301-311.

Jagannadham, P. T. K., Savadi, S., and Muthusamy, S. K. 2021. Plant Genome Editing in Basic Research to Understand Molecular Functions. In *Genome Editing in Plants* (pp. 187-202). CRC Press.

Manjunatha K, Srinivasa D. J., Chethan C. R. and Anandakumar T. M. 2021. Advances in geothermal energy technology. Seveda *et al.*, (Eds). Advances in Renewable Energy Engineering, Narendra Publishing House, Delhi, India. Pp: 313-327.

Preethi, P., Siddana Savadi, Vanitha, K., Vikas Ramteke, S. Mangalaserry and Sandesh, M.S.2021Cashew (*Anacardium occidentale* L.). In: Tropical Fruit Crops – Theory to Practical. (Eds. S.N. Ghosh and R.R. Sharma). Jaya Publishing House, New Delhi. 137-183p.

Shrinivasa D. J., Manjunatha K., Chethan C.R., Shashikumar, V.K. Tripathi and Anandakumar T. M. 2021. Hydrogen Fuel Cell Technology. Seveda *et al.*, (Eds). Advances in Renewable Energy Engineering, Narendra Publishing House, Delhi, India. Pp: 259-278.

Thakur, R. K., Prasad, P., Savadi, S., Bhardwaj, S. C., Gangwar, O. P., & Kumar, S. 2021. Understanding Rhizosphere Through Metatranscriptomic Approaches. In *Microbial Metatranscriptomics Belowground* (pp. 219-237). Springer, Singapore.

Vanitha, K. 2020. 'Bees are important for increasing nut yield in cashew – a confirmative study' In: Agricultural Entomology (published in Tamil), Eds. Drs. P. Anandhi, Sel. S. Leka Priyanka, Dr. P. Usha Rani and Dr. I. Merlin Kamala. Published by Agricultural Scientific Tamil Society, New Delhi - 110012, ISBN: 978-81-947040-8-9. 219-221p.



9.5 TECHNICAL REPORTS / COMPENDIA

Annual Report, 2020. All India Co-ordinated Research Project on Cashew. ICAR-Directorate of Cashew Research (DCR), Puttur, P. (Editor – Dr. Mohana, G.S.)

Annual Report- 2020. ICAR-Directorate of Cashew Research, Puttur, Karnataka, India p. 106 (Eds. Vanitha, K., Mohana, G.S., Mangalassery, S. and Savadi, S.)

Annual Report-DCR (Hindi). 2020. ICAR-Directorate of Cashew Research, Puttur, Karnataka, India p. 106 (Eds. Vanitha, K., Mohana, G.S., Mangalassery, S. and Savadi, S.)

Cashew News, 2021. ICAR-Directorate of Cashew Research, Puttur, Vol. 26 (1), p. 19 (Eds. Vanitha. K, Mohana, G.S., Shamsudheen, M and Siddanna Savadi)

9.6 TECHNICAL BULLETINS

Muralidhara, B.M., Sandesh, M.S., Siddanna Savadi, Preethi, P., Veena, G.L., Manjunatha, K., Rajukumar, A.D. and Shamsudheen.m, 2021. Geru hannina koylotthara tantrikathe (Post harvet technologies of cashew apple). Technical bulletin No. 35, ICAR-Directorate of Cashew Research, Puttur, Karnataka, India, p. 32.

Nayak, M.G., Muralidhara, B.M., Mangalassery, S. and Preethi, P. 2020. Gerubelayalli poshakamshakala nirvahane. Technical Bulletin No. 32, ICAR-Directorate of Cashew Research, Puttur, Karnataka, India, p. 30. [<http://krishi.icar.gov.in/jspui/handle/123456789/36897>].

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9.7 EXTENSION BULLETINS / PAMPHLETS

Raviprasad, T.N., Vanitha, K. and Shivarama Bhat, 2021. Geru beleyallina pramukha keetagalu mattu avugala nirvahane haagu paragasparshi keetagala mahatva" (Major pests of Cashew and their management and importance of pollinators) [Kannada]. Published by the Asst. Director of Agriculture, Puttur, Govt. of Karnataka during February, 2021.

9.8 POPULAR ARTICLES

Jaya Prabhavathi, S., Vanitha, K., Vijayaraghavan, C. and Subrahmaniyan, K.2021. Cashew Leaf Miner: Biology, Nature of Damage and its Management. *Just Agriculture*, (2):2, 1-7.

Raviprasad T.N. and Vanitha, K. 2021. Newer insecticides to contain incidence of TMB and CSRB. *Cashew News*, 26 (1): 2-3.

Mangalassery, S., Savadi, S., Preethi, P., Nayak, M.G., and Muralidhara, B.M. 2021. Role of interactive ICTs in plant health clinic museum for effective communication. *Just Agriculture*, 1(6): 46-47.

Savadi, S; Sandesh M S; Muralidhara, B.M. 2021. Strategies for enhancing cashew production in India to meet the growing demand in domestic and international markets. *Kerala Karshakan (e-Magazine)* 9: 28-31.

Vanitha, K. and Raviprasad, T.N. 2021. Promising native bees make nest in cashew plants. *Sanrag e-new letter*, 2 (1): 5-6.

Vanitha, K. and Raviprasad, T.N. 2021. Incidence of *Nanaguna* sp. and *Perixera* sp. on cashew flowers – Emerging potential menaces in cashew production. *Insect Environment*, 24 (2): 272-274.

Vanitha, K. and Raviprasad, T.N. 2021. Simple ways to conserve native bees pollinating cashew. *Cashew News*, 26 (1 26 (1): 3-4.

Vanitha. K. 2021. Red ants devour mosquitoes too. *Insect Environment*, 24 (4): 563-364.

Vanitha K. and Raviprasad. T.N. 2021. *Helopeltis theivora* finds a new host, Anthurium sp. - an observation. *Insect Environment*, 24 (4): 567-368.



10. LINKAGES / COLLABORATION

Organization	Area of collaboration
ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR), Bengaluru	Identification of kairomones/ pheromones of major pests of cashew
ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru	Biosystematics of tea mosquito bug and natural enemies
	Biotechnology Department for SSR marker analysis in cashew
University of Agricultural Sciences (UAS), GKVK, Bengaluru	Identification of arthropod fauna associated with cashew
ICAR-Indian Agricultural Research Institute (IARI), New Delhi	
Directorate of Cashewnut and Cocoa Development (DCCD), Kochi	Training programmes for farmers and frontline demonstrations
ICAR-Central Institute of Agricultural Engineering (ICAR-CIAE), Bhopal	Development of postharvest technology machinery
Department of Horticulture, Karnataka. Horticultural Research Station, Ullal, Mangaluru Zonal Agricultural Research Station, Brahmavar, Udupi district, Karnataka.	Training programmes for farmers and Krishi Melas
KVK, Mangaluru Achal Industries, Mangaluru UAHS, Shivamogga KCMA, Mangaluru	Transfer of technology
AICRP-Cashew Centres located in SAUs / ICAR institutes	Multilocational testing, exchange of research findings/germplasm/planting material.
ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala	Evaluation of EPN species in cashew ecosystem value addition and post-harvest product development
ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat	Identification and synthesis of organic components in the Whole-Body Extracts (WBE) of virgin females of TMB.
M/s Environment, Measurement and Control, (EMCON), Kochi, Kerala	Development of moisture meter for cashew in Public-Private-Partnership (PPP) mode



Kerala State Agency for the expansion of Cashew Cultivation (KSACC), Kollam	For large scale distribution of planting material and area expansion in cashew
All India Cashew Growers Association, Puttur	Facilitated its formation and provided technical inputs
K.S. Hegde Medical Academy under NITTE, Mangaluru	Studies on health benefits of different cashew-based value-added products
Alvas College Mudibidri	Research and training collaboration
KVK, Mangaluru	Exposure tours under SCSP activities
<i>KIIT Technology Business Incubator (KIIT-TBI)</i> BIRAC Sparsh Social Innovation Immersion Program (SIIP) <i>KALINGA Institute of Industrial Technology (KIIT) University, Bhubaneswar, Odisha</i>	Collaboration with ABI Unit of DCR, Puttur
CG MF Federatio, Chhattisgarh	Cashewnut processing
ICAR-NRC Grapes	Research on nutraceuticals in Cashew
National Knowledge Network (NKN) National Informatics Centres (NIC) GOI	High speed internet facility



