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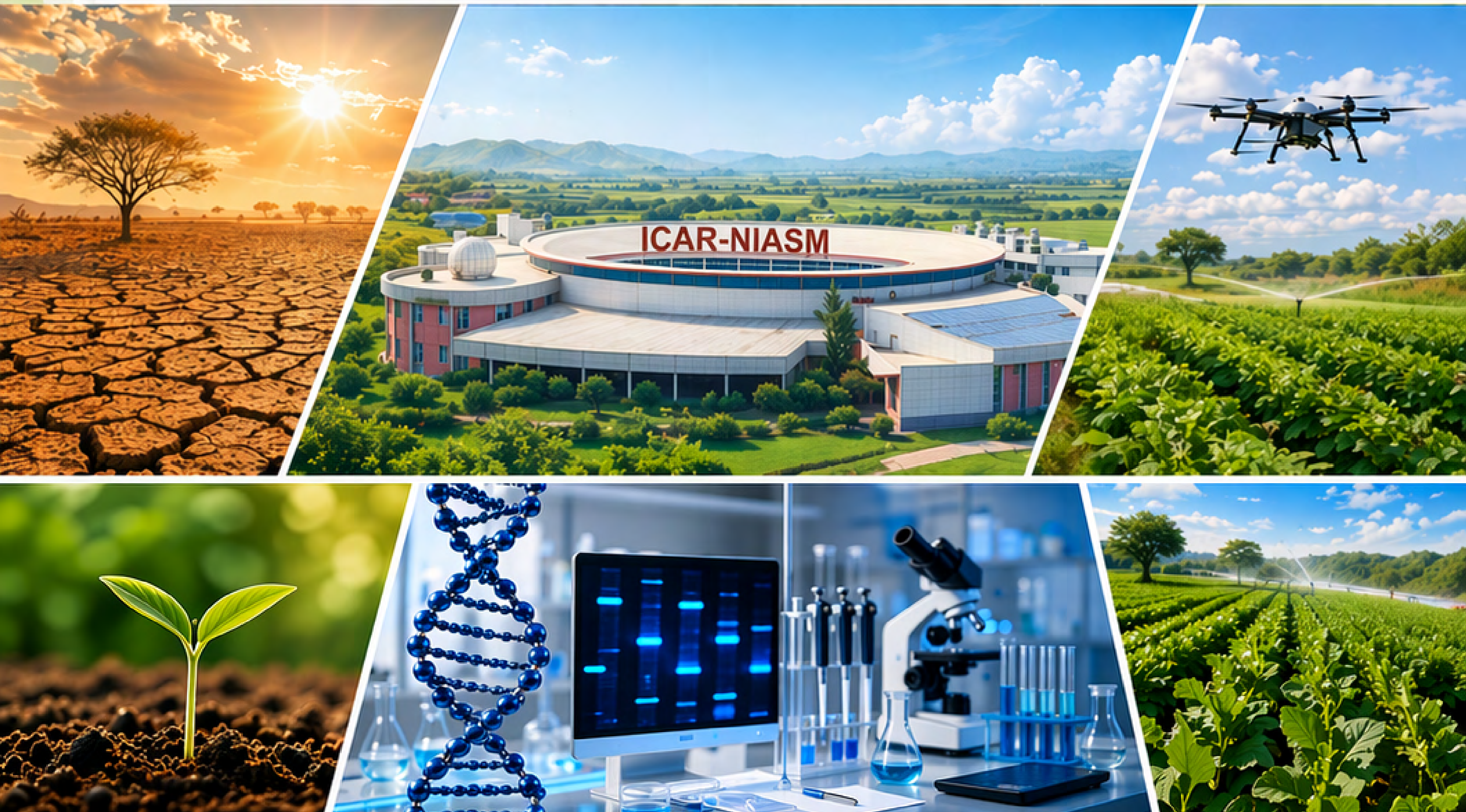
2025

ICAR-NIASM



भाकृअनुप
ICAR

आईसीएआर-राष्ट्रीय अजैविक
स्ट्रैस प्रबंधन संस्थान

ICAR-NATIONAL INSTITUTE OF
ABIOTIC STRESS MANAGEMENT

Annual Report 2025

वार्षिक प्रतिवेदन २०२५

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Dr K Sammi Reddy
Director, ICAR-NIASM

