भाकृअनुप
ICAR

Golden Jubilee Year

वार्षिक प्रतिवेदन
Annual Report










2025

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान
ICAR-Indian Institute of Spices Research
Marikkunnu (P.O.), Kozhikode-673 012, Kerala, India

वार्षिक प्रतिवेदन 2025

Annual Report 2025

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड़-673 012,केरल,भारत

ICAR-Indian Institute of Spices Research, Kozhikode-673 012, Kerala, India
(Three-time winner of Sardar Patel Outstanding ICAR Institution Award)

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PREFACE

It is with immense pride and gratitude that I present the Annual Report of ICAR-Indian Institute of Spices Research for 2025, a landmark year marking the Golden Jubilee of the Institute. Over the past five decades, ICAR-IISR has remained steadfast in its commitment to advancing scientific research, fostering innovation, and contributing significantly to the growth and sustainability of India's spice sector. Our journey has been characterized by notable achievements and transformative contributions that have shaped the spice economy of the country.

A major highlight of the year was the release of two new spice crop varieties. IISR Navya, a high- and stable-yielding ginger mutant, with reduced susceptibility to rhizome rot disease under field conditions and IISR Sujyothi, a cardamom variety distinguished by its high yield and superior essential oil content. These varietal releases exemplify the Institute's commitment to farmer-centric research and consumer-oriented varietal improvement.

The year was particularly eventful, marked by several key milestones that reaffirm our pursuit of scientific excellence and effective technology dissemination. During the year, the Institute issued 43 technology licenses, reflecting growing industry confidence and interest in our research outputs. We were granted two patents and six copyrights, underscoring our strong focus on IP generation. Memoranda of Agreement were signed with Synthite Industries Pvt. Ltd. for technology transfer, post-harvest processing of turmeric, and scientific guidance in turmeric cultivation, and with the Spices Board for promoting the production of pesticide-free spices using bio-inputs. Through collaborative partnerships, technical consultancy services, contract research programmes, and targeted initiatives under the Pan India CSR-Tata Trust fund, TSP, SC-SP, and NEH programmes, the Institute significantly strengthened its outreach, ensuring that research benefits reached spice-growing regions across the country.

Entrepreneurship development remains a central focus of the institute. Recognising the importance of nurturing new business opportunities and innovative practices, the institute has consistently prioritised the creation and implementation of supportive programmes. Among the various initiatives, the 3-day conclave on Entrepreneurs Meet and Agri Expo 'RISE UP 2.0' stands out as a driving force in promoting agripreneurship among women, youth, and students.

In our ongoing efforts to strengthen collaboration, we have established productive partnerships with sister ICAR institutions, including ICAR-IIHR, ICAR-CPCRI, ICAR-CTCRI, ICAR-DFR, ICAR-DOGR, and ICAR-NBAIR. These alliances are a testament to our commitment to collectively maximise the impact of our research, streamline resources, and advance the overall objectives of 'One ICAR'.

I express my profound gratitude to Dr. Mangi Lal Jat, Director General, ICAR and Secretary, DARE, for his unwavering support and guidance. I also extend my sincere thanks to Dr. S.K. Singh, Deputy Director General (Horticultural Sciences), for his invaluable leadership and encouragement. Special appreciation is due to Dr. Sudhakar Pandey, Assistant Director General (Flowers, Vegetables, Spices and Medicinal Plants) for his insightful guidance and continued support. I am grateful to the editorial team for their meticulous efforts in compiling this report. With renewed determination and optimism, we look forward to another year of impactful research and meaningful contributions to the spice sector.

Kozhikode
30 January 2026

R. Dinesh
Director

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कार्यकारी सारांश

काली मिर्च

- पेरुवण्णामुषि प्रायोगिक प्रक्षेत्र में 3,511 काली मिर्च अक्सेशनें, आईसीएआर-आईआईएचआर, सीएचईएस, चेताली में 735 अक्सेशनें, और संस्थान के मुख्यालय में 80 कोर अक्सेशनें, और 222 फील्ड जीन बैंक अक्सेशनें को बनाये रखे जा रह है।
- जो नए जर्मप्लाज्म जोड़े गए, उनमें कासरगोड, मलप्पुरम, और पलक्कड़ के संवर्धित किस्में और मिजोरम से संग्रहित पाइपर ब्रोमेरिफोलम शामिल है।
- असम के इन्डो-भूटान सीमांत जिले और मेघालय के पश्चिम और पूर्व गरो पर्वतों में बड़े पैमाने पर जर्मप्लाज़म की खोज की गईं, और जंगली और अर्ध-जंगली काली मिर्च प्रजातियों की नर और मादा की पौधों का अलग अलग आबादी इकट्ठा की गईं जिससे काली मिर्च की अनुवंशिक विविधता बढ़ी है।
- त्रिगुणित स्थानीय किस्म वडक्कन की 30 खुले परागित संततियों का मूल्यांकन किया गया, जिसमें उपज, पाइपरिन, सुगंधित तेल और ओलिओरसिन की मात्रा में व्यापक भिन्नता देखी गईं और भविष्य के चयन के लिए उच्च गुणवत्ता के लक्षणों वाली आशाजनक वंशों की पहचान की गई।
- 39 अक्सेशन की जीनोम आधारित पुनरनुक्रमण करने पर 26 अक्सेशनों में 159,390 CNVs, पाइपरिन जैवविश्लेषण और पौधों की प्रतिरोधकता के मार्ग के लिए संवर्धित CNVs की पहचान की गई।
- SNPs, SSRs, InDels सहित व्यापक आनुवंशिक संसाधनों और 30 आनुवंशिक प्रकार के के एक छोटी 'मुख्य संग्रह' विकसित किया गया।
- एसएसआर प्रोफाइल का इस्तेमाल करके QR कोड आधारित डिजिटल प्रजाति पहचान प्रणाली बनायी गयी।
- पूरे जीनोम बाइसल्फाइट अनुक्रमण के माध्यम से 2,098 सूखे पर असर डालने वाले DMRs की पहचान की गयी।
- जीनोमिक्स, आणविक प्रजनन और कार्यात्मक अध्ययनों का समर्थन करने के लिए कई विशेष डेटाबेस विकसित किए गए थे, जिसमें 150,828 बहुरूपी एसएसआर के साथ PnGeneSSRdb, BPCNVDb, BPncDB और BP2SSRDb शामिल है।
- 32 RNA-seq डेटासेट से 4,972 lncRNAs और 4,994 circRNAs की पहचान की गई, जिससे बड़े नियामक नेटवर्क का पता चला।
- तनाव प्रतिक्रिया, रोग प्रतिरोधकता, उपापचय, और P450 पाथवे से जुडे SSRs को कार्यात्मक ढंग से चरित्रांकित किया गया।
- पन्नियूर-1 और श्रीकरा के बीच पोषक तत्व परिवाहकों की विभेदक जीन अभिव्यक्ति देखी गयी।
- शरीरिक अध्ययन से पता चला है कि आईआईएसआर तेवम जलभराव और फाइटोफ्थोरा तनाव के लिए ज्यादा सहिष्णु है।
- जल्दी छाया नियामन और समय पर सिंचाई करने से यह देखा गया कि स्पाइक की गुणवत्ता बेहत्तर हुई और पैदावार में लगभग 4 कि. ग्रा. /बेल की वृद्धि हुई।
- सुखाने पर किए गए अध्ययनों से पता चला है कि एसेंशियल तेल और ओलिओरसिन को बनाए रखने के लिए इंफ्रारेड, वैक्युम और होट-एयर ड्राइंग (55-60^{0}C) बेहत्तर है।
- फाइटोफ्थोरा कैप्सीसी और पी. ट्रॉपिकालिस के प्रति मध्यम प्रतिरोधी और प्रतिरोध अक्सेशनों की पहचान की गईं।
- फाइटोफ्थोरा प्रतिरोधकता के लिए NPR3 जीन को लक्षित करते हुए CRISPR/Cas 9 जीनोम एडिटिंग शुरू हुई।
- फ्लूओपाइरम का इस्तेमाल करके सूत्रकृमि प्रबंधन तकनीक विकिसित की गई, जिससे >96% आबादी में कमी आई और >26% की पैदावार बढ़ी।
- पाइपर येल्लो मोटल वाइरस का तेज़ी से पता लगाने के लिए RPA–CRISPR–Cas12a–LFA परख, जिसकी संवेदनशीलता PCR से कहीं ज्यादा है, विकसित किया गया।

- पोल्लू बीटल के लिए क्लोरेंट्रानिलिप्रोल के खेत मूल्यांकन से पुष्टि हुई कि यह बहुत असरदार है, प्राकृतिक शत्रुओं से सुरक्षित है और लेबल एक्स्पांशन के लिए सही है।

इलायची

- भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान क्षेत्रीय केंद्र, अप्पंगला के राष्ट्रीय सक्रिय जर्मप्लाज़म साइट (एनएजीएस) में 625 इलायची अक्सेशनों का संरक्षण किया जा रहा है।
- उच्च पैदावार वाली मलबार प्रकार के अक्सेशन को सुल्लिया, दक्षिण कन्नड़, (कर्नाटक) से इकट्ठा की गई।
- 120 अक्सेशनों के रूपवैज्ञानिक और उत्पादन स्वभाव के चरित्रांकन से पता चला कि अक्सेशन आईसी 54716 में सबसे ज्यादा टिलर्स, पैनिकिल्स, कैप्स्यूल और उत्पादन थे। 75 अक्सेशनों में एसन्श्यल तेल की मात्रा में 4.19% से 8.89% तक का अंतर था। जीसी-एमएस प्रोफाइलिंग से मुख्य एरोमा संयोग, विशेषकर 1, 8 सिनोल और α- टेरपिनाइल एसिटेट में बड़ा अंतर दिखाया।
- 15 नमी तनाव सहनेवाली प्रकारों के मूल्यांकन से पता चला कि MS 584058-5 ज्यादा पैदावार देने वाली थी। 42 संकर प्रजातियों में से, 7-2021-14 ने सबसे अधिक ताज़ी और सूखी उपज दर्ज की।
- बहु वर्षीय सीवीटी में बोल्ड × IC-547219 को सबसे अच्छा संकर पहचान लिया और इसे आईआईएसआर सुज्योति के रूप में विमोचित करने की सलाह दी गई।
- बहुस्थानीय पर्ण ब्लाइट के परीक्षणों में IC-349649 को न्यूनतम रोग आपतन वाली के रूप में पहचान लिया। थ्रिप्स सहनशीलता के मूल्यांकन में IC-349362 को वृद्धि, उपज और कैप्स्यूल की संख्या की दृष्टि से बेहत्तर बताया गया।
- टिश्यु-स्पसिफिक ट्रान्स्क्रिप्टोम सीक्वनसिंग (बीज, पत्ता, जड़) से α-टरपिनिल एसिटेट जैवसंश्लेषण में शामिल मुख्य घटक जीन (मोनोटरपिनिल सिंथेस 7 और 8, BAHD एसाइल ट्रान्सफरेस) का पता चला।
- सुलिया में गैर-पारंपरिक कम ऊंचाई वाले इलाकों (समुद्र तट से 107-150 मी. ऊंचाई) में सुपारी और नारियल की खेती के साथ इलायची की सफल खेती दिखाई गई। ऐसे इलाकों में उगाए जाने लायक खास जीनोटाइप की पहचान की गई और उन्हें स्वीकार करने हेतु परीक्षण के लिए संरक्षित किया। किसानों ने संशोधित छाया और सिंचाई के तहत 450 पौधों से 100 कि. ग्रा. तक का उत्पादन प्राप्त हुआ।
- 22 जीनोटाइप के जीसी-एमएस आधारित कीमो विविधता विश्लेषण से अलग अलग क्लस्टरिंग पैटर्न का पता चला। मुडिगरे 2, पनिकुलंगरा 2, एलराजन, पनिकुलंगरा 1 , तिरुताली और पीवी 2 जैसे जीनोटाइप में लिनालूल की मात्रा अधिक थी, जबकि इन जीनोटाइप और आईसीआरआई 2 और आईआईएसआर अविनाश में α-टरपिनिल एसिटेट अधिक और 1,8 सिनोल प्रोफाइल कम थी।
- वैक्युम इम्प्रग्नेशन का इस्तेमाल करके इलायची के स्वाद वाली कद्दू कैंडी बनाई गई, जिससे बेहत्तर पोषण और सेंसरी गुणवत्ता और कम सूक्ष्मजीवजनित संदूषण मिलती है।
- इलायची मोसाइक वाइरस (CdMV) का तेज़ी से पांइट – ऑफ-केयर पता लगाने के लिए RT-RPA–LFA परीक्षण बनाया गया। इस परीक्षण ने अधिक विशेषता और संवेदनशीलता दिखाई और इसे केरल और कर्नाटक के लिए मूल्यांकन किया गया।
- इलायची के चिर्के रोगों के लिए RPA-LFA (CBDV) और RT-RPA-LFA (LCCV) परीक्षण बनाए गए। इस परीक्षण ने पीसीआर की अपेक्षा समान और अधिक संवेदनशीलता दिखाई दी और 35-45 मिनट के अंदर ऑन साइट डिटक्शन किया गया, जिससे साफ रोपण सामग्रियों के कार्यक्रम को समर्थन मिला।

अदरक

- आईसीएआर-आईआईएसआर प्रायोगिक प्रक्षेत्र, पेरुवण्णामुषि, केरल के फील्ड जीन बैंक में 668 अदरक अक्सेशनों को बनाए रखा जा रहा है।
- आईसीएआर-एनबीपीजीआर अनुसंधान केंद्र, शिल्लोंग के साथ एक सहयोगी जर्मप्लाज़म अन्वेषण के माध्यम से सात स्पीसीस (जिंजिबर ओफीशनेल, जिंजिबर मेघालयन्स, जिंजिबर लिगुलाटम, जिंजिबर पर्पुरियम, जिंजिबर ज़ेरुमपेट और दो अज्ञात प्रजातियों) का प्रतिनिधित्व करने वाले 11 जिंजीबर अक्सेशनों और अन्य जिंजीबरेसी जनीरा

(अलपीनिया, अमोमम और एटलिंजेरा) से छह अक्सेशनों को एकत्र किए गए।

- IISR नव्या, जो गामा-इरेडिएशन से तैयार किया गया अदरक का एक म्यूटेंट है, जिसकी औसत ताज़ी पैदावार 15.3 t ha^{-1} और संभावित पैदावार 36.0 t ha^{-1} है, और जिसमें बेहतर क्वालिटी की खूबियां हैं (सूखा रिकवरी 18.78%, एसेंशियल ऑयल 2.7%, ओलियोरेसिन 6.65%), उसे रिलीज़ के लिए रिकमेंड किया गया।
- पेरुवण्णामुषि और अप्पंगला में किए गए सीवीटी में, प्रविष्टी G 2023-16 ने दोनों जगहों पर बेहत्तर उत्पादन और उच्च उपलब्धी दर्ज की। प्रविष्टि G 2023-5 और G 2023-6 ने लगातार अलग अलग जगहों पर उच्चतर उपज अंकित की।
- पूरी ट्रांसक्रिप्टोम माइनिंग से खास जिंजरोल बायोसिंथसिस जीन (KAT5, CHS) के कई आईसोफॉर्म की पहचान हुई। एक स्नेकमेक-आधारित पाइपलाइन ने लगभग 800,000 lncRNA सीक्वेंस बनाए, जिससे GingerLnc डेटाबेस बना।
- अलग अलग प्राकृतिक और एकीकृत पोषकतत्व प्रबंधन प्रणाली (आईएएम) के मूल्यांकन से मिट्टी और पत्ती के पोषकतत्व, उपज और गुणवत्ता में काफी अंतर दिखाया। सबसे ज्यादा उपज (13.07 टन/हेक्टर) जैविक (50%) +बायो इनपुट के तहत अंकित की गई, जिसमें ज्यादा जैविक इनपुट के तहत बेहत्तर तेल और ओलिओरसिन घटक थे।
- FAO–IIASA AEZ आधारित मूल्यांकन से पश्चिमी घाट और पूर्वोत्तर क्षेत्र में अदरक की खेती के लिए सबसे उच्च से लेकर उच्चतम अनुकूल क्षेत्रों की पहचान करने में मदद मिली।
- अदरक में संक्रमित पाइथियम ग्रैमिनिकोला और पी. मायरियोटाइलम की पहचान की गई और उनका चरित्रांकन किया गया।
- लोबिया और सरसों के साथ फसल चक्रण से मिट्टी में पाइथियम की आबादी और मृदु गलन का प्रकोप काफी कम हो गया। फ्लूपिकोलाइड + फोसटाइल-Al को पाइथियम की आबादी और मृदु गलन के प्रकोप को कम करने में एक असरदार नई पीढ़ी के फंगीसाइट के रूप में पहचाना गया।
- बीज प्रकंद से राल्स्टोनिया सुडोसोलानेसियारम को खत्म करने के लिए हीट और रासायनिक वैक्युम इनफिल्ट्रेशन उपचार के तरीके को अनुकूलित किया गया। AMF प्राइमिंग ने मृदु गलन आपतन को कम किया और मेलोयिडोगाइन इनकोग्निटा के प्रवेश को रोक लिया। इसने जैवरासायनिक प्रतिरोध (पेरोक्सिडेस, कटालेस, β-1,3-ग्लूकानेस) को भी बढ़ाया और मुख्य प्रतिरोध जीन (NPR1, TGA, AP2, 4CL, LOX2, AOC) के प्रकटन को नियामित किया।
- बैसिलस पुमिलस KG6 और प्स्यूडैसिडोवोरैक्स इंटरमीडियस NCC15 जैसे एंडोफाइट्स को पी. मिरियोटैलम के प्रति शक्तिशाली प्रतिरोधक के रूप में पहचाना गया।
- मेलोयिडोगैन इनकोग्निटा के प्रति प्रतिरोधक तीन अदरक अक्सेशनों (NE local 2, GC9, ACC 891) की पहचान की गई। फ्लुओपाइरम इस्तेमाल करने से ~85% सूत्रकृमियों की कमी आई और उत्पादन में ~3.25 गुना वृद्धि हुई।
- ट्रान्स्क्रिप्टोमिक विश्लेषण से पता चला कि नियंत्रण की तुलना में पोचोणिया क्लामिडोस्पोरिया से तैयार पौधों में इंड्यूस्ड क्रमिक प्रतिरोधक से जुड़े पाथवे सक्रिय हो गये।
- कम जोखिम वाले कीटनाशक क्लोरेंट्रानिलिप्रोल और स्पिनोसाद ने अदरक और हल्दी में प्ररोह बेधक (कोनोगीथस पंक्टिफरालिस) पर 100% तक नियंत्रण प्रदान किया। यह उपचार फाइटोटॉक्सिक रहित थे और प्राकृतिक शत्रुओं से बचाने वाले थे।

हल्दी

- हल्दी के कुल 1,404 कुरकुमा स्पीसीस जर्मप्लाज़म अक्सेशनों को संरक्षित किया जा रहा है, जिनमें 1,132 हल्दी अक्सेशनें हैं। इन सभी अक्सेशनों के लिए रूपवैज्ञानिक और प्रकंदों का चरित्रांकन पूरा कर लिया गया था, जबकि 800 अक्सेशनों को गुणवत्ता ट्रेट्स के लिए चरित्रांकित किया गया था। 1,067 हल्दी अक्सेशनों को पर्ण ब्लॉच के लिए छानबीन की गई और इनमें 633 अक्सेशनों को प्रतिरोधक के रूप में पहचान की गई।
- असम और मेघालय से C. longa और दो अज्ञात प्रजातियों का प्रतिनिधित्व करने वाले छह करकुमा एक्सेसन इकट्ठा किए गए। ।
- काली हल्दी परीक्षण में, अक्सेशन 751 ने उच्चतम

उपज (12.23 कि. ग्रा./बेड) अंकित किया, जिसके बाद PCC1, BT 162, और NBT 2 है।

- दो वर्षों के अंदर 170 खुले परागित प्रजातियों की जांच की गई और इनमें से 31 को बेहत्तर जीनोटाइप के रूप में लघु सूचिबद्ध करके जर्मप्लाज़म में जोड़ा गया।
- बहु पारिस्थितिक मूल्यांकन के लिए 139 प्रजातियों को एआईसीआरपीएस के विभिन्न केंद्रों को दिया गया।
- Acc. 849 × आईआईएसआर प्रतिभा के तुलनात्मक ट्रांसक्रिप्टोम विश्लेषण से टेरपेनॉइड बायोसिंथेसिस और माइटोकॉन्ड्रियल मेटाबॉलिज्म से जुड़े प्रमुख DEGs सामने आए, जो अनोखी खुशबू वाली विशेषताओं को समझाते हैं।।
- एकीकृत ट्रांस्क्रिप्टोमिक जीनोमिक विश्लेषण से 24,220 उच्च विश्वसनीय lncRNAs और ट्रेट-एसोसियेटड SNPs का पता चला।
- GoldenLncDB विकसित किया, जो पहले समर्पित lncRNA हल्दी डेटाबेस है।
- सबसे ज़्यादा ताज़े प्रकंद की पैदावार (13.56 टन/हेक्टर) पूरी तरह से जैविक प्रबंधन (INM के बराबर) के तहत दर्ज की गई। जैविक प्रणाली ने तेल, ओलिओरसिन और कुरकुमिन की मात्रा को बढ़ाया। आर्थिक विश्लेषण से पता चला कि उच्चतम B:C अनुपात (2.77) INM (50%+ 50%) के अंतर्गत थे।
- अलग-अलग न्यूट्रिएंट मैनेजमेंट तरीकों के तहत राइजोस्फीयर बैक्टीरियल कम्युनिटीज़ के मेटाजेनोमिक एनालिसिस से प्रोटीओबैक्टीरिया, बैक्टेरियोडोटा, बैसिलोटा, एसिडोबैक्टीरियोटा और एक्टिनोबैक्टीरियोटा का दबदबा सामने आया।
- हल्दी, चारा फसल, नारियल, केला, लोबिया और पशुधन को मिलाकर एक IFS मॉडल विकसित किया गया, जिससे प्रति एकड़ ₹0.84 लाख का नेट प्रॉफिट और प्रति वर्ष 322 मानव-दिवस का रोज़गार मिला, जो रोज़ी-रोटी की मज़बूत संभावना को दिखाता है।
- SED और SSP सिनेरियो का इस्तेमाल करके हल्दी के लिए जलवायु परिवर्तन डॉटस्पॉट की पहचान की गई। महाराष्ट्र, गुजरात, मध्य प्रदेश, तमिल नाडु, असम और ओडीशा भविष्य की जलवायु के हिसाब से उच्च रिस्क वाले इलाके बनकर उभरे।
- CTGC अध्ययन से पता चला कि ज्यादा CO_2 और तापमान में गैस एक्स्चेंज बदल जाता है, और हीट स्ट्रेस में ट्रांस्पिरेशन और प्रकाशसंश्लेषण कम हो जाता है।
- नमी और एसेंशियल तेल का एक साथ अनुमान लगाने के लिए >93% सटीकता के साथ एक तेज़, नॉन - इनोवेटीव तरीका बनाया गया।
- प्राटीलिंगस प्रजाति का तेज़ी से पता लगाने के लिए, PCR से 100 गुना ज्यादा संवेदनशीलता वाले RPA–LFA परख विकसित किया गया और खेत नमूनों पर मूल्यांकन किया गया।
- लंबे समय तक के अध्ययन से पता चला कि प्ररोह बेधक के मामले में किस्म और फसल के समय का बहुत असर होता है। राजेंद्र सोनिया में कोई कीड़ा नहीं लगा, जबकि ACC. 849 सबसे ज्यादा असरदार था।

वैनिला

- वैनिला के 77 अक्सेशनों (65 वी. प्लानिफोलिया और 12 अन्य वैनिला स्पीसीस) को पोलीहाउस और खेत में संरक्षित किया जा रहा है।
- टिश्यु कल्चर पौधों को सख्त करने के दौरान, सभी पॉटिंग मीडिया में 100% जीवित रह गये। वर्मीक्युलाइट परलाइट (3:1) ने सबसे अच्छी वृद्धि और जड़ के गुण पैदा किए।
- मुख्य फ्लेवर संघटकों की मात्रा तय करने के लिए प्रोटोकॉल को मानक बनाया गया। अक्से.4751 (2.3%) और G9 (2.0%) में वैनिलीन की मात्रा ज्यादा थी, जबकि वी. अंडमानिका (गुलाबी प्रकार) में वैनिलीन मात्रा बहुत कम थी।

वृक्ष मसाले

जायफल

- फील्ड जीन बैंक में कुल 163 जायफल एक्सेशनों का संरक्षण किया जा रहा है।
- मोटे नट और मोटी जावित्री के एक उच्च उपज वाला संग्रह कक्काडमपोयिल, कोषिक्कोड से एकत्र किया गया और संग्रह में जोड़ा गया।

- मायरिस्टिका मालाबारिका के लाल और पीले मेस मॉर्फोटाइप के मूल्यांकन से पता चला कि लाल मेस में अंकुरण ज़्यादा और तेज़ी से होता है (41.7% और 55 दिन), जबकि पीले मेस में वानस्पतिक विकास थोड़ा बेहतर होता है।
- आईआईएसआर केरलश्री और आईआईएसआर विश्वश्री के सयोन का उपयोग करके जलभराव सहिष्णु एम. मैग्निफिका रूटस्टॉक पर सफल कलिकाएं प्राप्त की गई।

लौंग

- फील्ड जीन बैंक में 23 लौंग एक्सेशनों का संरक्षण किया जा रहा है।
- ज़ांजीबार लौंग x आम लौंग से 137 F_2 संततियों को विकसित किया गया। मार्कर SaM 3999 ने मेंडेलियन 1:2:1 सेग्रिगेशन दिखाया, जिससे इसकी को-डोमिनेंट इनहेरिटेंस और आनुवंशिक मापिंग के लिए उपयुक्तता की पुष्टि हुई।

दालचीनी

- फील्ड जीन बैंक में 172 दालचीनी अक्सेशनों का संरक्षण किया जा रहा है।
- मेघालय में जर्मप्लाज़म की खोज से चार सिनमोमम प्रजातियों में 9 एक्सेशन मिले।

सामान्य

- जलवायु नियंत्रित वृद्धि चेंबर और अनुकूलित लाइट स्पेक्ट्रम, फोटोपीरियड, तापमान और आर्द्रता का इस्तेमाल करके काली मिर्च में द्रुत प्रजनन प्रॉटोकॉल शुरु किए गए। इस सुविधा का इस्तेमाल करने पर प्रजनन चक्र का समय काफी कम हो गया, जिससे तेज़ी से कायिक वृद्धि हुई और जल्दी फूल भी आए।
- मसालों के नोडल DUS परीक्षण केंद्र ने छह किसान विकसित काली मिर्च किस्मों, एक किसान विकसित अदरक किस्म के पंजीकरण की सुविधा प्रदान की।
- DNA फिंगर प्रिंटिंग सुविधा ने केंद्रीय किस्म विमोचन समिति की 32वीं बैठक में अधिसूचित की गई 14 किस्मों के लिए DNA फिंगर प्रिंट बनाए, और अदरक और हल्दी के लिए किस्मों की पहचान, आणविक प्रमाणीकरण, किसानों के प्लॉट के बीज के सत्यापन में मदद की।
- जैवसूचना एवं इंटीग्रेटीव जीनोमिक्स सुविधा केंद्र (बी आई जी सुविधा) ने डेटा विश्लेषण और विशुअलैसेशन टूल किट की बीटा परीक्षण शुरू की, जिसे सुविधा के GitHub रपोसिटरी के ज़रिए लाइव होस्ट किया।
- लंबे समय तक बारिश के विश्लेषण (1986-2022) से पता चला कि उत्तरी पश्चिमी घाट में बारिश की तीव्रता और बदलाव बढ़ रहा है, और दक्षिणी चोटियों में तीव्रता कम हो रही है, जो काली मिर्च के उत्पादन में होने वाले बदलाव से मेल खाता है।
- खाने की पैकेजिंग के लिए कम जल बाष्पीकरण पारगम्यता और ज्यादा घुलनशीलता वाली ओलिओरसिन-मिश्रित स्वाभाविक रूप से सड़ने वाली फिल्में विकसित की गई।
- आईसीएआर-आईआईएसआर ने अच्छी गुणवत्ता की रोपण सामग्रियों के उत्पादन और वितरण में अपना उद्यम ज़ारी रखा और 1.5 लाख काली मिर्च कतरनें, 20,000 छोटी इलायची के पौधे, 5 टन अदरक और 10 टन हल्दी के बीज प्रकंद और जायफल के कलमी पौधे, दालचीनी के पौधे, झाडी काली मिर्च पौधे आदि तैयार की गयी।
- प्ररोह बेधक के खिलाफ मेटरहिज़ियम पिंगशेंस की मज़बूत जैवनियंत्रण क्षमता को विषाक्त जीन के इन विवो उप-नियमन के माध्यम से प्रदर्शित किया जाता है।
- ट्राइकोलाइम और बैक्टोलाइम के खेत मूल्यांकन से मिट्टी की अम्लता में असरदार सुधार, पोषकतत्वों की उपलब्धता में सुधार और सूक्ष्माणु दृढ़ता देख ली। नारियल, जायफल, हल्दी और काली मिर्च में इसके इस्तेमाल करने से उत्पादन में 23-42% वृद्धि हुई और जायफल में 28-45% वृद्धि देख ली।
- हल्दी में नाइट्रोजन फिक्सिंग और कैल्श्यम मोबिलाइज़िंग जीवाणु ने कम उर्वरक (50-75%) व्यवस्था के तहत बेहत्तर प्रदर्शन दर्ज किया।
- अदरक और हल्दी के लिए जीवाणु कनसोर्टियम आधारित एकीकृत प्रबंधन तकनोलोजी विकसित करके संस्तुत किया, जिससे उत्पादन में काफी सुधार हुआ और प्रकंद गलन में कमी आई।
- रोपण सामग्रियों की मांग, नर्सरी और प्रसंस्करण सेक्टर के MSMEs, रोज़गार की स्थिति, उपभोग रीति और नीति योजनाओं की डेटा विश्लेषण से मसाला आधारित उद्यमिता और मूल्य-वर्धन में विकास के लिए मज़बूत क्षमता और अवसरों की आवश्यकता का पता चला।

- एक विस्तृत सर्वेक्षण ने पुष्टि की कि उद्यमियों के नेतृत्व में विस्तार तकनोलोजी का प्रसार, किसानों तक पहुंच, अपनाने की दर, इनपुट की उपलब्धता और वैल्यु-चैन नेटवर्किंग बढ़ती है।
- मसालों की तकनोलोजी से लगभग 15 मिलियन कृषि भूमि पर असर पड़ता है। प्रति हेक्टर सबसे ज्यादा उत्पादन मूल्य (4.75 लाख रुपए प्रति हेक्टर) मिलता है, और बागवानी के उप-सेक्टर में सबसे तेज़ वृद्धि (2014-15 से 102.5%) दर्ज की गई है, जिससे छोटे और सीमांत किसानों को बहुत फायदा हुआ है।
- आदिवासी उप-योजना. NEH और SCSP कार्यक्रम के तहत आईसीएआर-आईआईएसआर ने कई राज्यों में एकीकृत क्षमता निर्माण, तकनोलोजी फैलाने और बीज और रोपण सामग्रियों का वितरण पहल लागू किया। लगातार खेत स्तर पर मदद और अच्छी गुणवत्ता की रोपण सामग्रियों और जैव इनपुट के वितरण से लाभार्थी किसानों की उत्पादकता, आमदनी और आजीविका में मज़बूती आईं।
- ATIC ने प्रौद्योगिकी अंतरण, क्षमता निर्माण, निदान और इनपुट वितरण के लिए एकजालक हब के तौर पर काम किया, जिससे VKSA के तहत 165 गांवों में 1,100 से ज्यादा प्रशिक्षार्थी, 1982 छात्र और 29,128 किसानों को लाभ हुआ।
- एआईसीआरपीएस के तहत किए गए प्रयासों से 6 नई मसाला किस्मों की सिफारिश हुई, केंद्रीय किस्म विमोचन समिति ने पांच नई मसालों की किस्मों की मंजूरी दी, कीट, रोग, पोषक तत्व और फसलन प्रणाली प्रबंधन के लिए क्षेत्र विशिष्ट, जलवायु अनुकूल तकनीकों का सत्यापन किया गया और एक ऑनलाइन डेटा प्रबंधन पाइपलाइन बनाई गई।
- I T M – A B I इकाई ने 43 आईआईएसआर तकनोलॉजी की लाइसेंसिंग में मदद की, जिससे 30.48 लाख रुपए मिले, 2 पेटेंट और 6 सर्वाधिकार (कॉपीराइट) हासिल किए गए।
- कृषि विज्ञान केंद्र, पेरुवण्णामुषि ने 90 ट्रेनिंग (56 ऑन-कैंपस, 34 ऑफ-कैंपस) आयोजित कीं, जिनसे 2,837 किसानों और 673 युवाओं को फायदा हुआ। केवीके ने 3 OFT (13 ट्रायल), ~70 किसानों के खेतों में 9 FLD भी लागू किए, और 2 EDP शुरू किए; एक्सपोज़र विज़िट, विशेष दिन/कार्यक्रम आयोजित किए, और नर्सरी मैनेजमेंट, मधुमक्खी पालन और उद्यमिता सहित S C - केंद्रित व्यापक कौशल कार्यक्रम चलाए।
- इस साल, IISR ने 4 कॉलेजों/यूनिवर्सिटीज़ के साथ MoU साइन किए। संस्थान स्टूडेंट हब के तौर पर काम करता रहा, जिसमें चार Ph.D. अवार्ड किए गए, ग्यारह नए Ph.D. रजिस्ट्रेशन हुए, स्टूडेंट्स का बड़े पैमाने पर जुड़ाव रहा (MSc, BSc, इंटर्नशिप, HRF), हैंड्स-ऑन HRD प्रोग्राम और एक समर इंटर्नशिप प्रोग्राम भी हुआ।
- संस्थान की गोल्डन जुबली साल भर चलने वाली एक्टिविटीज़ के ज़रिए मनाई गई, जिसमें स्पाइस यात्रा, वेबिनार, डेमोंस्ट्रेशन, एग्ज़िबिशन, मीडिया आउटरीच और 51 किसानों की सफलता की कहानियों और KVK के नेतृत्व वाली ट्रेनिंग का एक वीडियो कंपेंडियम जारी करना शामिल था। इसमें फ्लैगशिप इवेंट (SYMSAC-XI, ओमिक्स सिम्पोज़ियम, RISE UP 2.0, उदयम 2.0) और आठ गोल्डन जुबली लेक्चर भी शामिल थे, साथ ही स्टार्टअप और एग्रीप्रेन्योरशिप को बढ़ावा दिया गया।

EXECUTIVE SUMMARY

Black Pepper

- A total of 3,511 black pepper accessions are being maintained at the Experimental Farm, Peruvannamuzhi; 735 accessions at ICAR–IIHR CHES, Chettalli; and 222 field gene bank accessions with 80 core accessions at the ICAR-IISR Headquarters, Chelavur.
- New germplasm additions included cultivars from Kasaragod, Malappuram, Palakkad, and *Piper bromerifolum* from Mizoram.
- Extensive germplasm exploration was conducted across Assam (Indo–Bhutan border districts) and Meghalaya (West and East Garo Hills), and collected diverse male and female populations of wild and semi-wild *Piper* species, enriching genetic diversity.
- 30 open-pollinated progenies of triploid landrace "Vadakkan" were evaluated, revealing wide variation in yield, piperine, essential oil, and oleoresin content, and promising progenies with high- quality traits were identified for future selection.
- Through genome-wide resequencing of 39 accessions, 159,390 CNVs across all 26 chromosomes, CNVs enriched for piperine biosynthesis and plant immunity pathways were identified.
- Comprehensive genomic resources, including SNPs, SSRs, InDels, and a mini-core set of 30 genotypes, were developed.
- QR code–based digital varietal identity system using SSR profiles was established.
- 2,098 drought-responsive DMRs through whole-genome bisulfite sequencing were identified.
- Several specialized databases were developed to support genomics, molecular breeding, and functional studies, which include PnGeneSSRdb, BPCNVDb, BPncDB, and BP2SSRDb with 150,828 polymorphic SSRs.
- 4,972 lncRNAs and 4,994 circRNAs from 32 RNA-seq datasets, revealing extensive regulatory networks, were identified.
- SSRs linked to stress response, disease resistance, metabolism, and P450 pathways were functionally characterized.
- Differential gene expression of nutrient transporters was observed between Panniyur-1 and Sreekara.
- Anatomical studies showed higher tolerance of IISR Thevam to combined waterlogging and *Phytophthora* stress.
- The benefits of early shade regulation and timely irrigation, resulting in improved spike traits and a yield increase of about 4 kg vine^{-1} was demonstrated.
- Drying studies identified infrared, vacuum, and hot-air drying (55–60°C) as superior for essential oil and oleoresin retention.
- Moderately resistant and resistant accessions against *Phytophthora capsici* and *P. tropicalis* were identified.
- CRISPR/Cas9 genome editing targeting NPR3 gene for *Phytophthora* resistance was initiated.
- Nematode management technology using fluopyram, achieving >96% population reduction and >26% yield increase, was developed.
- RPA–CRISPR–Cas12a–LFA assay for rapid field detection of *Piper* yellow mottle

virus, with sensitivity far exceeding PCR, was developed.