11. HUMAN RESOURCE DEVELOPMENT AND CAPACITY BUILDING

Particulars	Details	Date
Sri. Muralikrishna, K.	Exposure visit CHES, Chettalli & IISR Appangala	6 th March 2021
Sri. Narayana Naik Sri. Vijaya Achary Sri. Veerappa Sri. Annu, K. Sri. Krishnappa Naik Sri. Sundara, V. Sri. Hariya Naik Sri. K. Umanath Shetty Sri. Narayana, K. Sri. Narayana Poojari Sri. B. Kushalappa Sri. Babu gowda Sri. T. Padmanabha Sri. Monappa, S. Sri. B. Seetharama Sri. K. Gopalakrishna Smt. Kasturi, S.	Exposure Visit CHES Chettalli and IISR-Regional station, Appangala	3 rd to 6 th March 2021
Dr. D. Balasubramanian	National dialogue on innovative food for hospitality industries – Intellectual Property and Technology Management (IP& TM) Unit, ICAR, New Delhi-Online	22 nd June, 2021
	Training workshop on 'Response Surface Methodology' – ICAR- National Academy of Agricultural and research Management, Hyderabad	24 th to 26 th August, 2021
Dr. Manjunatha, K.	Four-Week hands on training on "Application of Computer Aided Engineering (CAE) in Agriculture" during, organized by Centre for Advanced Agricultural Science and Technology (CAAST), Centre of Excellence for Digital Farming Solutions for Enhancing Productivity by Robots, Drones and AGVs, VNMKV, Parbhani (MS), under NAHEP Project sponsored by ICAR, New Delhi.	07 th to 3 rd July, 2021
Dr. Shamsudheen, M.	Online training programme on Right to Information – Public Information Officers organized by the Institute of Secretariat Training and Management, New Delhi	01 st to 03 rd September 2021



Dr. Eradasappa E.	Online training programme "Analysis of Multi-Location Experiments" organized by ICAR-NAARM, Hyderabad	28 th to 30 th October, 2021
Dr. Aswathy, C.	Online training programme "Data analysis in Social Sciences Research" organized by ICAR-NAARM, Hyderabad	4 th to 8 th October, 2021
	Online training programme on "Impact assessment of agricultural research and technologies"	18 th to 22 nd December, 2021
Dr. Siddanna Savadi	SNP Mining, GWAS & Genomic Selection is being organized by Centre for Agricultural Bioinformatics (CAB), ICAR-Indian Agricultural Statistics Research Institute, New Delhi	16 th to 21 st , December 2021
Dr. Veena, G. L.	10 days orientation cum exposure training at ICAR-DCR, Puttur	01 to 10 th December 2020



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

Particulars	Details	Date
Vanitha, K.	National Web-symposium on Recent Advances in Beneficial Insects and Natural Resins & Gums held at ICAR-IINRG, Ranchi.	25 th -26 th , February 2021
Mohana, G. S.	National Conference on Cashew organized by DCCD, Kochi at Goa	26 th -27 th of February 2021
Shamsudheen, M.	International conference on soil and water resource management-2021 (Eds. Manjeet Singh, Yadav, K. K. and Urmila) organized by Department of Soil and Water Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan 313001, India	26 th -27 th February 2021
Babli Mog	International Plant Physiology Virtual Symposium on "Physiological Interventions for Climate Smart Agriculture (IPPVS 2021)" held at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, in collaboration with Indian Society of Plant Physiology (ISPP), New Delhi, India	11 th -12 th March, 2021
Rajashekara, H.	National e-conference Recent Trends in Plant Pathology jointly organized by Indian Society of Plant Pathologists and Agricultural Research Station, ANGRAU, Vizianagaram, Andhra Pradesh	4 th May, 2021
Balasubramanian, D.	International Webinar on 'Agri Entrepreneurship for Millennium Circles' – Faculty of Agriculture, Kadri University, Indonesia	29 th May 2021
Shamsudheen, M.	Workshop on "EFC Presentation and Preparation organized through VC mode under the Chairmanship of Secretary, DARE and DG, ICAR	4 th June 2021
Rajashekara, H.	International webinar on Recent advances in sustainable integrated disease management in plantation crops organized by ICAR-IIOPR, Pedavegi	6 th -8 th July 2021
Shamsudheen, M.	International web conference on Innovative and current advances in agriculture and allied sciences organized by Society of Scientific Development in Agriculture and Technology, Meerut, UP, India	19 th -21 st July 2021
Siddanna Savadi	International Web Conference on Innovative and Current Advances in	19 th -21 st July 2021



	Agriculture and Allied Sciences, Society for Scientific Development in Agriculture and Technology, Meerut (UP), India	
Thondaiman, V. & Manjesh, G.N.	National Webinar on Canopy Architecture Management in Perennial Commercial Horticultural Crops organized by College of Horticulture Bidar (UHS, Bagalkot)	19 th -20 th July 2021
Dr. Manjesh, G.N.	Industrial Applications of Flow cytometry for the determination of Ploidy level, Genome Size and Pollen viability in Plants" organized by Sysmex	23 rd July 2021.
Balasubramanian, D.	Training of Master Trainers, organized by ICAR-CPCRI, Kerala and NEFTM (Erstwhile IIFPT), Tamil Nadu (Online).	24 th July 2021
	Achievements of ABI unit under ICAR-DCR during the Annual Meet of ABI, IP& TM, ICAR, New Delhi	28 th July 2021
Shamsudheen, M.	International webinar on sustainable ground water management: Current challenges around the world organized by the Department of Soil and Water Engineering, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India	30 th July 2021
	5 th International conference on advances in agriculture, environmental and biosciences for sustainable development organized by Agro Environmental Development Society, Majhra Ghat, Rampur, UP, India.	5 th -7 th August 2021
Babli Mog, Veena, G.L. & Manjunatha, K.	2 nd International web conference on the future of Food and Agriculture: Trends and Challenges (TFFA), Shri Vaishnav Vidyapeeth Vishwavidyalaya, Shri Vaishnava Institute of Agriculture, Indore (M.P), India.	20 th -21 st September, 2021,
Shamsudheen, M.	Review and sensitization workshop of ZTMUs/ITMUs/PMEs under NAIF Scheme & presented the achievements of DCR, Puttur	6 th October 2021
Mohana, G.S.	National Steering Committee Meeting on Cashew at Krishi Bhavan, New Delhi	28 th October 2021
	Horticulture Science Congress, Kanpur Organised by Indian Academy of Horticultural Sciences, New Delhi.	18 th -21 st , November 2021
Shamsudheen, M	The sensitization workshop on NAARM DRIVE organized by ICAR-NAARM, Hyderabad	26 th November 2021



Veena, G. L.	International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2021) at SKRAU Bikaner, Rajasthan, India.	13 th –15 th December, 2021
Manjunatha, K.	24 th Biennial Symposium on Plantation Crops, Indian Cardamom Research Institute, Spice Board India.	14 th -16 th December 2021
Vanitha, K.	National symposium - PLACROSYM-24 'Coping with the pandemic and beyond: research and innovations in the plantation crops sector', Kochi, Kerala.	14 th -16 th December, 2021
Eradasappa, E.	International Webinar on 'Exchange on Biochemical and Molecular Techniques (BMT) Guidelines and Implementation of BMT in DUS under Indo-German Co-operation on Seed Sector Development organized by PPV&FRA, New Delhi, Dept.of Agri. & Farmers Welfare, Min.of Agri. & FW, GOI and Federal Min.of Food and Agri. (BEML), Germany.	16 th to 17 th December, 2021
Balasubramanian, D.	Entrepreneurship Development Training on Agriculture Food Processing, Packing and Marketing organized by College of Agricultural Engineering and Odisha University of Agricultura and Technology (OUAT), Bhubaneshwar (Online)	23 rd December 2021
Vanitha, K.	5 th National Symposium on plant protection in horticulture (NSPPH-2021): Challenges and a roadmap ahead at IIHR, Bengaluru.	27 th to 29 th December 2021