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Typesetting & Designing

Mr Pravin More

Contact

ICAR-National Institute of Abiotic Stress Management
Malegaon Kh., Baramati, Pune, Maharashtra 413 115, India
Phone: +91-2112-258000/01
Email: niamdirector@gmail.com; director.niasm@icar.org.in
Web: niam.res.in

PREFACE

Climate change continues to intensify, with rising temperatures and erratic weather patterns exacerbating cascading risks across India's agricultural systems. Aligned with India's commitment to climate-resilient development and the Sustainable Development Goals (SDGs), ICAR-National Institute of Abiotic Stress Management (NIASM) spearheaded research innovations, academics, and community reach through extension programmes in 2025. This annual report is a reflection of the dedicated efforts taken by its human resources in the planning and execution of its year-round activities. During 2025, ICAR-NIASM made significant research advancements in climate resilience, stress mitigation, and sustainable agriculture, collectively addressing the emerging abiotic challenges in India's agroecosystems. Highlights include: Identification of salt-tolerant local mango genotypes ('Musti 10', 'Malegaon 1', 'Malegaon 2'); successfully mitigation of waterlogging stress in maize using a foliar application of 2% urea, resulting in a 17.37% increase in grain yield; genome editing and gene silencing (VIGS) experiments to enhance water and salinity stress tolerance in soybean and Spatiotemporal analysis of rainfall revealing ENSO (El Niño-Southern Oscillation) as the dominant driver for monsoon and annual rainfall teleconnections and long-term studies demonstrating that mango and sapota orchards successfully maintained significantly higher Total Organic Nitrogen pools compared to barren land after 12 years.

The institute's commitment to academic excellence and capacity building was demonstrated through its engagement with the ICAR-IARI Baramati Hub, hosting 26 students in the BSc (Hons) Agri. 2024-25 batch, alongside several M.Sc. and Ph.D. scholars. We also successfully hosted 49 M.Sc./Ph.D. students from other universities for their research work, with a total of six M.Sc./M.Tech. students graduating from the IARI-NIASM Hub with thesis work on topics ranging from stress tolerance to food engineering. In an effort to strengthen agricultural frameworks, the Institute was highly active in outreach and capacity development through DAPSC interventions, nearly 1,500 farmers and seven self-help groups (SHG) across 20 villages were supported and through Tribal Sub-Plan activities in Nandurbar District, the institute benefitted 3,567 beneficiaries. Under the. NIASM also organized several key training programs, including the 21-day online National Training on "Advanced Statistical and Machine Learning Techniques for Data Analysis" for 778 participants and numerous PMFME online training programs on the processing and value addition of turmeric, jackfruit, and jamun for farmers. The year also brought notable recognition to our staff through various awards and recognition. This report also provides a detailed compilation of institute publications for the year, including a new Policy Framework on

"Abiotic Stress Resilience in Indian Agriculture", 14 new books and book chapters, 3 new technical bulletins, 16 new extension folders, 76 research papers, and 10 review papers, along with teaching, extension, linkages, and other collaboration activities.

I sincerely thank Dr ML Jat, Secretary (DARE) & Director General (ICAR); Shri Sanjay Garg, Additional Secretary (DARE) & Secretary (ICAR); Shri Sandeep Sarkar, Additional Secretary (DARE) & Financial Advisor (ICAR); Dr AK Nayak, Deputy Director General (Natural Resource Management); and Dr A Velmurugan, Assistant Director General (Soil and Water Management) for their continued support and guidance. I also acknowledge the guidance and support received from Dr V Praveen Rao, Chairman and other esteemed members of the Research Advisory Committee (RAC); members of the Institute Management Committee (IMC) and Institute Research Council (IRC) of the Institute. The support of state agriculture departments, farmers, KVKs, and the funding agencies is gratefully acknowledged. I sincerely thank the Heads of the Schools; Scientists; and Technical, Administration, and Finance staff of the institute for their wholehearted efforts and dedication in carrying out the activities of the institute. I also appreciate the efforts made by the members of the Publication Committee in compiling this document.