- Field evaluation of chlorantraniliprole for pollu beetle confirmed high efficacy, safety to natural enemies, and suitability for label expansion.

Cardamom

- 625 cardamom germplasm accessions are being conserved at the National Active Germplasm Site (NAGS), ICAR–IISR Regional Station, Appangala.
- A high-yielding Malabar-type accession was collected from Sullia, Dakshina Kannada (Karnataka).
- Morphological and yield characterization of 120 accessions revealed that Accession IC 547164 had the highest bearing tillers,

  panicles, capsules, and yield. Essential oil content in 75 accessions ranged from 4.19% to 8.89%. GC–MS profiling showed large variation in key aroma compounds, particularly 1,8-cineole and α-terpinyl acetate.
- Evaluation of 15 moisture-stress-tolerant lines revealed that MS 584058-5 was a high yielder. Among 42 hybrid progenies, 7-2021-14 recorded the highest fresh and dry yields.
- Multi-year CVT identified Bold × IC 547219 as the best-performing hybrid and was recommended for release as IISR Sujyothi.
- Leaf blight multilocation trials identified IC 349649 with minimum disease incidence. Thrips tolerance evaluation highlighted IC 349362 as superior in growth, yield, and capsule number.
- Tissue-specific transcriptome sequencing (seed, leaf, root) revealed key candidate genes (monoterpene synthase 7 & 8, BAHD acyltransferase) involved in α-terpinyl acetate biosynthesis.
- Successful cultivation of cardamom was demonstrated in non-traditional low elevation areas (107–150 m MSL) in Sullia under arecanut and coconut systems. Exceptional genotypes grown under such areas have been identified and conserved for adaptability trials.
- GC–MS-based chemo-diversity analysis of 22 genotypes revealed distinct clustering patterns. Genotypes such as Mudigere 2, Panikulangara 2, Elarajan, Panikulangara 1, Thiruthalli, and PV2 showed high linalool content, while high α-terpinyl acetate and low 1,8-cineole profiles were observed in these genotypes and in ICRI 2 and IISR Avinash.
- Cardamom-flavoured ash gourd candy using vacuum impregnation, yielding superior nutritional, microbial, and sensory quality, was developed.
- RT-RPA–LFA assay for rapid, point-of-care detection of cardamom mosaic virus (CdMV) within 40–50 minutes using crude extracts was developed. The assay demonstrated high specificity and sensitivity and was validated across Kerala and Karnataka.
- Developed RPA-LFA (CBDV) and RT-RPA-LFA (LCCV) assays for bushy dwarf and chirke diseases in large cardamom. Assays showed equal or higher sensitivity than PCR and enabled on-site detection within 35–45 minutes, supporting clean planting material programs.

Ginger

- About 668 ginger accessions are being maintained in the field gene bank at the ICAR-IISR Experimental Farm, Peruvannamuzhi, Kerala.
- Through a collaborative germplasm exploration with ICAR–NBPGR, RS,

Shillong, 11 *Zingiber* accessions representing seven species (*Z. officinale, Z. meghalayense, Z. ligulatum, Z. purpureum, Z. zerumbet*, and two unidentified species) and six accessions from other Zingiberaceae genera (*Alpinia, Amomum, and Etlingera*) were collected.

- IISR Navya, a gamma-irradiation– derived ginger mutant, with an average fresh yield of 15.3 t ha^{-1} and a potential yield of 36.0 t ha^{-1}, with superior quality traits (dry recovery 18.78%, essential oil 2.7%, oleoresin 6.65%), was recommended for release.
- In a bold ginger and high oil ginger CVT conducted at Peruvannamuzhi and Appangala, entry, G 2023-16 recorded superior yield and dry recovery at both places. Entries, G 2023-5 and G 2023-6 consistently recorded higher yields across locations.
- Comprehensive transcriptome mining identified multiple isoforms of key gingerol biosynthesis genes (KAT5, CHS). A Snakemake-based pipeline generated approximately. 800,000 lncRNA sequences, leading to the creation of the GingerLnc Database.
- Evaluation of different natural and integrated nutrient management (INM) systems showed significant variation in soil and leaf nutrients, yield, and quality. The highest yield (13.07 t ha^{-1}) was recorded under organic (50%) + bio-inputs, with superior oil and oleoresin content under higher organic inputs.
- FAO–IIASA AEZ-based assessment helped in the identification of very high to highly suitable regions for ginger cultivation in the Western Ghats and North Eastern region.
- *Pythium graminicola* and *P. myriotylum* infecting ginger were identified and characterized.
- Crop rotation with cowpea and mustard significantly reduced soil *Pythium* population and soft rot incidence. Fluopicolide + Fosetyl-Al was identified as an effective new-generation fungicide in reducing *Pythium* population and soft rot incidence.
- Heat and chemical vacuum infiltration treatment method for eliminating *Ralstonia pseudosolanacearum* from seed rhizomes was optimized. AMF priming reduced soft rot incidence and restricted *Meloidogyne incognita* penetration. It also enhanced biochemical defenses (peroxidase, catalase, β-1,3-glucanase) and regulated expression of key defense genes (NPR1, TGA, AP2, 4CL, LOX2, AOC).
- Endophytes like *Bacillus pumilus* KG6 and *Pseudacidovorax intermedius* NCC15 were identified as potent antagonists against *P. myriotylum*.
- Three ginger accessions (NE local 2, GC9, ACC 891) resistant to *Meloidogyne incognita* were identified. Fluopyram application achieved ~85% nematode reduction and ~3.25-fold yield increase.
- Transcriptomic analysis revealed activation of induced systemic resistance-related pathways in *Pochonia chlamydosporia* primed plants compared to controls.
- Low-risk insecticides like chlorantraniliprole and spinosad provided up to 100% control of shoot borer (*Conogethes punctiferalis*) in ginger and turmeric. Treatments were non-phytotoxic and safe to natural enemies.

Turmeric

- A total of 1,404 *curcuma* spp. germplasm accessions, including 1,132 turmeric accessions, are being conserved. Morphological and rhizome characterization were completed for all these accessions, while 800 accessions were

characterized for quality traits. 1,067 turmeric accessions were screened for leaf blotch, and 633 resistant accessions were identified.

- Six *Curcuma* accessions representing *C. longa* and two unidentified species from Assam and Meghalaya were collected.
- In the black turmeric trial, accession 751 recorded the highest yield (12.23 kg bed^{-1}), followed by PCC1, BT 162, and NBT 2.
- 170 open-pollinated seedling progenies were evaluated over two years, and 31 superior genotypes were shortlisted and added to the germplasm.
- 139 progenies were distributed to AICRPS centres for multi-environment evaluation.
- Comparative transcriptome analysis of Acc. 849 vs IISR Prathibha showed key DEGs linked to terpenoid biosynthesis and mitochondrial metabolism, explaining unique aroma traits.
- Integrated transcriptomic genomic analysis revealed 24,220 high-confidence lncRNAs and trait-associated SNPs.
- Developed GoldenLncDB, the first dedicated lncRNA turmeric database.
- Highest fresh rhizome yield (13.56 t ha^{-1}) was recorded under complete organic management (on par with INM). Organic systems enhanced oil, oleoresin, and curcumin contents. Economic analysis showed the highest B: C ratio (2.77) under INM (50% + 50%).
- Metagenomic analysis of rhizosphere bacterial communities under different nutrient management practices revealed dominance of Proteobacteria, Bacteroidota, Bacillota, Acidobacteriota, and Actinobacteriota.
- Developed an IFS model integrating turmeric, fodder, coconut, banana, cowpea, and livestock, which generated ₹0.84 lakh net profit per acre and 322 man-days of employment per year, demonstrating strong livelihood potential.
- Identified climate change hotspots for turmeric using SED and SSP scenarios. Maharashtra, Gujarat, Madhya Pradesh, Tamil Nadu, Assam, and Odisha emerged as high-risk regions under future climates.
- CTGC studies showed altered gas exchange under elevated CO_2 and temperature, with reduced transpiration and photosynthesis under heat stress.
- Developed a rapid, non-invasive method for simultaneous estimation of moisture and essential oil with >93% accuracy.
- RPA–LFA assay for rapid on-site detection of *Pratylenchus* spp., with 100× higher sensitivity than PCR, was developed and validated on field samples.
- Long-term studies showed a strong influence of variety and crop duration on shoot borer incidence. Rajendra Sonia showed no pest incidence, while ACC. 849 was most susceptible.

Vanilla

- A total of 77 vanilla accessions (65 *V. planifolia* and 12 other *Vanilla* sp.) are being conserved under polyhouse and field conditions.
- During hardening of tissue culture plants, 100% survival across all potting media was achieved. Vermiculite + perlite (3:1) produced the best growth and root traits.
- Protocols for the quantification of major flavour compounds were standardized. Accessions 4751 (2.3%) and G9 (2.0%) recorded high vanillin content, while *V. andamanica* (pink type) showed very low vanillin content.

Tree Spices

Nutmeg

- A total of 163 nutmeg accessions are being conserved in the field gene bank.
- A high-yielding accession with bold nut and thick mace was collected from Kakkadampoyil, Kozhikode, and added to the repository.
- Evaluation of Red- and yellow-mace morphotypes of *Myristica malabarica* revealed that red mace had higher and faster germination (41.7% and 55 days), while yellow mace exhibited slightly superior vegetative growth.
- Successful budding was achieved on waterlogging-tolerant *M. magnifica* rootstock using IISR Keralashree and IISR Vishwasree scions.

Clove

- 23 clove accessions are being conserved in the field gene bank.
- 137 F_2 progenies from Zanzibar clove × common clove was developed. Marker SaM 3999 showed Mendelian 1:2:1 segregation, confirming its co-dominant inheritance and suitability for genetic mapping.

Cinnamon

- 172 cinnamon accessions are being conserved in the field gene bank.
- Germplasm exploration in Meghalaya yielded 9 accessions across four *Cinnamomum* species.

General

- Initiated speed breeding protocols in black pepper using a climate-controlled growth chamber and optimized light spectrum, photoperiod, temperature, and humidity. Using this facility, the breeding cycle duration was significantly reduced, achieving rapid vegetative growth and early flowering.
- The nodal DUS test centre for spices facilitated registration of six farmer-developed black pepper varieties, one farmer-developed ginger variety.
- The DNA fingerprinting facility generated DNA fingerprints for 14 varieties notified in the 32nd CVRC meeting, and supported varietal identification, molecular authentication, and farmers' seed plot verification for ginger and turmeric.
- The centre for Bioinformatics & Integrative Genomics (BIG facility), initiated beta testing of a Data Analysis and Visualization Toolkit, which it was hosted live through the facility's GitHub repository.
- Long-term precipitation analysis (1986–2022) revealed increasing rainfall intensity and variability in the Northern Western Ghats, and declining intensity in Southern peaks, which matches the black pepper yield variability.
- Oleoresin-blended biodegradable films with low water vapour permeability and high solubility were developed for food packaging.
- ICAR-IISR continued its efforts in the production and distribution of quality planting material and produced 1.5 lakh black pepper cuttings, 20,000 small cardamom seedlings, 5 t ginger and 10 t turmeric seed rhizomes, and nutmeg grafts, cinnamon seedlings, and bush pepper plants.
- The strong biocontrol potential of *Metarhizium pingshaense* against shoot borer is demonstrated through *in vivo* upregulation of virulent genes.
- Field validation of Tricholime and Bactolime showed effective soil acidity amelioration, improved nutrient availability, and microbial persistence. Its application in coconut, nutmeg, turmeric, and black pepper resulted in 23–42% yield

increase and 28–45% yield gains in nutmeg.

- N-fixing and K-mobilizing bacteria in turmeric registered superior performance under reduced fertilizer (50–75%) regimes.
- Developed and recommended a bacterial consortium-based integrated management technology for ginger and turmeric, which significantly improved yield and decreased rhizome rot.
- Data analysis of planting material demand, nursery and processing-sector MSMEs, employment status, consumption patterns, and policy schemes revealed strong potential and opportunities for spice-based entrepreneurship and value-chain development.
- A detailed survey confirmed that entrepreneur-led extension enhances technology dissemination, farmer outreach, adoption rates, input access, and value-chain networking.
- Spices technologies impact nearly 15 million farm holdings, generate one of the highest output values per hectare (Rs. 4.75 lakh ha^{-1}), and recorded the fastest growth (102.5% since 2014–15) among horticultural subsectors, strongly benefiting small and marginal farmers.
- Under the Tribal Sub Plan, NEH, and SCSP programmes, ICAR-IISR implemented integrated capacity-building, technology dissemination, and seed and input distribution initiatives across multiple states. Continuous field-level handholding and access to quality planting materials and bio-inputs enhanced productivity, income, and livelihood resilience among beneficiary farmers.
- ATIC functioned as a single-window hub for technology transfer, capacity building, diagnostics, and input supply, reaching over 1,100 trainees, 1,982 students, and 29,128 farmers across 165 villages under VKSA.
- Efforts under AICRPS resulted in recommending 6 new spice varieties, CVRC approval of five new spice varieties, validation of region-specific, climate-resilient technologies for pest, disease, nutrient, and cropping system management, and an online data management pipeline.
- The ITM–ABI Unit facilitated the licensing of 43 IISR technologies, generating Rs. 30.48 lakhs, secured 2 patents and 6 copyrights.
- KVK, Peruvannamuzhi conducted 90 trainings (56 on-campus, 34 off-campus) benefiting 2,837 farmers and 673 youth. KVK also implemented 3 OFTs (13 trials), 9 FLDs across ~70 farmers' fields, and initiated 2 EDPs; organized exposure visits, special days/events, and extensive SC-focused skill programmes including nursery management, apiculture, and entrepreneurship.
- During the year, IISR signed an MoU with 4 Colleges/Universities. The institute continued to act as a student hub with four Ph. Ds awarded, eleven new Ph. D. registrations, extensive student engagement (M.Sc., B.Sc., internships, HRF), hands-on HRD programmes, and a Summer Internship Programme.
- The Golden Jubilee of the institute was celebrated through Year-long activities, including Spice Yatra, webinars, demonstrations, exhibitions, media outreach, and the release of a video compendium of 51 farmer success stories and KVK-led trainings. It also included flagship events (SYMSAC-XI, Omics Symposium, RISE UP 2.0, Udayam 2.0) and eight Golden Jubilee lectures while catalyzing startups and agripreneurship.

INTRODUCTION

History

Intensive research on spices in India was initiated with the establishment of a Regional Station of Central Plantation Crops Research Institute (CPCRI) at Kozhikode, Kerala, in 1975, by the Indian Council of Agricultural Research (ICAR). In 1986, this Regional Station was upgraded to the National Research Centre for Spices (NRCS) through its merger with the Cardamom Research Centre of CPCRI at Appangala, Kodagu district, Karnataka. The NRCS was elevated to the present Indian Institute of Spices Research (IISR) on 1 July 1995. In 2025, the institute celebrated its Golden Jubilee, marking 50 years of dedicated research and development in spices.

Location

The laboratories and administrative offices of the institute are located at Chelavoor (50 m above MSL), 11 km from Kozhikode (Calicut), Kerala, on the Kozhikode - Kollegal road (NH 212), in an area of 14.3 ha. The main research farm is located 51 km North East of Kozhikode at Peruvannamuzhi (60 m above MSL), on the Peruvannamuzhi-Poozhithode road in Kozhikode District, in an area of 94.08 ha. The Regional Station at Appangala (920 m above MSL), Kodagu District, Karnataka, is located 8 km from Madikeri on the Madikeri-Bhagamandala road, 8 km from Madikeri, in an area of 17.4 ha.

Mandate

The mandate of the institute was revised with effect from 16 May 2016 during the 87th Annual General Meeting of the ICAR Society held on 04 February 2016 (DARE vide Letter F.No. 13(102)/2015-Cdn.Tech. dated 20 May 2016).

- Basic, applied, and strategic research on genetic resource management, crop improvement, crop production, and protection technologies for enhanced production of safe spices.
- Transfer of technology, capacity building, and impact assessment of technologies.
- Coordinate research and validation of technologies under AICRP on Spices.

The spice crops on which research is being conducted at the institute include black pepper (*Piper nigrum* Linn.), cardamom (*Elettaria cardamomum* Maton), ginger (*Zingiber officinale* Rosc.), turmeric (*Curcuma longa* Linn.), cinnamon (*Cinnamomum verum* J. Presl.), cassia (*C. cassia* Nees ex Blume), clove (*Syzygium aromaticum* (L.) Merrill & Perry), nutmeg (*Myristica fragrans* Houtt.), allspice (*Pimenta dioica* (L.) Merrill & Perry), Garcinia (*Garcinia gummi-gutta* (L.) N. Robson and *G. indica* Choisy) and vanilla (*Vanilla planifolia* Jacks. ex Andrews).

Organization

The Director is the administrative head of the institute. The Institute Management Committee, Research Advisory Committee, and Institute Research Council assist the Director in matters relating to management and research activities of the institute. Research on various aspects of the mandate crops is conducted in three divisions, namely, the Division of Crop Improvement and Biotechnology, the Division of Crop Production and Post-Harvest Technology, and the Division of Crop Protection, besides a Social Sciences Section. The other facilities available at the institute include the Agricultural Technology Information Centre, Agricultural Knowledge Management Unit, Bioinformatics Centre, and Krishi Vigyan Kendra. The institute also functions as the headquarters for the All India Coordinated Research Project on Spices (AICRPS). The institute has also linkages with several universities, research institutes, and developmental agencies for collaborative research and developmental activities in spices.

Budget

The total budget of the institute was ₹ 3300 lakhs during the year. The institute earned revenue through the sale of planting materials, biocontrol agents, training, publications and consultancy services etc.

Staff

The Institute has a sanctioned strength of 47 Scientific, 35 Technical, 31 Administrative, and 31 Supporting Staff, of which 41, 23, 13, and 03 of Scientific, Administrative, Technical, and Supporting Staff, respectively, are in position. The KVK has a sanctioned strength of 01 scientific, 11 technical, 02 administrative, and 02 supporting staff.

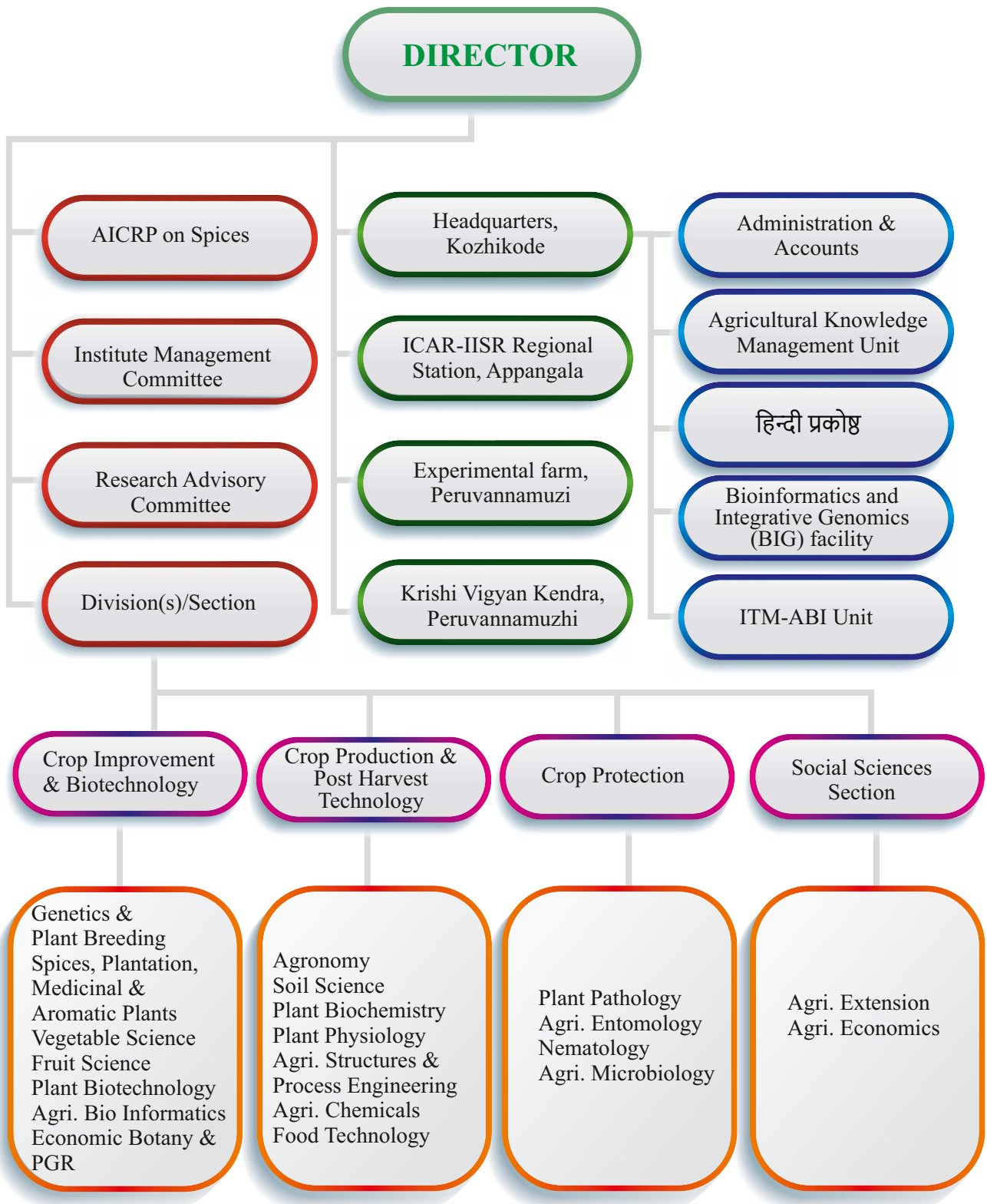
Staff position of the Institute

Category	Sanctioned	In position			Total	Vacant
		Kozhikode	Peruvannamuzhi	Appangala		
Director	01				01	00
Scientist	47	32	03	06	41	06
Technical	35	15	05	03	23	12
Administration	31	12	01	00	13	18
Supporting	31	01	01	01	03	28
Total	**145**	**61**	**10**	**10**	**81**	**64**

Staff position of KVK

Category	Sanctioned	In position	Total	Vacant
Scientific	01	01	01	00
Technical	11	07	07	04
Administration	02	00	00	02
Supporting	02	01	01	01
Total	**16**	**09**	**09**	**07**

ORGANIZATIONAL CHART



ACHIEVEMENTS AT A GLANCE

Over five decades of dedicated research, the ICAR-IISR, Kozhikode, has released 38 improved varieties focusing on enhanced yield, superior quality, disease tolerance, and suitability for speciality markets. The institute has also developed numerous sustainable production, protection, and processing technologies for spice crops, with a strong focus on the farmers, entrepreneurs, and spice industry. In recent years, the institute has also introduced several technologies aimed at generating resources through consultancies, contract research, and commercialization.

ICAR-IISR, being the National Active Germplasm Site (NAGS) for spices, conserves 6,743 primary and secondary genepools of spices, which are used in breeding programmes and other research activities. Of these, 18 germplasm accessions have been registered with the ICAR–National Bureau of Plant Genetic Resources (ICAR-NBPGR) for their unique characteristics. The plant tissue culture facility at ICAR-IISR is a dedicated facility for the *in vitro* culture and micro-propagation of key spice crops - black pepper, ginger, turmeric, vanilla and others. Robust protocols have been developed for vanilla seed germination, somatic embryo regeneration, anther culture, and micro-rhizome multiplication in ginger and turmeric. A new flagship project on genome editing has been initiated to develop disease-resistant varieties in ginger and black pepper.

Integrated organic and natural farming packages for major spices have been developed and recommended for adoption. A software, Spice FeRt, has been developed and copyrighted for soil test-based fertility classification and fertilizer recommendation for major spice crops. The crop-weather relationships of black pepper and turmeric have been quantified and weather- based models for yield prediction have been developed. Efficient spice-producing zones were mapped,

and climate analogue sites were identified for spices.

The Institute has developed granular lime-based microbial formulations that mitigate the drawbacks of soil acidity and simultaneously deliver beneficial microbes for effective growth and establishment of crops, ensuring optimal plant growth and nutrient uptake. This innovative product can save labour costs and time involved in applying lime and beneficial organisms individually. This formulation also benefits the crop by improving the physical condition of the soil, enhancing secondary nutrient availability, and boosting soil microbial activity. The formulations are available in the name of Tricholime and Bactolime for acidic soil and Trichogypsum and Bactogypsum for alkaline soil.

Antioxidant activities of different spice extracts were studied. *In vitro* hypoglycemic activities of different and spice extracts were studied, and cinnamon extract was found to have maximum inhibitory activity against α-amylase and α-glucosidase enzymes. *In vivo* hypoglycemic potential of cinnamon and turmeric extracts was studied using an albino Wistar rat model, and it was found that these extracts reduced the blood glucose level of diabetic rats.

Some of the key technologies which are patented and commercialized for the benefit of farming community include crop-specific micronutrient formulations, PGPR consortium for growth promotion, soil nutrient mobilization and biocontrol and encapsulation technology for smart delivery of agriculturally important microorganisms (Biocapsules).

A spice processing facility, which serves as an incubation centre for spice entrepreneurs, has been established at the Experimental Farm Peruvannamuzhi. The facility has a black pepper cleaning unit, a curry powder production unit, and a white pepper production unit. An agro-processing centre for spices for primary processing, cleaning, and grading of black pepper and cardamom was established at IISR Regional Station at Appangala, Karnataka.

The etiology and epidemiology of major diseases of spices were surveyed in the spice-growing areas of the country, and integrated pest/disease management measures have been developed. The Institute is actively engaged in developing pest/disease-resistant lines and biocontrol agents that suppress the pathogens. Notable among the resistant lines developed are IISR Shakthi (*Phytophthora* resistant black pepper variety), Pournami (root knot nematode resistant black pepper variety), IISR Vijetha (cardamom mosaic virus resistant variety), IISR Avinash (rhizome rot resistant cardamom variety), IISR Mahima (root knot nematode resistant ginger selection), and IISR Pragati (root knot nematode tolerant turmeric variety). The efficient strains of biocontrol agents developed are *Trichoderma asperellum*, *Pochonia chlamydosporia, Bacillus licheniformis, Lecanicillium psalliote, Metarhizium pingshaense,* etc. The agents are quite popular among the farming community and have been successfully commercialized. Highly reliable and sensitive diagnostic tools have been standardized for rapid detection of viruses, bacteria, fungi, and nematodes infecting spices. A technology package for sustaining the health and yield of virus- infected (mild & moderately affected) black pepper was developed. Sensitive molecular diagnostics based on polymerase chain reaction (PCR), loop-mediated isothermal amplification (LAMP), recombinase polymerase amplification (RPA), and rapid onsite detection based on RPA-lateral flow assay (RPA-LFA) have been developed for viruses in major spices. The technology can be used for the detection and certification of planting materials free from pathogens.

Entrepreneur-led and collaborative extension models, agroforestry-based spice cultivation systems, and robust impact assessment methodologies for micronutrient and high-

curcumin turmeric technologies were also developed by the Institute, which significantly improved technology dissemination and livelihood outcomes among tribal and marginalized communities. It also led to a value chain development model for turmeric aimed at enhancing tribal livelihoods. The Institute was also awarded the Fakhrudin Ali Ahammed Award for Outstanding Research in Tribal Farming System. Additionally, three policy briefs were published addressing self-sufficiency in spices, pesticide policy challenges, and the future of India's asafoetida economy.

The DNA fingerprinting and barcoding facility has facilitated the release of varieties from AICRPS centres/ ICAR institutes and state agricultural universities. The facility has identified DNA marker-based technology for establishing the uniqueness of proposed new varieties of spice crops. So far, variety-specific DNA profiles of more than 50 spice varieties of tropical spices, as well as seed spices, have been developed using ISSR, SSR, and RAPD markers.

The Bioinformatics and Integrative Genomics (BIG) Facility serves as a central hub supporting multidisciplinary research in spices. The facility provides computational expertise across genomics, transcriptomics, metagenomics, metabolomics, and proteomics, enabling researchers to explore gene expression, regulation, and molecular mechanisms underlying plant growth, stress responses, and disease. The BIG Facility has developed scalable and reusable bioinformatics pipelines to enable robust, reproducible, and high-quality analysis of large biological datasets.

The Institute's Technology Management-Business Planning and Developing Unit to Agri Business incubation unit has established a strong record in intellectual property protection and technology commercialization. A total of 19 patents have been filed, of which 10 patents have been granted, reflecting the Institute's focus on innovation and translational research. Further, the Institute has successfully executed 197 license agreements, demonstrating effective technology dissemination and stakeholder engagement. Of these, 196 licenses are national, and one is an international license, highlighting the growing impact of the Institute's technologies along with emerging global outreach.

The Human Resource Development (HRD) unit at ICAR–IISR plays a crucial role in strengthening the institute's research, education, and extension mandates by developing competent and motivated human resources. The major roles of IISR-HRD include capacity building and training for scientific, technical, and administrative staff. HRD supports for professional development of scientists through nominations for national and international training, workshops, conferences, advanced courses, and higher studies to enhance research excellence and leadership. ICAR-Indian Institute of Spices Research, Kozhikode, has been recognized as a centre for doctoral studies by Agricultural Universities under NARS (Indira Gandhi Krishi Vishwavidyalaya, Raipur; Tamil Nadu Agricultural University, Coimbatore and University of Horticultural Sciences, Bagalkot) and Non-agricultural universities (Mangalore University, University of Calicut, Acharya Nagarjuna University and Kannur University) in various subjects. As of now, 100 Ph.D and 381 M.Sc students were passed out from the institute.

Over the years, the institute has been honored with several prestigious awards, reflecting its commitment to excellence and innovation in spices. Among these accolades are the ICAR Team Research Award, the Hari Om Trust Award, and the Sardar Patel Outstanding ICAR Institute Award, which it has won three times. These recognitions highlight the institute's prominent role and outstanding achievements in agricultural research and development.

RESEARCH ACHIEVEMENTS

Black Pepper

Genetic resources

Three thousand five hundred and eleven accessions are being maintained in the black pepper germplasm nursery at the Experimental Farm, Peruvannamuzhi, Kozhikode, Kerala. In the alternative germplasm site at ICAR-IIHR Central Horticultural Experiment Station (CHES), Chettalli, Karnataka, 735 black pepper germplasm accessions are being maintained and characterized for qualitative and quantitative traits. A field gene bank containing 222 accessions and 80 core accessions is being maintained and characterized at the ICAR-IISR, Kozhikode.

Collection of germplasm

Two black pepper cultivars were collected from Sheni, Kasaragod, a variegated pepper mutant from Pandikkad, Malappuram, one Karimunda accession from Ambalappara, Palakkad, and *Piper bromerifolum* from Mizoram. These lines are currently undergoing multiplication for subsequent screening studies.