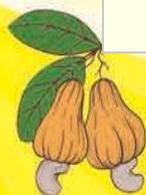
13. ONGOING AND CONCLUDED RESEARCH PROJECTS

Ongoing projects

Sl. No.	Title & duration	PI	Co-PIs
CROP IMPROVEMENT			
Priority area I: Management of cashew genetic resources			
1.	Collection, conservation, characterisation and evaluation of cashew genetic resources [1986 – Long term] <i>[Old title: Management of genetic resources in cashew]</i>	Mohana, G.S.	Vanitha, K. Eradasappa, E. Muralidhara, B.M* Veena, G.L Rajashekara, H.
Priority area II. Genetic improvement of cashew for yield and quality traits			
2.	Genetic improvement of cashew through hybridisation and seedling selection approaches [1986 -Long Term] <i>[Old title: Genetic improvement of cashew for yield and quality traits]</i>	J.D. Adiga	Mohana, G.S. Eradasappa, E. Siddanna Savadi Veena, G.L. Muralidhara, B.M.* Mr. Rajkumar, A.D.
3.	Breeding in cashew for special traits [06/2012-05/2027] <i>[Old title: Development of dwarf and compact cashew hybrids]</i>	Eradasappa, E.	Mohana, G.S. J.D. Adiga Veena, G.L.
4.	Breeding approaches for developing TMB tolerance [09/2017-08/2030]	Mohana, G.S.	Eradasappa, E. K. Vanitha
5.	Genetics of traits in cashew [05/2019 – 04/2025] <i>[Old title: Generation mean analysis in cashew to understand the nature of gene action for important traits]</i>	Eradasappa, E.	Mohana, G.S.
6.	Evaluation of big cashew apple genotypes for apple yield and quality [10/2013-06/2021] Extended till 06/2022)	Eradasappa, E.	K. Vanitha Veena, G.L. Rajkumar, A.D.



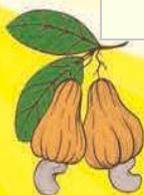
7.	Polyploidy breeding in cashew [10/2020-09/2030]	Mohana, G.S.	Eradasappa, E. Manjesh, G.N.
8.	New proposal: Evaluation of dwarf and semi dwarf accessions and their seedling progenies for high density planting system [09/2021-08/2032]	Mohana, G.S.	Eradasappa, E.
Priority area III. Development, refinement and use of biotechnological approaches in cashew			
9.	<i>De novo</i> genome assembly, linkage analysis and population structure studies in cashew (<i>Anacardium occidentale</i> L.) [09/2017 – 08/2022]	Siddanna Savadi	Mohana, G.S. J.D. Adiga B.M. Muralidhara*
10.	Genetic dissection of QTLs governing nut yield and cashew nut shell liquid (CNSL) content in cashew [06/2018-05/2025]	Siddanna Savadi	Eradasappa, E Mohana, G.S. B.M. Muralidhara*
11.	Externally Funded Project: Development of morphological descriptors and DUS test guidelines for cashew Funded by: Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), New Delhi Budget: Rs. 10 Lakhs [04/2015-03/2022]	Mohana, G.S.	-
12.	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	Mohana, G.S. Anitha Karun V. Thondaiman Shamsudheen Mangalassery
CROP MANAGEMENT			
Priority area IV: Enhancing input use efficiency and productivity			
13.	Developing nutrient management strategies for	Shamsudheen Mangalassery	V. Thondaiman Babli Mog J.D. Adiga



	cashew based on soil and leaf status [10/2020-09/2023] [Old title: Development of nutrient management schedules for cashew based on leaf nutrient status]		Manjesh. G.N Aswathy Chandrakumar
14.	Carbon cycling, sequestration and nutrient dynamics in cashew orchards [10/2020-09/2023]	Shamsudheen Mangalassery	Babli Mog K. Manjunatha B.M. Muralidhara*
Priority area V: Physiological and basic studies			
15.	Characterization of physiological responses of cashew (<i>A. occidentale</i> L.) accessions to salt and drought stresses [10/2015-09/2022]	Babli Mog	Veena, G.L V. Thondaiman
16.	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. K.B. Hebbar Shamsudheen, M.
17.	Physiological and biochemical basis of salinity tolerance in cashew rootstocks [09/2021-08/2026]	Babli Mog	J.D. Adiga Shamsudheen, M. Manjesh, G.N. K.B. Hebbar
Priority area VI: Horticulture production technologies			
18.	Studies on pruning and phenology in cashew [09/2017-08/2021] IXX13900 IXX13638	J.D. Adiga	Siddanna Savadi V. Thondaiman Muralidhara. B.M*
19.	Effect of growth regulator in combination with flower and fruit-set enhancing chemicals on cashew (<i>Anacardium occidentale</i> L.) [10/2020-09/2022]	V. Thondaiman	J.D. Adiga K. Vanitha Babli Mog Veena, G.L
20.	Development of cashew (<i>Anacardium occidentale</i> L.) based cropping system for west coastal region [10/2020-09/2025]	V. Thondaiman	J.D. Adiga Shamsudheen, M. K. Vanitha Babli Mog H. Rajashekhara



	[Old title: Development of cashew (<i>Anacardium occidentale</i> L.) based cropping system under rainfed condition of Karnataka]		
21.	Design, development and performance evaluation of Cashew fruit and nut separator [10/2020-09/2024]	Manjunatha, K.	D. Balasubramanian Ravindra Naik
22.	Design and development of gadgets for cashew fruit harvesting and collection [10/2020-09/2024]	Manjunatha, K.	D. Balasubramanian Ravindra Naik J.D. Adiga
23.	Influence of weather parameters on growth dynamics of apple and nut in selected varieties of Cashew [09/2021-08/2024]	Manjesh, G. N.	J.D. Adiga Babli Mog K. Vanitha Rajkumar A.D
24.	Effect of inter-stocks in Cashew (<i>Anacardium occidentale</i>) [09/2021-08/2024]	V. Thondaiman	J.D. Adiga Muralidhara B M
25.	Biochemical and mineral composition studies in relation to phenology of fruit development and maturity in cashew [09/2021-08/2023]	B.M. Muralidhara / Veena, G. L.	Dr. V. Thondaiman Veena, G.L. J.D. Adiga Shamsudheen, M. Manjesh, G.N. Manjunatha. K.
CROP PROTECTION			
Priority area VIII: Integrated management of pests and diseases & ecosystem services in cashew			
26.	Investigations on inflorescence insect pests of cashew and their management [10/2016-05/2022]	K. Vanitha	T.N. Raviprasad
27.	Cashew tea mosquito bug interactions and the defensive responses [05/2019 – 04/2023]	K. Vanitha	T.N. Raviprasad V. Thondaiman Shamsudheen, M. Veena. G.L
28.	Characterization and synthesis of female sex pheromone of Tea Mosquito Bug; (<i>Helopeltis antonii</i>) and its bioassay	T N Raviprasad	K.Vanitha P Shivarama Bhat (Till 30-06-21) N Bakthavatsalam (till 31-07-21)



	[10/2020-09/2025]		Dr. K. Subaharan
29.	Influence of <i>Apis cerana</i> and <i>Braunsapis picitarsis</i> on pollination and fruit set of cashew [05/2019 – 04/2023]	K. Vanitha	Veena, G. L.
30.	Assessing the field effectiveness of entomopathogenic nematodes (EPN) and indigenous strain of entomopathogenic fungus (EPF) in management of cashew stem and root borers (<i>Plocaederus ferrugineus</i> and <i>Plocaederus obesus</i>) [09/2021-08/2026]	T.N. Raviprasad,	Vanitha, K. Rajkumar, CPCRI, Kasaragod
31.	Survey and diagnosis of diseases occurring in cashew crop and their morphological and molecular characterization [09/2021-08/2024]	H. Rajashekara	T. N. Raviprasad Siddanna, S. RTP Pandian, ICAR- CPCRI, RS, Vittal

POST HARVEST TECHNOLOGY

Priority area VIII: Post-Harvest Technology

32.	Design and development of mechanized slicer for cashew apple [10/2014 – 06/2022]	D. Balasubramanian	Dr Ravindra Naik (ICAR-CIAE)
33.	Studying comparative performance of cashewnut processing systems in India [10/2017-09/2022]	D. Balasubramanian	-
34.	Design and development of moisture meter for raw cashewnuts [07/2018-06/2022]	D. Balasubramanian	Sri. Sreejith (M/s EMCON, Kerala)
35.	Development of value-added products from cashew apple and sprouts [06/2018-05/2022] [Old title: Development of dehydrated products from cashew apple and sprouts]	Rajkumar AD	Veena, G.L. Shamsudheen, M.