Date: 31-12-2025 **(K Sammi Reddy)**

Baramati **Director**

प्रस्तावना

जलवायु परिवर्तन लगातार तेज हो रहा है, बढ़ते तापमान और अनियमित मौसम के पैटर्न से भारत की कृषि प्रणालियों में जोखिम बढ़ रहा है। जलवायु) अनुकूल विकास और सतत विकास लक्ष्यों-SDGs) के प्रति भारत की प्रतिबद्धता के अनुरूप, ICAR-राष्ट्रीय अजैविक तनाव प्रबंधन संस्थान)NIASM) ने 2025 में अनुसंधान नवाचारों, शिक्षाविदों और विस्तार कार्यक्रमों के माध्यम से समुदाय तक पहुँचने का नेतृत्व किया। यह वार्षिक रिपोर्ट 2025 के दौरान ICAR-NIASM द्वारा किए गए समर्पित प्रयासों का एक प्रतिबिंब है, जिसमें जलवायु अनुकूलनशीलता, तनाव शमन और टिकाऊ कृषि में महत्वपूर्ण अनुसंधान प्रगति की गई है, जो सामूहिक रुप से भारत के कृषि पारिस्थितिकी तंत्र में उभरती अजैविक चुनौतियों का समाधान करती है। मुख्य बातें इस प्रकार हैं: नमक सहनशील स्थानीय आम के जीनोटाइप्स)'Musti 10', 'Malegaon 1', 'Malegaon 2') की पहचान; 2% यूरिया के फोलियर अनुप्रयोग का उपयोग करके मक्का में जलजमाव तनाव का सफलतापूर्वक शमन किया जाना, जिसके परिणामस्वरूप अनाज की उपज में 17.37% की वृद्धि होना; सोयाबीन में जल और लवणता तनाव सहनशीलता को बढ़ाने के लिए जीनोम एडिटिंग और जीन साइलेंसिंग)VIGS) प्रयोग; वर्षा के स्थानिक कालिक विश्लेषण से पता चलना कि-ENSO (अल नीनो-मानसून और वार्षिक वर्षा टेलीकनेक्शन के लिए प्रमुख चालक है (दक्षिणी दोलन; अध्ययनों से पता चलना कि आम और सपोटा के बागानों ने 12 वर्षों के बाद बंजर भूमि की तुलना में काफी अधिक कुल कार्बनिक नाइट्रोजन पूल सफलतापूर्वक बनाए रखता है।

ICAR-IARI बारामती हब के साथ जुड़ाव के माध्यम से संस्थान की शैक्षणिक उत्कृष्टता और क्षमता निर्माण के प्रति प्रतिबद्धता प्रदर्शित हुई, जिसमें BSc (Hons) Agri. 2024-25 बैच में 26 छात्रों के साथ-साथ कईM.Sc. और Ph.D. विद्वानों को होस्ट किया गया। हमने अन्य विश्वविद्यालयों से 49 M.Sc./Ph.D. छात्रों को उनके शोध कार्य के लिए सफलतापूर्वक होस्ट किया, जिसमें IARI-NIASM हब से कुल छह M.Sc./M.Tech. छात्रों ने तनाव सहनशीलता से लेकर खाद्य इंजीनियरिंग तक के विषयों पर थीसिस कार्य के साथ स्नातक किया। कृषि ढांचे को मजबूत करने के प्रयास में, संस्थान DAPSC हस्तक्षेपों के माध्यम से आउटरीच और क्षमता विकास में अत्यधिक सक्रिय रहा, लगभग 1,500 किसानों और 20 गांवों में सात स्वयं सहायता समूहों)SHG) का समर्थन किया गया। इसके अलावा, नंदुरबार जिले में जनजातीय उपयोजना - गतिविधियों के माध्यम से, संस्थान ने 3,567 लाभार्थियों को लाभान्वित किया। NIASM ने कई प्रमुख प्रशिक्षण कार्यक्रम भी आयोजित किए, जिनमें 778 प्रतिभागियों के लिए उन्नत सांख्यिकीय और मशीन " लर्निंग तकनीकें डेटा विश्लेषण के लिए पर "21 दिवसीय ऑनलाइन राष्ट्रीय प्रशिक्षण और किसानों के लिए हल्दी, कटहल और जामुन के प्रसंस्करण और मूल्यवर्धन पर कई PMFME ऑनलाइन प्रशिक्षण कार्यक्रम शामिल हैं। इस वर्ष हमारे कर्मचारियों को विभिन्न पुरस्कारों और पहचान के माध्यम से उल्लेखनीय मान्यता भी मिली।