Fig. 1. Female spike of *Piper diffusum*

A germplasm exploration covering diverse landscapes along the Indo–Bhutan border and the districts of Barpeta, Baksa, Tamulpur, Kokrajhar, and Goalpara in Assam, as well as the West and East Garo Hills of Meghalaya, was carried out. The exploration resulted in the collection of both male and female populations of several *Piper* species. Notable *Piper* species collected included *Piper longum* (male and female), *P. sermentosum, P. betle, P. beteloides, P. peepuloides, P. diffusum* (Fig. 1), *P. sylvaticum* (male and female), *P. hamiltonii*, and *P. acutistigmatum*, in addition to a few unidentified *Piper* species, highlighting the rich diversity of wild and semi-wild *Piper* germplasm in the region.

Evaluation of open- pollinated progenies

Thirty open-pollinated progenies of the triploid landrace 'Vadakkan' were evaluated for quality traits, revealing significant variation. The fresh yield varied, from 16 g/vine in Coll. 4160 to 4,260 g/vine in Coll. 4143. Quality traits also showed significant variation: piperine content ranged from 2.59% (Coll. 4148) to 4.77% (Coll. 4164), essential oil content from 2.00% (Coll. 4140) to 4.00% (Coll. 4153), and oleoresin content from 5.39% (Coll. 4148) to 8.74% (Coll. 4142).

Genome-wide analysis of copy number variation in diverse accessions

Genome-wide resequencing of 39 accessions identified high-confidence copy number variations (CNVs) associated with agronomic traits. A total of 159,390 CNVs defined 11,360 CNV regions (CVNRs) distributed across all 26 chromosomes, with deletions (82,027) more

frequent than duplications (77,363). Genes located within CNVRs were significantly enriched for pathways related to piperine biosynthesis and plant immune responses. PCA revealed clear varietal differentiation and evolutionary relationships, highlighting the role of CNVs in elite genotype formation. Genotype IISR-Malabar Excel showed the highest number of deletions, whereas Acc.7211 exhibited the greatest number of duplications. Key phenylpropanoid biosynthesis genes were mapped to 33 CNVRs, indicating functional relevance of CNVs in black pepper improvement.

Genome-wide identification and functional characterization of SSRs

Whole-genome resequencing data of agronomically important genotypes were aligned to the reference genome to identify SSR repeat number variation. Varietal signature loci were generated by selecting 2–4 SSRs per chromosome to enable clear phylogenetic discrimination of genotypes. Several validated SSRs were functionally linked to genes involved in disease resistance, metabolism, cytochrome P450 pathways, and stress responses.

Transcriptome-wide profiling of lncRNAs and circRNAs across tissues

A total of 32 RNA-seq datasets representing multiple tissues were systematically analysed, including fruit (15 datasets), leaf (10), and root (4). A robust Snakemake-based computational pipeline was developed for the prediction and classification of long non-coding RNAs (lncRNAs) and circular RNAs (circRNAs) from transcriptomic datasets. This analysis led to the identification of high-confidence non-coding RNAs, comprising 4,972 lncRNAs and 4,994 circRNAs. Extensive regulatory interaction networks were predicted, revealing approximately 10,000 lncRNA-mediated miRNA – mRNA interactions and 4,647 circRNA - mediated miRNA–mRNA interactions.

Genetic diversity, population structure, and trait-linked marker discovery were investigated using 39 carefully selected samples comprising released varieties (21), farmers' varieties (2), wild *Piper nigrum* and *P. colubrinum* accessions (3), and genotypes representing key agronomic and quality traits such as high piperine content, bold berries, long spikes, *Phytophthora* resistance, and unique berry shapes. Whole-genome resequencing was performed for all 39 samples. Genome-wide SNPs, SSRs, and InDels were identified and systematically catalogued, resulting in the first comprehensive genomic variation resource for black pepper.

Using SNP data from 180 accessions, a mini-core set of 30 genotypes was developed. In addition, a QR code–based varietal digital identity system was established using unique SSR profiles for each genotype, enabling farmers and stakeholders to authenticate planting materials in molecular laboratories through SSR-based verification. Whole-genome bisulfite sequencing was carried out on six black pepper samples, including the high-piperine variety Sreekara, the low-piperine variety Narayakodi, and drought-induced samples of Accession 4226. Analysis of the drought-induced WGBS dataset (Acc. 4226) identified 2,098 differentially methylated regions (DMRs), providing valuable insights into epigenetic regulation associated with drought tolerance.

Root growth dynamics of IISR Thevam under nutrient stress conditions

The root growth dynamics of the variety, IISR Thevam, were studied under hydroponic conditions. Potassium- treated plants had the highest root length (30.00 ± 4.90 cm) and root spread (8.62 ± 1.70 cm), while there was no significant variation in the number of roots. Another experiment was conducted to compare

the plant growth in Hoagland solution (control) and modified Hoagland solutions (-N, -P, and -K). Root length and spread were highest in plants in the Hoagland solution with no N (-N) (23 ± 8.91 cm; 8.75 ± 2.50 cm). In contrast, plants subjected to P deficiency (–P) recorded the lowest number of roots (16.25 ± 12.74), root length (8.25 ± 3.20 cm), and root spread (3.75 ± 2.06 cm).

Response of nutrient use efficiency- related genes in Panniyur-1 and Sreekara

Panniyur-1 and Sreekara were grown under three media conditions - nutrient-deprived soil, soil + coir pith, and nutrient-rich potting mixture (soil: sand: FYM, 1:1:1)—with and without NPK fertilizer. Quantitative PCR analysis revealed variety-specific differential expression of nutrient transporter-related genes. Panniyur-1 showed downregulation of N transporter genes under nutrient-deprived soil and upregulation in nutrient-rich potting mixture. In contrast, Sreekara exhibited upregulation of N transporter genes in soil. The P starvation response gene was consistently upregulated in soil + coir pith and potting mixture under NPK treatment. Potassium transporter genes showed strong upregulation in Sreekara grown in the potting mixture with NPK, with the K^+ transporter exhibiting ~8.7-fold induction. The stellar K^+ outward rectifier was also upregulated in both varieties under the same conditions, while the K channel protein showed slight to moderate induction only in the potting mixture with NPK and remained unchanged in soil + coir pith.

Differential anatomical changes in IISR Thevam and Sreekara under combined waterlogging and *Phytophthora* stress

Anatomical investigations of IISR Thevam and Sreekara, subjected to waterlogging and *Phytophthora* infection, revealed pronounced structural alterations at 15 days after inoculation (DAI). Treated plants exhibited extensive tissue necrosis, marked reduction in xylem and phloem tissues, and collapse of the cortical region. These anatomical disruptions were more severe and widespread in Sreekara, whereas IISR Thevam showed comparatively lower levels of tissue damage, indicating a relatively higher tolerance.

Field evaluation of grafted Panniyur-1 on *Piper colubrinum* rootstock in Karnataka

Field evaluations of grafted Panniyur-1 on *Piper colubrinum* rootstock across Karnataka indicated good vine establishment and high yield potential. However, consistent root infections were observed in the *P. colubrinum* root system, which may be due to *Phytophthora* or related pathogens. Although the graft unions remained unaffected, yellowing and drying symptoms revealed root-level stress and pathogen incidence.

Databases developed

PnGeneSSRdb: Gene-Based SSR Marker Database for Black Pepper (*Piper nigrum*) is a comprehensive repository of highly transferable, gene-based SSR markers and is protected under Copyright Diary Number: SW-27555/2025-CO.

BPCNVDb: To provide genotype-specific information on copy number variations (CNVs) and copy number variation regions (CNVRs), and is accessible at: https://bpcnvdb. Daasbioin fromaticsteam. in/index.php.

BPncDB: Hosts high-confidence long non-coding RNAs (lncRNAs) and circular RNAs (circRNAs) identified from diverse *Piper nigrum* tissues. The database includes over 6,000 RNA–RNA interactions, thereby supporting functional genomics and molecular breeding research.

Additionally, the Black Pepper Polymorphic SSR Database (BP2SSRDb) was curated with 150,828 SSRs across all 26 chromosomes of black pepper.

Influence of weather and cultivation practices

The study was taken up in Hoskote Estate, Hosur,

Shakleshpura Taluk, Karnataka, situated at an elevation of 1200 m above mean sea level (MSL). Two adjacent blocks of 20 acres each were selected for the study. In the first block, shade was regulated in February-March and irrigated by sprinkler from 15 March onwards. In the second block, shade regulation was undertaken in April, with irrigation commencing from 15 April. The results clearly demonstrated the advantages of early shade regulation coupled with timely irrigation. In the February-March shade-regulated block with March irrigation, the number of spikes, spike length, number of filled and unfilled berries, and fruit set percentage were 160 m^{-2}, 15.78 cm, 98.16, 18.0, and 84.4%, respectively. Whereas, shade regulation in April followed by irrigation induced a lesser number of spikes, spike length, number of filled and unfilled berries, and fruit set percentage (76 m^{-2}, 13.3 cm, 33.8, 48.2, and 41.21%, respectively), clearly highlighting the benefits of early shade regulation and irrigation leading to increased yield of 4 kg per vine.

In the Kodagu and Hassan division, the number of spikes, spike length, number of berries per spike, and fruit set obtained were 61 m^{-2}, 10.9 cm, 37, and 65.5%, respectively, in TATA Coffee Estates. Overall yield parameters across estates indicated a low to medium crop during the current season due to a larger number of rainy and cloudy days (140-150 days).

Drying studies under infrared and vacuum drying conditions

The study investigated the drying characteristics and quality attributes of black pepper (var. IISR-Thevam) under four methods: vacuum tray drying, infrared drying, hot-air drying at 45°C, 50°C, 55°C, and 60°C, and sun drying. Vacuum drying at 60°C and infrared and hot air drying at 55°C exhibited the maximum value for essential oil. The highest value of oleoresin was observed at a temperature of 50°C for all three drying methods (7.55%).

Screening accessions with virulent isolates of *Phytophthora capsici* and *P. tropicalis*

Accessions that survived root infection with *Phytophthora capsici* and *P. tropicalis* were further subjected to leaf and stem inoculations and categorized based on the Overall Mean Disease Severity Index (OMDSI). Among the accessions surviving root infection with *Phytophthora capsici*, accessions 7439, 7445, 7467, and 7492 were classified as moderately resistant, whereas accessions 7457, 7482, and 7657 were identified as susceptible based on OMDSI. In contrast, among the accessions surviving root infection with *P. tropicalis*, accessions 7401, 7439, 7492, 7548, and 7577 were categorized as resistant; accessions 7563, 7657, 7748, and 7782 as susceptible; and accessions 7432, 7438, 7445, 7464, 7467, 7478, 7525, 7657, 7729, and 7738 as moderately resistant.

Development of black pepper lines resistant to *Phytophthora* through CRISPR/Cas genome editing

To develop black pepper lines resistant to *Phytophthora*, the NPR3 (Non-expressor of Pathogenesis-Related Proteins 3) gene was targeted for CRISPR/Cas-mediated genome editing. The NPR3 gene from the variety Sreekara was amplified by PCR, cloned, and sequenced. Sequence analysis against the black pepper genome database revealed the presence of four distinct isoforms of the NPR3 gene. To further characterize these isoforms, isoform-specific primers (MFP1, MFP2, MFP3, and MFP4) were designed and used to amplify the respective variants and assess sequence variation among them. Among the amplified products, a ~900 bp fragment obtained using the primer pair PN2-NPR3-IFP and PN2-NPR3-IRP was selected for guide RNA (gRNA) design.

The gRNA target sequences were identified using the online CRISPR design tool provided by Integrated DNA Technologies (IDT), which enabled the selection of optimal target sites within the gene based on predicted specificity and editing efficiency for CRISPR-Cas9–mediated genome editing. Two single-guide RNA (sgRNA) constructs were subsequently designed and cloned into the plant binary vector pKSE401 harboring the Cas9 endonuclease (Fig. 2). The pKSE401 vector is widely used for plant genome editing and contains a cauliflower mosaic virus 35S promoter–driven Cas9 expression cassette, a kanamycin resistance selectable marker, and Arabidopsis U6 promoter–driven gRNA expression cassettes with BsaI restriction sites for the insertion of custom gRNAs. Based on a pCAMBIA backbone, this vector facilitates efficient genome editing and mutant generation in plants. The presence of the gRNA inserts in the recombinant plasmids was confirmed by sequencing. Thermodynamic ensemble analysis of the sgRNAs indicated stable secondary structures with well-defined lobes and no inter-loop interference. The confirmed recombinant constructs were mobilized into *Agrobacterium tumefaciens* strain LBA4404 using the heat-shock method.

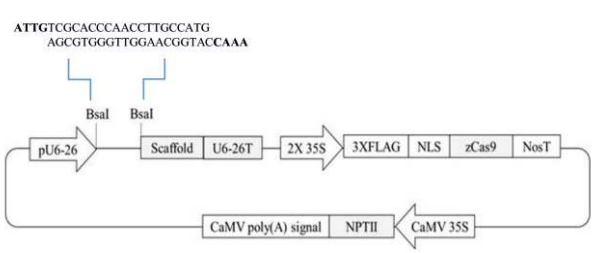


Fig. 2. Recombinant pKSE401 construct harbouring gRNA

CRISPR-Cas12a coupled RPA-LFA for the specific detection of piper yellow mottle virus in crude plant extracts

A rapid and highly sensitive recombinase polymerase amplification coupled with CRISPR-Cas12a and lateral flow assay (RPA–CRISPR–LFA) for the specific detection of piper yellow mottle virus (PYMoV) in black pepper was developed. In this assay, the RPA-amplified product is specifically recognized and cleaved by the Cas12a–crRNA complex, producing a visual signal detectable on a lateral flow strip (Fig. 3). Optimal reaction conditions were established using 500 nM LF reporter, 75 nM Cas12a, and 125 nM crRNA. Distinct test lines were observed within 30 min, with maximum signal intensity recorded at 1 hour. The assay exhibited high specificity, showing no cross-reactivity with other viruses infecting black pepper, and demonstrated a detection sensitivity 10-fold higher than RPA and 1000-fold higher

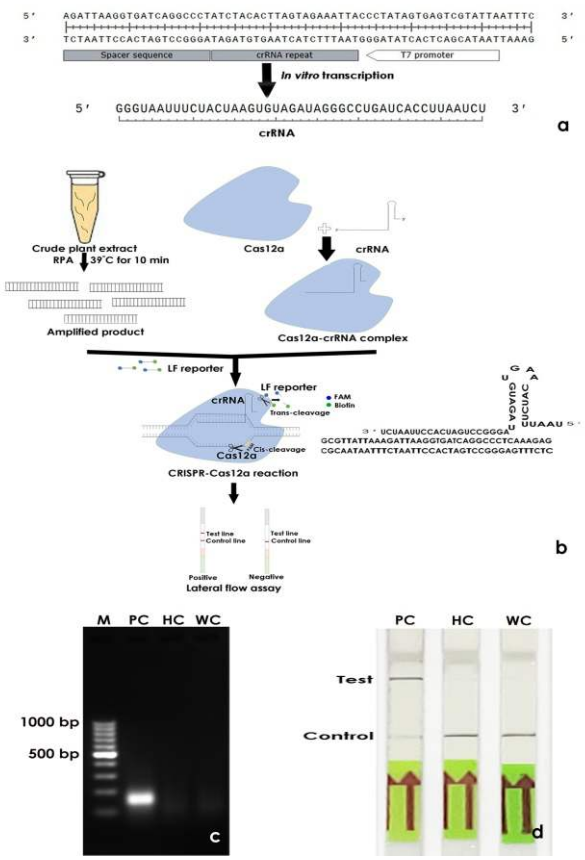


Fig. 3(a). Synthesis of crRNA through *in vitro* transcription. (b) Schematic representation of different stages in RPA-CRISPR-LFA. Detection of piper yellow mottle virus (PYMoV) by (c) RPA and (d) RPA-CRISPR-LFA using crude plant extract as template. Lane PC: positive control; Lane HC: healthy control; Lane WC: water control; Lane M: 100 bp DNA ladder

than conventional PCR. Validation with field samples confirmed its reliability and suitability for on-site detection of PYMoV.

Screening germplasm accessions against nematodes

Of the 103 accessions screened for resistance against burrowing nematode (*Radopholus similis*) and root-knot nematode (*Melodigyne incognita*), accessions 844, 2173, 4110, 4165, 5337, 5745, 7284, 7348, 8361, 8363, and P9CSN showed immune reaction for both nematodes.

Development of management technology for burrowing and root knot nematodes

Application of fluopyram 34.48% SC at 500 g a.i. (1250 mL ha^{-1}) as a single drench at the pre-flowering stage, or at 250 g a.i. (625 mL ha^{-1}) applied twice (at pre-flowering and 30 days after the first application), was found to be effective against the root-knot nematode, *Meloidogyne incognita*, and the burrowing nematode, *Radopholus similis*, under field conditions. Analysis of two-year pooled data revealed a reduction of more than 96% in parasitic nematode populations, accompanied by a significant yield increase exceeding 26%.

Evaluation of low-risk insecticides against pollu beetle for label expansion

Field trials were conducted at Kozhikode and at various AICRPS centres to generate bioefficacy, phytotoxicity, and residue data for chlorantraniliprole 18.5% SC applied at 0.0375, 0.05, and 0.0625% against pollu beetle (*Lanka ramakrishnai*), as well as to assess its effects on natural enemies for label expansion. The results indicated that the tested insecticide was effective in controlling the pest across all locations. In addition, the insecticide was found to be non-phytotoxic and safe to natural enemies.

Small Cardamom

Genetic resources

A total of 625 accessions are being conserved at the National Active Germplasm Site (NAGS) at ICAR-IISR, Regional Station, Appangala. In addition to the cultivated cardamom (*Elettaria cardamomum*), the collection includes allied taxa comprising five species from related genera, namely *Amomum aculeatum, Amomum pterocarpum, Hedychium coccineum, Hedychium flavescens,* and two *Alpinia* spp. A high-yielding Malabar-type cardamom germplasm was collected from Sullia, Dakshina Kannada District, Karnataka.

A subset of 120 accessions was characterized based on morphological traits and yield parameters, revealing significant variation among the accessions. The accession IC 949391 exhibited the highest plant height (396.00 cm), while IC 547164 recorded the highest number of bearing tillers (28.65), panicles (39.32), capsules per plant (455), along with the highest fresh yield (1286.42 g $plant^{-1}$) and dry yield (284.80 g $plant^{-1}$). Essential oil content was estimated for 75 germplasm accessions, with values ranging from 4.19% (IC 647008) to 8.89% (IC 647015). Volatile profiling of 20 samples using GC-MS revealed considerable variation in key aroma constituents. The content of 1,8-cineole (Eucalyptol) ranged from 28.97% to 45.27%, with MA28 exhibiting the highest concentration. Similarly, α-terpinyl acetate content varied from 31.68% to 48.64%, with GG × CCS1 exhibiting the maximum concentration.

Evaluation of moisture stress-tolerant lines

Yield performance was evaluated in 15 moisture stress-tolerant lines developed through artificial screening using polyethylene glycol (PEG). Among these lines, MS 584058-5 recorded a fresh yield of 1080 g $plant^{-1}$ and a dry yield of 182 g $plant^{-1}$.

Evaluation of hybrid progenies

Among the 42 hybrid progenies evaluated, hybrid progeny 7-2021-14 recorded the highest fresh yield (1975 g plant^{-1}) and dry yield (426 g plant^{-1}). This was followed by hybrid progeny 7-2021-8, which recorded a fresh yield of 1809 g plant^{-1} and a dry yield of 380 g plant^{-1}.

Evaluation of hybrids

The CVT trial consisting of nine hybrids, *viz*., Bold × IC 547219, (GG × Bold) × Appangala 1, (GG×NKE 19) × Bold from ICAR-IISR, RS, Appangala; MHC-1 & MHC-2 from ICRI, Myladumpara; SHC-1 & SHC-2 from ICRI, RS, Sakaleshapura, and PH-13 & PH-14 from Pampadumpara, along with check variety *Njallani* green gold, was carried out at ICAR-IISR, RS, Appangala for three consecutive years. Based on the pooled data over three years, the hybrid Bold × IC 547219 recorded the highest fresh yield (3805.8 kg ha^{-1}) and dry yield (705.20 kg ha^{-1}). The hybrid was recommended for release under the name IISR Sujyothi (Fig. 4).

Fig. 4. IISR Sujyothi

Multilocation trial of leaf blight-resistant accessions

Multilocation trial on leaf blight tolerant lines is in progress with five leaf blight tolerant genotypes, *viz.,* IC 349650, IC 547222, IC 547156, IC 349649, and IC 349648, along with resistant checks: Appangala 1, *Njallani* Green Gold, and susceptible check - IISR Vijetha. The disease incidence ranged from 11.67 to 25.00, with the minimum disease incidence recorded in IC 349649.

Multilocation evaluation of thrips-tolerant lines

Multilocation evaluation of thrips-tolerant lines was undertaken with four tolerant lines (IC 349370, IC 349606, IC 349362, and IC 349364) and two check varieties (Appangala 1 and *Njallani* green gold). The genotype IC 349362 recorded the maximum plant height (193.5 cm), the highest average number of panicles (33.6), and the highest average number of capsules (46.3). The highest average fresh yield was also observed in IC 349362, recording 2012 g per five plants, followed by IC 349370 (1103 g per five plants) and IC 349364 (853 g per five plants). The standard checks, namely *Njallani* green gold and Appangala 1, recorded average fresh yields of 1290 g and 1900 g, respectively.

Transcriptome sequencing and identification of candidate genes in the ATA pathway

A comprehensive tissue-specific transcriptome analysis was completed using high-quality RNA extracted from seed, leaf, and root tissues. *De novo* transcriptome assembly coupled with differential expression analysis revealed significant transcriptional variation between tissues, particularly between seed versus leaf and seed versus root. It was further revealed that three key candidate genes, *viz*., monoterpene synthase 7, monoterpene synthase 8, and BAHD acyltransferase, were associated with the biosynthesis of α-terpinyl acetate (ATA), a major component responsible for the unique aroma in cardamom. These findings provide novel molecular insights into the ATA biosynthetic pathway.

Cardamom cultivation in non-traditional areas

Mr. Krishna Bellare of Sullya successfully cultivated cardamom in an arecanut plantation at a low elevation of about 150 m above MSL with Malabar types. Among the population, one plant exhibited exceptional performance, recording 40 tillers and 60 panicles, with panicle lengths of 0.5 - 0.75 m, 15 - 18 internodes, 4 - 5 capsules per node, 30 - 40 capsules per panicle, and a fruit set of 70–80%. This genotype performed well even at 107 m MSL and was collected for conservation. High relative humidity (70–90%) from April onwards and continuous rainfall for nearly seven months favoured good crop establishment. Similarly, Mr. Santhosh of Bromasandar, Tumkur, cultivated cardamom in a non-traditional area under coconut plantations by creating additional shade using *Sesbania grandiflora* and under arecanut plantations supported with mini-sprinkler irrigation. From 450 plants, he harvested approximately 100 kg of cardamom.

Chemo-diversity analysis of germplasm

A total of 22 genotypes were analysed for their volatile constituents using GC-MS. Multivariate statistical analyses of the volatile profiles were performed using MetaboAnalyst 5.0. The 2D plot of PLS-DA analysis showed that genotypes ICRI-6 and IISR Vijetha have clustered differently from other genotypes. The dendrogram showed that genotypes having high linalool content, such as Mudigere 2, Panikulangara 2, Elarajan, Panikulangara 1, Thiruthalli, and PV2, clustered together. Along with the above mentioned genotypes, ICRI 2 and

IISR Avinash showed higher α-terpinyl acetate and lower 1,8-cineole content.

Cardamom flavour impregnation

Cardamom flavour was incorporated into ash gourd through osmotic dehydration (OD) and vacuum impregnation (VI) to develop value-added ash gourd candy, and its physicochemical, biochemical, microbial, and sensory qualities were evaluated (Fig. 5). Response Surface Methodology optimized process parameters for both the methods. Optimal OD conditions (50.95°C, 67.09°Brix, 2.48 h) yielded 70.05% water loss and 37.98% sugar gain, while VI conditions (58.97°C, 67.17°Brix, 15.69 min) resulted in 63.67% water loss and 31.38% sugar gain. Products developed through vacuum impregnation exhibited improved nutritional composition, lower microbial load, and superior sensory acceptability compared to those prepared by OD. Volatile profiling using GC–MS confirmed higher 1,8-cineole content in VI-treated candy, establishing vacuum impregnation as a superior technique for functional ash gourd candy production.

Rapid detection of cardamom mosaic virus in crude plant extracts using reverse transcription-recombinase polymerase amplification-lateral flow assay (RT-RPA-LFA)

An assay based on reverse transcription-recombinase polymerase amplification (RT-RPA) combined with lateral flow assay (RT-RPA-LFA) was optimized for the specific and sensitive detection of CdMV (Fig. 6). The forward and reverse primers selected for RT-RPA were labeled with 6-carboxyfluorescein (FAM) and biotin, respectively, at the 5′end. The tedious total RNA preparation was avoided by using the crude extract as a template for the assay. A magnesium acetate concentration of 14 mM, 0.4 M betaine, temperature from 37 to 42°C, and 20 min of incubation time were found to be optimum for the assay. The entire RT-RPA-LFA from sample preparation to visualization of results could be completed within 40-50 min, and the assay is suitable for Point-of-Care testing. The assay is specific for CdMV and could detect the virus up to 10^{-5} dilutions of the crude extract. The assay was validated using field samples collected from different cardamom-growing regions of Kerala and Karnataka, India.

Fig. 5. Vacuum-impregnated cardamom-flavoured ash gourd candy

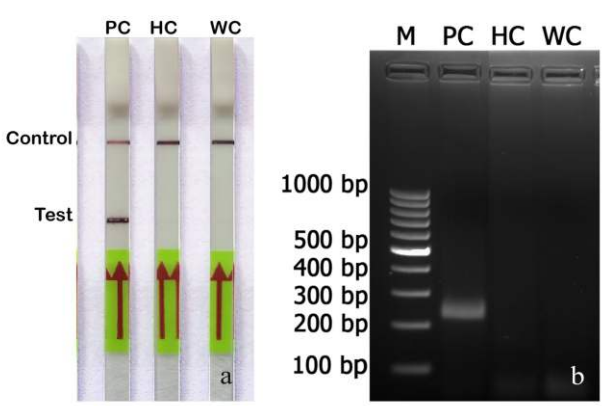


Fig. 6. Detection of cardamom mosaic virus by RT-RPA-LFA performed with the addition of 0.4 M betaine in the reaction mix through (a) lateral flow assay and (b) agarose gel electrophoresis. Lane PC: positive control; Lane HC: healthy control; Lane WC: water control; Lane M: 100 bp DNA ladder

Impact of thrips damage on the quality attributes

The quantitative and qualitative damage caused by thrips (*Sciothrips cardamomi*) to cardamom capsules was studied by categorisation of infested capsules into six damage scales (I–VI) based on the extent of pericarp scar coverage (Fig. 7). Studies indicated that the capsule length decreased sharply from Scale III onwards, with the highest reduction (38.1%) recorded at Scale VI. Although capsule width was less affected, Scales V and VI showed up to 18.5% reduction. Seed count per capsule steadily declined from Scale II, with a 41% loss at Scale VI. Seed weight also declined significantly, reaching a 40% loss at the highest damage scale. In contrast, husk weight increased progressively with damage, peaking at a 62% increase at Scale IV. This shift led to a drastic change in the seed-to-husk ratio from 72:28 in healthy capsules to 43:57 in heavily damaged ones. Essential oil recovery remained unaffected until Scale III but declined significantly thereafter, with a 53.5% loss at Scale VI. GC– MS chromatographic analysis revealed substantial shifts in oil composition: 1,8-cineole increased from 35.05% (Scale I) to 42.57% (Scale IV), while α-terpinyl acetate decreased from 41.5% to 32.26% in severely damaged capsules. Other monoterpenes followed similar trends, indicating that thrips damage alters both yield and aromatic quality of the oil (4).

Fig. 7. Categorization of thrips-damaged cardamom capsules based on scar severity: sequential images of a single capsule for each damage scale

Large cardamom

Rapid on-site detection of bushy dwarf virus and chirke virus using RPA- coupled lateral flow assays

Foorkey and *chirke* are the two major viral diseases impacting productivity, caused by cardamom bushy dwarf virus (CBDV), a DNA virus, and large cardamom chirke virus (LCCV), an RNA virus, respectively. Relying solely on visible symptoms for diagnosing these infections is unreliable. In this study, an RPA-LFA assay was developed for detecting CBDV and an RT-RPA-LFA assay for LCCV, using TwistAmp reagents, labeled primers, and crude extracts from infected plants. Optimization of the assay using 1 M betaine eliminated false positives by suppressing nonspecific amplification. The optimized assays demonstrated either comparable (CBDV) or tenfold higher sensitivity (LCCV) than conventional PCR. The entire workflow could be completed within 35-45 min, making it suitable for large-scale indexing of planting material. Both assays were successfully validated using field-collected samples of large cardamom that included asymptomatic and mixed infections.

Ginger

Genetic resources

Six hundred and sixty-eight accessions are being maintained in the field gene bank at ICAR-IISR, Experiment Farm, Peruvannamuzhi, Kerala.

Collection of germplasm

A collaborative germplasm exploration with ICAR-NBPGR, RS Shillong, was conducted in various districts of Assam and Meghalaya. Eleven accessions of *Zingiber,* including seven species (*Z. offcinale, Z. meghalayense, Z. ligulatum, Z. purpureum, Z. zerumbet*, and two unidentified species) and six accessions of the other genera of Zingiberaceae (*Alpinia, Amomum,* and *Etlingera*) were collected.

IISR Navya: a new ginger mutant variety

IISR Navya, a high- and stable-yielding ginger mutant variety, was recommended for release by the XXXVI Annual Group Meeting of ICAR-AICRPS held during 29-31 October, 2025, at the ICAR Complex for NEH Region, Barapani, Meghalaya (Fig. 8). The variety was developed through gamma irradiation. The average fresh rhizome yield across the locations is 15.3 t ha^{-1}, with a potential yield of 36.0 t ha^{-1}. It exhibits good quality attributes *viz*., dry recovery (18.78%), essential oil (2.7%), oleoresin (6.65%), fibre (6.5%), zingiberene (20%), and beta-sesquiphellandrene (10%). The variety is less susceptible to rhizome rot disease under field conditions, with a Percent Disease Index (PDI) of 14.1. It is suitable for Kerala, West Bengal, and the North -Eastern region (Meghalaya).

Fig. 8. IISR Navya

Coordinated varietal trial (CVT) on high essential oil ginger

A Coordinated varietal trial on high essential oil ginger with nine entries and one check variety is being conducted at Peruvannamuzhi and Appangala. Among the entries evaluated, G 2023-16 recorded significantly higher yield at Peruvannamuzhi (25.49 kg bed^{-1}) and Appangala (11.85 kg bed^{-1}), with dry recovery of 19.5% and 20.9% at Peruvannamuzhi and Appangala, respectively.

Coordinated varietal trial on bold ginger

A coordinated varietal trial on bold ginger with 10 entries and one check variety is being conducted at Peruvannamuzhi and Appangala. Among the entries evaluated, G 2023-5 and G2023-6 recorded significantly higher yield of 14.23 and 13.33 kg $bed^{-1,}$ respectively, at Appangala, and G 2023-6, G 2023-5, and G 2023-1 recorded significantly higher yield of 16.44, 11.15, and 10.00 kg $bed^{-1,}$ respectively, at Peruvannamuzhi.

Comprehensive transcriptome mining reveals isoform diversity and lncRNA landscapes

Genome-wide isoform mining of key genes involved in the gingerol biosynthetic pathway identified nine KAT5 isoforms and five CHS isoforms. In addition, a Snakemake-based computational pipeline was developed for the prediction and classification of long non-coding RNAs (lncRNAs) from transcriptomic datasets. Using this pipeline, on average, approximately 4,000 putative lncRNAs were identified per transcriptome, resulting in a comprehensive dataset of nearly 800,000 lncRNA sequences across transcriptomes. Leveraging these data, the first dedicated lncRNA resource, the GingerLnc Database, was developed (Fig. 9).

Fig. 9. Interface of GingerLnc Database

Functional characterization of differentially expressed genes during *Ralstonia* infection

Gene-specific primers were designed for five differentially expressed genes. Three genes were cloned in to pCRII cloning vector and sequence

re-confirmed and characterized *in silico*. Computational methods were employed to analyze one of the genes, xyloglucan endotransglucosylase, Xet23, and other members of this family. Phylogenetic analysis followed by molecular modelling has identified structural differences between XET genes belonging to different subclusters - XET23 and XET10. sgRNAs were designed, and pCAMBIA-based gene editing constructs were prepared for functional characterization of genes that are overexpressed during *Ralstonia* infection in ginger. Friable embryonic calli were developed in variety IISR Varada. The calli were developed using bud and shoot tissues for *Agrobacterium* mediated transformation and genome editing through particle-bombardment (Fig. 10).