36.	Optimizing Processing Parameters in Cashew For Enhancing Whole Kernel Recovery [10/2020-09/2021]	D. Balasubramanian	
37.	Development of Ready to Eat alternate Snack food using cashew apple - Extrusion and Vacuum frying approach [09/2021-08/2024]	D. Balasubramanian	M. R. Manikandan Rajkumar Arjun Dagadkhair R. Pandiselvam
38.	Development of Probiotic Food Product/s from Cashew Apple [09/2021-08/2024]	Rajkumar, A.D	H. Rajashekara Manjesh. G.N Veena, G.L
39.	Phytochemical characterization of cashew (leaf and apple) nutraceuticals for its utilization in development of functional foods [09/2021-08/2025]	Rajkumar, A.D	Manjesh. G.N. Veena, G.L. Shabbir, A.
TRANSFER OF TECHNOLOGY			
Priority area IX: Transfer of technology and knowledge management			
40.	Knowledge management and technology transfer in cashew [09/2021-Long term]	Aswathy Chandrakumar	T. N. Raviprasad J. Dinakara Adiga Mohan, G. S. Manjesh, G.N Rajkumar, A.D.
41.	Analysis of socio-economic dimensions and innovation system dynamics in Cashew sector [09/2021-Long term]	Aswathy Chandrakumar	D. Balasubramanian Eradasappam E. V. Thondaiman C. Thamban, CPCRI Jayasekhar, S., CPCRI
42.	Externally Funded Project: Development of an exclusive android application for cashew cultivation Funding: Directorate of Cashewnut and Cocoa Development (DCCD), Cochin Budget: Rs. 5.0 Lakhs	Mohana, G.S.	-



	[09/2017-03/2022]		
43.	<p>Externally Funded Project:</p> <p>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. 1.89 Crores [04/2018 to 03/2022]</p>	Shamsudheen Mangalassery	
44.	<p>Externally Funded Project:</p> <p>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 03/2022]</p>	Shamsudheen Mangalassery	Manjunatha, K. Veena, G.L. Rajkumar, A.D. Aswathy Chandrakumar
45.	<p>Externally Funded Project</p> <p>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 03/2022]</p>	Mohana, G.S.	E. Eradasappa
46.	<p>Externally Funded Project:</p> <p>Development of an AI-based app for identification of pests and diseases in cashew Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 16 lakhs [04/2020 to 03/2022]</p>	Mohana, G.S.	K. Vanitha Shamsudheen, M. H. Rajashekar



<p>47.</p>	<p>Externally Funded Project: Establishment of an exclusive 'Cashew Parlour' for creating awareness on value added products of cashew Funded by: RKVY-FAFTAAR, Government of Karnataka Budget: Rs. 2.2 Crores [04/2020 to 03/2022]</p>	<p>Mohana, G.S.</p>	<p>Rajkumar, A.D. Manjunatha, K.</p>
<p>Concluded Project</p>			
<p>48.</p>	<p>Studies on pruning and phenology in cashew 9/2018 to 10/2021</p>	<p>J. Dinakara Adiga</p>	<p>B. M. Muralidhara Siddanna Savadi Preethi, P^a. V. Thondaiman</p>

*Transferred to ICAR-IIHR Regional Station Chettalli

^aTransferred to ICAR-IIHR, Bengaluru



14. PATENTS, COMMERCIALISATION OF TECHNOLOGY, CONSULTANCY, ADVISORY VISITS AND TALKS DELIVERED

Patent/Plant Variety/Microbe/Insect registration

PME &/or ITMU, ICAR-DCR facilitated the following plant variety registration processes.

IC Number: Applications were submitted and IC numbers were obtained for the following cashew accessions

Sl. No.	NAGS / NCFGB No.	Collector No	IC Number allotted	Speciality
1	NRC-547	H-126	IC-0639952 SCIONS	Jumbo nut ($\geq 12g$) with cluster bearing
2.	NRC-548	H-125	IC-0639953 SCIONS	Jumbo nut ($\geq 12g$) with cluster bearing
3.	NRC-549	Tree No. 130	IC-0639954 SCIONS	Bold nut type (8g), cluster bearing with high yield
4.	NRC-550	Tree No. 163	IC-0639955 SCIONS	Bold nut (8.5g), cluster bearing with high yield
5.	NRC-551	Tree No. 186	IC-0639956 SCIONS	Dual purpose with big ($\geq 100g$) and delicious apple and bold nut ($\geq 9g$)
6.	NRC-552	Tree No. 480	IC-0639957 SCIONS	High yield, medium nut type, cluster bearing with double flushing.

PPV&FRA Registration: The application has been filed for the registration of the following varieties of cashew

1. Nethra Vaaman
2. Nethra Jumbo-1



15. RAC/ IRC/ IMC/ IJSC MEETINGS

15.1. Research Advisory Committee (RAC)

The first meeting of 9th RAC was held on 7th and 13th July 2021, in virtual mode with a warm welcome and introductory remarks by the Director (Acting), Dr. Anitha Karun. This was followed by introductory remarks of the Chairman, Dr. N.K. Krishna Kumar. He highlighted recent global trends in horticultural research with emphasis on cashew. Dr. P.C. Lenka, member, RAC, expressed the need to improve productivity in cashew on a priority mode. The other members, Dr. N. Basavaraja, Dr. George V. Thomas, Dr. V. Duraisamy and Dr. R. M. Prasad, too opined about the research priorities for cashew in their respective fields of expertise. The farmers' representatives of IMC expressed the difficulties and concerns of cashew farmers in recent years. Action Taken Report on the previous RAC recommendations was presented by Dr. T. N. Raviprasad, Member Secretary.

Subsequently, presentations on the progress of research in Crop Improvement were completed on 07.07.2021, while the sessions on Crop Management, Crop Protection, Post-Harvest Technology, and Transfer of Technology were made by the scientists of DCR on 13.07.2021. After completing the deliberations under different sections, the members of the RAC discussed at length about feedback from the scientists, farmers, processors, and consumers concerned with future needs of cashew research. The meeting concluded with vote of thanks by Dr. T.N. Raviprasad, Member Secretary.

1.	Dr. N.K. Krishnakumar, Former DDG (Hort), ICAR	Chairman
2.	Dr. N. Basavaraj, Former Director of Research, UHS, Bagalkot	Member
3.	Dr. George V. Thomas, Former Director, ICAR-CPCRI, Kasaragod	Member
4.	Dr. P.C. Lenka, Former Professor, Horticulture, CA, OUAT, Bhubaneswar	Member
5.	Dr. A. Prakash, Former Head, Crop Protection, ICAR-NRRI, Cuttack	Member
6.	Dr. V.M. Duraisamy, Former Professor, AEC&RI, Coimbatore	Member
7.	Dr. R.M. Prasad, Former Director of Extension, KAU, Thrissur	Member
8.	Two Non- Official members nominated by Hon'ble Minister for A&FW in the IMC of the Institute	Member
9.	Assistant Director General (HS-II), ICAR Hqrs, KAB-I, New Delhi	Ex-officio Member
10.	Director, ICAR-Directorate of Cashew Research, Puttur	Ex-officio Member



11.	Dr. T.N. Raviprasad, Principal Scientist (Agricultural Entomology), ICAR-DCR, Puttur	Member Secretary till 10-11-2021
12.	Dr. K. Vanitha, Senior Scientist, (Agricultural Entomology), ICAR-DCR, Puttur	Member Secretary from 10-11-2021

15.2. Institute Research Committee (IRC)

The meeting of the 34th Institute Research Committee was held during 6 to 8, September 2021 under the Chairpersonship of Dr. Anitha Karun, Director (Acting), ICAR-DCR, Puttur in virtual mode through Zoom platform. Dr. Shamsudheen M, Member Secretary, IRC welcomed the Chairperson, members of IRC and resource persons. In a brief address, the Chairperson, IRC, Dr. Anitha Karun welcomed the scientists and appreciated the efforts of the staff members and achievements made under different projects.

The member secretary, IRC, Dr. Shamsudhhen M made a brief presentation on action points under 6th Quinquennial Review Team (QRT) report and 25th meeting of RAC held during 7th and 13th July 2021 and the general Action taken Report on 33rd IRC. It was emphasized that the action points of QRT and RAC recommendations should be addressed by the identified scientists within the suggested timeframe.

This was followed by presentations and discussion of the ongoing/concluded and new research projects (institute and external funded) by all the scientists of ICAR-DCR, Puttur.