यह रिपोर्ट वर्ष के लिए संस्थान के प्रकाशनों का एक विस्तृत संकलन भी प्रदान करती है, जिसमें पर एक नई नीतिगत रूपरेखा "भारतीय कृषि में अजैविक तनाव अनुकूलनशीलता", 14 नई किताबें और पुस्तक अध्याय, 3 नए तकनीकी बुलेटिन, 16 नए विस्तार फोल्डर, 76 शोध पत्र, और 10 समीक्षा पत्र शामिल हैं, साथ ही शिक्षण, विस्तार, लिंकेज और अन्य सहयोग गतिविधियाँ भी शामिल हैं।

मैं निरंतर समर्थन और मार्गदर्शन के लिए डॉएमएल जाट ., सचिव और महानिदेशक (डीएआरई) (आईसीएआर); श्री संजय गर्ग, अतिरिक्त सचिव (आईसीएआर) और सचिव (डीएआरई); श्री संदीप सरकार, अतिरिक्त सचिव (आईसीएआर) और वित्तीय सलाहकार (डीएआरई); डॉएके नायक ., उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन); और डॉए वेलमुरुगन ., सहायक महानिदेशक का (मृदा और जल प्रबंधन) sincerely धन्यवाद करता हूँ। मैं अनुसंधान सलाहकार समिति वी प्रवीण राव .के अध्यक्ष डॉ (आरएसी) और अन्य सम्मानित सदस्यों; संस्थान प्रबंधन समिति और संस्थान अनुसंधान परिषद (आईएमसी) के सदस्यों से प्राप्त मार्गदर्शन और समर्थन को भी स्वीकार करता हूँ। राज्य कृषि विभागों (आईआरसी), किसानों, केवीके)KVKs), और फंडिंग एजेंसियों के समर्थन के लिए आभार व्यक्त किया जाता है। मैं संस्थान की गतिविधियों को पूरा करने में उनके पूरे दिल से किए गए प्रयासों और समर्पण के लिए स्कूलों के प्रमुखों; वैज्ञानिकों; और तकनीकी, प्रशासन, और वित्त कर्मचारियों का sincerely धन्यवाद करता हूँ। मैं इस दस्तावेज़ को संकलित करने में प्रकाशन समिति के सदस्यों द्वारा किए गए प्रयासों की भी सराहना करता हूँ।

दिनांक :31-12-2025 **(के सम्मी रेड्डी)**

बारामती **निदेशक**

EXECUTIVE SUMMARY

- During the year 2025, various experiments were conducted under the Institute, Umbrella and Flagship projects and also under externally funded projects. The outreach programmes were also carried under Development Action Plan for Schedule Caste (DAPSC) and Tribal Sub-Plan (TSP). The achievements of all activities are briefly highlighted below under broader theme titles:

- वर्ष 2025 के दौरान, संस्थान, अम्ब्रेला और फ्लैगशिप परियोजनाओं के साथ-साथ बाहरी रूप से वित्त पोषित परियोजनाओं के तहत विभिन्न प्रयोग किए गए। विकास कार्य योजना अनुसूचित जाति (DAPSC) और जनजातीय उप-योजना (TSP) के तहत भी आउटरीच कार्यक्रम आयोजित किए गए। उपरोक्त सभी गतिविधियों और अन्य की उपलब्धियों को संक्षेप में नीचे व्यापक विषय शीर्षकों के तहत उजागर किया गया है:

- **Identification of salt-tolerant and salt-sensitive local mango genotypes:** Fourteen genotypes were evaluated under three irrigation treatments (0, 50, and 100 mM NaCl). 'Musti 10', 'Malegaon 1', and 'Malegaon 2' were identified as relatively more salt tolerant based on morphological and physiological responses. ‘Kesar’ and ‘Mulgoa’ were identified as salt-sensitive genotypes, recording higher leaf injury index values. Local genotypes ‘Medad-1’ and ‘Pandare-2’ exhibited the highest seedling vigour.