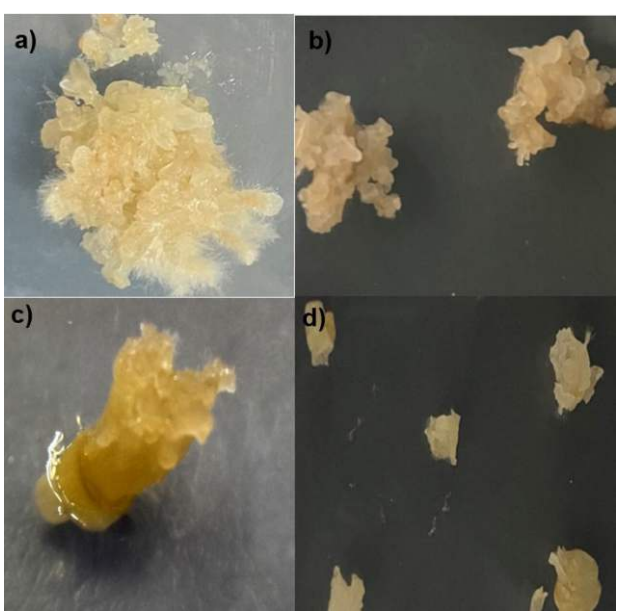


Fig. 10. Calli developed from IISR Varada shoot explants using different hormonal compositions; a) 0.5mg L^{-1} 2,4-D (Immature shoot base - I Subculture), b) 0.5mg L^{-1} 2,4-D (Immature shoot base - II Subculture), c) 3mg L^{-1} 2,4-D (Immature shoot base), d) 1mg L^{-1} 2,4-D and 1mg L^{-1} BAP (Mature shoot base)

Evaluation of the natural farming system

Evaluation of different natural and integrated nutrient management (INM) systems revealed marked variations in soil nutrient availability, leaf nutrient status, yield, and quality parameters in ginger. Availability of N, Ca, Mg, Fe, and Zn was highest under 100% organic treatment, while P was highest in INM (75% + 25%) and K in 100% inorganic treatment. Leaf nutrient analysis at 120 days after planting (DAP) indicated higher potassium and K under INM (50% + 50%), and higher P and Mn under 100% inorganic and organic (50%) treatments supplemented with bio-inputs such as beejamrut, ghanajeevamrut, and jeevamrut. The highest yield (13.07 t ha^{-1}) was recorded in organic (50%) with bio-inputs, followed by 75% organic (12.93 t ha^{-1}), while the lowest yield occurred under organic (25%) with bio-inputs (10.33 t ha^{-1}). Maximum oil content (1.83%) was observed in 100% and 75% organic treatments, and the highest oleoresin content (3.75%) was observed in 75% organic and INM (75% + 25%) treatments.

Crop suitability

To assess the impacts of climate change on suitability and agro-ecologically attainable yields, the Agro-Ecological Zonation (AEZ) methodology, developed by FAO and the International Institute for Applied Systems Analysis (IIASA), was employed. The assessment considered critical land characteristics influencing ginger growth, including climatic regime, soil attributes, topography, and erosion hazards, and the site suitability classification was structured into four categories: S1 (highly suitable), S2 (moderately suitable), S3 (marginally suitable), and S4 (not suitable).

Each zone suitability rating (Very High / High / Moderate / Low) is listed below and is depicted in Fig. 11.

- Malabar coast and Western Ghats (Kerala highlands and mid-hills; parts of Karnataka).
- Malabar coast and Western Ghats (Kerala highlands and mid-hills; parts of Karnataka Konkan, Tamil Nadu Nilgiris): Very High suitability.

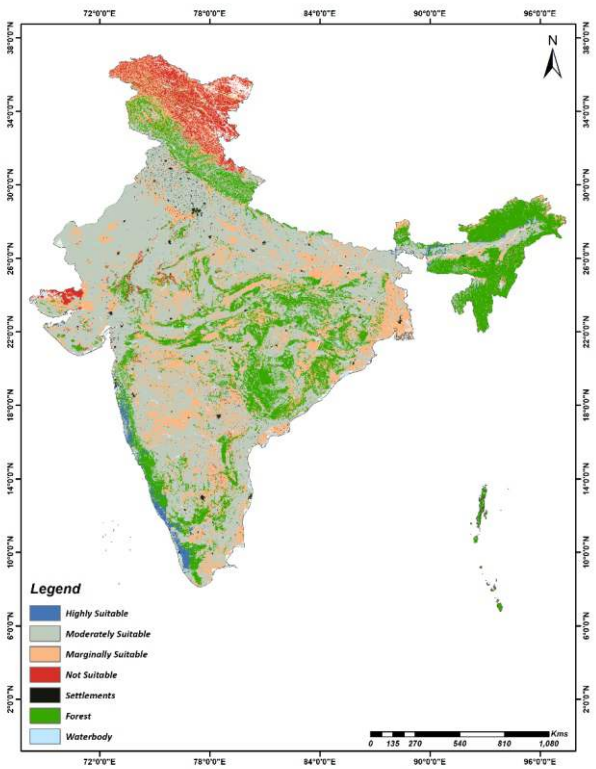


Fig. 11. Crop suitability map of ginger

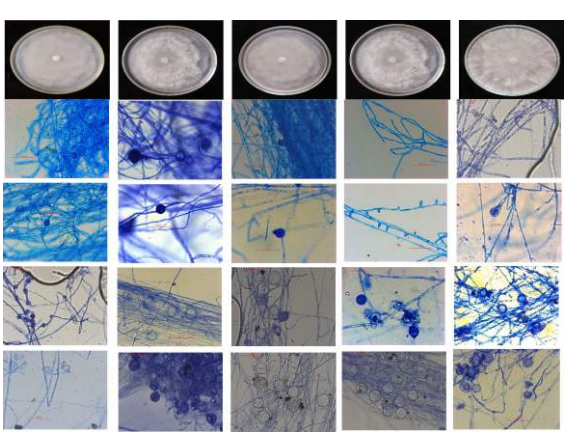
- North Eastern region (Assam, Meghalaya, Arunachal Pradesh, Manipur): Very High to High suitability.
- Odisha and Gangetic fringe (coastal and eastern plains): High suitability in well-drained pockets; Moderate suitability elsewhere.
- Sikkim and Sub-Himalayan hills (Darjeeling foothills, Darjeeling-Sikkim ranges): High suitability in hill belts.
- Maharashtra (Konkan region and Western Ghats slopes): Moderate to High suitability in Konkan and Ghats; Low suitability in the interior Deccan Plateau.
- West Bengal (southern and hilly districts): Moderate suitability.
- Tamil Nadu (Western Ghats fringe and southern hills): High suitability in hill regions and Ghats fringe; Low to Moderate in dry plains.
- Central and Northwestern India (Madhya Pradesh, Rajasthan, Gujarat, Punjab, Haryana): Low suitability.

Assessing the efficacy of the vacuum infiltration method to eliminate rhizome-borne *Ralstonia pseudosolanacearum* from infected ginger rhizomes

The artificially inoculated rhizomes with *Ralstonia pseudosolanacearum* were subjected to heat (in the sett treatment device) and chemicals (without heat treatment) at different times (10, 15, and 20 minutes) and temperatures (46 °C, 48 °C, 50 °C, 52°C and 54 °C) regimes. Under pot culture conditions, maximum germination and production of tillers (with heat treatment) were noticed with 52 °C for 20 minutes, with no disease incidence. Whereas, with different chemicals, maximum germination and tiller production were observed with copper oxychloride (0.4%) for 10 minutes.

Morphological and molecular characterization of *Pythium* spp. infecting ginger

Molecular characterization of five *Pythium* isolates was completed using the internal transcribed spacer (ITS) region, cytochrome oxidase subunit II (COX II), and β-tubulin gene sequences. Based on sequence analysis and morphological features, the isolates were identified as follows: IISR Py5 – *Pythium graminicola*, IISR Py8 – *Pythium myriotylum*, IISR Py14 – *Pythium graminicola*, IISR Py15 – *Pythium myriotylum,* and IISR Py0822 – *Pythium myriotylum* (Fig. 12).



IISR Py5 IISR Py8 IISR Py14 IISR Py15 IISR Py0822

Fig. 12. Identification of Pythium isolates associated with ginger based on morphological and sequence analysis

Influence of crop rotation with non-host crops on soft rot incidence

Field trials were conducted to assess the effect of crop rotation with non-host crops, namely mustard, amaranthus, French bean, cowpea, and sorghum, on *Pythium* population dynamics and soft rot incidence in ginger. Crop rotation with cowpea and mustard significantly reduced soil *Pythium* population and soft rot incidence compared to other rotations.

Evaluation of integrated disease management schedules for soft rot

The integrated management strategies comprised soil solarization, crop rotation with non-host crops, application of bioagents, and need-based fungicide application under field conditions. Bioagents such as *Trichoderma asperellum, Bacillus safensis,* and *Bacillus amyloliquefaciens* were applied as soil drenching at different crop stages. Application of bioagents significantly reduced soil *Pythium* population and soft rot incidence compared to the untreated control. Need-based application of metalaxyl–mancozeb was included in the IDM schedule to manage disease during periods conducive to soft rot development. Among the crop rotations tested, cowpea and mustard were found to be the most effective, recording a significant reduction in soil *Pythium* population and soft rot incidence compared to other non-host crops. The results indicated integrated application of soil solarization, rotation with cowpea or mustard, application of bioagents (*Bacillus safensis*, *B. amyloliquefaciens,* and *Trichoderma asperellum*) at 30 days interval, and need-based fungicide application resulted in improved germination, enhanced plant growth, and reduced the incidence of soft rot disease.

Field evaluation of new generation fungicide molecules against *Pythium* spp.

Field trials were conducted to evaluate the efficacy of three new-generation fungicide molecules against *Pythium* spp. Observations on soil population of *Pythium*, germination, growth parameters, and PDI were recorded. Among the molecules tested, Fluopicolide + Fosetyl-Al was found effective in reducing *Pythium* population and soft rot incidence.

Effect of Arbuscular mycorrhizal fungi (AMF) colonization on *P. myriotylum* and *M. incognita* tolerance in ginger

Ginger plants primed with arbuscular mycorrhizal fungi (AMF) and subsequently challenged with *Pythium myriotylum* recorded a disease incidence of 40%, whereas the non-mycorrhizal control plants challenged with *P. myriotylum* exhibited a higher disease incidence of 80% (Fig. 13A). The presence of AMF in ginger plants significantly inhibited the penetration of second-stage juveniles (J2s) of *M. incognita* into the roots compared to plants treated only with *M. incognita* (J2s) (Fig. 13B).

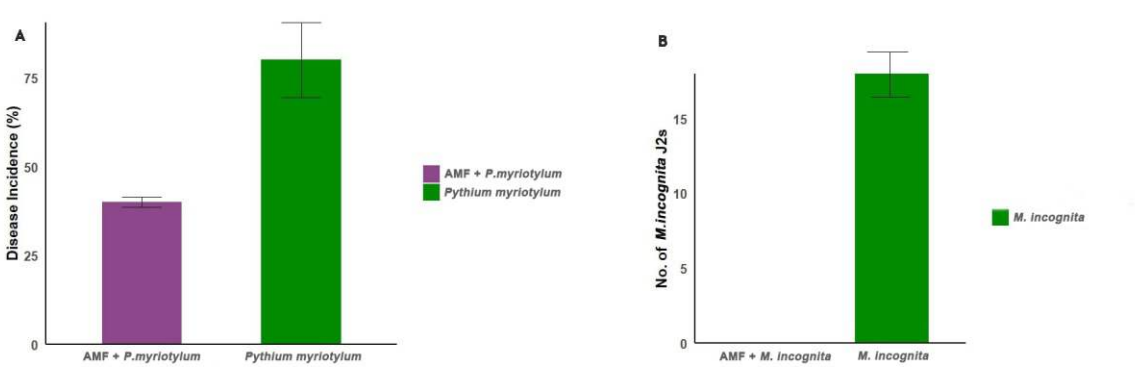


Fig. 13. Effect of arbuscular mycorrhizal fungi on the (A) soft rot incidence and (B) root-knot nematode penetration in ginger

Biochemical defense responses to mycorrhizal colonization and *Pythium myriotylum* and *Meloidogyne incognita* infection

Peroxidase activity increased markedly in both leaves and roots under AMF + *P. myriotylum* and AMF + *M. incognita* treatments. Plants inoculated with *P. myriotylum* alone showed elevated peroxidase activity at 1 day after inoculation (DAI), followed by a sharp decline by 3 DAI in leaves. In contrast, the combined AMF + *M. incognita* + *P. myriotylum* treatment maintained consistently high peroxidase activity in both tissues throughout the observation period. Catalase activity in roots increased in response to pathogen infection, with the highest levels observed in *M. incognita*-inoculated plants from 1 to 3 DAI. In leaves, a significant increase in catalase activity was recorded only under the AMF + *M. incognita* treatment. β-1,3-glucanase activity in roots showed a pronounced increase by 3 DAI under the AMF + *M. incognita* + *P. myriotylum* treatment. Conversely, plants inoculated with *M. incognita* alone exhibited a declining trend in root β-1,3-glucanase activity from 1 to 3 DAI. In leaves, single inoculation with *P. myriotylum* or *M. incognita* resulted in higher enzyme activity at 1 and 2 DAI, respectively, followed by a significant reduction at 3 DAI.

Expression of defense-related genes in response to mycorrhizal colonization and *Pythium myriotylum* and *Meloidogyne incognita* infection

Upon *P. myriotylum* infection, NPR1 expression in roots was rapidly induced at 1 DAI. In contrast, AMF-primed plants showed initial suppression at 1 DAI followed by enhanced expression at 3 DAI, indicating a delayed but regulated defense response. The AMF + *M. incognita* + *P. myriotylum* treatment exhibited a consistent increase in NPR1 expression up to 3 DAI. In leaves, NPR1 expression increased steadily over time in AMF-treated plants challenged with both pathogens. TGA expression showed treatment-specific regulation. In roots, AMF + *P. myriotylum* caused a slight reduction at 2 DAI, followed by upregulation at 3 DAI, whereas AMF + *M. incognita* showed the highest expression with early induction at 1 DAI and a peak at 3 DAI. In leaves, co-inoculation with AMF and either pathogen resulted in sustained upregulation from 1 DAI onwards.AP2 expression in roots was strongly induced in AM-colonized plants challenged with *P. myriotylum* and *M. incognita*, showing 3–4 fold increases at 2–3 DAI, but declined by 3 DAI in AMF-primed plants. In leaves, *P. myriotylum* alone induced steady upregulation, while dual pathogen challenge resulted in strong and sustained induction, reaching up to 16-fold. The 4CL gene showed strong induction in roots under individual pathogen infection, while AMF priming resulted in transient induction. In leaves, sustained upregulation occurred under sole pathogen inoculation, whereas AMF priming caused downregulation by 3 DAI. JA-pathway genes LOX2 and AOC showed strong induction under pathogen stress, with AMF priming moderating but sustaining their expression in both roots and leaves.

Optimization of nutritional factors for enhanced production of bioactive metabolites from promising endophytic bacteria from selected Zingiberaceae species

Four endophytic bacterial strains, *Bacillus amyloliquefaciens* CC11, *B. pumilus* KG6, *Pseudacidovorax intermedius* NCC15, and *Rhizobium* sp. NCC17 were isolated from *Kaempferia galanga* and *Curcuma caesia*. *Pythium myriotylum* served as the test pathogen. Bacterial cultures were fermented for 48 h, biomass quantified, and methanolic extracts evaluated for anti-Pythium activity using the agar well diffusion assay. Among the isolates, *B. pumilus* KG6 and *P. intermedius* NCC15 showed the strongest inhibition. Glucose markedly enhanced biomass and metabolite production, while sodium nitrate and ammonium oxalate further improved pathogen suppression by

B. pumilus KG6 and *P. intermedius* NCC15, respectively (Fig. 14). Mineral supplementation (0.05%) revealed dipotassium hydrogen phosphate as the most effective in enhancing bacterial biomass and bioactive metabolite production against *Pythium myriotylum.*

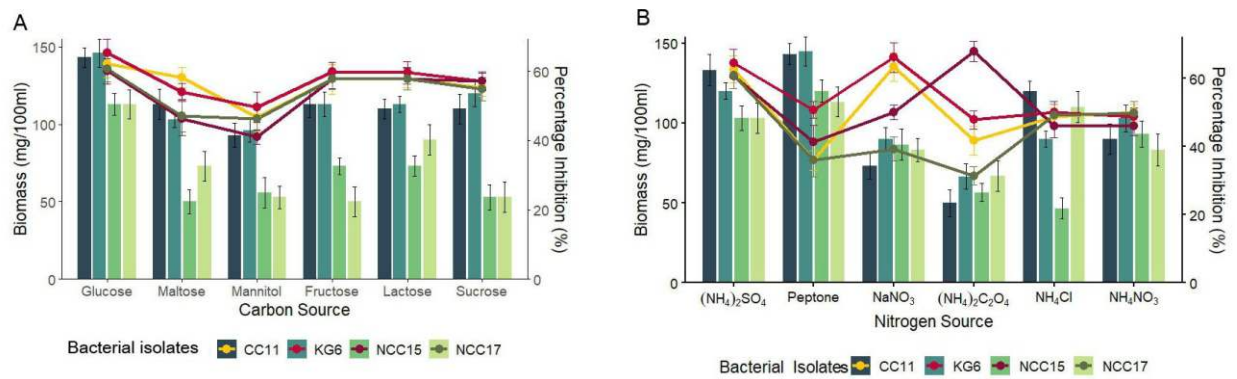


Fig. 14. Effect of (A) Carbon and (B) Nitrogen sources on bacterial biomass and anti-*Pythium* activity

Host plant resistance

Of the 11 accessions screened for resistance against *M. incognita,* three accessions, namely, *NE local 2*, *GC9,* and *ACC 891,* showed resistance reaction.

Evaluation of the nematicidal potential of newer molecules against the root-knot nematode

Field experiment for the 2nd season for evaluating nematicidal potential of newer molecules revealed that application of fluopyram @ 1250 ml ha^{-1} as a single dose before planting or application of fluopyram @ 625 ml ha^{-1} in two doses (before planting and 30 days after planting) had significant effects on root-knot nematode suppression. These two treatments outperformed all the other treatments in terms of nematode population reduction (~85%), and this superior nematode control translated into markedly higher yields in these two treatments (~ 3.25-fold).

Deciphering the mechanism of *Pochonia chlamydosporia* mediated *Meloidogyne incognita* control in ginger

An RNA-Seq–based comparative transcriptomic analysis was conducted to elucidate the molecular mechanisms underlying the tripartite interaction among ginger, *M. incognita*, and *M.chlamydosporia*. Ginger rhizomes were primed with *P. chlamydosporia* at the time of planting and subsequently challenge-inoculated with *M. incognita* 15 days later. Non-primed rhizomes inoculated only with *M. incognita* served as the control. Transcriptomic analysis revealed 2,216 differentially expressed transcripts, of which 1,864 were upregulated and 352 were downregulated in *P. chlamydosporia*-primed plants challenged with *M. incognita*. Notably, several transcripts associated with induced systemic resistance (ISR), including wall-associated kinase 5, calcium-dependent protein kinase 26, glutamate receptors, respiratory burst oxidase homologs (RBOH), and jasmonate-induced proteins, were significantly upregulated.

Evaluation of low-risk insecticides against the shoot borer (*Conogethes punctiferalis*) infesting ginger and turmeric for label expansion

Two low-risk insecticides, chlorantraniliprole 18.5% SC and spinosad 45% SC, were evaluated at 0.0375, 0.05, and 0.0625% doses, along with a

standard check (lambda-cyhalothrin 5% EC), against the shoot borer, *Conogethes punctiferalis*, infesting both ginger and turmeric at ICAR-IISR, Kozhikode, and at various AICRPS centres. The tested insecticides were effective in controlling the pest, recording up to 100% reduction in shoot borer damage at the recommended dose. Furthermore, no phytotoxic symptoms were observed in treated plants, even at twice the recommended dose. The tested chemicals were also found to be safe to natural enemies, such as spiders.

Turmeric

Genetic resources

A total of 1404 *Curcuma* spp germplasm is being maintained, among which 1132 are turmeric accessions, which have been characterized for morphological and rhizome characters, and 800 have been characterized for quality characters.

Collection of germplasm

Six accessions of *Curcuma*, including three species (*C. longa* and 2 unidentified sp.), were collected from various districts of Assam and Meghalaya.

Black turmeric trial for high yield

Among the seven entries, Acc. 751 recorded a significantly higher yield of 12.23 kg bed^{-1}, followed by PCC1 (10.42 kg bed^{-1}), BT 162 (10.25 kg bed^{-1}), and NBT 2 (10.00 kg bed^{-1}), which were on par.

Evaluation of seedling progenies

170 seedling OP progenies were evaluated for two years, 2023-2024 and 2024-25 at ICAR IISR, Experimental farm, Peruvannamuzhi. Among them 31 (SLP-18/13, SLP-18/23, SLP-20/1, SLP-20/6, SLP-20/10, SLP-20/11, SLP-65/1, SLP-65/3, SLP-65/13, SLP-65/18, SLP-69/9, SLP-69/10, SLP-126/1, SLP-126/4, SLP-126/5, SLP-138/65, SLP-354/3, SLP-359/4, SLP-389/1, SLP-395/2, SLP-399/1, SLP-415/3, SLP-415/10, SLP-15/12, SLP-415/13, SLP-417/1, SLP-421/2, SLP-426/3, SLP 434/3, SLP 435/4 and SLP 449/7) genotypes were shortlisted based on the yield and rhizome colour variation and included to the germplasm. 139 open-pollinated progenies have been given to AICRPS centres for evaluation under different environmental conditions.

Comparative transcriptome study of Acc. 849 with IISR Prathiba to understand the unique aroma

Based on the comparative transcriptome study, a targeted subset of 12 DEGs was selected for qPCR validation, with five transcripts significantly upregulated and seven downregulated in Acc. 849, relative to IISR Prathibha. Functional annotation revealed that these genes are predominantly involved in terpenoid backbone biosynthesis, glycosylation, and mitochondrial metabolic processes. Notably, *isopentenyl pyrophosphate isomerase*, a key enzyme modulating the isomerization of IPP to DMAPP in terpenoid biosynthesis, was markedly downregulated in Acc.849, implicating potential diversion of precursor flux.

Integrated transcriptomic and genomic analyses reveal regulatory lncRNAs and trait-associated SNPs

A total of 26 RNA-seq datasets were analyzed, comprising leaf (5 datasets) and rhizome (21 datasets) tissues, leading to the identification of 24,220 high-confidence lncRNAs from turmeric transcriptomic data. Putative lncRNA–miRNA–mRNA regulatory interaction networks were constructed to explore potential regulatory mechanisms. These results were consolidated into GoldenLncDB, the first dedicated lncRNA database for turmeric, which provides a centralized platform for the storage, retrieval, and exploration of turmeric lncRNAs and includes integrated BLAST functionality for sequence similarity searches. In addition, GWAS was performed on 51 accessions, identifying significant SNPs associated with key phenotypic traits.

Fig. 15. Categorization of turmeric germplasm accessions based on leaf blotch screening

Screening germplasm for leaf blotch resistance

A total of 1,067 germplasm accessions were screened for leaf blotch and categorized based on percent disease index (PDI). Of these, 633 accessions were resistant, 10 moderately resistant, 24 moderately susceptible, 84 susceptible, and 316 highly susceptible (Fig. 15).

Evaluation of the natural farming system

Complete natural farming practices recorded the highest soil pH and enhanced availability of P, K, Ca, Mg, Mn, and Zn. In contrast, higher OC, N, and Fe contents were observed under integrated nutrient management (INM: 50% organic + 50% inorganic) supplemented with botanicals and bioagents. The maximum fresh rhizome yield was obtained under the complete organic package (13.56 t ha^{-1}), which was on par with INM (50% + 50%), yielding 13.52 t ha^{-1} in the variety IISR Prathibha. The organic package also recorded maximum oil (4.83%), oleoresin (11.05%), and curcumin (5.50%) contents.

Evaluation of organic farming systems

At 120 days after planting, soil pH, Fe, and Cu were higher under 75% organic treatment, while OC, N, Ca, Mg, Mn, and Zn were highest under 100% organic management in turmeric. Soil enzyme activities (acid phosphatase, alkaline phosphatase, and dehydrogenase) were highest under 75% organic treatment, followed by 100% organic. Maximum yield (37.52 t ha^{-1}) was recorded under INM (50% + 50%) and 100% inorganic systems. Among varieties, IISR Pragati produced the highest fresh yield (43.98 t ha^{-1}).

Among different management systems, the highest oil and oleoresin contents were observed in INM (50% + 50%), which was 4.87% and 13.10%, respectively. The highest curcumin content of 5.70% was observed in INM (75% + 25%). Among the varieties, maximum oil, oleoresin, and curcumin contents were recorded in Suguna (4.93%), IISR Pragati (13.85%), and

Prathiba (5.86%), respectively.

The total cost of cultivation of turmeric under organic (100%), organic (75%), inorganic, integrated (75+25%), and (50+50 %) was Rs. 1,82,499/-, 1,71,712/-, 1,48,208/-, 1,73,109/-, and 1,63,989/- respectively. The BC ratio (calculated at the market price of dry turmeric @ Rs 70 kg^{-1}) was found to be higher in the integrated system 50% +50% (2.77), followed by integrated system 75% +25% (1.74). At 25% premium price, a B: C ratio of 1.83 was noticed in 75% organic system.

Impact of different management practices on soil microbial diversity

The impact of distinct nutrient management regimes, organic (ONM), integrated (INM), and chemical (CNM), on the diversity and structure within rhizosphere bacterial communities, and their relationships with soil properties, was studied in the turmeric rhizosphere. Metagenomic sequencing was performed.

The high-quality sequences were classified into 36 bacterial phyla and 87 classes. The dominant groups, at the phylum taxonomic level, included Proteobacteria, Bacteroidota, Bacillota, Acidobacteriota, and Actinobacteriota, accounting for 96.64% of the total bacterial sequences. Compared to CNM treatment, the ONM and INM treatments showed a significant decrease ($P < 0.05$) in the relative abundance of Acidobacteriota, while Bacteroidota, Cyanobacteria, and Actinobacteriota were more abundant. At the class level, Betaproteobacteria (51%), Gammaproteobacteria (17%), Alphaproteobacteria (8%), Bacilli (7%), and Flavobacteria (5%) were the most prevalent bacterial classes in the soil, collectively accounting for over 80% of the total bacterial sequences.

Correlation of the top twenty Genera with soil properties showed that Genera such as *Bradyrhizobium*, *Flavobacterium*, *Pseudomonas*, *Acinetobacter*, *Pseudoduganella*, *Achromobacter*, *Burkholderia*, *Caballeronia*, *Sphingomonas*, and *Lysobacter* were significantly ($P <0.05$) influenced by soil properties. The α-diversity of soil bacterial communities under different nutrient management regimes was assessed using the Chao1 richness, Shannon–Weiner, and Simpson indices. Changes in soil pH, OC, and P levels have a more obvious effect on the alteration of bacterial diversity and richness ($P <0.05$) across the treatments.

Development of an integrated organic farming system model

An integrated organic farming system (IFS) model combining spices, fodder, and vegetables was established at the ICAR–Indian Institute of Spices Research, Chelavoor Farm. The system included cultivation of turmeric, fodder grasses (CO-3, CO-4, DHN-6, and Congo signal grass), coconut, banana, and cowpea. As part of the integrated livestock component, two cows along with their calves are maintained in the farm. The system yielded 164 kg of turmeric, 12,800 kg of fodder grass, 1,500 Nos. of coconut, 80 kg of banana, and 30 kg of cowpea. Fodder grass was fed to the cows that were maintained at the IISR farm. The integrated organic farming system generated a net profit of ₹0.84 lakh per acre and created 322 man-days of employment per year, demonstrating its potential for income enhancement, resource recycling, and employment generation under organic farming conditions.

Hotspot of climate change in turmeric-growing areas

Hotspot identification for turmeric cultivation under climate change was carried out using the Standard Euclidean Distance (SED) approach to assess deviations of future climate from current conditions based on temperature and rainfall variables. The analysis revealed region-specific vulnerability patterns across India, with Maharashtra, Gujarat, and Madhya Pradesh emerging as major hotspots due to increasing temperatures and erratic rainfall. Temperature-driven risks were evident in Telangana, Andhra

Pradesh, Tamil Nadu, and Odisha, while rainfall stress was prominent in Maharashtra, Madhya Pradesh, Karnataka, and Andhra Pradesh. Under worst-case projections for 2050, Tamil Nadu, Gujarat, Maharashtra, and Assam show increased vulnerability, which further intensifies by 2100, particularly in Gujarat, Maharashtra, Assam, West Bengal, and Odisha. Hotspots of future scenarios with respect to shared socio-economic pathways (SSP) are shown in Fig. 16.

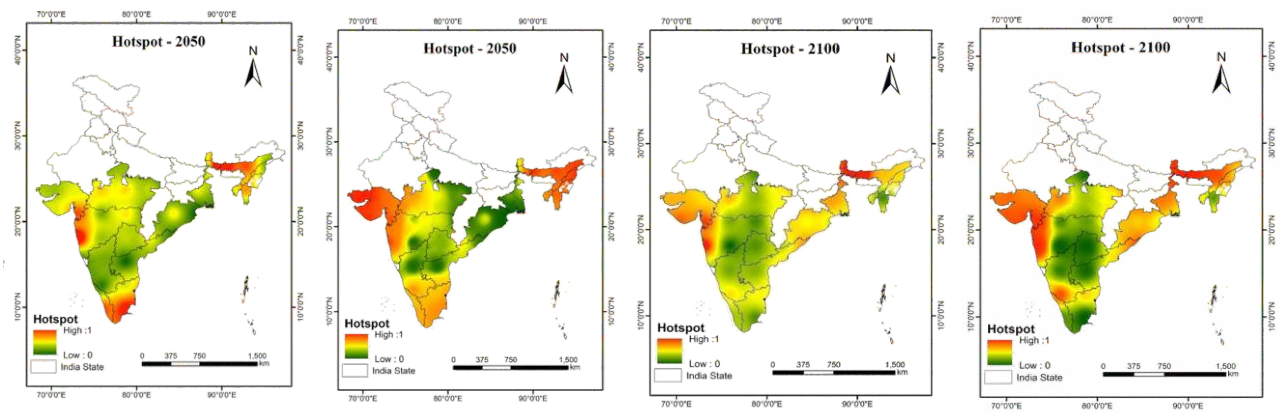


Fig. 16. Hotspots of future scenarios A) SSP 2-4.5 (2050) B) SSP 5-8.5 (2050) C) SSP 2-4.5 (2100) D) SSP 5-8.5 (2100)

Gas exchange parameters as influenced by climate change treatments

Turmeric (variety IISR Alleppey Supreme) was maintained in a carbon dioxide temperature gradient chamber (CTGC) under four environments, *viz.* 1) Ambient CO_2 and temperature, 2) elevated temperature (eT) and ambient CO_2, 3) ambient temperature and elevated CO_2 (eCO_2), 4) elevated temperature and elevated CO_2 ($eTCO_2$). The results showed that transpiration rate and the stomatal conductance were lower, and internal CO_2 (Ci) was higher under $eTCO_2$ and eCO_2 compared to ambient temperature and CO_2 conditions. Photosynthetic rate was lowest under eT, followed by $eTCO_2$, compared to ambient conditions, which was on par with eCO_2.

Simultaneous determination of essential oil and moisture content

A non-invasive method was developed for the simultaneous estimation of essential oil and moisture content in turmeric using a moisture meter. The method involves two drying kinetics studies on the same sample. In the first cycle (DK1), 40-mesh turmeric powder was dried in a moisture meter, where the final reading included both moisture and essential oil. In the second cycle (DK2), moisture was restored to the dried sample and re-dried, yielding a reduced drying rate due to the absence of essential oil. The difference between the two drying curves quantified essential oil content, while the remaining value represented true moisture content. The method showed accuracies of 94.3% for moisture and 93.1% for essential oil, and is rapid, solvent-free, cost-effective, and eco-friendly.

Rapid onsite RPA–LFA for the detection of *Pratylenchus* spp.

The assay utilized primers targeted to the ITS region of the *Pratylenchus* spp., and optimization was achieved with 14 mM magnesium acetate at 39°C for 15 minutes using a simple rhizome crude extract template. The inclusion of 1 M betaine was critical for suppressing non-specific signal generation on the LFA strips. The completed RPA-LFA assay demonstrated high

specificity, showing no cross-reactivity with *Meloidogyne incognita*, *Radopholus similis,* or free-living nematodes and exceptional sensitivity, with the LFA component detecting purified DNA up to 7.5 picograms, making it 100 times more sensitive than conventional PCR and 10 times more sensitive than RPA. The entire workflow, from sample preparation to result, was achieved rapidly, within 30-40 minutes. Successful validation against field samples confirmed the assay's accuracy and reliability, establishing the RPA-LFA method as an ideal tool for rapid, high-sensitivity, on-site diagnosis and effective management of *Pratylenchus* spp. infestation in turmeric.

Influence of plant phenology and varieties on the occurrence of the shoot borer

The influence of plant phenology and crop duration on the seasonal incidence of shoot borer (*Conogethes punctiferalis*) was studied for the fourth consecutive year at ICAR-IISR, Kozhikode. Pest incidence was recorded at fortnightly intervals in two short-duration varieties (IISR-Pragati and Rajendra Sonia), two long-duration varieties (IISR-Prathiba and Alleppey Supreme), and one extra-long-duration variety (ACC. 849). The results showed that pest incidence began 45 days after planting in IISR Prathiba, 61 days in ACC. 849, and after 90 days in IISR Pragati and Alleppey Supreme. No pest incidence was recorded in the variety Rajendra Sonia. During the study year, the highest pest incidence was observed in ACC. 849, followed by IISR Prathiba, Alleppey Supreme, and IISR Pragati.

Vanilla

Genetic resources

A total of 77 accessions comprising 65 *Vanilla planifolia* and 12 *Vanilla sp* were established in poly house and field conservatory at ICAR-IISR, Chelavur campus.

Hardening of *in vitro* plants

Hardening of *in vitro*–raised vanilla plants was carried out using different potting media combinations, namely vermicompost + coirpith (3:1), vermiculite + perlite (3:1), coirpith, and charcoal. A 100% survival rate was recorded in all potting media combinations after 40 days of hardening. Superior morphological characters like tall plants (12.83 cm), more leaves (6.67), nodes (5.33), more roots per node (4.67), and a thicker stem (2.36 cm) were observed in the potting media composition of vermiculite + perlite (3:1).

Quality profiling

Quantification of major flavour compounds of vanilla, *viz*., vanillin, p-hydroxybenzoic acid, p-hydroxybenzaldehyde, and vanillic acid, was standardized, and validation is being continued with vanilla beans from a selected population. Among the population studied, Acc. 4751 and G 9 recorded 2.3% and 2% vanillin content, respectively. The *V. andamanica* (Pink) collection showed only 0.013% vanillin and traces of p-hydroxybenzoic acid and p-hydroxybenzaldehyde.