Dr. Manish Mishra, Principal Scientist (Horticulture), ICAR-CISH, Lucknow and Dr. T.E. Sheeja, Principal Scientist (Biotechnology), ICAR-IISR, Kozhikode served as resource persons for the Crop Improvement division. For the crop management division, Dr. Subramanian P, Principal Scientist (Agronomy), ICAR-CPCRI, Kasaragod & Dr. T. Vidhan Singh, Principal Scientist (Agricultural Engineering), ICAR-IIRR, Hyderabad served as the resource persons. Dr. Chandrika Mohan, Principal Scientist (Agricultural Entomology), ICAR-CPCRI, Regional Station, Kayamkulam & Dr. Vinayaka Hegde, Head, Division of Crop Protection, ICAR-CPCRI, Kasaragod served as resource persons from the crop protection division. Dr. M.R. Manikandan, Principal Scientist (Post Harvest Technology), ICAR-CPCRI, Kasaragod served as resource person for the post-harvest technology projects and Dr. C. Thamban, Principal Scientist (Agricultural Extension), ICAR-CPCRI, Kasaragod served as resource person for transfer of technology projects.



15.3 ITMC Meeting

The 18th Institute Technology Management Committee (ITMC) meeting was held on 6.10.2021 at 2.00 PM at ICAR-DCR, Puttur under the Chairmanship of Dr. Anitha Karun, Director (Acting), ICAR-DCR, Puttur and progress of ITMU activities and licensing of Bhaskara variety were discussed.

15.4 Institute Management Committee (IMC)

50th IMC meeting held at this Directorate on 10.11.2021

1	Joint Director of Horticulture Directorate of Horticulture Govt. of Karnataka Lalbagh, Bengaluru-4	2	The Special Officer (Cashew) Aravind Chambers, Mundakkal West Near DCC Office Kollam-691001, Kerala
3	Associate Director of Research ZARS, Brahmavara (UAHS Shimoga) Udupi District-576213 Karnataka State.	4	Sri Kadamajalu Subhash Rai Kedambady Village & Post Thingaladi, Puttur Taluk -574210 DK District, Karnataka State
5	Sri Udaya Kumar M S/o Vasudeva Acharya Cauvery Prasad House Pernaje, Mandekolu Post & Village DK District, Sullia Taluk-574239.	6	Dr. Ishwara Bhat Principal Scientist ICAR-Indian Institute of Spices Research Marikunnu P.O, Kozhikode- 673012, Kerala.
7	Dr. M.K. Rajesh Principal Scientist ICAR- Central Plantation Crops Research Institute, Kudlu Post Kasaragodu Kerala 671124.	8	Dr.D.V.Sudhakar Rao Principal Scientist Indian Institute of Horticultural Research Hessaraghatta lake post Bangalore- 560089, Karnataka
9	Dr. M.N.Sheela Head, Crop Improvement ICAR- Central Tuber Crops Research Institute, Sreekariyam P.O. Thiruvananthapuram- 695017, Kerala.	10	Asst. Director General (Hort-II) Indian Council of Agricultural Research Krishi Anusandhan Bhavan — II Pusa Campus ,NEW DELHI - 110012.
11	Senior Finance & Accounts Officer ICAR- Central Plantation Crops Research Institute, Kudlu Post Kasaragodu Kerala 671124.		



15.5 Institute Joint Staff Council (IJSC)

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



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

16.1 Programmes organized

Cashew Day

Cashew Day- 2021 was celebrated at the institute on 17th of February which commenced with the theme of Scientist-farmer interaction and application of drone technology in Cashew. Shri. Kishore Kumar Kodgi, President, CAMPCO, Mangalore was the Chief Guest and Dr. M. Veerangouda, Dean (AG. Engg.), College of Agricultural Engineering, Raichur and Kadamajalu Subhash Rai were guests of honours for the function. A dwarf cashew variety named "Netra Vaaman", suitable for home gardens was released during the function. Also, the cashew pest database developed by the Directorate was released during the function. A detailed presentation and demonstration of drone application in agriculture with special emphasis on cashew was a major attraction of the function.

Drone mounted sprayer demonstration



University of Agricultural Sciences, Raichur, Karnataka. The field demonstration was attended by about 55 farmers apart from, nursery men, representatives of KVK, development departments, NGOs and scientists.

On the occasion of Cashew Day (17th Feb 2021), a field day cum demonstration was organized during which the drone mounted sprayer was demonstrated in the Directorate's cashew fields with the help of College of Agricultural Engineering,



National Science Day

The National Science Day was celebrated at the institute on 2nd March, 2021. Dr. Mahesh Prasanna K, Principal, Vivekananda College of Engineering and Technology, Puttur was invited as chief guest for the programme. Students of class 6th, 7th and 8th of Government Upper Primary School, Kemminje were also invited for the function. Dr. Mahesh Prasanna K, an expert in IoT (Internet of Things) and AI (Artificial Intelligence), delivered a presentation on "Life with IoT and AI" wherein he



explained about the evolution of these technologies and how it has been used in our day-to-day life. He further elaborated on the recent developments in this field, its scope in future and concluded with the merits and demerits of using such technology. Prizes were distributed to the students who won first, second and third prizes in the science quiz held at the institute on 27th February, 2021. Further, Dr. Gangadhara Nayak, Principal Scientist (Horticulture) gave presidential remarks signifying the evolution of science and how it should be effectively utilized for a good cause.

International Women's Day celebration



As a part of International Women's Day celebration held on March, 2021, two young progressive women farmers *viz.*, Mrs. Divya Anil Rai and Mrs. Navyashree K were invited and felicitated for their contribution in the field of agriculture and allied activities. Mrs. Divya Anil Rai was an

organic farmer owning 25 acres of land while Navyashree K was a BCom graduate growing different crops like banana, pepper, arecanut, coconut and cashew on her 22 acres of land. They shared their experiences, the hardships they faced and motivated the audience.

On this occasion, Dr. Sulekha Varadaraj, a child specialist and psychotherapist was invited for the function to deliver a talk on women health, nutrition and hygiene. She addressed the women on this topic and also gave many valuable insights on emotional intelligence and parenting citing many incidents from her work life.



World Water Day celebration

The World Water Day was observed in ICAR-DCR on 22nd March, 2021 with the theme "Valuing water". ICAR-DCR invited Smt. Roopa T Shetty, Commissioner, City Municipal Council, Puttur taluk as a chief guest for the function. The programme commenced with ICAR song followed by welcome address by Dr. Manjesh, G.N



Scientist (SP&MAP). The event was presided by Dr. Anitha Karun, Director (Acting) and in her presidential address she emphasized on scientific management of water and about water budgeting as a scientific tool to effectively combat water crisis from the agriculture perspective. The chief guest gave thrust on the efforts of the City Municipal Council to ensure water supply in Puttur and also urged the gatherings to stop wasting water by quoting effective methods. A lecture on "Water Resource Utilization and Management" was delivered by Dr. Manjunatha, K. Scientist (FMP) to the farmers, students and staff of ICAR-DCR. As a part of the celebrations, a drawing competition was held on the topic "Water for life" for 6th, 7th and 8th standard students of Government Upper Primary school, Mottethadka and prizes were distributed during the function.

Virtual State Tour for III-year B.Sc. students of College of Horticulture, Hiriyyur

A virtual state tour was organized for the 3rd year B.Sc. students of College of Horticulture, Hiriyyur (University of Agricultural and Horticultural Sciences, Shimoga) on 16th June 2021 at 2.30 pm. It was organized through the Google Classroom and 88 students had participated in the online presentation. Dr. Shamsudheen, Senior Scientist (Soil Science) briefed the students on the history and research and extension activities of this Directorate.

Poshan Vatika Mahabhiyan



As a part of the campaign on Nutri-Garden and Tree Plantation drive (*Poshan Vatika Mahabhiyan*) organised by Indian Council of Agricultural Research (ICAR), Ministry of Agriculture and Farmers Welfare, ICAR-DCR organised an awareness campaign on importance of millets on 17th September, 2021. Dr. T N Raviprasad, Principal Scientist

(Agricultural Entomology) gave a brief lecture to the students of Sandeepani school, farmers of Ammunja village and the staff of Directorate on the topic "Millets – Benefits waiting to be exploited". He emphasized on the need to include millets in our diet and how its benefits can be exploited



for health and nutrition. Following this, Smt. Jayamala N V, Headmistress, Sandeepani school gave her remarks on the importance of millets in addressing lifestyle diseases and how a healthy lifestyle should be followed. The tree plantation drive was flagged off by presenting a cashew graft to the farmer by Smt. Jayamala N V, Chief Guest for the programme. The programme concluded with tree planting drive conducted in Ammunja village, wherein farmers were given cashew grafts and coconut seedlings and planted in their fields.