- **नमक-सहिष्णु और नमक-संवेदनशील स्थानीय आम जीनोटाइप की पहचान:** चौदह जीनोटाइपों का मूल्यांकन तीन सिंचाई उपचारों (0, 50, और 100 mM NaCl) के तहत किया गया। 'मुस्टी 10', 'मालेगांव 1', और 'मालेगांव 2' को रुपात्मक और शारीरिक प्रतिक्रियाओं के आधार पर अपेक्षाकृत अधिक नमक सहिष्णु के रूप में पहचाना गया। ‘केसर’ और ‘मुल्गोआ’ को नमक-संवेदनशील जीनोटाइप के रूप में पहचाना गया, जिनमें पत्ती की चोट सूचकांक का मान अधिक दर्ज किया गया। स्थानीय जीनोटाइप ‘मेदाद-1’ और ‘पांडारे-2’ ने उच्चतम पौधा शक्ति का प्रदर्शन किया।

- **Mitigating waterlogging stress in maize through foliar application of nitrogen sources and growth regulators:** Waterlogging at 15 days after emergence (DAE) was the most sensitive stage, resulting in the highest grain yield reduction (46.01%). Foliar application of urea (2%) improved stomatal conductance by 41.32% and net photosynthetic rate by 36.03% compared to water-sprayed plants. This strategy consequently increased grain yield by 17.37%, enhancing stress tolerance and yield stability.

- **नाइट्रोजन स्रोतों और विकास नियामकों के पर्णीय अनुप्रयोग के माध्यम से मक्का में जलजमाव तनाव को कम करना:** उभरने के 15 दिनों के बाद (DAE) जलजमाव सबसे संवेदनशील चरण था, जिसके परिणामस्वरूप उच्चतम अनाज उपज में कमी (46.01%) हुई। यूरिया (2%) के पर्णीय अनुप्रयोग ने पानी के छिड़काव वाले पौधों की तुलना में स्टोमेटल चालन में 41.32% और शुद्ध प्रकाश संश्लेषक दर में 36.03% का सुधार किया। इस रणनीति के परिणामस्वरूप अनाज की उपज में 17.37% की वृद्धि हुई, जिससे तनाव सहिष्णुता और उपज स्थिरता बढ़ी।

- **Performance of Ambronics Pot under Deficit Irrigation in Tomato Cultivation:** Among cultivation systems, mulching recorded the highest fruit yield (40.63 t ha^{-1}), followed by the Talia tray system (38.63 t ha^{-1}). Pot cultivation under 75% ETc irrigation resulted in a fruit yield of 36.98 t ha^{-1}, which was statistically superior to the control treatment receiving 100% ETc.

- **टमाटर की खेती में घाटे की सिंचाई के तहत एम्ब्रोनिक्स पॉट का प्रदर्शन:** खेती प्रणालियों में, मल्चिंग ने उच्चतम फल उपज (40.63 t ha^{-1}) दर्ज की, जिसके बाद तालिया ट्रे प्रणाली (38.63 t ha^{-1}) रही। 75% ETc सिंचाई के तहत पॉट खेती के परिणामस्वरूप 36.98 t ha^{-1} की फल उपज हुई, जो 100% ETc प्राप्त करने वाले नियंत्रण उपचार से सांख्यिकीय रूप से बेहतर थी।

- **Expression Profiling of Fermentative and Stress-Responsive Genes in Pigeon Pea Genotypes under Waterlogging Stress:** Genotypes (e.g., ICP 12410, ICP 2405) were evaluated for waterlogging tolerance at the knee-height stage.

- **जलजमाव तनाव के तहत अरहर जीनोटाइप में किण्वक और तनाव-उत्तरदायी जीनों का अभिव्यक्ति प्रोफाइलिंग:** घुटने की ऊँचाई के चरण में जलजमाव सहिष्णुता के लिए जीनोटाइप (जैसे, ICP 12410, ICP 2405) का मूल्यांकन किया गया।

- **Chemical Characterization of Nutrient Inputs Used in the Nutrient Management System:** Biochar was strongly alkaline (pH 9.2–9.6), had the highest total organic carbon (36–38%), and the greatest Cation Exchange Capacity (41–46 cmol kg^{-1}). Bioprom contained exceptionally high phosphorus (2.5–2.7%) and potassium (1.8–2.1%), serving as a nutrient-dense bio-input.