Tree spices

Nutmeg

Genetic resources

The field gene bank for nutmeg is being maintained with 163 accessions. A high-yielding nutmeg accession with a bold nut and thick mace collected from Kakkadampoyil, Kozhikode, has been added to the germplasm repository.

Seed germination, seedling growth, and budding success in *Myristica* species

Two morphotypes of *Myristica malabarica*, namely red mace and yellow mace, were collected from the Myladumpara region of Idukki district and evaluated for seed germination and early seedling growth. The red mace showed better germination performance (41.67%),

compared to the yellow mace (33.33%). Additionally, red mace seeds germinated more quickly, taking 55 days, whereas yellow mace took 70 days. However, the yellow mace morphotype exhibited marginally better post-germination growth, recording greater plant height (18.2 cm) and a higher number of leaves (4) compared to red mace (17.7 cm height and 3 leaves). Overall, red mace demonstrated superior germination efficiency, while yellow mace showed marginally better vegetative growth.

Budding was performed on *M. magnifica*, a waterlogging-resistant rootstock, using buds from IISR Keralashree and IISR Viswasree (*M. fragrans*) as scions. This resulted in successful bud union, yielding ten budded plants each.

Clove

Genetic resources

The field gene bank for clove is being maintained with 23 accessions.

Hybridization

F_2 progenies of a Zanzibar clove (Acc. 9833) x common clove (Acc. 9838) hybrid have been produced by selfing of the F_1 generation. A total of 137 F_2 progenies were genotyped using the polymorphic co-dominant marker *SaM 3999*. The F_2 progenies segregated into three distinct classes, consisting of female parental type (38 progenies), male parental type (32 progenies), and hybrid type (61 progenies). The observed segregation pattern of P_1: hybrid: P_2 was tested against the expected 1:2:1 Mendelian ratio for a single co-dominant locus in an F_2 population. A Chi-square goodness-of-fit test confirmed this expectation, yielding X^2 (2, N=131) = 1.034; P = 0.59, which indicates no significant deviation from the expected Mendelian segregation. This result validated the co-dominant inheritance of the *SaM 3999* marker and supports its utility for genetic mapping studies. The marker segregation data in a subset of the F_2 population are visually represented in Fig. 17.

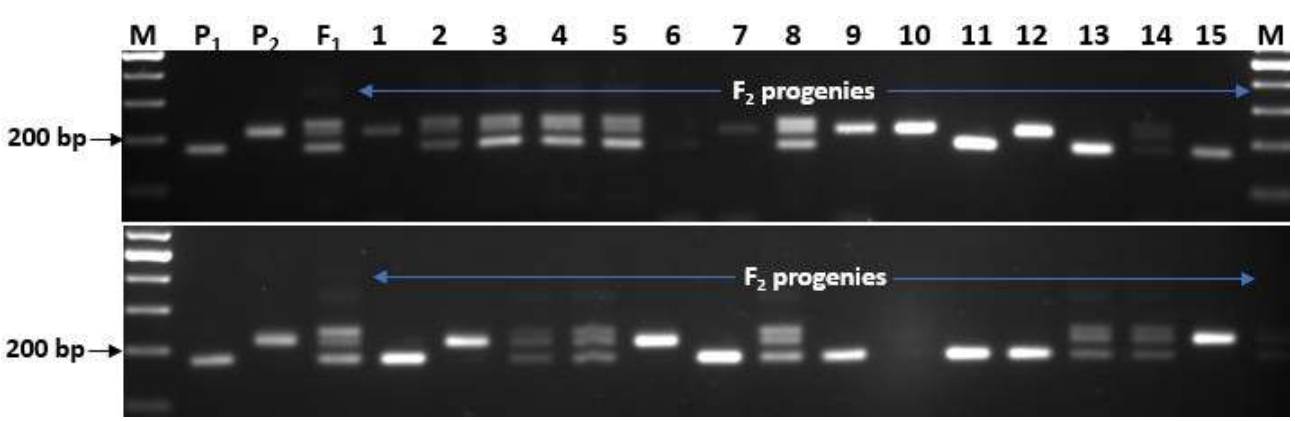


Fig. 17. Segregation analysis of marker *SaM3999* in an F_2 population. Genotypic profile of a subset of F_2 individuals derived from the cross Acc. 9833 × Acc. 9838. **M:** 100 bp DNA ladder; **P_1:** Male parent (Acc. 9838); **P_2:** Female parent (Acc. 9833); **F_1:** Hybrid control. **Lanes 1–15:** F_2 progenies.

Cinnamon

Genetic resources

The field gene bank for cinnamon is being maintained with 172 accessions at the Experimental Farm, Peruvannamuzhi.

Collection

Germplasm exploration was conducted in Meghalaya, and 9 accessions of *Cinnamomum* consisting of four species (*C. tamala*, *C. bejholgota*, *C. impressinervium,* and an unidentified species) were collected and conserved.

General

Initiatives in the development of a speed breeding protocol in tropical spice crops

The development of speed breeding protocols for black pepper was initiated in a custom-made climate-controlled plant growth chamber (Nexsel, Pune). Consolidated meteorological data from major black pepper production zones in Kerala (Wayanad and Idukki) were used for the optimization and later standardized the spectral quality (blue: red ratio), light intensity, photosynthetic photon flux density (PPFD), and photoperiod duration. One-month-old plants of the black pepper variety IISR Chandra, grown under an extended photoperiod of 16 h, a 2:1 red: blue spectral ratio, 25°C temperature, and 75% relative humidity, exhibited substantially enhanced vegetative growth compared to ambient controls. Under these optimized conditions, plant height, stem girth, number of leaves, leaf length, and leaf width increased by 9.92-fold, 1.56-fold, 2.85-fold, 1.79-fold, and 1.38-fold, respectively, within five months (Fig. 18). Under the same controlled environment, IISR Thevam bush pepper cuttings showed early floral induction, higher spiking intensity, and improved berry set. The treated plantsinitiated flowering within the same month of exposure, whereas the control plants required four months to initiate flowering. Test plants produced 10 spikes (more than 3 times over control) and set 22 berries at 5 months after exposure to the modified growing conditions.

Fig. 18. Accelerated growth of test plants compared to the control plants

DUS test centre for spices

ICAR-IISR, functioning as the nodal DUS test centre for major spices, facilitated the registration of six black pepper farmer varieties during the year, namely Aswathi, Master Kare, Mallisara, Basri Balli, Raaza-1, and Kurimala, and one ginger farmer variety, Hatte Saunth, besides two extant notified varieties like IISR Vajra (ginger) and Appangala 2 (small cardamom). Besides these activities, reference varieties of black pepper, cardamom, ginger, and turmeric were conservedat the centre, and candidate varieties of these crops are currently under evaluation.

DNA Fingerprinting Facility

In 2025, the facility successfully generated DNA fingerprints for 14 horticultural varieties released during the 32nd CVRC meeting (Notification No. S.O. 4000(E), dated 1 September 2025). The notified varieties include Coriander: Karan Dhania 1 (RCr 565); Fennel: Gujarat Fennel 3 and Gujarat Fennel 13; Turmeric: IISR Surya (Acc. 849) and Narendra Haldi-5 (NDH-98); Ginger: IISR Surasa and SAS-KEVU; Cumin: Jodhpur Jeera-1 (MCU 105); Fenugreek: Karan Methi-1 (RMt 259); Mango ginger: IISR Amrit; Kokum: Goa Kokum-1, Goa Kokum-2, and Goa Kokum-3; Nutmeg: Goa Nutmeg-2.

The facility also supported AICRPS varietal identification during the 36th Annual Group Meeting by DNA fingerprinting of newly identified varieties, including IISR Navya, Ajmer Ajwain-24, Gujarat Ajwain-4, and Karan Saunf-1. Molecular authentication was provided for turmeric accession AFT 31 and ginger accessions CG-47 and CG-31, distinguishing them from closely related varieties. In addition, varietal authentication of ginger varieties IISR Varada and IISR Rejatha, and turmeric variety IISR Prathibha, was carried out in farmers' seed production plots.

Bioinformatics and Integrative Genomics Facility

Beta testing of the Data Analysis and Visualization Toolkit was initiated, with the beta version uploaded to the GitHub repository of the Bioinformatics and Integrative Genomics (BIG) facility and made live for testing.

Analysis of climate extreme indices

Precipitation patterns across the Northern and Southern Peaks of the southernmost region of the Western Ghats region was investigated by employing precipitation indices recommended by

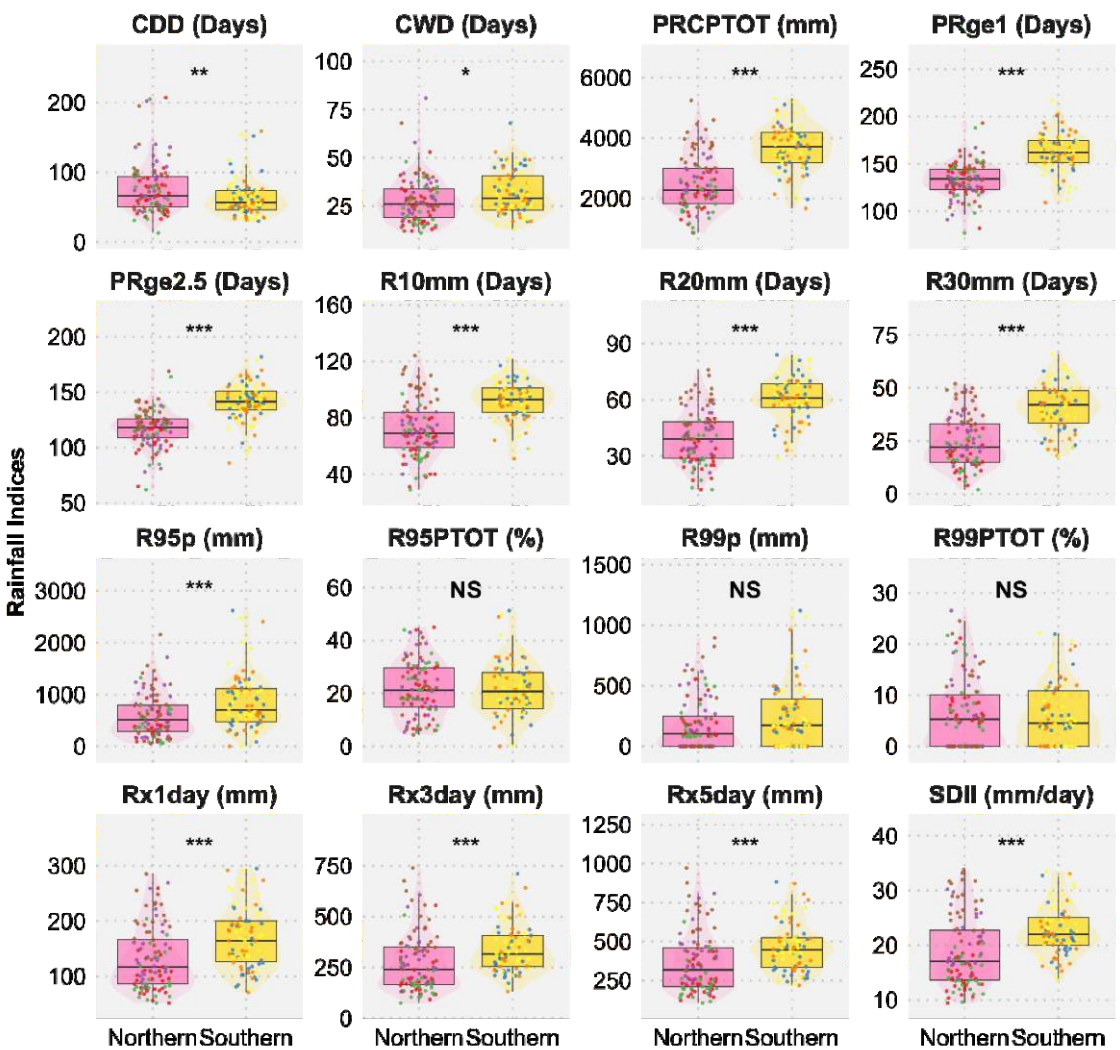


Fig. 19. Comparative Analysis of Precipitation Indices between Southern and Northern Peaks using Independent t-Test and Wilcoxon Rank Test. Significance levels are indicated as follows: * for 5%, ** for 1%, and *** for 0.1%, with 'NS' denoting non-significance. The pink boxplot represents the Northern Peak data, while the yellow boxplot represents the Southern Peak data

the Expert Team on Climate Change Detection and Indices (ETCCDI), World Climate Research Programme (WCRP), and through statistical analysis of India Meteorological Department (IMD) precipitation data during 1986-2022 time-periods using non-parametric Modified Mann-Kendall Test and Sen's Slope estimator.

The Northern Peak is characterized by extended dry spells, as evidenced by increased positive trend in consecutive dry days (CDD), in addition to consecutive wet days (CWD), total precipitation (PRCPTOT), and extreme rainfall events, such as PRge1 and PRge2.5 days. These changes are accompanied by an upward trend in the Simple Daily Intensity Index (SDII), indicating a shift towards more intense and variable rainfall. In contrast, the Southern Peak shows significant decreases in consecutive wet days (CWD), total precipitation (PRCPTOT), and Simple Daily Intensity Index (SDII). Despite high precipitation in the Southern peak, there is a reduction in extreme rainfall indices such as rainfall exceeding 1 mm or 2.5 mm (PRge1/ PRge2.5 days), and heavy precipitation days (R10mm, R20mm, R30mm), reflecting a decline in rainfall intensity and frequency.

The study revealed distinct precipitation patterns, where the Northern Peak faces increased intensity and variability in rainfall, while the Southern Peak shows reduced rainfall intensity and variability, as shown in Fig. 19. Black pepper production data also showed more variation in Northern Peak compared to Southern Peak in line with the climatic variation.

Development and evaluation of spice oleoresin blended films for foods

Optimized the binder and oleoresin concentration for oleoresin blended films (Fig. 20). The optimized film showed a minimum water vapour permeability of 0.000592 g.mm/m^2. day.kPa along with a high solubility of 69.7%. The films were evaluated for various parameters, including moisture content, swelling index, solubility, heat sealability, free fatty acid content, peroxide value, and water vapour permeability.

Fig. 20. Spice blend impregnated packaging for paneer

Production of quality planting materials

During the reporting year, 1.5 lakh rooted black pepper cuttings of improved varieties were produced from the Main campus, Experimental Farm, and Regional Station and distributed to Farmers and developmental agencies. Twenty thousand suckers and seedlings of small cardamom were produced from the Regional Station, Appangala, and supplied to farmers. A total of 5 tonnes of seed rhizomes of improved ginger varieties were produced both at ICAR-IISR and through a participatory seed production programme with farmers, and distributed to growers. The participatory mode of ginger seed production was implemented in five farmers' fields during the year. Further, 10 tonnes of seed rhizomes of improved turmeric varieties were produced and supplied to farmers. In collaboration with Krishi Vigyan Kendra, Peruvannamuzhi, 1,000 grafted nutmeg plants (cv. Keralashree), 5,000 cinnamon seedlings, and 5,000 bush pepper plants were produced and distributed.

In vivo expression of *Metarhizium pingshaense* virulence genes in infected insects

The relative expression of the *chitinase* and *protease* genes in *C. punctiferalis* infected by *M. pingshaense* was analyzed over time, at 72, 96, and 120 h post-infection (hpi). It was observed that the expression of virulence and pathogenesis-associated genes was significantly upregulated as the infection progressed in the insects. At 72 hpi, the relative expression of the *chitinase* and *protease* genes remained low, showing no significant change compared to the untreated control. A significant up-regulation of *chitinase* and *protease* genes was observed at 120 hpi, with levels rising more than 2900 and 3000-fold, respectively, in infected insects (Fig. 21).

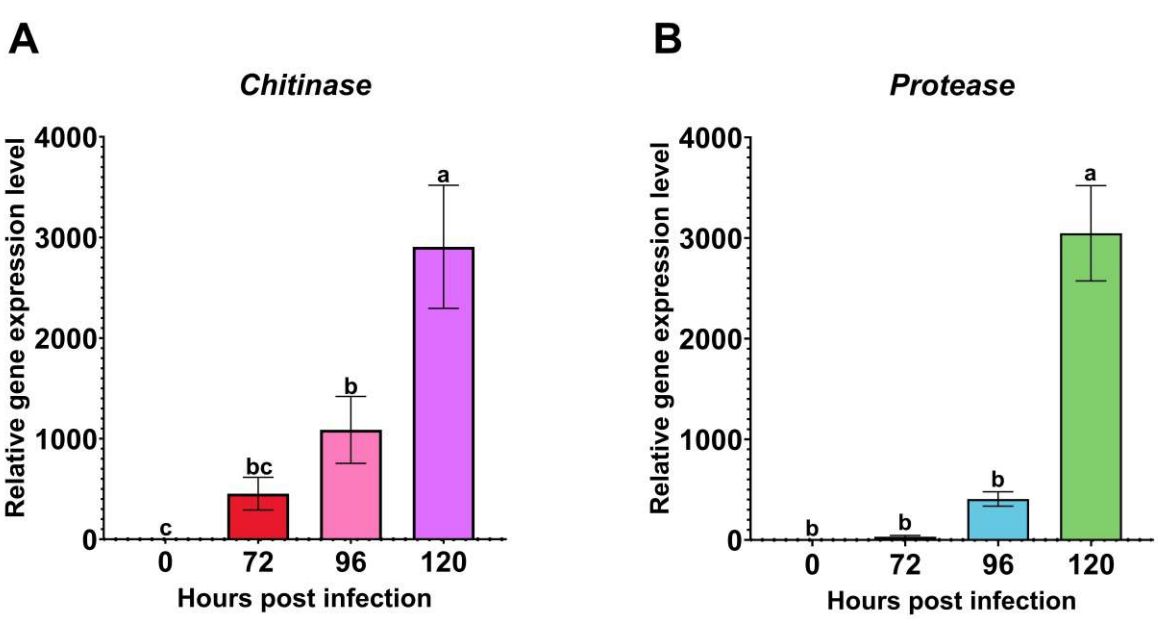


Fig. 21. Relative expression levels of (A) *chitinase* and (B) *protease* genes in *Conogethes punctiferalis* infected by *Metarhizium pingshaense* strain IISR-EPF-14

Evaluation of novel lime-based microbial formulation under field conditions

The lime-based microbial formulations were tested in different crops, *viz.,* black pepper, coconut, nutmeg, and turmeric, under field conditions. Field trials with lime-based microbial formulations (Tricholime and Bactolime) demonstrated that soil application at the recommended lime dose, either as a single application or in split doses, significantly enhanced the availability of major and secondary nutrients. The treatments effectively ameliorated soil acidity, bringing both surface and subsurface soil layers close to neutrality, and reduced aluminium toxicity in these layers within the crop basins studied. The formulations facilitated the simultaneous delivery of microbial agents (*Trichoderma* or *Bacillus*) into the soil and promoted their movement to deeper soil layers, maintaining adequate populations even four months after application.

This has played a decisive role in enhancing plant health, thereby leading to improved crop yields. In coconut, nut yield per palm increased significantly, yielding 45 to 48 nuts per tree in two harvests, compared to 30 nuts per tree in the control (no lime application). Similarly, in nutmeg, the number of fruits per tree increased to 413 to 547, compared to 248 fruits per tree in the control. Application of the formulations also enhanced nutrient movement into subsurface soil layers, facilitating greater nutrient uptake by roots and thereby improving plant health and yield in coconut and nutmeg. Both Tricholime and Bactolime formulations were effective in increasing the yield by 23-42% as compared to its microbial drenching + dolomite application. These lime-based formulation applications have improved the yield of coconut, nutmeg, and turmeric significantly as compared to the normal dolomite application or control.

Demonstration of lime-based microbial formulation in the farmers' field

The effect of lime-based microbial formulations was demonstrated in nutmeg farmers' fields in the Kozhikode District of Kerala. The results showed that the application of the formulation has resulted in improved fruit yield per tree in both plots, recording 138-280 fruits per tree as compared to 107-193 fruits per tree in the control (no lime application), indicating 28-45% increased yield performance by the technology adoption. Bactolime formulation was also demonstrated in one farmer's plot on nutmeg and resulted in increased fruit yield of 274 fruits per tree as compared to 193 in the control, with a yield increase of 41%.

Evaluation of selected PBRM for N fixation in turmeric under field conditions

Shortlisted NFB isolates, *viz.,* NFB 19 (*Bacillus subtilis*) and *Raoultella terrigena* (NFB 41), were evaluated for their nitrogen- fixing ability and plant growth promotion traits in turmeric under field conditions. Treatments with combined application of fertilizer at 75 and 50% N along with NFBs were found to be superior with an increase in soil chemical parameters, *viz.,* organic carbon, available nitrogen, yield, etc., and plant parameters include shoot and root length, shoot and root weight, and number of leaves.

Evaluation of selected PBRM for K mobilization in turmeric under field conditions

Shortlisted KSB isolates, *viz.,* KSB 1 (*Pantoea cypripedii*) and KSB 6 (*Bacillus cereus*) were evaluated for its K mobilization and plant growth promotion traits in turmeric under field conditions. Treatments with combined application of fertilizer at 75% and 50% K along with KSBs were found to be superior, with an increase in available K, yield, and plant growth parameters.

Evaluation of bacterial consortia in ginger and turmeric under field conditions

Field evaluation of a bacterial consortium of *Raoultella terrigena*, *Bacillus safensis*, *Acinetobacter* sp., and *Bacillus*

amyloliquefaciens was conducted in ginger and turmeric at Peruvannamuzhi. Growth parameters, percent disease index (PDI), and plant and soil nutrient status were recorded at 90 days after planting (DAP), while yield and nutrient status were assessed at harvest. Application of the bacterial consortia in combination with graded levels of fertilizers (100%, 75%, and 50% NPKZn) resulted in a significant improvement in growth and yield of both crops compared to individual applications of consortia or fertilizers alone. The combined treatments, particularly consortia with 100% and 75% NPKZn, recorded significantly higher rhizome yield than the absolute control and consortia-alone treatments. The incidence of rhizome rot in ginger was markedly reduced (<5%) in treatments receiving consortia along with 100%, 75%, or 50% NPKZn, compared to fertilizer-alone treatments and the absolute control. Enhanced soil microbial activity under consortia-treated plots was evidenced by significantly higher dehydrogenase activity. Based on the field results, a technology was recommended involving soil drenching with a bacterial consortium (*B. safensis, B. amyloliquefaciens, R. terrigena,* and *Acinetobacter baumannii*) at planting, followed by drenching with metalaxyl–mancozeb (0.125%) at 45 DAP, and subsequent applications of the consortia at 60 and 90 DAP. This integrated approach effectively promoted plant growth and suppressed rhizome rot in ginger and turmeric

Economics and social sciences

Spicepreneurship ecosystem

Collected and analysed data on various aspects of the spicepreunership ecosystem, like demand for planting materials and scope for nursery entrepreneurship, MSMEs in the spice processing sector, schemes and programmes, in addition to the status of employment in the spice processing sector. Data on the consumption pattern of spices was also collected and analyzed to identify the potential and opportunities for spice-based entrepreneurship.

Entrepreneur-led extension model

A detailed survey was carried out among experts to validate the entrepreneur -led extension model. Survey content included twenty-five key statements, identified through an extensive literature review and expert consultation, that addressed both the benefits and challenges of entrepreneur-led extension models. Our survey used a five-point Likert scale to assess expert opinions on each statement. Nine out of twenty-five statements were found to have consistently positive responses, considering the high median and high Kappa values. These statements were related to the introduction of innovative technologies to farmers, reaching more farmers, a higher rate of adoption, facilitating a network of farmers, facilitating access to quality inputs, the threat of concentrating on profitable areas and solutions, the sustainability of enterprises, and the need for regulatory measures. Case studies among entrepreneurs have pointed out the role of entrepreneurs in developing spice-based value chain development. Access to capital is perceived as a major bottleneck, which needs to be addressed through customized schemes and programmes.

Estimation of research contribution to export earnings

The availability of exportable surplus is a prerequisite for nurturing the export sector in any crop. In a crop sector with a high degree of export orientation, this factor gains added significance. During 2024-25, the spice exports from the country are valued at 4723 million USD. The research efforts of the institute have played a significant role in strengthening and nurturing the spice export sector. The estimates of the contribution of ICAR-IISR towards the gains in net exports in crops like cardamom, ginger, turmeric, and nutmeg were generated using conservative assumptions on the diverse impact pathways through which research efforts are translated to gains in parameters like net export earnings. It is estimated that the monetary value of

the contribution of ICAR-IISR to the gains in net export of these commodities would be 552.8 crores for the period from 2019-20 to 2024-25 (Fig. 22). This includes gains from export earnings in cardamom (₹ 130.2 crores), ginger (₹ 77.3 crores), turmeric (₹ 293.7 Crores), and nutmeg (₹51.6 crores).

The sphere of influence of spice crops

The technologies developed and deployed in spices benefit nearly 15 million agricultural holdings across the country. The spices sector gives one of the highest values of output per unit area (4.75 lakhs per ha in 2022-23), contributing significantly to the objective of doubling farmers' income. The predominance of marginal and smallholdings in spices (more than 90%) underscores the potential of technology interventions in benefitting smallholder production systems. Spices also constitute a critical component of the horticultural sector in the country. The output growth since 2014-15 was highest for the spices sector (102.5%) among all the major horticultural subsectors, including flowers (60.5%), vegetables (29.6%), fruits (32.2%), and plantation crops (8.4%). During the period between 2014-15 and 2022-23, the value of output of spices (in constant prices, 2011-12) increased by 56.4%, indicating strong relative growth in real terms.

Training programme on Good Agricultural Practices in black pepper and distribution of production inputs at Velom, Kozhikode

TRIBAL SUB PLAN (TSP) PROGRAMMES

Training programme on black pepper and cardamom at Kolli Hills

A one-day training programme on black pepper and cardamom was organized in collaboration with Spices Board and the Department of Forest, Government of Tamil Nadu, at Kolli Hills, Namakkal District, on 03 April 2025. The training programme was inaugurated by Mr. Basav Singh, IFS, Assistant Conservator of Forests, Namakkal. The training attracted 175 tribal farmers from different parts of Namakkal District. As part of technology dissemination in the region, 200 kg of black pepper micronutrient mixture and 1,500 *Trichoderma* biocapsules were distributed to the participating farmers. challenges faced by black pepper and cardamom growers in the region.

Workshop on Good Agricultural Practices (GAP) in Spices

A two-day workshop on Good Agricultural Practices (GAP) was conducted in Tinsukia District of Assam from 08 to 09 July, 2025, aimed at providing handholding support and capacity building of women farmers in the district. The programme was organized in collaboration with the Assam State Rural Livelihoods Mission, Xotphul Mahila Krishak Producer Company Ltd., and the Foundation for Development of Rural Value Chain (FDRVC). The workshop comprised several technical training sessions and awareness sessions on input use. The participants were trained on aspects like varietal selection, nutrient management, integrated pest management, and post-harvest value addition in black pepper and ginger. Participants at the Kachamari and Borjiya Gram Panchayat offices received practical guidance and *Trichoderma* capsules, and the program was concluded with field visits and experience-sharing sessions, marking a successful effort to modernize spice farming in the region through scientific and institutional collaboration.

Seminar on sustainable spices production and management

A seminar on sustainable spices production and management under a changing climate was organised as a part of Wayanad Community Seed Fest on March 02, 2025, for the benefit of tribal farmers in the region. The programme was organised in collaboration with M S Swaminathan Research Foundation. The programme witnessed participation of nearly 2000 farmers, mostly tribal. The event also drew considerable attention from other stakeholders in the spice sector of the district.

Training programme for tribal farmers in Chintapalli

The institute has been continuously engaging with the tribal farming community in Alluri Sitharama Raju district over the past several years. In furtherance of this objective, a two-day initiative including training and a field visit was organized at Chintapalli from 17 to 18 June 2025. The programme was organized in collaboration with Vijayavahini Charitable Foundation and Horticultural Research Station, YSR Horticultural University, Chintapalli. The training programme titled Techniques for sustainable cultivation of turmeric held on 17 June 2025 was attended by 60 farmers. The training sessions focused on providing customized solutions to the tribal farmers that are suited to blend in with the existing resource availability while providing visible, positive, and significant improvement in their yield outcomes. Field visits were conducted on 18 June 2025 to Genjigedda, Thtamamidi Burisingi (Mulangodi), and Vamugedda Kothuru villages.

Awareness programme on ginger cultivation

A strategic training and awareness programme on ginger cultivation was undertaken on 06 March 2025 at Mananthawady in Wayanad district of Kerala, amidst the widespread apprehension about the spread of fungal diseases in the crop. Under the programme, one tonne of seed material of elite ginger variety IISR Varada was distributed to tribal farmers. The awareness programme stressed the need to adopt prophylactic measures for controlling disease outbreaks in ginger.

Promoting nutritional security in tribal households

To augment the nutritional security of tribal households, ICAR-IISR procured1000 vegetable seed kits from ICAR-IIHR and distributed them to various tribal hamlets across Kozhikode, Kannur, and Wayanad districts of Kerala. The distribution of seed kits was undertaken in collaboration with multiple institutional partners, like Community Agro Biodiversity Centre – MS Swaminathan Research Foundation, Non-Governmental Organizations, Wayanad Social Service Society, etc. In Cheeyambam tribal hamlet, a Farmer-Scientist Interaction, field disease diagnostic visit, and training on vegetable cultivation were held in connection with the vegetable seed kit distribution held on 14 November 2025. Critical bio inputs were also distributed to farmers to ensure the successful cultivation of vegetables.

NORTH EASTERN HILL (NEH) PROGRAMMES

Strategic focus on the ginger seed chain

To strengthen the ginger value chain in the North Eastern states of the country, the ICAR-Indian Institute of Spices Research, under its North Eastern Hill (NEH) programme, has implemented a strategic intervention focused on the distribution of high-quality planting materials. By providing farmers with improved, high-yielding, and disease-free ginger varieties such as IISR Varada, IISR Mahima, and IISR Rejatha, the institute aims to replace traditional, low-yielding cultivars that are often susceptible to pests and diseases. This initiative serves as the foundation for a sustainable seed supply chain, empowering local farmers to transition from subsistence cultivation to a "seed-to-seed" model where they become primary multipliers of certified genetic stock.

Beyond simple distribution, this program fosters a decentralized production network across the North Eastern states in collaboration with Krishi Vigyan Kendras, FPOs, and other institutional partners. This approach helped in ensuring that quality seeds are accessible within the region's unique agro-climatic zones. By establishing these multiplication hubs, ICAR-IISR reduces the dependence on external seed sources and mitigates the risk of transporting soil-borne pathogens. This systemic approach not only improves the productivity of North Eastern ginger but also strengthens the livelihood security of tribal farmers by integrating them into a more organized and profitable national ginger supply chain. Regular field monitoring and advisory support were provided during the entire crop season to reduce crop failure and to address knowledge gaps in beneficiary villages.

Training programmes and field monitoring

As part of the activities aimed at the development of the NEH region, critical training programmes across crops and stakeholder communities were organized during the year. Six capacity building programmes on sustainable cultivation practices and advanced technologies for ginger and turmeric cultivation were organized in Nagaland, Assam, and Mizoram. These capacity-building programmes were carried out under the outreach activities of the Tata Trust- funded project in collaboration with grassroots institutions focusing on the NEH region. Apart from this, two training sessions on piper diversity and the importance of genetic conservation were conducted with the support of ICAR-NBPGR for farmers from Ri-Bhoi and Jaintia districts of Meghalaya during October 2025.

SCHEDULED CASTE SUB PLAN (SCSP) PROGRAMMES

Under the SCSP program of the institute, a range of need-based interventions were implemented to empower Scheduled Caste (SC) beneficiaries to enhance agricultural sustainability, income generation, and livelihood security in the spice and horticultural sectors. Crop adaptation strategies were introduced among SC spice growers in different parts of spice -growing areas to improve resilience to climatic variability and enhance farm income. Training-cum-input distribution programmes and distribution of agricultural implements were conducted to strengthen production efficiency, while apiculture-based livelihood diversification was promoted through training and distribution of honey bee hives. Skill development initiatives on nursery management and value-added product development from spices further supported entrepreneurship among SC beneficiaries. Capacity-building programmes were organized to strengthen technical skills through structured training and skill development activities. SC youth and FPO members were trained in digital and social media marketing for spice marketing, along with programmes on post-harvest handling to reduce losses and improve product quality. Quality-driven value addition initiatives enabled farmers and FPOs to access competitive markets. Collectively, these programmes contributed to inclusive growth, skill enhancement, and sustainable livelihood development among SC communities.

Summary of initiatives under the SCSP programme

1. Crop adaptation strategies for improving sustainability and income for scheduled caste spice growers in Idukki district (Location: Kerala)
2. Training cum input distribution program to SC beneficiaries (Location: Kerala)
3. Training cum distribution of honey bee hives to empower the livelihood of SC beneficiaries (Location: Kerala)
4. Capacity building of SCSP beneficiaries through various trainings and skill development programmes (Location: Kerala, Tamil Nadu)
5. Empowering Scheduled Caste (SC) farmers on innovative Horticultural Technologies (Location: Tamil Nadu)
6. Creating Awareness on Innovative Horticultural Technologies among SC Farmers for Doubling the Income (Location: Tamil Nadu)
7. Empowering scheduled caste young FPO members on digital and social media marketing techniques for spice marketing through skill development training (Location: Karnataka)
8. Post-harvest handling of spices for livelihood security of rural youth (Location: Karnataka)
9. Quality-driven value addition in spices: empowering farmers/FPOS for a competitive market (Location: Karnataka)
10. Skill development for sc beneficiaries on nursery management/ development of value-added products from spices (Location: Kerala)
11. Training cum input distribution program to SC beneficiaries (Location: Kerala)
12. Training cum distribution of agricultural implements to SC beneficiaries (Location: Kerala)

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

A total of 36 training programmes focused on technology transfer were organized by ATIC, both independently and with partner agencies. The beneficiaries of the training were from all over India. These include various project- based, online, customized request training, and also off-campus programmes. Around 1144 beneficiaries got benefitted out of the training programmes. Topic covered ranged from advanced cultivation practices, GAPs on spices, hands-on training in plant propagations, value addition, spices processing, and entrepreneurship development in spices. The beneficiaries of the training programmes were farmers, planters, department officials, industrial staffs etc. The total revenue generated by the institute through ATIC in the year 2025 is ₹ 65,98,533.00.