Hindi fortnight celebration

Under the auspice of Puttur Town Official Language Implementation Committee and the Directorate Hindi fortnight was organized from 14th to 29th Sept, 2021. During the fortnight various programs were arranged. Hindi essay competition for students were organized on 14th September to promote and inspire Hindi learning among the school children. Hindi Sulekhan, Hindi General Knowledge competitions were conducted for the staff members. Hindi Knowledge competition was conducted for the sake of supporting staff members. On 29th, valedictory function was arranged. Dr. T N Raviprasad Prin. Scientist, Agri. Entomology presided over the function. Prizes were distributed to winners of various competitions. Cash awards were also given to staff members who are doing their official work in office in Hindi.



Vigilance Awareness Week

ICAR-Directorate of Cashew Research, Puttur celebrated the Vigilance Awareness Week -2021. A week-long programme was conducted by the Directorate from 26th October 2021 to 1st November 2021. During the period, various activities was organized at ICAR-DCR, Puttur starting with integrity



pledge taken by staff members and general public. Posters on the theme "Public interest disclosure and protection of informer resolution, 2004" were displayed to sensitize the people. 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.



The valedictory function was held at the main conference hall of the Directorate on 01-11-2021, observing the COVID protocol. Dr. H. Rajasekhara, Scientist & Administrative Officer I/c, ICAR-DCR, Puttur welcomed the gathering. The programme was inaugurated by Shri. Ramesh, M, Hon'ble Principal Senior Civil Judge & ACJM and Chairman, Taluk Legal Services Committee, Puttur. He stressed on the need for creating awareness on vigilance and the importance of inculcating values and morals in our lives for building the integrity of the nation. Sri. Manohar. K.V, President, Bar Association, Puttur also addressed the gathering and highlighted on how law needs to be used for the good cause of the society.

The resource person, Adv. Soorya Narayana N.K, Puttur, delivered a special talk on the theme "Independent India @75: Self Reliance with integrity". The programme was presided over by Dr. T.N. Raviprasad, Director (Acting) of the Directorate. The programme was concluded by vote of thanks by Dr. V. Thondaiman, Scientist (Spices, plantation and Medicinal Plants), ICAR-DCR, Puttur. The programme was organized jointly by DCR, Puttur, Legal Cell, Puttur and Bar Association, Puttur. Around 50 people had attended the programme.



Celebration of Constitution Day – Activities

To commemorate the adoption of the Constitution of India, 'Constitution Day' is celebrated on 26th November every year. In this connection, all ICAR-DCR staff participated in reading 'The Preamble' to the Indian constitution on 26.11.2021. Further, all staff were informed about the celebrations of Constitution Day live from Central Hall of Parliament on 26th November, 2021



Agriculture Education Day

As a part of Agriculture Education Day, students of classes 6th, 7th and 8th were invited on 3rd December, 2021 for an orientation lecture on "Opportunities in Agriculture". Students of Narendra Pre University College and Government school in Mottethadka



were invited for the talk. Dr. Eradasappa E, Senior Scientist, Genetics and Plant Breeding gave an informative and detailed talk on the scope of agriculture education, pursuing higher studies and the job opportunities available.

Swachhta Pakhwada

The ICAR- Directorate of Cashew Research, Puttur, Karnataka has observed "Swachhta Pakhwada" from 16.12.2021 to 31.12.2021 by conducting various day-wise activities as per the guidelines received from the Indian Council of Agriculture Research. The day-wise activities like, pledge taking, display of banners in prominent places of the institute, cleaning of office premises, cleaning of residential area, cleanliness awareness campaign in nearby villages, celebration of Kisan Diwas, debate related to Swachhta, VIP address on Importance of Swachhta, webinar on Swachhta, visit to community compost pits, demonstration of composting technology, lectures on waste water recycling and generation of wealth from cashew apple waste have been conducted. The programme has increased the awareness about the Swachhta among the staff and public.



Webinars organised as a part of *Azadi Ka Amrut Mahotsav* campaign

As a part of *Azadi Ka Amrut Mahotsav* campaign, a flagship programme of Govt. of India which is celebrated to commemorate 75 years of India's independence, a series of weekly webinars have been initiated by the Directorate since 6th August, 2022. During this period, a total of 19 webinars were organised, the details of which has been given in the table below.

Sl. No.	Title of webinar/activity	Resource person with contact details	Date	No. Of participants
1.	Overview of Global Cashew Scenario and India's Future Forward	Shri Appanna Choneera Poonacha (Ex General Manager-Technical (Plantation and Horticulture), NABARD	06.08.2021	50
2.	Conservation and Utilisation of Horticultural Genetic Resources in India	Dr. Rajasekharan P E, Principal Scientist, Division of Flower & Medicinal Crops, IIHR, Bangalore	13.08.2021	51
3.	Agriculture and Nutrition: The way of Tribal Agriculture	Dr. M. Jadegowda, Associate Professor, College of Forestry, Ponnampet, Kodagu	21.08.2021	25
4.	Avocado: A fruit for nutrition security and higher income	Shri. Muralidhara, B.M. Scientist (Fruit Science) ICAR-DCR, Puttur	26.08.2021	51
5.	Prospects of Cashew cultivation and its value addition in Kerala	Dr. Jalaja Menon Assistant Professor and Head, Cashew Research Station, (KAU) Madakkathara	03.09.2021	48
6.	Cocoponics- A new method of growing vegetables in soilless culture	Dr. D. Kalaivannan, Scientist (Soil Science), ICAR-IIHR, Bangalore	09.09.2021	71
7.	Cashew cultivation prospects in Tamil Nadu	Dr. M. Mohanalakshmi Assistant Professor (Horticulture), Vridhachalam, AICRP Centre	17.09.2021	25
8.	Recent advances in temperate fruit and nut crops for higher	Dr. M.K. Verma, Principal Scientist (Hort. – Fruit Science),	24.09.2021	96



	productivity and nutritional security	Division of Fruits and Horticultural Technology ICAR-IARI, New Delhi, India		
9.	Prospects of Cashew Cultivation in West Bengal	Dr. Mini Poduval, OIC, Cashew AICRP Centre, BCKV, Jhargram	01.10.2021	51
10.	Empowering daughters of India in Agriculture	Ms. Suvarna Bhatt, CEO, Bhoomiputri NGO, initiative of Kadamba	14.10.2021	24
11.	Jackfruit and Banana: Potential crops for food and livelihood security	Shri Shree Padre, Editor, Adike Patrike,	16.10.2021	92
12.	New trends in coffee processing and innovative coffee products for health and wellness	Dr. Pushpa S Murthy, Principal Scientist, Spice and Flavour Science Department, CSIR-CFTRI, Mysore	22.10.2021	59
13.	Prospects of Cashew Cultivation and processing in Southern Madian tracts of Karnataka	Dr. Ramachandra R K Head, AICRP on Cashew and HREC, Hogalagare	29.10.2021	21
14.	Interaction with students on "Agriculture and environment for Future Citizens"	Shree. Nagesh Hegde Environmentalist and Visiting Professor to IIJNM, Bangalore	05.11.2021	54
15.	Prospects of Cashew Cultivation in Andhra Pradesh	Dr. K Umamaheswara Rao Senior Scientist (Hort.) Cashew Research Station Dr. Y S R Horticultural University Bapatla, AP	12.11.2021	20
16.	Integration of medicinal and aromatic plants in different cropping systems	Dr. V Thondaiman Scientist (SPM & AP)	20.11.2021	14
17.	Cashew Cultivation in South East Asian countries: Case study	Varanashi Krishnamoorthy, Managing Trustee Varanashi	26.11.2021	30



	from Vietnam and Cambodia	Development and Research Foundation, Adyanadka, Dakshina Kannada		
18.	Value addition potential in Cashew	Dr. Rajkumar A Dagadkhair Scientist (Food Science) ICAR-Directorate of Cashew Research, Puttur	10.12.2021	48
19.	Cashew Manufacturing in India: Role of Science and Technology	Sri. Giridhar Prabhu Executive Director Achal Cashew Industries Pvt. Ltd. Mangalore	18.12.2021	49