- **पोषक तत्व प्रबंधन प्रणाली में उपयोग किए जाने वाले पोषक तत्व इनपुट का रासायनिक लक्षण वर्णन:** बायोचार दृढ़ता से क्षारीय (pH 9.2–9.6) था, इसमें उच्चतम कुल कार्बनिक कार्बन (36–38%) और सबसे बड़ी धनायन विनिमय क्षमता (41–46 cmol kg^{-1}) थी। बायोप्रोम में असाधारण रूप से उच्च फास्फोरस (2.5–2.7%) और पोटेशियम (1.8–2.1%) था, जो एक पोषक तत्व-सघन जैव-इनपुट के रूप में कार्य करता है।

- **Soil Quality status of rice growing areas at different landscape positions:** The lower slope area (LSA) reflected the best soil quality, while the upper slope area (USA) had the poorest soil quality. Topsoil (0-15 cm) showed the highest Total Soil Quality Index (TSQI).

- **विभिन्न परिदृश्य स्थितियों में चावल उगाने वाले क्षेत्रों की मिट्टी की गुणवत्ता की स्थिति:** निचले ढलान वाले क्षेत्र (LSA) ने सर्वोत्तम मिट्टी की गुणवत्ता को दर्शाया, जबकि ऊपरी ढलान वाले क्षेत्र (USA) में सबसे खराब मिट्टी की गुणवत्ता थी। ऊपरी मिट्टी (0-15 cm) ने उच्चतम कुल मिट्टी गुणवत्ता सूचकांक (TSQI) दिखाया।

- **Long term effect of land use change on vertical distribution of soil carbon and nitrogen pools:** Introduction of arable crops (e.g.,

- **मिट्टी कार्बन और नाइट्रोजन पूल के ऊर्ध्वाधर वितरण पर भूमि उपयोग परिवर्तन का दीर्घकालिक प्रभाव:** बंजर भूमि परिवर्तन की प्रारंभिक अवधि में खेती योग्य फसलों (जैसे, गेहूं-

wheat–soybean system) provided the highest soil cover (up to 60% at the surface) in the initial period of barren land transformation. The nitrogen pools followed the order: Fruit orchards -> Perennial field crops -> Annual crop -> Barren land.

सोयाबीन प्रणाली) की शुरूआत ने उच्चतम मिट्टी आवरण (सतह पर 60% तक) प्रदान किया। नाइट्रोजन पूल का क्रम इस प्रकार था: फलों के बगीचे -> बारहमासी खेत फसलें -> वार्षिक फसल -> बंजर भूमि।

- **Land use systems effect on soil N dynamics over the period of 10 years:** After 12 years, mango and sapota orchards maintained the largest Total Organic N (TON) pools (880–900 kg ha^{-1} at 0–15 cm) against barren land (320 kg ha^{-1}), a nearly threefold increase. The non-hydrolysable N fraction (long-term reserve) was highest under mango orchards (290 kg ha^{-1} at surface).

- **10 वर्षों की अवधि में मिट्टी N गतिशीलता पर भूमि उपयोग प्रणालियों का प्रभाव:** 12 वर्षों के बाद, आम और सपोटा के बगीचों ने बंजर भूमि (320 kg ha^{-1}) के मुकाबले सबसे बड़े कुल कार्बनिक N (TON) पूल (0-15 cm पर 880-900 kg ha^{-1}) को बनाए रखा, जो लगभग तीन गुना वृद्धि थी। गैर-हाइड्रोलिसेबल N अंश (दीर्घकालिक भंडार) आम के बगीचों के तहत सबसे अधिक था (सतह पर 290 kg ha^{-1})।

- **Weather at ICAR-NIASM, Baramati (2025):** Total rainfall was 756.9 mm over 40 rainy days (about 125% of the LPA of 608.0 mm). The highest monthly cumulative rainfall was 345.9 mm in May. The warmest month was April (30.5°C mean). The highest daily maximum temperature was 41.1°C on April 24.

- **ICAR-NIASM, बारामती में मौसम (2025):** 40 बरसात के दिनों में कुल वर्षा 756.9 मिमी थी (LPA के 608.0 मिमी का लगभग 125%)। उच्चतम मासिक संचयी वर्षा मई में 345.9 मिमी थी। सबसे गर्म महीना अप्रैल था (30.5°C औसत)। 24 अप्रैल को उच्चतम दैनिक अधिकतम तापमान 41.1°C था।

- **Spatiotemporal analysis of rainfall in agro-climatic zones of India:** The study detected a general decline in winter rainfall and decreasing trends in monsoon, post-monsoon, and annual rainfall over northern, central, and eastern India. Western and southern regions exhibited increasing rainfall trends.