Training for farmers and officials from the Andaman and Nicobar Islands

A five-day training cum exposure visit on advances in spice crop technologies was organized at ICAR - Indian Institute of Spices Research, Kozhikode, from 21 to 25 July 2025, for officials from the Directorate of Agriculture, Andaman and Nicobar Administration, and progressive farmers from the islands. The programme covered recent advancements in varietal development, soil and nutrient management, integrated pest and disease management, processing and quality assurance, along with exposure visits to spice farms, research facilities, and agri-enterprises. The training aimed to equip participants with region-specific spice cultivation technologies and strengthen the spice sector in the Andaman region.

Students' visits/ Exhibitions/ Mass media programmes

In addition to its commitment to the farming community, the Agricultural Technology Information Centre (ATIC) functions as a vital educational hub that provides students from diverse academic institutions with invaluable practical exposure to the world of spice research and cultivation. This year, around 53 student groups visited the institute. A total of 1,982 students visited the Institute, comprising 584 boys and 1,398 girls. In 2025, ICAR-IISR participated in 15 national-level exhibitions conducted in Kerala. The institute also participated in 10 radio programmes and 7 media programmes where the institute's technologies were shared with the public. Updates regarding the implementation of Viksit Krishi Sankalp Abhiyaan were aired frequently through Akashvani, Kozhikode, and Akashvani Real FM during the period.

Viksit Krishi Sankalp Abhiyan

The Viksit Krishi Sankalp Abhiyan (VKSA-2025) was conducted from 29 May to 12 June, 2025, as part of a nationwide agricultural transformation campaign launched by the Indian Council of Agricultural Research (ICAR). The institute actively participated in this pre-*kharif* agricultural outreach initiative designed to empower over 1.5 crore farmers across India through a convergence model involving ICAR Institutes, State Agricultural Universities, and Krishi Vigyan Kendras (KVKs).

Twenty one Scientists from the institute were deputed to 12 districts in Kerala and Karnataka in different phases, ensuring comprehensive geographical coverage and targeted outreach to diverse farming communities across both states. These scientists actively interacted with farmers in the field, providing direct technical support and guidance while demonstrating IISR technologies and varieties that have been developed through years of research and development. In this programme, around 165 villages were covered and reached 29128 farmers. During these field interactions, the scientists showcased improved spice varieties, sustainable cultivation practices, and innovative agricultural technologies that could enhance productivity and profitability for spice farmers. Problems and constraints faced by farmers were systematically sought and documented, creating a comprehensive understanding of ground- level challenges in spice cultivation across different agro - climatic zones. Feedback was actively collected from participating farmers regarding their experiences with existing practices, adoption challenges, and specific requirements for technological interventions.

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES (AICRPS)

XXXVI Annual Group Meeting of ICARAll India Coordinated Research Project on Spices (AICRPS)

The XXXVI Annual Group Meeting of the ICAR–All India Coordinated Research Project on Spices (AICRPS) was held from 29 to 31 October 2025 at ICAR-Research Complex for North Eastern Hill (NEH) Region, Umiam, Meghalaya. The meeting was inaugurated by Dr. B.C. Deka, Hon'ble Vice-Chancellor, Assam Agricultural University, Jorhat. Dr. Sudhakar Pandey, Assistant Director General (FVS & MP), ICAR, presided over the inaugural session. The programme featured addresses by distinguished guests, including Dr. R. Dinesh, Director, ICAR-Indian Institute of Spices Research (IISR), Kozhikode; Dr. Vinay Bharadwaj, Director, ICAR-National Research Centre on Seed Spices (NRCSS), Ajmer; Dr. Samarendra Hazarika, Director, ICAR-Research Complex for NEH Region, Umiam; and Dr. G. Kadirvel, Director, ICAR-ATARI Zone VI, who highlighted emerging challenges and future strategies. The deliberations emphasized strengthening India's spice sector.

During the meeting, outstanding contributions to the spice sector were recognised. Padma Shri awardee, Mrs. Trinity Saioo, was honoured for her pioneering role in popularizing Lakadong turmeric, symbolizing the critical role of progressive farmers in strengthening the spice economy. The ICAR- AICRPS Best Centre Award was conferred upon the Agricultural Research Station, Mandore, Agricultural University, Jodhpur, in recognition of its outstanding contributions in Spice R&D. Variety and technology certificates for newly developed spice varieties and key technologies were presented. The occasion also marked the release of 24 new publications, documenting recent research achievements and best practices under the AICRPS network. The workshop also provided an occasion for the release of a new online data management pipeline designed for the recording, storage, and analysis of multi-location research data generated under the ICAR–AICRPS network.

New spice varieties recommended for release

During the XXXVI AGM of AICRPS, six spice varieties were identified in three crops for release:

1. **Karan Saunf-1 (RF 234 / UF-231):** It is a high-yielding fennel variety with superior industrial quality, developed by SKNAU, Jobner, Rajasthan. It recorded a mean seed yield of 1742 kg ha^{-1}, along with high volatile oil content (3.32%) and oil yield (57.83 L ha^{-1}). The variety possesses excellent essential oil quality, characterized by 18 aromatic compounds, with Estragol (52.54%) and Anethole (16.67%) as the major constituents. The variety has been identified for release in fennel-growing regions of Rajasthan, Gujarat, Uttarakhand, Uttar Pradesh, Bihar, Madhya Pradesh, and Haryana.
2. **Gujarat Ajwain-4 (JA 2019-01)**: It is a high-yielding ajwain variety developed by the Seed Spices Research Station, SDAU, Jagudan, Gujarat, with a mean seed yield of 1136 kg ha^{-1}. It is characterized by early

flowering and maturity, bold seeds, and high volatile oil content (4.18%). The variety has been identified for cultivation in ajwain-growing regions of Rajasthan, Gujarat, Andhra Pradesh, Uttar Pradesh, and Chhattisgarh.

3. **Hisar Ajwain-7 (HAJ-7):** This high-yielding variety is developed by CCS Haryana Agricultural University, Hisar, with an average seed yield of 1193 kg ha^{-1}. It is a medium-duration variety with higher numbers of umbels and seeds per umbel. The variety contains high essential oil (4.96%) and exhibits tolerance to root rot, along with a low incidence of aphids. It has been identified for release in Rajasthan, Gujarat, and Haryana.

4. **Ajmer Ajwain-24 (AA-24)**: This high-yielding ajwain variety is developed by ICAR–National Research Centre on Seed Spices, Ajmer, with a mean seed yield of 1216 kg ha^{-1}. The variety is of medium duration and possesses superior yield components. It is rich in quality attributes, with high thymol content (49.47%) and essential oil (4.96%), and shows tolerance to root rot. The variety has been identified for ajwain-growing regions of Rajasthan.

5. **IISR Navya (HP 0.5/2)**: It is a stable, high-yielding ginger variety developed by ICAR-Indian Institute of Spices Research, Kozhikode, with an average fresh rhizome yield of 15.3 t ha^{-1} and a yield potential of up to 36 t ha^{-1}. It is field- tolerant to rhizome rot and possesses good quality attributes, including essential oil (2.7%), oleoresin (6.65%), and dry recovery (18.78%). The variety has been identified for release in Kerala, West Bengal, Meghalaya, and the NEH region.

6. **OUAT Kalinga Ginger-4 (Koraput Ada / V1E4-5):** It is a high-yielding ginger variety developed by HARS, Odisha University of Agriculture and Technology (OUAT), Pottangi, Odisha, with an average yield of 15.9 t ha^{-1}. It is of medium duration with bold rhizomes and exhibits superior quality characterized by low fibre content and high dry recovery. The variety shows resistance/tolerance to major diseases and pests and performs well under diverse agro-ecological conditions. It has been identified for release in Odisha and Andhra Pradesh.

Recommended technologies

During the AGM, several need-based and region-specific technologies were recommended for integrated pest and disease management, growth regulation, eco-friendly disease control, intercropping systems, and nutrient-use efficiency.

1. **Management of pollu beetle (*Lanka ramkrishnai*) in black pepper:** Three rounds of insecticidal sprays using chlorantraniliprole 18.5% SC or flubendiamide 39.35% SC at 0.3 to 0.5 ml per litre of water during July, August, and September is recommended as technology for the management of pollu beetle in black pepper-growing regions of Kerala and Karnataka.

2. **Use of plant growth regulators for yield enhancement in fenugreek:** The technology of foliar sprays of brassinosteroid (1.0 ppm) or benzyl adenine (20 ppm), twice, at 30 and 60 days after sowing in fenugreek, resulted in a 25–30% increase in seed yield and higher net returns of ₹15,000–17,000 per hectare. The technology is recommended for Rajasthan, Bihar, Haryana, and Uttar Pradesh.

3. **Management of powdery mildew in fenugreek:** Management of powdery mildew in fenugreek was recommended through timely fungicidal sprays at the initial appearance of the disease, followed by a second spray after 15 days. Hexaconazole 5% SC (0.1%) was recommended for Gujarat, hexaconazole or tebuconazole

(0.1%) for Rajasthan, and tebuconazole 25.9% EC (0.1%) for Madhya Pradesh, providing effective disease control and yield protection.

4. **Eco-friendly management of cumin blight**: Seed treatment followed by four foliar sprays of *Bacillus subtilis* 1.15 WP (40 g/10 L) combined with *Pseudomonas fluorescens* 1.15 WP (50 g/10 L), starting from 40 days after sowing, effectively managed the disease. The technology is recommended for Rajasthan and Gujarat.

5. **Intercropping systems in ginger**: Intercropping ginger with elephant foot yam (2:2) is recommended for Andhra Pradesh, Bihar, and West Bengal; ginger with maize (2:1 or 2:2) for Odisha, Nagaland, Himachal Pradesh, and Mizoram; ginger with French bean (2:2) for West Bengal; and ginger with coriander, followed by leafy vegetables for Sikkim.

6. **Application of plant growth-promoting rhizobacteria (*Bacillus safensis*) for phosphorus and zinc solubilization in ginger**: The technology involves applying 75% of the recommended phosphorus, 50% zinc, and *Bacillus safensis* at planting, 30, and 60 days after planting. It is recommended for Kerala, Andhra Pradesh, West Bengal, Uttar Pradesh, Arunachal Pradesh, and Odisha**.**

7. **Use of growth regulators to improve yield and quality in coriander**: Foliar application of salicylic acid (50 ppm) at 30 and 60 days after sowing resulted in higher productivity and profitability and is recommended for Rajasthan, Madhya Pradesh, Chhattisgarh, Haryana, Tamil Nadu, and Andhra Pradesh.

These technologies collectively strengthen climate resilience, reduce dependency on chemical inputs, promote eco-friendly crop management, and enhance farm profitability across diverse spice-growing regions of the country.

Central Varietal Release Committee (CVRC)

The 32nd meeting of the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Horticultural Crops was held on 4 April, 2025 under the chairmanship of Dr. S.K. Singh, Deputy Director General (Horticulture), ICAR, in Krishi Bhawan, New Delhi. During the meeting, five AICRPS- identified varieties of spice crops were considered for release and notification for the region recommended. These included ginger variety, SAS-KEVU; turmeric variety, IISR Surya; fennel variety, Gujarat Fennel-13 (GF-13); cumin variety, Jodhpur Jeera-1 (JJ-1 / MCU-105); and mango ginger variety, IISR Amrit. In addition to the nationally released varieties, the committee also considered AICRPS centres to release and notify region-specific/state-wide varieties based on multi-location AICRPS trial data. These included one ginger variety (IISR Surasa), one fennel variety (Gujarat Fennel-3), and three turmeric varieties (NDH-98, Pitambari, and Amruta).

INSTITUTE TECHNOLOGY MANAGEMENT - AGRIBUSINESS INCUBATION UNIT (ITM-ABI UNIT)

The ITM-ABI Unit plays a major role in technology commercialization, intellectual property management, industry collaboration, and promotion of agripreneurship in the spices sector. The major activities undertaken during the year are listed below:

Technology commercialization and revenue generation

Overall, 43 licences were issued to the entrepreneurs for technologies developed by ICAR–IISR and revenue of ₹30.48 lakh was generated.

Intellectual Property (IP) portfolio

Patents

- **Patent No. 567347**: An antimicrobial composition for coating rhizomes and tubers and a process for its preparation (Filed on 08-10-2020 and granted on 11-06-2025)
- **Patent No. 573444**: A novel liquid process for mass multiplication of *Pochonia chlamydosporia* (Filed on 06-10-2017 and granted on 07-11-2025)

Copyrights

S.No	Registration No.	Title	Filed date	Granted date
1	SW-20266/2025	ZoMMD: *Zingiber officinale* Molecular Marker Database	27-01-2025	25-03-2025
2	SW-2025020578	Spice-AgroTech	03-01-2025	23-05-2025
3	SW-2025021155	IISR-eZnProbe	09-06-2025	05-08-2025
4	SW-2025021751	PnGeneSSRdb: Gene-Based SSR Marker Database for Black Pepper (*Piper nigrum*)	10-07-2025	06-10-2025
5	SW-34269/2025-CO	BPncDB: A comprehensive database of non-coding RNAs in Black Pepper (*Piper nigrum* L.) and their interactions with mRNAs	25-08-2025	12-12-2025
6	SW-37339/2025-CO	Oleomiisran: Ready-to-mix tool for liquid spice blends	15-09-2025	27-11-2025

IP applications

Patents: 5

Copyrights: 1

Trademarks: 2

PPV&FRA registration: 1 (Ginger variety, IISR Surasa)

MoUs / Memoranda of Agreement (MoA)

An MoA was signed with Synthite Industries Pvt. Ltd. on 13 November 2025 for:

- Technology transfer
- Post-harvest processing of turmeric
- Scientific guidance in turmeric cultivation

An MoA was signed with the Spices Board to promote the production of pesticide-free spices through bio-inputs.

Technical consultancy services

The unit facilitated the consultancy visit of IISR scientists for yield estimation, guidance in cultivation, and spicedisease management to TATA Coffee Pvt Ltd., Karnataka; Acadian Seaplants India Private Limited, Tamil Nadu; V.K Plantation, Nilgiris, Tamil Nadu; Puliyarmala and Purakkadi Estate, Wayanad, Kerala; Kodi Estates, Chikkamagalur, Karnataka; Balmaadi Estate, Gudalur, Tamil Nadu; and New Ambadi Estates Pvt Ltd., Kanyakumari, Tamil Nadu.

Contract research programmes

Contract research programmes on agrochemical efficiency, growth regulation, and disease management in spices were facilitated with:

- IFFCO, New Delhi
- Allegro Sciences Pvt. Ltd., Aurangabad, Maharashtra
- Bayer Crop Science Pvt. Ltd., Mumbai, Maharashtra
- Corteva Agriscience India Pvt. Ltd., Hyderabad, Telangana

Capacity building, entrepreneurship, and startup promotion

Training and awareness programmes

- Conducted a virtual session on World Intellectual Property Day 2025 (29 April 2025) on *"Patents in Agriculture – Strategic Research Orientation"*. On the occasion, Dr. Shweta Sharma, Registered Patent Agent & Principal Associate, M/s Khurana and Khurana, Greater Noida, Uttar Pradesh, an ICAR Empaneled attorney, delivered the lead talk on the topic "Navigating Agricultural Patenting in India."
- Organized an Entrepreneurship Awareness Programme for women entrepreneurs at ICAR-IISR, Kozhikode (14 participants).
- Organized an orientation programme for final-year students of College of Agriculture, Ambalavayal (21 March 2025).
- Hosted 34 entrepreneurs under an Entrepreneurship Development Programme organized by the District Industries Centre, Kozhikode (05 August 2025).
- Organized an Awareness Session on Microgreens (16 September 2025) with the participation of over 60 stakeholders. The session was led by Mrs. Anushree of M/s Infant Leaves, Calicut, and an IISR-ABI incubatee.

Exhibitions and outreach programs

- Exhibited institute technologies in 12 national-level programmes.
- Organized Resourcing Innovations and Spice Entrepreneurship for Unlocking Potential (RISE UP 2.0) – Entrepreneurs Meet & Agri Expo (19–21 February 2025). The three-day conclave featured the NavUdyam program, including an Idea Hackathon and Startup Orientation.

The Udayam 2.0 Agri Expo showcased over 70 entrepreneurs presenting farm tools, bio-inputs, and innovative spice products. The Udyamitha Business Meet highlighted ready-to-market technologies, while the Udyamika Conclave focused on women entrepreneurs. The event witnessed a footfall of over 1,000 visitors, with 60 entrepreneurs exhibiting their innovative products.

- Participated in the Startup Maha Kumbh during 3-5 April, 2025 at Bharat Mandap, New Delhi.
- Attended the Stakeholders and Startups Consultation Meeting organized by the National Turmeric Board in collaboration with a-IDEA on 15 July 2025 at ICAR-NAARM, Hyderabad.
- Participated in the three-day State Level Seminar on Entrepreneurship Opportunities for Island Youth and Women in Spices, Arecanut and Medicinal Plants Sector–2025, held from March 5 to 7, 2025, at ICAR-Central Island Agricultural Research Institute, Sri Vijaya Puram, Andaman and Nicobar Islands.

Startup and innovation support

- Submitted shortlisted proposals under MSME Idea Hackathon 5.0 as Host Institute.
- Collaborated with Kerala Institute for Entrepreneurship Development (KIED) for technology commercialization and startup support.

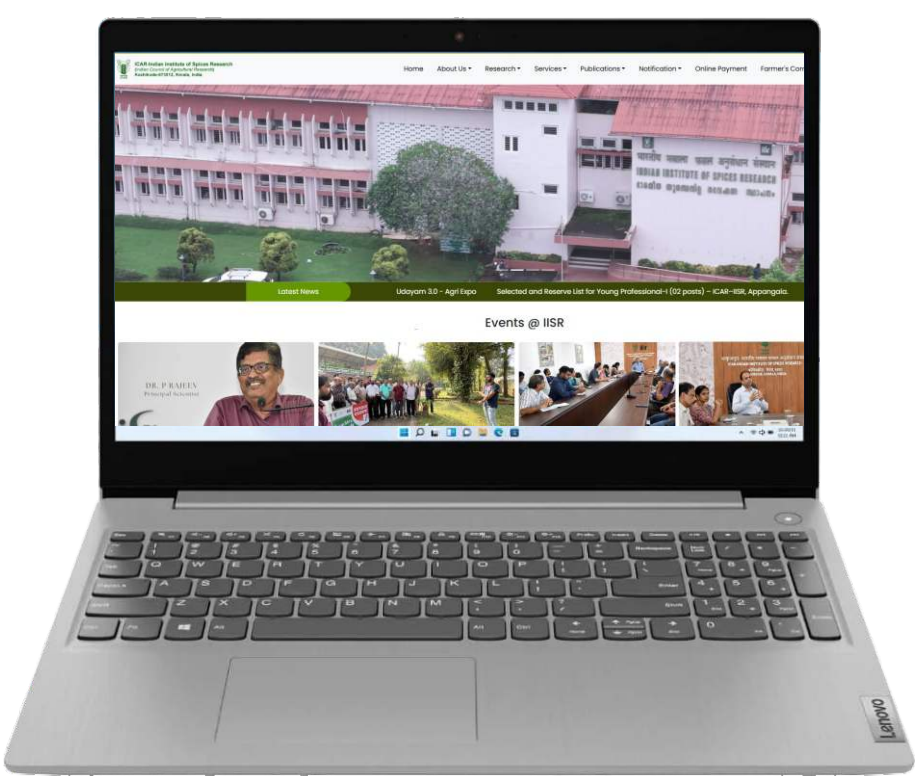
AGRICULTURAL KNOWLEDGE MANAGEMENT UNIT (AKMU)

During 2025, the Agricultural Knowledge Management Unit (AKMU) ensured uninterrupted IT and ICT-enabled services across the Institute, including the Regional Station Appangala, the Experimental Farm, and Krishi Vigyan Kendra, Peruvannamuzhi, through secure VPN connectivity.

The Institute's official website (https://spices.res.in) was comprehensively updated during the year, improving performance, security, accessibility, and content management. AKMU also hosted and managed multiple institutional and research databases, ensuring data security, availability, and reliable server performance through continuous monitoring and maintenance.

The Unit was responsible for the maintenance and upgradation of servers, network infrastructure, and hardware components, ensuring smooth institutional operations. Regular maintenance of computing systems, peripherals, and network security mechanisms was carried out.

AKMU maintained and updated the Institute's official websites, portals, and intranet, and supported digital outreach through content management and multimedia uploads. Technical support was provided for online meetings, webinars, training programmes, and workshops. The Unit also assisted in statistical analysis and scientific data management using advanced analytical tools, including R software.



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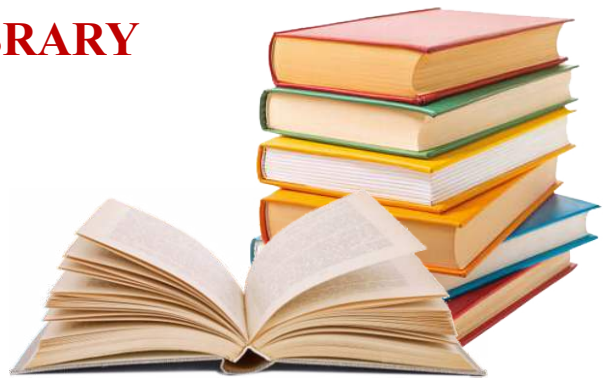

The IISRSpicE Library continues to prioritize excellence in academic support through its comprehensive online and offline services.

The library holdings include:

- Books:5227
- Gratis books:813
- Bound journals: 6010
- Reprints: 2308
- Technical reports:1037
- Ph.D. Theses: 210
- M.Sc. Theses: 448
- e-books: 325+

During 2024–25, the Library added 89 new books, including Hindi titles. In 2025–26, 47 new books, including Hindi titles, were added to the collection.

One Nation One Subscription (ONOS)

The ICAR–IISR Library has registered under the Government of India's ONOS initiative, which provides a cost-free, common platform and seamless access to approximately 13,000 journals published by leading international publishers such as Elsevier (Science Direct), Springer Nature, Wiley Blackwell, etc., thereby strengthening support for the research and academic activities in the institution.

Indian Research Information Network System (IRINS)

The ICAR-IISR Library supports IRINS, a web-based faculty profiling platform that captures, integrates, and showcases the scholarly output of ICAR-IISR faculty members, including publications, citations, h-index, projects, and other research contributions, thereby enhancing the visibility and impact of the institute's research at the national and international level.

DSpace

The institutional digital repository software DSpace was updated with institute publications. Out of 210 Ph.D. theses, 201 have been digitized and made available online. During the year 2025, 29 M.Sc. project reports were added to DSpace, and a total of 412 M.Sc. project reports have now been digitized for user access.

Koha

The library updated its collections, including newly added resources, in the Koha library automation software. Users can search the Online Public Access Catalogue (OPAC) by title, author, subject, publication details, and other parameters for easy access to library holdings.

Calibre

The library integrated over 325 e-books into Calibre, a powerful and user-friendly e-book management system, making it easier for users to access the digital content.

Plagiarism detection

The library extended its support to academic integrity by providing plagiarism detection services for research theses. During the year, 62 documents were processed for plagiarism checks.

Other services

A total of 746 students, staff, and researchers utilized the library facilities, and 337 users accessed the computer facility. The library was also utilized for meetings and training sessions.

KRISHI VIGYAN KENDRA (KVK)

Trainings

A total of 56 on-campus and 34 off-campus capacity building trainings were organized by KVK, which benefitted more than 2837 farmers and 673 youth participants. Topics like plant propagation, pepper plants production, seasonal vegetables cultivation, mushroom production, bio inputs production, Ornamental fish production, value addition of spices, millets, banana fibre extraction, farm machinery usage, and crop pest and disease management are in high demand. Training programmes of 2 to 3 days duration, on mushroom spawn production, ornamental fish production, and ATMA-sponsored trainings on mushroom production and value addition are other highlighted programmes.

Special capacity building programmes

Two batches of capacity-building programmes were conducted for 43 participants, focusing on the use of farm machinery, including a banana fibre extraction machine. Based on demand identified by the Department of Agriculture, additional training programmes on mushroom cultivation and organic vegetable production were offered to farmers. Beekeeping and vermicompost production, including training associated with CWRDM, were also conducted for farmers identified by the Department of Agriculture. In addition, one batch of a six-day on-the-job training (OJT) programme was conducted for students of GVHSS Meppayur. One-month RAWE attachment training programmes were also organized for students from Lovely Professional University and Guru Ghasidas University.

On-Farm Trial, Front Line Demonstrations (FLDs), and EDPs

During 2025, the KVK, implemented three On-Farm Trials (OFTs), comprising 13 trials, on (i) assessment of growth performance and yield of Nendran banana clones under a homestead system of cultivation, (ii) evaluation of biocontrol agents for the management of bacterial wilt in tomato, and (iii) assessment of mussel farming techniques to enhance production.

Out of ten approved FLD programmes, nine programmes, excluding the demonstration of a high-yielding watermelon variety (Arka Shyama), were initiated and conducted across approximately 70 farmers' fields. The FLDs included demonstrations on Tricholime for growth, yield, and soft rot management in grow-bag ginger cultivation (IISR Vajra); hybrid bitter gourd variety Pragathi; high-yielding and nutrient-use-efficient cassava variety Sree Annam; high-yielding black pepper variety IISR Chandra; Kalpavardhini nutrient mix for coconut in rainfed homesteads; integrated management of red palm weevil and rhinoceros beetle in coconut; integrated management of armoured scale insect (*Aulacaspis madiunensis* Zehntner) in *Cycas circinalis*; submersible box culture technique for mud crab fattening; and scientific farming of pacu fish (*Piaractus brachypomus*). These demonstrations were well received by the farming community.

In addition, two EDPs, namely "EDP on Commercial Production of Kalpavardhini (CPCRI) at KVK" and "Quality Planting Material Production of IISR Black Pepper Varieties," were initiated,

Interstate/ district farmer visits and training

Exposure visits and training on jack fruit cultivation and processing training to farmers from Dharmapuri district, Tamil Nadu, and vegetable cultivation for farmers from Mahe were conducted, and the visited farmers were supplied with bush pepper, Jack, mango grafts, along with quality seeds of kasturi turmeric, black turmeric, ginger, and turmeric for cultivation at their places. Likewise, farmers from Kannur

district also visited the KVK and got trained on vegetable cultivation, Natural farming, etc.

Important days and remarkable programmes

The tree plantation campaign involving planting of 1000 tree saplings was taken up in 3 phases. The 1st phase was on 5th June, coinciding with World Environment Day, the 2nd phase on 16 July, coinciding with the ICAR foundation day, and then the 3rd phase on 15 August 2025, coinciding with Independence Day. As part of the third phase of the tree plantation campaign, planting of various tree species like Ashoka, arecanut, curry leaf, mango, etc. were taken up in 150 farmers' fields in Chembanoda, Peruvannamuzhi village.

During World Environment Day, a farmers' seminar was conducted in which certificates and saplings of mango, sapota, arecanut, and pepper were distributed to DFI fellow farmers for planting on their farm lands. Another off-campus awareness programme was also conducted at Dr. Ambedkar Residential School, Kothode, on the planting of saplings.

PM Kisan Samman Nidhi 6th Anniversary and the release of the 19th instalment for 11 crore beneficiaries were organized as Kisan Samman Samaroh along with an SC Farmers' Meet at KVK on 24 February 2025. Besides, an exhibition was also arranged from 24 to 26 February at KVK showcasing the technologies in agriculture and allied fields, which was visited by 101 individuals.

International Women's Day was celebrated on 8 March 2025. The programme was inaugurated by Dr. P. Ratha Krishnan, Head of KVK. Six women SC farmers from various parts of Kozhikode district were honoured during the programme. Apart from these women, Smt. Thankamani E, a senior citizen and Collection agent of the post office, was also honoured by Smt. Indumathi, President, OISCA International, Perambra women's chapter.

National Fish Farmers' day celebrated on 10 July 2025 with the participation of 68 persons, including farmers and students from the Government UP School, Nadapuram. A training on the induced breeding technique in fish was organised.

The 8th episode of the Krishi Choupal programme on the topic "Integrated Pest Management" was streamed on 12 July 2025. The programme in DD Kisan was shown to farmers and staff at KVK Peruvannamuzhi.

Kisan Diwas was celebrated on 23 December 2025, during whicha training programme on mushroom cultivation was conducted for farmers.

In addition, two off-campus training programmes on farm mechanization were organized at Maruthonkara Grama Panchayat, in which 61 farmers participated. All the framers were apprised about the Viksit Bharat- Guarantee for Rozgar and Ajeevika Mission (Gramin) Bill 2025 (VB- G RAM G), and pamphlets on it were distributed to them. Special address on Kisan Diwas by Shri. Shivraj Singh Chouhan, Hon'ble Union Agriculture and Farmers Welfare Minister, was live-streamed to the farmers at KVK.

Special programme for SC beneficiaries

Special programmes comprising nine-month-long skill development trainings for Scheduled Caste (SC) youth on "Nursery Management" and bio-input production were conducted, with stipends provided to the participants. In addition, specialized skill training programmes on apiculture, farm machinery operation, value-added product development, and entrepreneurship, including nursery establishment and ornamental fish unit establishment, were organized. As part of livelihood support, about 1,000 SC beneficiaries in the district were provided with poultry chicks, vegetable seeds, seedlings, planting materials, and bio-inputs such as Ayar for banana, Trichoderma, and Pseudomonas. These programmes were implemented through local Panchayats, Krishi Bhavans, and Veterinary Clinics at Maruthonkara, Perambra, Arikulam,

Koothali, and Chakkittapara Panchayats.

Other important activities

The technology demonstration component of the NICRA project sponsored by CRIDA, Hyderabad, is being implemented by KVK at Maruthonkara Pachayat. Scientific cultivation of coconut, vegetables, tubers, and the introduction of new varieties of tapioca, marigold, etc were some successful activities. A custom hiring centre is being established with farm implements and tools.

KVK also documented five success stories, *viz.,* Mr. Satheesh Kumar, Kakkur (mushroom grower); Mr Benny (on Thekkan pepper cultivation); Mr Antony (Pepper growing on stone standards); Mr. Tomy Joseph (integrated farming), and Mr. Lineesh (successful NICRA farmer). KVK supported farmers, Mr. Siddique, has been serving as Farmer master trainer (Natural farming), and Smt V.K. Sibitha, Koyilandy, has been recognised as Krishi Jagran – Millionaire farmer – 2025 on YouTube.

The nursery and polyhouse units of KVK produced a total of about 26628 seedlings of vegetables, pepper rooted cuttings, bush pepper, nutmeg grafts, arecanut seedlings, etc and sold to 2921 farmers. About 2.8 quintals of turmeric (IISR Pragathi and Prabha turmeric) and ginger (IISR Varada and Vajra) seeds were produced and made available to farmers. Additionally, 28 quintals of bioinputs (vermicompost, trichoderma, goat manure, jeevamirtham, etc) were produced and sold. The layer birds and ornamental fish units of KVK sold about 250-layer chicks, 5000 eggs, 650 litres of milk, and 1380 ornamental fish.