16.2 Training/ Workshop

16.2.1 On-farm training programme on Canopy Management in Cashew



A team of scientists from ICAR-DCR, Puttur, comprising Dr. J Dinakar Adiga, Principal Scientist (Horticulture), Shri. Muralidhara B.M, Scientist (Horticulture), Dr. Manjesh G.N, Scientist (SP& MAP) and Dr. Aswathy Chandrakumar, Scientist (Agricultural Extension) visited cashew orchard of Navneet farm on 18th September, 2021 to advice about canopy management practices in cashew as well as other

fruit crops. Before the commencement of programme Mr. Venugopal Kedilaya, introduced the concerned scientific staff of DCR to the field workers and urged them to learn the canopy management practices from the experts of DCR. Dr. J. D. Adiga highlighted about the basic training practices as well as pruning practices to bring young cashew plants to proper shape for better penetration of sunlight and air. Later Shri. Muralidhara B.M. explained about the how to prune the plants right from beginning of the plantation as well as the time of pruning for various cashew varieties. This was followed by actual on-farm demonstration of canopy management in young cashew orchards located in the farm. After the demonstration the field workers of the farm were asked to demonstrate the technique of canopy management before the scientists for finetuning the acquired knowledge of field workers. There were 21



participants including field workers as well as owner of the farm, were satisfied with the on-farm training programme and clarified their queries related to pruning and training under normal as well as high density planting system. The time and extent of pruning for harvesting scion sticks were also explained in detail as requested by field workers. They also sought information about method and time of application of fertilizers.



16.2.2 Trainings conducted

- 5-days training program on 'Cashewnut Processing' conducted for Tribal Women operating cashewnut processing unit, Bastar, Jagadapur, Chhattisgarh from 4-8th October, 2021.
- One day training program organized for Women Shelf Help Group (60 Nos.) on 'Home scale cashewnut processing and its sustainability 'on 08.03.2021 ('Women Day') operating under Chhattisgarh State Minor Forest Produce Federation, Bastar, Jadalpur, Chhattisgarh
- 1-Day online training program on 'Quality assessment for raw cashewnuts' conducted for 70 Nos. of participants of Chhattisgarh State on 7th May, 2021.
- 3-days trainings offered under ABI for registered incubates – 15 Nos.,

16.2.3 Entrepreneurship-cum-Skill Development Training Programme under RKVY project



The ICAR-Directorate of Cashew Research, Puttur organized two 5-days "Entrepreneurship-cum-Skill Development Training Programme on Value added products from fruits & Vegetables" during 20-26 October 2021 and during 25-30 November 2021. This training programme for the youth and women was organized under the project funded by RKVY-RAFTAAR. Around 46 rural youths attended the training programme.



16.2.4 Farmer-Scientists interface on Climate resilient varieties, technologies and practices

A farmer-scientists interface was held on 28th September, 2021 to create awareness on climate resilient varieties, technologies and practices. Climate change is adversely affecting agricultural production and productivity. Adoption of climate resilient varieties, technologies and practices is an important means to combat this issue. In this regard, ICAR-Directorate of Cashew Research, Puttur conducted a farmer scientist interface on 28th September, 2021 as part of the “Mass awareness campaign for large scale dissemination of climate resilient technologies and methods” organised by Indian Council of Agricultural Research under *Azadi ka Amrut Mahotsav* initiative.

The programme commenced with the welcome address and introductory remarks by Dr. D Balasubramanian, Principal Scientist (AS & PE) of this directorate wherein he highlighted on the need to address climate change and oriented the



participants towards the programme. Following this, a live telecast of honourable PM Shri Narendra Modi addressing our farmers through virtual mode was arranged in the institute. During the online programme, honourable PM dedicated 35 crop varieties to the nation, which have been developed by National Agricultural Research System for sustainable agricultural production. Also, honourable PM interacted with 5 progressive farmers across the country to know their problems in agriculture. The new campus of “National Institute of Biotic Stress Management” at Raipur was virtually inaugurated during the online event and “Clean Green Campus award” winners among the institutes and universities were also announced by honourable PM. Following this a brief farmer scientist interface was arranged with the farmers invited from Puttur. Shri Uday Kumar, farmer and institute management committee member of this directorate, during this interaction emphasized that cashew is also affected by uneven rainfalls as blackening of nuts is becoming a problem in the fields. He stressed that climate resilient varieties need to be developed and such farmer scientist interface can help in realising prime minister’s dream of an *Atmanirbhar Bharat*.



16.2.5 Farmer-Scientists interface on Natural farming



Hon'ble Prime Minister Shri Narendra Modi addressed the nation on the importance of Natural farming during the "Pre-Vibrant Gujarat Summit" held on 16th December 2021. In this regard, a farmer-scientists interface was organized at this Directorate. Around 30 farmers including members

of Shri Kshetra Dharmasthala Rural Development Project (SKDRDP) attended the interface meeting. The programme commenced with the introductory remarks of Dr. J Dinakara Adiga, Director in charge. In his introductory remarks, he emphasized on the importance of Natural farming in the changing climatic conditions. Smt. Anitha M, a progressive tribal farmer practicing integrated farming system under the traditional farming system was invited to share her experience. Being a resource person for various capacity development programmes, she enlightened the farmers on various aspects of Natural farming. She explained to the audience about the preparation of Jeevamrutha and Bijamrutha. This was followed by a brief interaction between the farmers and scientists discussing the advantages and benefits of adopting Natural farming in field conditions. After a brief interaction with the farmers by the scientists, the "Pre-Vibrant Gujarat Summit" held at Anand, Gujarat was livestreamed at the Directorate. Hon'ble Prime Minister Shri Narendra Modi addressed the farmers on the role of Natural farming in making agriculture more sustainable. In his address, Hon'ble Prime Minister reiterated the role of ICAR and KVKs in lab to land transfer of sustainable, organic friendly technologies and urged the farming community to stop the indiscriminate use of chemical fertilizers. Hon'ble Union Minister of Agriculture and Farmers Welfare and President ICAR, Shri Narendra Singh Tomar, Hon'ble Union Home Minister, Shri Amit Shah and Shri Acharya Devvrat, Governor of Gujarat also shared their views on promoting Natural farming to protect nature.



17. राजभाषा कार्यान्वयन एवं प्रगति

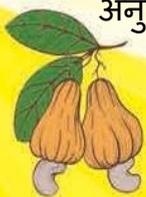
राजभाषा कार्यान्वयन समिति 2021

1. डा. अनिता करुण (अक्टोबर 2021 तक) डा. टी एन रविप्रसाद (अक्टोबर 2021 से)	अध्यक्ष
2. डा. राजशेकर (प्र. अधिकारी प्रभार)	सदस्य
3. डा. तोन्डाईमन	सदस्य
4. डा. रजकुमार दागडकैर	सदस्य
5. श्रीमती लीला एम.	सदस्य
6. श्रीमती रेष्मा के	सदस्य
7. श्री विजय आचारी	सदस्य
8. डा. रघुराम कुक्कडे	सदस्य
9. श्री प्रकाश जी. भट्ट	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 को 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 जागरूकता 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, क्विज़ प्रतियोगिता आदी आयोजित की जाती है।

इस वर्ष भी पुत्र नगर राजभाषा कार्यान्वयन समिति की अर्ध वार्षिक बैठक और दो तिमाहि बैठकों को आयोजन किया गया। कोरोना महामारी के कारण अर्ध वार्षिक बैठक और एक तिमाही बैठक को आन्लाइन् आयोजन किया गया। इन बैठकों में निदेशालय की 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। पखवाडा के अवसर पर विध्यार्थियों और कर्मचारियों के लिए भाषण, निबंद लेखन और सामान्य ज्ञान प्रतियोगिता आयोजन किया गया।

हिन्दी में कार्यालयीन काम करने वाले कर्मचारियों को नकद पुरस्कार से सम्मान लिया गया। राजभाषा को बढ़ावा देने के लिए पूरी कोशिश किया गया।