हिंदी प्रकोष्ठ

राजभाषा कार्यान्वयन समिति की बैठक

वर्ष 2025 में भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड़ में राजभाषा कार्यान्वयन समिति की चार बैठकें आयोजित की गयी। बैठकें दिनांक 03 फरवरी 2025, 2 जून 2025, 26 अगस्त 2025 तथा 15 दिसंबर 2025 को निदेशक डॉ. आर. दिनेश की अध्यक्षता में संपन्न हुई। समिति ने राजभाषा कार्यान्वयन की गतिविधियों की समीक्षा करके सुधारने के लिए सुझाव दिया।

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान क्षेत्रीय केंद्र, अप्पंगला, मडिकेरी, कर्नाटक में वर्ष 2025 में राजभाषा कार्यान्वयन समिति की तीन बैठकें आयोजित की गयी। दिनांक 09 मार्च 2025, 13 मई 2025, 29 दिसंबर 2025 को बैठकें कार्यालयाध्यक्ष एवं प्रधान वैज्ञानिक डॉ. एस. जे. आंके गौडा की अध्यक्षता में संपन्न हुई। समिति ने राजभाषा कार्यान्वयन की गतिविधियों की समीक्षा करके सुधारने के लिए सुझाव दिया। दिनांक 29 दिसंबर 2025 की बैठक में मुख्यालय से सुश्री. एन प्रसन्नकुमारी ने ऑनलाइन रूप से भाग लिया। उन्होंने राजभाषा कार्यान्वयन के सुचारू अनुपालन के लिए अवश्यक मार्ग निर्देश दिया।

हिंदी कार्यशाला

वर्ष 2025 की अवधि में भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड़ के अधिकारियों तथा कर्मचारियों के हिंदी ज्ञान को बढ़ाने के लिए चार कार्यशालाएं आयोजित की गयीं। इन कार्यशालाओं में, श्रीमती माया एस., वरिष्ठ प्रबंधक, बैंक ऑफ बडौदा, कालिकट, श्री. विनोद कुमार यादव, कनिष्ठ अनुवाद अधिकारी, भारतीय राष्ट्रीय पुस्तकालय, कोलकात्ता, श्रीमती सफिया नरिमुक्किल, हिंदी अध्यापिका (सेवानिवृत्त), रहमानिया उच्चतर माध्यमिक विद्यालय, कोषिक्कोड तथा श्री. षबीर एम. आई., हिंदी अध्यापक, सरकारी उच्चतर माध्यमिक विद्यालय, वाषक्काड, मलप्पुरम ने क्रमशः दिनांक 12.02.2025, 13.06.2025, 13.08.2025 तथा 22.10.2025 को "राजभाषा नीति, नियम एवं हिंदी टिप्पणी", विभिन्न अनुवाद उपकरण और कंठस्थ 2.0 टूल" " हिंदी में सामान्य त्रुटियाँ और उसका निराकरण", "हिंदी की सामान्य जानकारी" आदि विषयों पर व्याख्यान दिया।

दिनांक 12 फरवरी 2025 को आयोजित हिंदी कार्यशाला

दिनांक 13 जून, 2025 को आयोजित हिंदी कार्यशाला

दिनांक 13 अगस्त 2025 को आयोजित हिंदी कार्यशाला

दिनांक 22.10.2025 को आयोजित हिंदी कार्यशाला

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान क्षेत्रीय केंद्र, अप्पंगला, मडिकेरी, कर्नाटक में वर्ष 2025 की अवधि में केंद्र के अधिकारियों तथा कर्मचारियों के हिंदी ज्ञान को बढ़ावा देने के लिए चार कार्यशालाएं आयोजित की गयीं। कार्यशालाएं क्रमश: 05 मार्च, 2025, 13 अगस्त 2025, 16 सितंबर, 2025 तथा 29 दिसंबर, 2025 को आयोजित की गईं। पहली कार्यशाला में डॉ. भानु प्रताप सिंह, तकनीशियन, सीएचईएस, चेताली ने "हिंदी भाषा और व्याकरण" के

बारे में व्याख्यान दिया। इसमें दूसरी और चौथी कार्यशालाएं ऑनलाइन थी। दूसरी कार्यशाला में श्रीमती सफिया नरिमुक्किल, सेवानिवृत्त अध्यापिका, उच्चतर माध्यमिक विध्यालय, कोषिक्कोड ने "हिंदी की सामान्य त्रुटियां" पर व्याख्यान दिया। इसमें केंद्र के अधिकारियों ने ऑनलाइन रूप में भाग लिया। तीसरी कार्यशाला में डॉ. राजण्णा जी. ए., वरिष्ठ वैज्ञानिक, आईसीएआर-आईआईएसआर, अप्पंगला ने "भाषा संगम: भाषा, संस्कृति और संचार महोत्सव" पर व्याख्यान दिया। चौथी कार्यशाला में सुश्री एन. प्रसन्नकुमारी, मुख्य तकनीकी अधिकारी, आईसीएआर-आईआईएसआर, कोषिक्कोड ने "राजभाषा कार्यान्वयन के अनुपालन के प्रमुख मदों" पर व्याख्यान दिया। कार्यशाला में राजभाषा कार्यान्वयन की रिपोर्ट भरने के संबंध में आवश्यक दिशा निर्देश दिये गये।

दिनांक 05 मार्च, 2025 को आयोजित हिंदी कार्यशाला

दिनांक 29.12.2025 को आयोजित हिंदी कार्यशाला

हिंदी बैठक/सम्मेलन/कार्यशाला में सहभागिता

- श्री. जयप्रकाश पी. टी., उच्च श्रेणी लिपिक ने भाकृअनुप-केंद्रीय मत्स्यिकी शिक्षा संस्थान क्षेत्रीय केंद्र, कोलकत्ता में 21-22 अप्रैल 2025 को विकसित भारत संकल्पना में राजभाषा प्रबंधन की भूमिका पर आयोजित राष्ट्रीय राजभाषा संगोष्ठी में भाग लिया।
- श्रीमती एन. प्रसन्नकुमारी, मुख्य तकनीकी अधिकारी ने 11 जूलाई 2025 को राजभाषा विभाग द्वारा जीएमसी बालयोगी इन्डोर स्टेडियम, गच्बौली, हैदराबाद में आयोजित राजभाषा विभाग के सुवर्ण जयंती समारोह में भाग लिया।

नगर राजभाषा कार्यान्वयन समिति

- नगर राजभाषा कार्यान्वयन समिति की 73वीं अर्धवार्षिक बैठक 29 मई 2025 को होटल वुडीस ब्लेज़र, कालिकट में संपन्न हुई। प्रस्तुत बैठक में संस्थान से सुश्री. एन. प्रसन्नकुमारी, मुख्य तकनीकी अधिकारी ने भाग ली।
- नगर राजभाषा कार्यान्वयन समिति, मडिकेरी द्वारा दिनांक 08.09.2025 को जवहर नवोदय विद्यालय, मडिकेरी में आयोजित राजभाषा कार्यक्रम में डॉ. राजण्णा जी. ए., वरिष्ठ वैज्ञानिक एवं श्री सचिन के. पी (एम टी. एस.) ने भाग लिया। श्री सचिन के. पी. को हिंदी अनुच्छेद लेखन प्रतियोगिता में प्रथम पुरस्कार प्राप्त हुआ।
- नगर राजभाषा कार्यान्वयन समिति की 74वीं अर्धवार्षिक बैठक 25 नवंबर 2025 को होटल वुडीस ब्लेज़र, कालिकट में संपन्न हुई। प्रस्तुत बैठक में संस्थान से डॉ. अनीस के., प्रधान वैज्ञानिक एवं हिंदी अधिकारी तथा सुश्री. एन. प्रसन्नकुमारी, मुख्य तकनीकी अधिकारी ने भाग ली।

हिंदी प्रकाशन

- मसालों की महक 2025
- एआईसीआरपीएस वार्षिक प्रतिवेदन का कार्यकारी सारांश 2024-25
- आईसीएआर-आईआईएसआर के वार्षिक प्रतिवेदन का कार्यकारी सारांश 2024
- काली मिर्च के विषाणु रोग और उसका प्रबंधन।

राजभाषा रिपोर्ट

संस्थान के राजभाषा कार्यान्वयन की जनवरी-मार्च 2025, अप्रैल-जून 2025, जुलाई-सितंबर 2025 तथा अक्तूबर-दिसंबर 2025 की तिमाहियों की रिपोर्ट तैयार करके भारतीय कृषि अनुसंधान परिषद, नई दिल्ली को भेज दिया। यह रिपोर्ट राजभाषा

विभाग, नई दिल्ली को ऑनलाइन भर दिया। राजभाषा कार्यान्वयन का अर्धवार्षिक रिपोर्ट तैयार करके नगर राजभाषा कार्यान्वयन समिति को प्रस्तुत किया।

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान क्षेत्रीय केंद्र के राजभाषा कार्यान्वयन की जनवरी-मार्च 2025, अप्रैल-जून 2025, जुलाई-सितंबर 2025 तथा अक्तूबर-दिसंबर 2025 की तिमाहियों की रिपोर्ट तैयार करके राजभाषा विभाग, नई दिल्ली को ऑनलाइन भर दिया। राजभाषा कार्यान्वयन का अर्धवार्षिक रिपोर्ट तैयार करके नगर राजभाषा कार्यान्वयन समिति, मडिकेरी को प्रस्तुत किया।

हिंदी सप्ताह

राजभाषा हिंदी को बढ़ावा देने के लिए भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, कोषिक्कोड में 16 सितंबर से 22 सितंबर, 2025 तक हिंदी सप्ताह मनाया गया। उद्घाटन समारोह दिनांक 16.9.2025 को संपन्न हुआ। डॉ. के. अनीस, प्रधान वैज्ञानिक एवं हिंदी अधिकारी ने समारोह में सबका स्वागत किया। संस्थान के निदेशक डॉ. आर. दिनेश ने समारोह का उद्घाटन किया। उद्घाटन भाषण में उन्होंने हिंदी भाषा के महत्व पर प्रकाश डाला। उद्घाटन के बाद हिंदी शब्द निर्माण प्रतियोगिता आयोजित की। उसमें सभा में उपस्थित सभी अधिकारियों एवं कर्मचारियों ने भाग लिया। उसके बाद कचरा प्रबंधन विषय पर डॉ. के. अनीस ने हिंदी में व्याख्यान एवं स्लाइड प्रस्तुत किया। सुश्री एन. प्रसन्नकुमारी के धन्यवाद ज्ञापन के साथ समारोह समाप्त हुआ।

हिंदी सप्ताह के अवसर पर दिनांक 17.09.2025 से 22.09.2025 के दौरान हिंदी कविता रचना, हिंदी टिप्पणी एवं मसौदा लेखन, हिंदी आशु भाषण, हिंदी गीत, हिंदी में वीडियो निर्माण, हिंदी कमन्ट्री, हिंदी डम्प शराड्स आदि प्रतियोगिताएं आयोजित की। इन सभी प्रतियोगिताओं में अधिकारियों एवं कर्मचारियों ने सक्रिय रूप से भाग लिया। विभिन्न प्रतियोगिताओं में कुल मिलाकर 142 प्रतिभागियों ने भाग लिया।

हिंदी सप्ताह का समापन समारोह दिनांक 22 सितंबर 2025 को अपराह्न 3.30 बजे संपन्न हुआ। डॉ. के. अनीस, प्रधान वैज्ञानिक एवं हिंदी अधिकारी ने समारोह में सबका स्वागत किया। उसके बाद उन्होंने हिंदी सप्ताह के अवसर पर आयोजित कार्यक्रमों का विवरण प्रस्तुत किया। समारोह में संस्थान के निदेशक डॉ. आर दिनेश ने विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कार प्रदान किया। इसके अलावा वर्ष 2024-25 के दौरान हिंदी में 10,000 से अधिक शब्दों का प्रयोग किए गए अधिकारियों एवं कर्मचारियों को टिप्पणी एवं मसौदा लेखन पुरस्कार राशि एवं राजभाषा प्रोत्साहन पुरस्कार प्रदान किया। समारोह में वीडियो संपादन प्रतियोगिता के श्रेष्ठ दो वीडियो का प्रदर्शन किया गया।

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान, क्षेत्रीय केंद्र, अप्पंगला में 16 सितंबर से 22 सितंबर, 2025 तक हिंदी सप्ताह मनाया गया। हिंदी सप्ताह के अवसर पर दिनांक 16.9.2025 को हिंदी कार्यशाला आयोजित की। इसके अलावा हिंदी में विभिन्न प्रतियोगिताएं आयोजित कीं।

हिंदी सप्ताह की झलकियाँ

हिंदी पुरस्कार

नगर राजभाषा कार्यान्वयन समिति, मडिकेरी के तत्वावधान में वर्ष 2024-25 के लिए आयोजित राजभाषा शील्ड प्रतियोगिता में भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान क्षेत्रीय केंद्र, अप्पंगला को केंद्र सरकार कार्यालयों की श्रेणी में संघ की राजभाषा नीति के कार्यान्वयन की दिशा में उत्कृष्ट कार्य निष्पादन हेतु राजभाषा शील्ड 2024-25 का प्रथम पुरस्कार प्रप्त हुआ।

हिंदी तिमाही पुरस्कार योजना

प्रत्येक तिमाही में हिंदी में सर्वाधिक काम करने वाले अधिकारियों के लिए तिमाही पुरस्कार योजना लागू की गई। इसके अनुसार प्रत्येक तिमाही में सर्वाधिक काम करने वाले अधिकारी को नकद पुरस्कार दिया जाता है।

राजभाषा निरीक्षण

डॉ. सुधाकर पांडे, सहायक महानिदेशक, भारतीय कृषि अनुसंधान परिषद ने दिनांक 8 जनवरी, 2025 को संस्थान के राजभाषा कार्यान्वयन का निरीक्षण किया।

HUMAN RESOURCES DEVELOPMENT (HRD) PROGRAMMES

Memorandum of Understanding (MoU)

S.No.	Colleges / Universities
1	GEMS Arts and Science College, Kadungapuram P.O., Ramapuram, Malappuram, Kerala
2	Markaz Arts & Science College, Karthala P.O., Athavanad, Malappuram, Kerala
3	Providence Women's College, Malaparamba, Kozhikode, Kerala
4	Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Vel Nagar, Avadi, Chennai, Tamil Nadu

Training programmes attended by staff members

S.No.	Name	Deteils of the programme	Organizer	Date
Scientific staff				
1	Dr. C. Sellaperumal	3-days training programme on the identification and diagnosis of plant parasitic nematodes and nematode diseases of crops	ICAR-IARI, New Delhi	10 to 12 March 2025
2	Dr. Shamsudheen M.	Uncertainty measurement and decision rule as per ISO/IEC 17025:2017	Quality Council of India, New Delhi	21 to 22 September 2025
3	Dr. K.S. Krishnamurthy	Vigilance perspective for ICAR officers	ICAR-NAARM, Hyderabad	04 November 2025
Technical staff				
4	Mr. Rakesh M. Raghavan	MOOC on disease and pest control through bio-control agents (online)	Kerala Agricultural University, Thrissur	04 to 27 June 2025
5	Dr. Pavan Gowda M.	Advances in climate data analysis	TNAU, Coimbatore	23 to 26 June 2025
6	Mr. E.S. Sujeesh	The hybridization and planting material production training in coconut	CPCRI, Kasaragod	13 to 15 October 2025
7	Mr. V.S. Binoy Mr.			
8	A.R. Rasmish			
9	Dr. Pavan Gowda M	Online training programme on vertebrate pest management – wild boar, monkey, and birds	National Institute of Plant Health Management, Rajendranagar, Hyderabad	14 to 17 October 2025
10	Dr. Pavan Gowda M	Nursery management in fruit crops	ICAR-IIHR, Bengaluru	16 to 18 December 2025
11	Mr. E.S. Sujeesh			

Seminar/Symposium/Conferences attended

S.No.	Name	Seminar/Symposium/Conference details	Date
1.	Dr. V.K. Sajesh	National symposium on spices and aromatic crops (SYMSAC -XI) – Strategies for smart production, product diversification, and utilization, at ICAR -Indian Institute of Spices Research, Kozhikode, organised by the Indian Society for Spices (ISS) in collaborati on with ICAR, ICAR-IISR, Spices Board, DASD, and ICAR -NRCSS	07 to 09 January 2025
2.	Dr. M.S. Shivakumar		
3.	Dr. S. Aarthi		
4.	Dr. S. Mukesh Sankar		
5.	Dr. S.J. Ankegowda		
6.	Dr. Honnappa Asangi		
7.	Dr. P.S. Divya		
8.	Dr. V. Vinu		
9.	Dr. C.K. Thankamani		
10.	Dr. H.J. Akshitha		
11.	Dr. M. Pavan Gowda		
12.	Dr. Mohammed Faisal Peeran		
13.	Dr. C. Sarathambal		
14.	Dr. V. Srinivasan		
15.	Dr. P.V. Alfiya		
16.	Dr. E. Jayashree		
17.	Dr. P. Ratha Krishnan		
18.	Dr. P. Rajeev		
19.	Dr. S. J. Anke Gowda	National conference on value chain management in spices & aromatic plants for profit optimization & resilience at Jain Hills, JISL, Jalgaon, Maharashtra, organised by the Confederation of Horticulture Associations of India (CHAI) and Jain Irrigation Systems Ltd (JISL)	18 to 19 January 2025
20.	Dr. C. K. Thankamani		
21.	Dr. A. Ishwara Bhat	National conference on “Emerging issues and sustainable strategies in plant health management: A global perspective”, at Nagpur, organized by Indian Phytopathology in collaboration with ICAR -Central Citrus Research Institute	19 to 21 January 2025
22.	Dr. P. Ratha Krishnan	International conference on "Rainfed agriculture: Building pathways for resilience & sustainable livelihoods at ICAR-CRIDA, Santoshnagar, Hyderabad	29 to 31 January 2025

23.	Dr. B. Manimaran	National symposium on nematode management in Agriculture at Goa, organized by Syngenta India	01 February 2025
24.	Dr. C.M. Senthil Kumar	37th Kerala Science Congress at Kerala Agricultural University, Thrissur, organised by Kerala State Council for Science, Technology and Environment (KSCSTE) and Kerala Forest Research Institute (KFRI)	08 to 09 February 2025
25.	Dr. Sona Charles	National seminar and workshop on NGS data analysis, organised by the Department of Genomic Science, Central University of Kerala	19 to 22 February 2025
26.	Dr. R. Praveena	Second international conference on biological control: Biocontrol contributions to one health (2icbc2025) at Radisson Blu Atria Bengaluru, organised by the Society for Biocontrol Advancement (SBA) and the ICAR-National Bureau of Agricultural Insect Resources (ICAR–NBAIR), Bengaluru	25 to 28 February 2025
27.	Dr. C.M. Senthil Kumar		
28.	Dr. Sharon Aravind	National symposium on recent trends in omics in plant biology at ICAR-IISR, Kozhikode	20 to 22 May 2025
29.	Dr. S. Aarthi		
30.	Dr. S.R. Maneesha		
31.	Dr. Shameena Beegum P.P.	International workshop on strengthening coconut gene banks for a climate resilient and sustainable future (SCG4CFSF-2025) at ICAR–CPCRI, Kasaragod	01 September 2025
32.	Dr. H.J. Akshitha	11th Indian Horticulture Congress-2025, organised by the Indian Academy of Horticultural Sciences (IAHS) at the University of Agricultural Sciences, Bengaluru	06 to 09 November 2025
33.	Dr. Alfiya P.V.	59th Annual Convention of the Indian Society of Agricultural Engineers, organised by the Indian Society of Agricultural Engineers (ISAE), at ICAR-Central Institute of Agricultural Engineering, Nabi Bagh, Berasia Road, Bhopal	10 to 12 November 2025
34.	Dr. E. Jayashree		

35.	Dr. C. Sellaperumal	12th International conference on agriculture & veterinary: Transformative approaches, research & innovations, organised by the College of Agriculture, Goa	16 to 18 November 2025
36.	Dr. C. Sellaperumal		
37.	Dr. T.P. Muhammed Azharudheen	International Symposium on Global Perspectives in Angiosperm Systematics, Traditional Knowledge and Biodiversity Conservation, organised by Indian Association for Angiosperm Taxonomy (IAAT), at St. Joseph's College (Autonomous), Devagiri, Kozhikode, Kerala	21 to 23 November 2025
38.	Dr. S. Mukesh Sankar		
39.	Dr. G.A. Rajanna	Sixth International Agronomy Congress on 'Re-envisioning agronomy for smart agri-food systems and environmental stewardship', at Delhi, organised by the Indian Society of Agronomy, New Delhi	24 to 26 November 2025
40.	Dr. P.V. Alfiya	International conference on process engineering and sustainable technology – STEP 2025, Department of Chemical Engineering, Government Engineering College, Kozhikode (Under the aegis of YUKTHI 2025)	03 to 05 December 2025
41.	Dr. S.R. Maneesha	6th International conference on plant physiology, Tamil Nadu Agricultural University (TNAU), Coimbatore	15 to 18 December 2025
42.	Dr. B. Manimaran	National conference on Transforming plant health management: Integrating traditional practices with modern innovations for global food security, organised by the Indian Phytopathological Society (Southern Zone Chapter) at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA &RI), Karaikal, UT of Puducherry	18 to 19 December 2025
43.	Dr. S. Aarthi	International conference on community agrobiodiversity management, Kerala Agrobiodiversity Conference 2025, at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala	22 to 23 December 2025
44.	Dr. Sharon Aravind		

Ph.D. Awarded

S.No.	Name	Guide	Subject	Universiry
1	Ms. Theertha A.P.	Dr. K.S. Krishnamurthy	Botany	University of Calicut, Malappuram, Kerala
2	Ms. Nazmin Banu C.V.			
3	Ms. Mery Rincy K.	Dr. Santhosh J. Eapen	Biotechnology	
4	Ms. Saleena P.	Dr. E. Jayashree	Food Science and Technology	Kerala University of Fisheries and Ocean Studies, Kochi, Kerala

Ph.D. registrations

S.No.	Name	Subject	Guide
1	Ms. Shahma K.	Biochemistry	Dr. R. Sivaranjani
2	Ms. Rabisha V.P.	Biochemistry	Dr. T.E. Sheeja
3	Ms. Neelima. A.P.	Biochemistry	
4	Ms. Lulu	Botany	Dr. K.S. Krishnamurthy
5	Ms. Anjana Vijayan	Botany	Dr. R. Sivaranjani
6	Ms. Shelly E.P.	Botany	Dr. Sharon Aravind
7	Ms. Jaleesha M.	Botany	
8	Mr. Muhthasim K.V.	Botany	
9	Ms. Sreelakshmi K.	Botany	Dr. R. Praveena
10	Ms. Athira U.	Botany	Dr. S. Aarthi
11	Ms. Athulya K.K.	Botany	Dr. K. Anees

Student dissertations and trainings

- M.Sc. Projects: 19
- Post M.Sc. training programmes: 04
- B.Sc. projects: 02
- Internship programmes: 37
- Honorary Research Fellows: 13

HRD programmes organised

S.No.	Programme details	Date	No. of participants
1	Hands-on Training Programme on Molecular Biology, Bioinformatics, and Tissue Culture (3 batches)	27 to 29 May 2025 28 to 30 July 2025 25 to 27 September 2025	28
2	Summer Internship Programme 2025	01 to 30 May 2025	27

MAJOR EVENTS

National Symposium on Spices and Aromatic Crops (SYMSAC-XI)

The National Symposium on Spices and Aromatic Crops (SYMSAC-XI) – Strategies for Smart Production, Product Diversification, and Utilization was successfully held at ICAR-IISR, Kozhikode, from 7th to 9th January 2025. The event, organized by the Indian Society for Spices (ISS) in collaboration with ICAR, ICAR-IISR, Spices Board, DASD, and ICAR-NRCSS, brought together experts and stakeholders to discuss the latest trends and technologies in spice and aromatic crop production.

The Chief Guest, Dr. Sanjay Kumar Singh, Deputy Director General (Horticultural Science), ICAR, emphasized the need for the adoption of modern technologies in spice cultivation.

The Guest of Honor, Dr. Sudhakar Pandey, Assistant Director General (Flowers, Vegetables, Spices, Medicinal Plants), ICAR, discussed the need to establish benchmarks for developing colorant and nutraceutical varieties from spices.

A crucial session on 'Farmers-Scientist-Industry-FPO' was organized, emphasizing the collaboration between different stakeholders to address the challenges faced by the spice industry. The symposium also delved into cutting-edge technologies such as gene editing, climate-smart agriculture, and safe spice production. An exhibition displaying innovative technologies from various research organizations was also held. Additionally, the symposium highlighted promising technologies for commercialization, including a rapid detection method for Piper yellow mottle virus, micronutrient-based foliar formulations for small cardamom growth, and innovative approaches to managing diseases in cardamom and fennel.

DASD sponsored farmers training Programme at ICAR- IISR RS, Appangala

ICAR- Indian Institute of Spices Research Regional Station, Appangala, organized one day MIDH-farmers training programme on "Agro-Technological Practices for Sustainable Black Pepper Production" on 13.02.2025, sponsored by the Directorate of Arecanut and Spices Development(DASD), Kozhikode. The programme was inaugurated by Dr. V. Srinivasan, Head, Division of Crop Production & PHT, ICAR-IISR, Kozhikode.

RISE UP – Startup Conclave

The RISE UP Startup Conclave, hosted by the ICAR-Indian Institute of Spices Research, Kozhikode, from 19-21 February, concluded successfully, bringing together entrepreneurs, students, and industry stakeholders to foster collaboration in the agriculture and spice sectors.

Dr. George Ninan, Director, ICAR-CIFT, Kochi, inaugurated the event. The first day featured the NavUdyam program, which included a theme-based Idea Hackathon and a Startup Orientation Programme. This programme, conducted in collaboration with the Kerala Startup Mission, provided a platform for participants to present their ideas to an expert panel and gain valuable insights into launching and growing a startup. On the second day, Dr. R. Dinesh inaugurated the exhibition stalls for the Udayam 2.0 Agri Expo. Held at the IISR campus, the exhibition showcased around 70 small-scale entrepreneurs and agricultural product manufacturers. The diverse displays included farm tools, bio-inputs, seeds, and value-added products. Innovations developed at IISR, such as bio-capsules and unique spice varieties, were also featured. Additionally, the 'Udyamitha' Business Meet was organized, where ICAR institutes, Kerala Agricultural University, and NIFTEM Thanjavur presented their ready-to-market technologies. Entrepreneurial support schemes were also introduced by institutions such as the District Industries Centre, MSME-DFO, and the Department of Agriculture. On the third day, the 'Udyamika' – Women Entrepreneurs Conclave was held at the institute, addressing the unique challenges and opportunities for women entrepreneurs in the agriculture and spice sectors.

The event concluded with a valedictory session, during which Shri P. Prasad, Hon'ble Minister for Agriculture, Kerala, commended IISR for its continuous support of entrepreneurial efforts, recent research innovations, such as the spice-infused jaggery mix, and also highlighted IISR technologies aimed at reducing wildlife-related damage to crops. During the event, Hon'ble Minister presented awards for the best exhibition stalls and innovative products and handed over license agreements for the production of seed materials of IISR varieties – IISR Surasa, IISR Surya, and IISR Vajra – to the respective recipients.

International Women's Day Celebration

The Institute Women's Cell of ICAR-IISR organized a women's day celebration on the theme "For ALL women and girls: Rights, Equality, Empowerment." The event was graced by Smt. K C Rosakkutty, Chairperson of the Kerala State Women's Development Corporation, as the Chief Guest. Renowned Malayalam writer Smt. B M Suhara was the Guest of Honour and addressed the IISR fraternity on womens' empowerment. An awareness session on "Empowerment through Fitness and Nutrition" was conducted by Mr. Muhammed Ashraf, Ex-Indian Army Coach and Former Mr. India, focused on the critical role of fitness and nutrition in empowering individuals

National Symposium on Recent Trends in Omics in Plant Biology

The 'National Symposium on Recent Trends in Omics in Plant Biology' from May 20–22, 2025, was conducted as part of its Golden Jubilee celebrations. The event brought together over 70 participants, including scientists, academicians, students, and industry representatives from across India, to deliberate on the advances and applications of omics technologies in plant sciences. The symposium commenced with the Pre- Symposium Workshop on May 20, 2025, which focused on hands-on training in transcriptomics, Genome Wide Association Studies, metagenomics, and machine learning using tools such as Galaxy, R, and Python.

Visit of the Parliamentary Standing Committee on Agriculture, Animal Husbandry and Food Processing

The Parliamentary Standing Committee on Agriculture, Animal Husbandry and Food Processing, chaired by Shri Charanjit Singh Channi, Hon'ble Member of Parliament, Lok Sabha, visited the ICAR-Indian Institute of Spices Research (IISR), Regional Station, Appangala on 23rd May 2025. The delegation comprised 12 Members of the Lok Sabha, 4 Members of the Rajya Sabha, and officials from the Lok Sabha Secretariat. During the visit, the institute organized an exhibition highlighting the latest varieties and technologies in spice cultivation developed by ICAR-IISR. The exhibition was inaugurated by Shri Charanjit Singh Channi, the Hon'ble Chairman of the Committee.

Launch of Pradhan Mantri Dan Dhanya Yojna

A training session on Black Pepper farming was organized in connection with the launch of the PM Dhanya Yojana (PM DDY) Scheme on 11th October 2025. More than 60 farmers from various panchayats of Kozhikode district participated in the training. As part of the event, a live telecast of the PM Dhan-Dhanya Yojana inauguration, held at the ICAR Headquarters, New Delhi, was also arranged at the institute

Janjatiya Gaurav Varsh Pakhwada

As part of the nationwide observance of Janjatiya Gaurav Varsh Pakhwada commemorating the 150th Birth Anniversary of Bhagwan Birsa Munda, ICAR-IISR organized a series of outreach, training, and empowerment programmes at multiple locations across the country during 1-15 November 2025. A hands-on training programme on multiplication techniques in black pepper was conducted, benefiting 220 tribal farmers, followed by an exposure visit of tribal farmers from Chhattisgarh, Madhya Pradesh, and Jharkhand. A special outreach and empowerment programme was organized in collaboration with The Wayanad Social Service Society, Mananthavady, Wayanad District, Kerala, involving 75 tribal Self-Help Groups. A training programme on sustainable cultivation technologies for ginger was conducted for 30 women tribal farmers from Phuvkiu and Mongtsuwong villages of Kiphire District, Nagaland. In addition, a technical session on piper diversity in Meghalaya and cultivation of black pepper in Ri-Bhoi District was organized as part of the one-day training programme on conservation of local genetic resources of spices, in collaboration with ICAR–NBPGR, Regional Station, Shillong, benefiting 100 tribal households.

Viksit Krishi Sankalp Abhiyaan

The ICAR–Indian Institute of Spices Research (IISR), Kozhikode, organized a series of outreach

activities as part of the nationwide initiative, 'Viksit Krishi Sankalp Abhiyan', launched by the Union Ministry of Agriculture and Farmers Welfare in collaboration with ICAR. The campaign ran from May 29 to June 12, intending to strengthen dialogue between agricultural scientists and farming communities.

As part of the programme, multidisciplinary teams comprising IISR scientists, officials from various state agriculture departments, and local stakeholders visited different regions to interact directly with farmers. The initiative, aligned with the Centre's 'Lab to Land' approach, focused on translating scientific advancements into practical solutions for farmers, while promoting sustainable agricultural practices.

Dr. Y.R. Sarma Memorial Lecture

The 9th Dr. Y.R. Sarma Memorial Lecture was held at ICAR - Indian Institute of Spices Research in fond remembrance of Dr. Y.R. Sarma, an eminent plant pathologist and former Director of the institute. Jointly organized by the Dr. Y.R. Sarma Memorial Trust and ICAR-IISR, the lecture was delivered by Dr. Diby Paul, Professor of Biology, College of Life and Health Sciences at Truett McConnell University, Cleveland, USA, and a former student of Dr. Sarma. The lecture was on the topic 'Quorum Sensing and Quorum Quenching with Special Reference to Plant Pathogenic Bacteria', explaining the potential of this advanced technique in plant disease management.

Vigilance Awareness Week 2025

ICAR–Indian Institute of Spices Research, Kozhikode, observed Vigilance Awareness Week 2025 from 28 October to 2 November 2025 with the theme "Vigilance: Our Shared Responsibility." The observance began with an Integrity Pledge. A series of awareness programmes was conducted within the institute, including slogan writing, elocution, cartoon drawing, and quiz competitions. A Vigilance Awareness Rally was also organized to spread the message of integrity among the public, during which PIDPI pamphlets were distributed in English, Malayalam, and Hindi. A special vigilance awareness lecture was delivered by Mr. O. Sasi, Legal Advisor, Vigilance and Anti-Corruption Bureau, Northern Range, Kozhikode, enriching participants with insights into the importance of vigilance in public life.

Swachh Bharat Abhiyaan

As part of commemorating Swachh Bharat Mission, ICAR-Indian Institute of Spices Research organized Swachhotsav, a nationwide cleanliness campaign themed under Swachhata Hi Seva, from 17 September to 2 October 2025. Additionally, Swachhta Pakhwada was observed from 16 to 31 December 2025. During Swachhta Pakhwada 2025, ICAR–IISR has organized a wide range of cleanliness, awareness, and community outreach activities. These included Swachhta pledge programmes for staff, students, farmers, and community members; systematic cleaning of campuses, laboratories, processing units, record rooms, staff quarters, and public spaces; tree plantation and green drives; waste-to-wealth initiatives such as vermicomposting and banana fibre extraction; recycling of wastewater for irrigation; awareness classes, quizzes, drawing and waste-to-art competitions; plogging rallies, signature campaigns, farmer interactions on Kisan Diwas; and extensive digital outreach and media documentation to ensure wider public engagement.

Celebration of 150 years of '*Vande Mataram*'

ICAR - Indian Institute of Spices Research, along with the ICAR-IISR Regional Station, Appangala; ICAR-IISR Experimental Farm, Peruvannamuzhi; and ICAR-IISR KVK, Peruvannamuzhi, joined the nationwide mass singing to mark 150 years of '*Vande Mataram*', on 7th November.

RESEARCH PUBLICATIONS

1. Alfiya, P.V., Jayashree, E. and Theertha, K.V. 2025. Conventional sun drying and infrared convective drying of spices: A comparative evaluation on kinetics and quality. *Solar Energy*, 291:113396. https://doi.org/10.1016/j.solener.2025.113396
2. Alfiya, P.V., Jayashree, E. and Theertha, K.V. 2025. Design and development of infrared convective dryer for spices: 4E (energy, efficiency, exergy, and economic) analysis. *Biomass Conversion and Biorefinery*, 15:20107–20118. https://doi.org/10.1007/s13399-025-06535-3
3. Alfiya, P.V., Jayashree, E. Anees, K., Shahala, P. and Avantika, S. 2025. Optimization and characterization of turmeric oleoresin impregnated biodegradable packaging film. *Packaging Technology and Science*, 1–18 https://doi.org/10.1002/pts.70051
4. Alfiya, P.V., Jayashree, E., Anees, K. 2025. Techno-economic, environmental impact and exergy analysis microwave assisted drying of nutmeg mace. *Environmental Progress and Sustainable Energy*, e14550. https://doi.org/10.1002/ep.14550
5. Alfiya, P.V., Jayashree, E. and Anees, K. and Ann Mary, A. 2025. Drying characteristics, color kinetics and quality evaluation of black pepper (*Piper nigrum*) under conventional and novel drying methods. *Environmental Progress and Sustainable Energy*, e70232. https://doi.org/10.1002/ep.70232
6. Alfiya, P.V., Jayashree, E., Anees, K. and Sunisha, K. 2025. Drying kinetics and quality Evaluation of mace under solar, vacuum and hot-air drying methods, *Journal of Food Process Engineering*, 48:e70212. https://doi.org/10.1111/jfpe.70212
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8. Anitta Abraham, Sarathambal, C. Srinivasan, V., Thankamani, C.K. 2025. Management practices on soil biochemical parameters and rhizosphere microbial communities of turmeric (*Curcuma longa* L.): An overview. *Agricultural Reviews*, R-2740, 1-10.
9. Ansheef Ali, Anees, K., Srinivasan, V., Verma, V.K. and Rachit Saxena. 2025. Trait-led valorization of North Eastern Sub-Himalayan Indian turmeric landraces: Curcuminoids, essential oil, minerals, colour metrics, and antioxidant capacity for nutraceutical and industrial uses. *Industrial Crops & Products*, 236: 122086.
10. Azharudheen, T.P.M., Fayad, A.M. and Sheeja, T.E. 2025. Genetic diversity and phylogenetic relationships among *Piper* species using gene-based cross-transferable simple sequence repeat (SSR) markers. *Genetic Resources and Crop Evolution*, 1–9.
11. Balaji Rajkumar, M., Sivaranjani, R., Senthil Kumar, C.M., Punithavalli, M., Honnappa Asangi and Ankegowda, S.J. 2025. Impact of thrips (*Sciothrips cardamomi*) damage on volatile composition and other attributes of cardamom capsules (*Elettaria cardamomum*). *Annals of Applied Biology*, 1-14.
12. Binsy, K.C., Aravind, S., Soudath, K.F., Sankar, S.M., Muhthasim, K.V. and Babu, K.N. 2025. *In vitro* regeneration and advances in micropropagation for conservation and genetic enrichment of

ginger (*Zingiber officinale* Rosc.). *Planta*, 263(1): 25.

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14. Charles, S., Kaprakkaden, A., Duraisamy, P., Thotten Elampilay, S. and Arif, S. 2025. Integrating omics for future-ready plant science: Reflections from the national symposium on recent trends in omics in plant biology, held in Kozhikode, India. *OMICS*, 29(9): 473–474. https://doi.org/ 10.1177/ 15578100251367325

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ONGOING PROJECTS

Division of Crop Improvement and Biotechnology

Mega Project I: Characterizing genetic resources to identify core collections and their long-term conservation [Project Leader: Dr. M.S. Shivakumar]

1. Gen. XXVIII (813): Conservation and characterization of *Piper* germplasm (2008-2025) [Dr. Muhammed Azharudheen T.P., Dr. M.S. Shivakumar, Dr. Honnappa Asangi, Dr. R. Sivaranjani & Dr. Maneesha S.R.]
2. Gen. XIX (813): Conservation, characterization, evaluation and improvement of *Zingiber* and *Curcuma* sp. (2007-2026) [Dr. S. Aarthi, Dr. V. Vinu, Dr. H.J. Akshitha, Dr. D. Prasath, Dr. Anees K. & Mr. V.A. Muhammmed Nissar] (External support: Dr. C.N. Biju)
3. Gen. XXXIII (813): Identification of core collection, characterization, and maintenance of cardamom germplasm (2012- 2025) [Dr. Honnappa Asangi, Dr. S.J. Ankegowda, Dr. H.J. Akshitha, Dr. Mohammed Faisal Peeran, Dr. M. Balaji Rajkumar & Dr. Sivaranjani R.]
4. Gen. XXXVI (813): Genetic resources management in tree spices and vanilla (2018-2028) [Mr. V.A. Muhammed Nissar, Dr. Sharon Aravind, Dr. Honnappa Asangi, Dr. Muhammed Azharudheen T.P., Dr. Maneesha S.R. Dr. S. Aarthi, Dr. Sivaranjani R., Dr. Mohammed Faisal Peeran] (External support: Dr. Shivakumar M.S. & Dr. Anees K.)

Mega Project II: Genomics assisted breeding for trait specific varieties in spices [Project Leader: Dr. T. E. Sheeja]

1. Gen. XXXI (813): Breeding black pepper for high yield, quality, and resistance to stresses (2012-2025) [Dr. M.S. Shivakumar, Dr. K.S. Krishnamurthy, Dr. Muhammed Azharudheen T.P. & Mr. Mukesh Sankar S.] (External support: Dr. S.J. Ankegowda, Dr. C.N. Biju)
2. Gen. XXXVI (813): Evolving high yielding, biotic and abiotic stress resistant cardamom lines through selection and hybridization (2018 - 2029) [Dr. H.J. Akshitha, Dr. S.J. Ankegowda, Dr. M. Balaji Rajkumar, Dr. M.S. Shivakumar, Dr. Mohammed Faisal Peeran & Dr. Honappa Asangi]
3. Gen. XXXVIII (813): Screening and evaluation of black pepper (*Piper nigrum* L.) genotypes for nutrient use efficiency (2023-2028) [Dr. Maneesha S.R., Dr. M.S. Shivakumar, Dr. V. Srinivasan, Dr. T.E. Sheeja, Dr. K.S. Krishnamurthy & Dr. Shamsudheen M.]
4. Gen. XXXIX (813): Rootstock breeding in nutmeg and black pepper for enhanced yield, tolerance to biotic and abiotic stresses (2023- 2028) [Dr. Sharon Aravind, Dr. Maneesha S.R., Mr. V.A. Muhammad Nissar, Dr. K.S. Krishnamurthy & Dr. C.N. Biju]
5. Gen. XXXX (813): Development and evaluation of chemically induced ginger mutants for Pythium tolerance (2025-2030) [Dr. V. Vinu, Dr. S. Aarthi, Dr. T.E. Sheeja & Dr. Praveena R.]
6. Gen. XXXXI (813): Development of doubled haploid production in black pepper (*Piper nigrum* L.) (2025-2030) [Dr. Mukesh Sankar S., Dr. Sharon Aravind, Dr. T.E. Sheeja, Dr. M.S. Shivakumar]
7. Biotech. XIV (813): DNA fingerprinting and barcoding in spices (2018 - 2026) [Dr. T.E. Sheeja, Dr. Mukesh Sankar S., Dr. Muhammed Azharudheen T.P. & Dr. Maneesha S.R.]
8. Biotech. XV (813): Identification and characterization of gene editing targets for disease resistance

in ginger (2021-2026) [Dr. P. S. Divya, & Dr. C.N. Biju) (External support: Dr. T.E. Sheeja & Dr. D. Prasath]

9. Biotech. XVI (813): Development of data-driven pipelines and tools for multiple high throughput sequencing data from spices (2022-2025) [Dr. Sona Charles & Dr. T.E. Sheeja]

10. ICAR-CIB-III: Genomics-assisted identification of trait-specific markers for major biotic and abiotic stresses and development of core collections of black pepper (2021-2026) [Dr. T.E. Sheeja, Dr. K.S. Krishnamurthy, Dr. M.S. Shivakumar, Dr. Sona Charles, Dr. Muhammed Azharudheen T.P., Dr. U.B. Angadi & Dr. Sunil Kumar]

11. DUS project (2010-2025) [Dr. Sharon Aravind, Dr. V. Vinu, Dr. S. Aarthi, Dr. H.J. Akshitha, Dr. Maneesha S.R. & Dr. Muhammed Azharudheen T.P.] (External support: Dr. M.S. Shivakumar & Dr. Honnappa Asangi)

12. ICAR-CIB IV: Enabling climate resilience and ensuring food and nutritional security through genome editing in horticultural crops (2024-2026)

Sub project: Application of genome editing to develop trait-specific varieties/hybrids in ginger crops [Dr. P.S. Divya, Dr. T.E. Sheeja, Dr. Biju C.N. & Dr. Praveena R.]

Sub project: Application of genome editing to develop trait-specific varieties/hybrids in black pepper [Dr. Mohammed Faisal Peeran & Dr. Sharon Aravind]

13. NASF-CIB I: Integrating whole genome resequencing transcriptome sequencing and genome wide association analysis for allele mining of yield and quality traits in black pepper and cardamom (2024-2027) [Dr. T.E. Sheeja, Dr. M.S. Shivakumar, Dr. Mukesh Sankar S., Dr. Muhammed Azharudheen T.P., Dr. Sona Charles, Dr. H.J. Akshitha & Dr. Honnappa Asangi]

14. DBT-CIB X: National Network Project on Crop Bioinformatics (2024-2029) [Dr. D. Prasath, Dr. Sona Charles & Dr Anees K.]

15. CSIR-CIB I: Establishment of efficient in vitro techniques for the production of amide alkaloids from *Piper longum* L. (2024-2027) [Dr. Sharon Aravind & Dr. R. Sivaranjani)

New projects sanctioned

NASF-CIB II: Pangenome delineation and Genome-Wide Association Studies for NLRome and structural variation for seed sterility mapping in ginger (*Zingiber officinale* Roscoe) (Nov 2025-October 2028) [Dr. D. Prasath. Dr. Mukesh Sankar S., Dr. S. Aarthi, Dr. V. Vinu, Dr. Praveena R. D. Ajith Kumar Sigh (CARS, Raigarh) & Dr. Shilesh Kumar (NIPGR)]

Division of Crop Production and Post -Harvest Technology

Mega Project III: Enhancing input-use efficiency and productivity in spices through smart farming [Project leader: Dr. V. Srinivasan]

1. Phy. X (813): Evaluation of black pepper and cardamom elite lines for yield and quality under moisture stress (2010–2025) [Dr. S.J. Ankegowda & Dr. K.S. Krishnamurthy] (External support: Dr. H.J. Akshitha and Dr. M.S. Shivakumar]

2. Agr. XXXVII (813): Production of nucleus planting materials of improved varieties of spice crops (2006-2025) [Dr. V. Srinivasan, Dr. P. Rajeev, Dr. Sharon Aravind, Dr. Lijo Thomas, Dr. Honnappa Asangi & Dr. H.J. Akshitha] (External support: Dr. S.J. Ankegowda, Dr. D. Prasath, Dr. R. Praveena, Mr. V.A. Muhammad Nissar)

3. Biochem. X (813): Study on spike abscission: Developing chemically induced method for harvesting black pepper (*Piper nigrum* L.) (2018-2026) [Dr. Anees, K., Dr. K.S. Krishnamurthy & Dr. C.N. Biju]
4. ICAR-CPPHT-1: Network project on organic farming (2014-2025) [Dr. V. Srinivasan, Dr. Shamsudheen M., Dr. R. Praveena, Dr. C. Sarathambal, Dr. C. Sellaperumal & Dr. B. Pradeep]
5. NICRA-CPPHT 1: NICRA Strategic Component Project: Climate change impact, mitigation and climate resilience studies in black pepper, ginger and turmeric (2021-2026) [Dr. K.S. Krishnamurthy, Dr. U. Surendran, Dr. V. Srinivasan, Dr. R. Sivaranjani, Dr. S.J. Ankegowda, & Dr. Mukesh Sankar S.]
6. SSC VII (813): Optimisation of fertigation and development of UAV-assisted spraying strategies for spice crops (2024-2027) [Dr. Shamsudheen. M., Dr. V. Srinivasan, Dr. C.M. Senthil Kumar, Dr. Praveena R., Dr. Manimaran. B, Dr. B. Honnappa Asangi & Dr. Manjunatha K. (ICAR-DCR, Puttur)]

Mega Project IV: Value addition in spices through post-harvest interventions and product diversification [Project leader: Dr. E. Jayashree]

1. CPPHT X (813) Non-conventional approaches for spice processing, preservation and packaging (2023- 2026) [Dr. Alfiya P.V., Dr. E. Jayasree & Dr. Anees K.] (External Support: Dr. C. Sarathambal)
2. CPPHT XI (813): Development of secondary and tertiary processed products from spices (2025-2030) [Dr. E. Jayashree, Dr. Alfiya P.V. & Dr. Anees K.]
3. Biochem. XI (813): Novel protocol development for quality evaluation and extracting phytochemicals from spices (2024-2027) [Dr. Anees K., Dr. E. Jayashree, Dr. R. Sivaranjani, Dr. Alfiya P.V. & Dr. Sarathjith M.C. (Scientist B, CWRDM, Kozhikode)]
4. Biochem. XII (813): Pre and post-harvest interventions for quality improvement in major spices (2025-2030) [Dr. Sivaranjani R., Dr. Anees K., Dr. Krishnamurthy K.S. & Dr. Akshitha H.J.]

New projects

1. CPPHT XII (813): Development of sensitive and robust analytical methods for determination of pesticide residues and assessment of decontamination strategies in major spices (December 2025-2028) [Dr. Pritam Ganguly, Dr. Madhu T. & Dr. Anees K.] (External support: Dr. C.M. Senthil Kumar & Dr. Sivaranjani R.)
2. Agr. XXXVIII (813): Integrated resource management for mitigating drought stress and enhancing productivity in Spice crops (December 2025-2030) [Dr. Rajanna G.A., Dr. Ankegowda S.J., Dr. Akshitha H.J., Dr. Honnappa Asangi & Dr. V. Srinivasan] (External support: Dr. Praveena R. & Dr. Shivakumar M.S.)
3. CPPHT XIII (813): Valorization of spice-byproducts for developing functional food ingredients and probiotic beverages (December 2025 – 2028) [Dr. Shameena Beegum P.P., Dr. Alfiya P.V., Dr. E. Jayashree, Dr. C. Sarathambal & Dr. Pritam Ganguly] (External support: Dr. Anees K. & Dr. Sivaranjani R.)

Division of Crop Protection

Mega Project V: Bio-intensive management of pests and diseases in spices [Project Leader: Dr. A. Ishwara Bhat]

1. Ent. XVI (813): Development of an integrated deep learning and molecular tool-based automated expert system for early detection and identification of major insect pests and vector-transmitted viruses of spice crops (2024-2027) [Dr. C.M. Senthil Kumar, Dr. A. Ishwara Bhat Dr. M. Balaji Rajkumar & Dr. Gopi Krishna (Saramekala, NIT-C)]
2. Ent. XVII (813): Evaluation of new generation insecticides against major pests of spices for registration and label claim expansion (2025 -2028) [Dr. C.M. Senthil Kumar, Dr. M. Balaji Rajkumar, Dr. Mukesh Sankar S.] [External support: M.A. Ansar Ali and P. Thiyagarajan (Spices Board)]
3. Ent. XVIII (813): Characterization and evaluation of entomopathogenic fungi for biological control of cardamom root grub, *Basilepta fulvicornis* (2025-2028) [Dr. M. Balaji Rajkumar & Dr. C.M. Senthilkumar]
4. Nema. VIII (813): Multimodal approach to manage nematode pests infesting ginger (*Zingiber officinale* Rosc.) (2023-2028) [Dr. Manimaran, B., Dr. C. Sellaperumal & Dr. V. Vinu] (External support: Dr. D. Prasath, Dr. A. Ishwara Bhat, Dr. C.N. Biju, Dr. R. Praveena & Dr. C. Sarathambal)
5. Nema. IX (813): Multipronged management approaches for the major nematode problems in black pepper and turmeric cultivation (2024-28) [Dr. C. Sellaperumal, Dr. B Manimaran, Dr. S. Aarthi & Dr. T.P. Muhammed Azharudheen]
6. Path. XXVIII (813): Novel strategies for managing bacterial wilt and soft rot diseases of ginger (2018-2025) [Dr. C.N. Biju, Dr. Mohammed Faizal Peeran & Dr. P.S. Divya]
7. Path. XXX (813): Development and formulation of Plant Beneficial Rhizosphere Microorganisms (PBRMs) for disease antagonism, soil nutrient solubilization and plant growth promotion (2020-2025) [Dr. R. Praveena, Dr. R. Dinesh & Dr. C. Sarathambal] (External support: Dr. V. Srinivasan)
8. Path. XXX1 (813) Development of off- and on-site detection techniques for major pathogens of spice crops. (2020-2025) [Dr. A. Ishwara Bhat, Dr. C.N. Biju & Dr. Mohammed Faisal Peeran]
9. Path XXXII (813): Diversity analysis, survival studies and management of Pythium spp. infecting ginger (2023-2026) [Dr. R. Praveena, Dr. C.N. Biju & Dr. C. Sarathambal]
10. Path XXXIV (813): Development of arbuscular mycorrhizal fungi based bioinoculant formulation for growth promotion and disease tolerance in major spices (2024-28) [Dr. C. Sarathambal, Dr.V. Srinivasan, Dr. R. Praveena, Dr. H.J. Akshitha & Dr. B. Manimaran]
11. Path XXXV (813): Developing a weather-based prediction model and exploring new generation anti-oomycete fungicides to manage foot rot of black pepper (2024-28) [Dr. C.N. Biju, Dr. S.J. Ankegowda, Dr. T.P. Muhammed Azharudheen & Dr. Mohammed Faisal Peeran]

Social Sciences Section

1. Ext. VI (813). Capacity building and front-line intervention programmes for (spice sector development in NE states and tribal empowerment (2014-25) [Dr. P. Rajeev, Dr. Lijo Thomas & Dr. Sajesh V.K.]

2. Eco. IV (813): Developing models for enhancing technology and policy impact in spices sector 2020-2025) [Dr. Lijo Thomas, Dr. P. Rajeev, & Dr. Sajesh V.K.]
3. TATA Ext I (813): Pan India action research project on the improvement of spice value chains (2023-2026) [Dr. R. Dinesh, Dr. Lijo Thomas, Dr. D. Prasath, Dr. Sharon Aravind, Dr. Maneesha S.R., Mr. Muhammed Nissar V.A., Dr. Shivakumar M.S., Dr. V. Srinivasan, Dr. Anees K., Dr. Sivaranjani R., Dr. C.N. Biju, Dr. .C Sellaperumal, Dr. Mohammed Faisal Peeran, Dr. M. Balaji Rajkumar, Dr. P. Rajeev, Dr. Sajesh V.K. & Dr. V. Vinu]
4. Ext. VII (813). Entrepreneurship development in agriculture: A multi-dimensional study with special reference to spices (2023-27) [Dr. Sajesh V.K., Dr. P. Rajeev, Dr. Lijo Thomas, Dr. Maneesha S.R. & Dr. Sheeja T.E.]

Other Externally Funded Projects

1. Institute Technology Management – Agri Business Incubation (ABI) Unit [Dr TE Sheeja, Dr. Sajesh VK, Dr. Maneesha SR, Dr. Sharon Aravind, Dr. Shameena Beegum, P.P.]
2. RKVY-CP-2: An advanced centre for mass production of beneficial microflora for sustainable agriculture (2021-2024) [Dr. R. Praveena, Dr. C.M. Senthil Kumar & Dr. C. Sarathambal]
3. NBB-CPPHT-1: Establishment of mini honey testing laboratory (2024-2025) [Dr. Sivaranjani. R., Dr. Shamsudheen, M. & Dr. Aiswariya K.K.]
4. RKVY-CP-3: Enhancing production of quality planting material in cardamom and black pepper with nursery entrepreneurship training (2025-2027) [Dr. Akshitha H.J., Dr. Ankegowda S.J., Dr. Shivakumar M.S., Dr. Honnappa Asangi & Dr. M. Balaji Rajkumar]

   RKVY-CP-4: Establishment of a centre of excellence for spice biotechnology with advanced molecular facilities (20205-2027) [Dr. Shivakumar, M.S, Dr. Akshitha.H.J., Dr. Honnappa Asangi, Dr. M. Balaji Rajkumar & Dr. Ankegowda S.J.]

PERSONNEL

Headquarters (ICAR-IISR, Chelavoor, Kozhikode)

Scientific staff

S.No.	Name	Designation
1	Dr. R. Dinesh	Director
2	Dr. D. Prasath	Project Coordinator (AICRP on Spices)
3	Dr. V. Srinivasan	Head, Division of Crop Production & Post -Harvest Technology
4	Dr. T.E. Sheeja	Head, Division of Crop Improvement & Biotechnology
5	Dr. A. Ishwara Bhat	Head, Division of Crop Protection
6	Dr. P. Rajeev	Principal Scientist (Agricultural Extension)
7	Dr. K.S. Krishnamurthy	Principal Scientist (Plant Physiology)
8	Dr. E. Jayashree	Principal Scientist (Agricultural Engineering)
9	Dr. C.M. Senthil Kumar	Principal Scientist (Agricultural Entomology)
10	Dr. C.N. Biju	Principal Scientist (Plant Pathology)
11	Dr. Shamsudheen M.	Principal Scientist (Soil Science)
12	Dr. Lijo Thomas	Principal Scientist (Agricultural Economics)
13	Dr. Anees K.	Principal Scientist (Biochemistry-Plant Science)
14	Dr. Divya P.S.	Senior Scientist (Agricultural Biotechnology)
15	Dr. C. Sarathambal	Senior Scientist (Agricultural Microbiology)
16	Dr. R. Praveena	Senior Scientist (Plant Pathology)
17	Dr. Sajesh V.K.	Senior Scientist (Agricultural Extension)
18	Dr. C. Sellaperumal	Senior Scientist (Nematology)
19	Dr. Mukesh Sankar S.	Senior Scientist (Genetics & Plant Breeding)
20	Dr. Sharon Aravind	Senior Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
21	Dr. S. Aarthi	Senior Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
22	Dr. V. Vinu	Senior Scientist (Genetics & Plant Breeding)
23	Dr. Maneesha S.R.	Senior Scientist (Fruit Science)
24	Dr. R. Sivaranjani	Senior Scientist (Plant Biochemistry)
25	Dr. Manimaran B.	Senior Scientist (Nematology)
26	Dr. Shameena Beegum P. P.	Senior Scientist (Food Technology)
27	Dr. Pritam Ganguly	Senior Scientist (Agricultural Chemicals)
28	Dr. M. Balaji Rajkumar	Senior Scientist (Agricultural Entomology)
29	Mr. V.A. Muhammed Nissar	Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
30	Dr. Alfiya P.V.	Scientist (Agriculture Structure & Process Engineering)
31	Dr. Sona Charles	Scientist (Agricultural Bioinformatics)
32	Dr. Madhu Tippannavar	Scientist (Agricultural Chemicals)
33	Dr. Gayathri G.N.	Scientist (Agricultural Extension)

Administrative Staff

S.No.	Name	Designation
1	Mr. Babu R.K.	Senior Finance & Accounts Officer
2	Mrs. C.K. Beena	Private Secretary
3	Mr. V.V. Sayed Mohammed	Assistant Administrative Officer
4	Mr. Ajith K.S.	Assistant Administrative Officer
5	Mr. Abdul Rasheed T.K.	Assistant Administrative Officer
6	Ms. M. Seema	Assistant
7	Mr. Amaan Usmani	Assistant
8	Mr. Anuj Kumar	Assistant
9	Ms. Rebeena N.	Upper Division Clerk
10	Mr. P.K. Rahul	Upper Division Clerk
11	Mr. Krishnakumar P.C.	Lower Division Clerk
12	Ms. Archana N.	Lower Division Clerk

Technical Staff

S.No.	Name	Designation
1	Mr. R. Bharathan	Chief Technical Officer
2	Mrs. N. Prasannakumari	Chief Technical Officer
3	Mr. Sujeesh E.S.	Assistant Chief Technical Officer
4	Mr. A. Sudhakaran	Assistant Chief Technical Officer
5	Dr. Priya George	Technical Officer
6	Mr. Rakesh M. Raghavan	Technical Officer
7	Ms. Rabisha V.P.	Senior Technical Assistant
8	Dr. Vijesh Kumar I.P.	Senior Technical Assistant
9	Ms. N. Karthika	Technical Assistant
10	Mr. V.S. Binoy	Technical Assistant
11	Mr. O.G. Sivadas	Senior Technician
12	Mr. Vishnu B.	Senior Technician
13	Ms. Shajina O.	Senior Technician
14	Mr. Debayan Banarjee	Technician
15	Mr. Satya Priya Singh	Technician

Multi-Tasking Staff

S.No.	Name	Designation
1	Mr. Abhi Balagopal K.P.	Multi-Tasking Staff

ICAR-IISR Experimental Farm, Peruvannamuzhi, Kozhikode

Scientific Staff

S.No.	Name	Designation
1	Dr. Muhammed Azharudheen T.P.	Senior Scientist (Genetics & Plant Breeding)
2	Dr. Mohammed Faisal Peeran	Senior Scientist (Plant Pathology)

Technical Staff

S.No.	Name	Designation
1	Dr. Pavan Gowda M.	Senior Technical Officer
2	Mr. T.R. Sadasivan	Technical Officer
3	Mr. Rasmish A.R.	Technical Assistant
4	Ms. Rejina P. Govind	Senior Technician
5	Mr. Nikhil C.M.	Senior Technician

Administrative Staff

S.No.	Name	Designation
1	Mr. K. Faisal	Personal Assistant

Multi-Tasking Staff

S.No.	Name	Designation
1	Mr. Vijesh V.	Multi-Tasking Staff

ICAR-IISR Regional Station, Appangala, Madikeri

S.No.	Name	Designation
1	Dr. S.J. Anke Gowda	Principal Scientist (Plant Physiology & Head I/c)
2	Dr. Rajanna G.A.	Senior Scientist (Agronomy)
3	Dr. H.J. Akshitha	Senior Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
4	Dr. Honnappa Asangi	Senior Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
5	Dr. M.S. Shivakumar	Senior Scientist (Genetics & Plant Breeding)

Technical Staff

S.No.	Name	Designation
1	Mr. H.C. Rathish	Technical Officer (Driver)
2	Mr. N. Cholurappa	Senior Technician
3	Mr. Ranjith P.B.	Senior Technician

Multi-Tasking Staff

S.No.	Name	Designation
1	Mr. Sachin K.P.	Multi-Tasking Staff

Krishi Vigyan Kendra (KVK), Peruvannamuzhi, Kozhikode

Scientific Staff

S.No.	Name	Designation
1	Dr. P. Ratha Krishnan	Principal Scientist & Head, KVK

Technical Staff

S.No.	Name	Designation
1	Dr. P.S. Manoj	Chief Technical Officer (SMS – Horticulture)
2	Dr. K.M. Prakash	Chief Technical Officer (SMS – Agronomy)
3	Dr. B. Pradeep	Chief Technical Officer (SMS – Fisheries)
4	Ms. A. Deepthi	Chief Technical Officer (SMS – Home Science)
5	Dr. K.K. Aiswariya	Chief Technical Officer (SMS – Plant Protection)
6	Mr. T.C. Prasad	Technical Officer (Driver-cum-Mechanic)
7	Mr. C.K. Jayakumar	Senior Technical Officer (Programme Assistant – Computer)

Multi-Tasking Staff

S.No.	Name	Designation
1	Mr. C. Ravindran	Multi-Tasking Staff

WEATHER DATA - 2025

Month	Temperature (°C)					
	Headquarters Kozhikode		Experimental Farm Peruvannamuzhi		Regional Station Appangala	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	33.5	22.5	33.9	19.3	22.4	11.6
February	33.7	23.4	35.0	20.6	23.7	13.0
March	34.8	24.9	35.2	23.4	26.0	15.4
April	34.5	25.3	33.8	23.7	26.8	16.4
May	33.1	24.7	32.1	23.1	25.4	15.3
June	30.4	23.9	30.2	22.5	22.9	13.0
July	27.2	22.6	27.9	21.8	23.3	14.5
August	27.1	23.9	29.0	23.3	23.6	15.6
September	30.8	24.1	30.9	23.1	24.2	14.8
October	32.6	23.8	31.8	22.8	23.3	13.1
November	32.4	23.1	32.3	21.8	22.8	12.1
December	32.4	21.4	32.9	19.2	22.3	11.1

Month	Rainfall (mm)					
	Headquarters Kozhikode		Experimental Farm Peruvannamuzhi		Regional Station Appangala	
	Total rainfall	No. of rainy days	Total rainfall	No. of rainy days	Total rainfall	No. of rainy days
January	0.0	0	3.0	1	0	0
February	0.0	0	0.0	0	0	0
March	39.0	4	100.0	5	24.0	3
April	29.0	5	230.2	12	102.6	8
May	213.0	7	1079.2	16	613.2	14
June	702.1	20	1273.2	26	637.6	28
July	769.1	30	1212.0	31	754.5	31
August	335.4	16	746.4	20	497.7	20
September	24.7	1	326.6	15	258.6	20
October	42.0	7	489.4	19	166.4	17
November	129.1	6	46.0	6	36.0	2
December	19.7	2	16.6	1	0	0

ICAR–IISR GOLDEN JUBILEE CELEBRATIONS

The ICAR-Indian Institute of Spices Research (ICAR–IISR), Kozhikode, commemorated its Golden Jubilee with a year-long series of scientific, extension, entrepreneurial, and outreach activities, reflecting five decades of excellence in spices research, development, and technology dissemination.

Outreach programmes and capacity building

As part of the Golden Jubilee celebrations, extensive farmer awareness and outreach programmes were organized through the Krishi Vigyan Kendra (KVK), ICAR–IISR, focusing on spice innovations and improved production technologies. A video CD documenting 51 farmer success stories was released, showcasing the impact of ICAR-IISR technologies at the grassroots level.

The **Spice Yatra** initiative was envisaged and implemented to popularize ICAR-IISR technologies among farming communities, enhancing visibility and adoption of improved practices in spices cultivation.

As a part of the celebrations, a series of webinars was organized addressing areas such as agro-processing and agri-tech entrepreneurship, FSSAI licensing and regulatory requirements, essentials of packaging and labelling, branding of food and agri-products, product development and technology transfer strategies, branding consultations, intellectual property rights in agri-food sectors, and business prospects in spice extraction.

A comprehensive set of training, demonstration, and extension programmes was conducted during the Golden Jubilee year. These included:

- Farmers' training: 54
- General training programmes: 33
- Training for priority sector beneficiaries: 21
- Front Line Demonstrations: 126
- Input supply activities and programmes: 22
- Media programmes: 6
- Exhibitions: 10

These initiatives significantly strengthened farmer capacity, promoted technology adoption, and enhanced awareness of sustainable and profitable spice cultivation practices.

Entrepreneurship development programmes

To foster agripreneurship, ICAR-IISR organized several entrepreneurship development programmes (EDPs) focusing on value addition in mushrooms, fruits, and vegetables, startups and innovation, and inspirational entrepreneurship awareness programmes (EAPs) for aspiring entrepreneurs.

Major flagship events included RISE UP 2.0 Entrepreneurship Conclave and Udayam 2.0 Agri Expo. The Agri Expo featured the NavUdyam programme, Idea Hackathon, and Startup Orientation, providing a dynamic platform for innovation, ideation, and startup incubation in the agri-spices sector.

Golden Jubilee Lecture Series

A total of eight golden jubilee lectures were delivered by eminent experts, addressing contemporary and emerging issues in agriculture and allied sciences, including:

- Sustainable water management and climate-smart agriculture by Dr. Manoj P. Samuel, Executive Director, CWRDM, Kozhikode.
- Invasive pest threats to Indian agriculture by Dr. S.N. Sushil, Director, ICAR NBAIR, Bengaluru.
- Safety and efficacy assessment of spice molecules by Dr. B. Sasikeran, MD, former Director, National Institute of Nutrition (ICMR), Hyderabad.

- Harnessing wild relatives of horticultural crops by Dr. V. Arunachalam, Director, KSCSTE- Jawaharlal Nehru Tropical Botanical Garden and Research Institute, Thiruvananthapuram.
- Quorum sensing and quenching in plant pathogenic bacteria by Dr. Diby Paul, Truett McConnell University, USA
- Plastic pollution and global policy perspectives by Dr. George Thomas C, Former Chairman, Kerala State Biodiversity Board.
- Genome editing prospects in agriculture, by Dr. Asokan, Principal Scientist (Retd), ICAR-IIHR, Bengaluru.
- Management of biological invasions by Dr. K.V. Sankaran, Ex-Director, KFRI, Thrissur.

These lectures enriched scientific discourse and provided strategic insights for future research directions.

Publications

Special Golden Jubilee editions of Spice India, Indian Horticulture, Indian Journal of Spices, Arecanut & Medicinal Plants, along with technical bulletins and extension folders on various aspects of spices research and cultivation, were released, reinforcing ICAR–IISR's commitment to knowledge dissemination.

As part of the Golden Jubilee celebrations, ICAR-IISR organized major national scientific events, such as

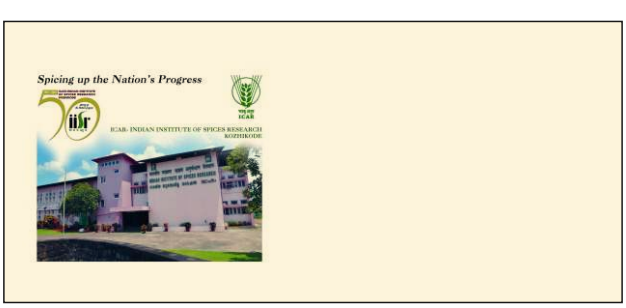
- National Symposium on Spices and Aromatic Crops – Strategies for smart production, product diversification and utilization (SYMSAC-XI) held from 07 to 09 January 2025 at ICAR–IISR, Kozhikode.
- National Symposium on Recent Trends in Omics in Plant Biology, organized by ICAR–IISR and its Bioinformatics and Integrative Genomics (BIG) Facility from 20 to 22 May 2025.

These symposia provided vibrant platforms for scientific exchange, showcasing cutting-edge research and fostering national collaboration.

Release of the Golden Jubilee special postal cover and MyStamp

As part of the Golden Jubilee of the institute and recognizing 50 years of contributions to Indian agriculture and spices research, a special postal cover and MyStamp were released for ICAR-Indian Institute of Spices Research by the India Post on 30 June, 2025.

The release was officiated by Mr. Ganesh Kumar V.B., IPoS, Director, Postal Services, Northern Region, Kozhikode, and received by Dr. R. Dinesh, Director, ICAR-IISR.



Concluding event and foundation day celebrations

The Golden Jubilee celebrations culminated with the concluding event and foundation day celebrations, graced by Dr. B. Ashok, IAS, Agricultural Production Commissioner, Government of Kerala, and Vice Chancellor, Kerala Agricultural University, as the Chief Guest. The function was presided over by Dr. Sanjay Kumar Singh, Deputy Director General (Horticultural Science), ICAR, New Delhi. The event was attended by several distinguished dignitaries, including senior ICAR officials, Vice Chancellors, former Directors of ICAR-IISR, and Directors of allied ICAR institutes, etc.

During the occasion, the **Advanced Biocontrol Laboratory** was inaugurated, and the foundation stone for the **Golden Jubilee Conference Hall** was laid. Several important scientific publications were released, licensing agreements for selected research technologies were signed, and the prestigious Spice Awards 2025 were presented in recognition of outstanding contributions to spice research and development.

The ICAR-IISR Golden Jubilee celebrations stood as a landmark milestone, reflecting the institute's rich legacy and forward-looking vision. Through integrated efforts in research, extension, entrepreneurship, and policy engagement, the celebrations reaffirmed ICAR-IISR's pivotal role in advancing spices research, empowering farmers and entrepreneurs.

भाकृअनुप-भारतीय मसाला फसल अनुसंधान संस्थान

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