राजभाषा नियम 1976 नियम 11 के अनुपालन हेतु आवश्यक सामग्रियों जैसे प्रपत्र, रबड़ की मोहरें, नाम पट्ट आवश्यकतानुसार द्विभाषी में तैयार कर समय समय पर मार्गनिर्देश दिया जाता है। सम्मेलनों का बैनर एवं निमंत्रण पत्र द्विभाषा में ही प्रदर्शित किया जाता है। हिंदी पत्रों की आवृत्ति 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 कुल चार कार्यशालाओं को आयोजन किया जा रहा है। इस वर्ष भी अनुभवी मार्गदर्शकों की मार्गदर्शन में मसौदा लेखन, टिप्पण, अनुवाद एवं राजभाषा नियम, 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 कार्यालयों में राजभाषा हिन्दी का कार्यान्वयन सुनिश्चित करने की दृष्टि 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 39वीं अर्धवार्षिक बैठक दिनांक 23.1.2021 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 निम्न लिखित रिपोर्ट हिंदी में प्रकाशित किया गया:

1. निदेशालय का वार्षिक प्रतिवेदन (वर्ष 2020) पूर्ण रूप से हिंदी में।
2. अखिल भारतीय समन्वित काजू अनुसंधान परियोजना की वार्षिक प्रतिवेदन सारांश (वर्ष 2020-21)
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 संस्थान के काम में राजभाषा हिंदी के कार्यान्वयन के लिए अपनी प्रतिबद्धता दोहराते हैं।



18. DISTINGUISHED VISITORS

Name	Address	Date of Visit
Mrs. Archana N.H.	Department of Agriculture, Doddaballapura, Bangalore Rural	18.03.2021
Dr. Chowdappa	Former Director, ICAR-CPCRI, Kasaragod, Kerala	29.03.2021
Sri. VijayaKumar B	Assistant Professor and Head, Department of PSMAP, College of Horticultural Sciences, Bangalore	03.09.2021
Sri. Suryanarayan N.K.	Advocate, Puttur, Dakshina Kannada	1.11.2021
Sri. Manohar K V	President Advocate Association Puttur	01.11.2021
Dr. P.R. Rao Dr. S. Ravichandra	ICAR-IRR ICAR-NAARM, Hyderabad	20.12.2021
Dr. P.S. Bhat	Principal Scientist (Retd.), ICAR-IIHR, Bangalore	24.12.2021
Sri. Sajeev, U.	Manager, Plantation Corporation Kerala	08.02.2022
Dr. V Aravindan Nambi	Independent Expert On Biodiversity Chennai	19.02.2022



19. PERSONNEL

Research Management Position		
1.	Dr. Anitha Karun	Director (Acting) till October 2021
2.	Dr. T.N. Raviprasad	Director (Acting) from October 2021
Scientific		
1.	Dr. T.N. Raviprasad	Principal Scientist (Agricultural Entomology)
2.	Dr. D. Balasubramanian	Principal Scientist (Agricultural Structures and Processing Engineering)
3.	Dr. J.D. Adiga	Principal Scientist (Horticulture)
4.	Dr. Mohana, G.S.	Principal Scientist (Genetics & Cytogenetics)
5.	Dr. Shamsudheen Mangalassery	Senior Scientist (Soil Science)
6.	Dr. Eradasappa, E.	Scientist (Plant Breeding)
7.	Dr. K. Vanitha	Scientist (Agricultural Entomology)
8.	Shri. Rajkumar Arjun Dagadkhair	Scientist (Food Technology)
9.	Dr. Babli Mog	Scientist (Plant Physiology)
10.	Dr. Siddanna Savadi	Scientist (Agricultural Biotechnology)
11.	Dr. Thondaiman, V.	Scientist (Plantation, Medicinal Spices and Aromatic crops)
12.	Dr. Rajashekara, H.	Scientist (Plant pathology)
13.	Dr. Veena, G.L.	Scientist (Fruit Science)
14.	Dr. Manjunatha, K.	Scientist (Farm machinery and power Engineering)
15.	Dr. Manjesh, G. N.	Scientist (Plantation, Medicinal Spices and Aromatic crops)
16.	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. K.V. Ramesh Babu	Sr. Technical Officer
7.	Shri. R. Muthuraju	Sr. Technical Officer
9.	Shri. M. Bhojappa Gowda	Technical Officer



10. Shri. Ravishankar Prasad	Sr. Technical Assistant
11. Shri. Honnappa Naik, P.	Sr. Technician

Administration

1. Shri.T.E. Janardhanan	Administrative Officer (on additional charge from 30.12.2019)
2. Smt. M. Rathna Ranjini	Assistant Administrative Officer
3. Shri. O.G. Varghese	Private Secretary
4. Smt. Reshma, K	Personal Assistant
5. Ms. Winnie Lobo	Assistant
6. Smt. M. Leela	Assistant
7. Shri. Umashankar	Upper Division Clerk
8. Smt. K. Padminikutty	Upper Division Clerk

Skilled Supporting Staff

S.No.	Name	S.No.	Name
1.	Sri. K. Shiva	10.	Sri. K. Narayana
2.	Sri. N. Narayana Naik	11.	Sri. B. Narayana Poojari
3.	Sri. Vijaya Achari	12.	Sri. B. Kushalappa
4.	Sri. Veerappa	13.	Sri. B. Babu Gowda
5.	Sri. K. Annu	14.	Sri. T. Padmanabha
6.	Sri. Krishnappa Naik	15.	Sri. S. Monappa
7.	Sri. V. Sundara	16.	Sri. B. Seetharama
8.	Sri. C.H. Hariya Naik	17.	Sri. K. Gopalakrishna
9.	Sri. K. Umanath hetty	18.	Smt. S. Kasturi

Retirement

- Dr. M. Gangadhara Nayak, Principal Scientist (Hort.) retired on superannuation on 31.07.2021
- Shri. Umanath Shetty, Senior Technical Assistant superannuated on 31 January 2021

Promotion

- Dr. T. N. Raviprasad, Principal Scientist taken over the charge of Director (Acting) on 28.10.2021.
- Smt. M. Rathna Ranjini, AAO was promoted as AO w.e.f. 05.11.2021



- Sri. Umashankar UDC was promoted to Assistant w. e. f. 13.08.2021.
- Sri R. Muthuraju Sr. Technical Officer was promoted as Asst. Chief Technical Officer w.e.f. 14.11.2019.
- Sri. Manikandan N., Senior Technical Officer promoted as Asst. Chief Technical Officer w.e.f. 01.07.2017.

Transfer

- Shri. Muralidhara B. M Scientist (Fruit Science) has been relieved from this Directorate on 07.10.2021 consequent on his Inter Institutional transfer to ICAR-CHES, Chettali.



20. Meteorological DATA (2021)

Month	Temperature (° C)		Humidity (%)		Rainy days	Rainfall	Mean wind velocity	Sunshine	Pan evaporation
	Max	Min	FN	AN	(Nos)	(mm)	(km/h)	(h)	(mm)
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	-	-	-

Rainfall, rainy days and sunshine hours are monthly total; other parameters are monthly mean values.



21 PUBLICATIONS FOR SALE

Sl. No.	Publication	Price (Rs.)
1.	Cashew production technology (Revised)	60.00
2.	Softwood grafting and nursery management in cashew (Revised)	45.00
3.	Catalogue of minimum descriptors of cashew	
4.	Germplasm accessions - I	165.00
5.	Germplasm accessions - II	125.00
6.	Germplasm accessions - III	128.00
7.	Germplasm accessions - IV	--
8.	Germplasm accessions - V	--
9.	Process catalogue on development of economically viable on-farm cashewnut processing	45.00
10.	Annotated bibliography on cashew (1995-2007)	205.00
11.	Soil and water management in cashew plantations	30.00
12.	Biochemical characterization of released varieties of cashew	85.00
13.	Pruning and canopy architecturing in cashew	40.00
14.	Development of dual-mode dryer for raw cashewnut	90.00
15.	Alternate energy utilization of cashew shell cake for thermal application	90.00
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Address your enquiries to the Director, ICAR-Directorate of Cashew Research, Puttur-574 202, Dakshina Kannada, Karnataka.

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This calculator is to provide a general idea about the initial requirements. It is to mention that for yielding trees irrigation should commence only after flowering. After installing the system, the user has to make field adjustments after making several test runs.

Cashew site suitability

Developed by: Dr. Shamsudheen Mangalassery, Dr. R. Rejani, Dr. Preethi P. Mr. B.M. Muralidhara, Dr. J. D. Adiga, Dr. M G Nayak, Dr. Babli mog and Dr. Siddanna Savadi

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Cashew Nutrient Deficiency

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Developed by: Dr. H. Rajashekan, Dr. K. Vanitha, Dr. M. Loganathan, Dr. T.N. Raviprasad, Dr. Shamsudheen Mangalassery

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