- **भारत के कृषि-जलवायु क्षेत्रों में वर्षा का स्थानिक-टेम्पोरल विश्लेषण:** अध्ययन में उत्तरी, मध्य और पूर्वी भारत में सर्दियों की वर्षा में सामान्य गिरावट और मानसून, मानसून के बाद और वार्षिक वर्षा में घटते रुझानों का पता चला। पश्चिमी और दक्षिणी क्षेत्रों में वर्षा के बढ़ते रुझान प्रदर्शित हुए।

- **Teleconnections of rainfall with ENSO and IOD:** Significant correlations were observed between monsoon and annual rainfall and the El Niño-Southern Oscillation (ENSO) indices (JJAS, OND, and annual composite). Correlation with the

- **ENSO और IOD के साथ वर्षा का दूरसंचार:** मानसून और वार्षिक वर्षा और अल नीनो-दक्षिणी दोलन (ENSO) सूचकांकों (JJAS, OND, और वार्षिक समग्र) के बीच महत्वपूर्ण सहसंबंध देखे गए। हिंद महासागर द्विध्रुव (IOD) के साथ सहसंबंध

Indian Ocean Dipole (IOD) was mostly non-significant, suggesting ENSO remains the dominant driver.

- **Spatiotemporal analysis of drought and its teleconnections:** Long-term trends showed significantly increasing drying tendencies in the central, northern, and eastern parts of the country. The peninsular India has shown wetting trends, except in the western coastal plains.
- **Targeted knockout of PARP and ERA1 genes using genome editing tool to enhance water stress tolerance in soybean:** An Agrobacterium-mediated transformation protocol was optimized, and in-planta transformation was performed using Cas9 constructs. PCR analysis identified four positive plants for the PARP1A1AE2gRNA1 construct and two plants for the ERA1AE2gRNA construct.
- **Silencing of negative regulator genes using VIGS approach:** Virus-Induced Gene Silencing (VIGS) was used to functionally analyze regulatory genes (EIN2, FNSL, WRKY, and ARF) to improve water and salinity stress tolerance in soybean.
- **Development of an Efficient Protoplast Isolation Method:** A method was developed to isolate good quality and quantity of protoplasts from immature soybean cotyledons for potential plasmid-free RNP-Based Genome Editing.
- **Assessment of Drought- and Salinity-Induced Crop Yield Losses in Baramati Tehsil:** The average farmer yield for sugarcane (88.52

अधिकतर गैर-महत्वपूर्ण था, यह सुझाव देता है कि ENSO प्रमुख चालक बना हुआ है।

- **सूखे का स्थानिक-टेम्पोरल विश्लेषण और इसका दूरसंचार:** दीर्घकालिक रुझानों में देश के मध्य, उत्तरी और पूर्वी हिस्सों में महत्वपूर्ण रुप से बढ़ती सुखाने की प्रवृत्तियों को दिखाया गया। प्रायद्वीपीय भारत ने पश्चिमी तटीय मैदानों को छोड़कर, गीलापन के रुझान दिखाए हैं।
- **सोयाबीन में पानी के तनाव सहिष्णुता को बढ़ाने के लिए जीनोम एडिटिंग टूल का उपयोग करके PARP और ERA1 जीनों का लक्षित नॉकआउट:** एक Agrobacterium-मध्यस्थता परिवर्तन प्रोटोकॉल को अनुकूलित किया गया था, और Cas9 निर्माणों का उपयोग करके in-planta परिवर्तन किया गया था। PCR विश्लेषण ने PARP1A1AE2gRNA1 निर्माण के लिए चार सकारात्मक पौधों और ERA1AE2gRNA निर्माण के लिए दो पौधों की पहचान की।
- **VIGS दृष्टिकोण का उपयोग करके नकारात्मक नियामक जीनों का साइलेंसिंग:** सोयाबीन में पानी और लवणता तनाव सहिष्णुता में सुधार के लिए नियामक जीनों (EIN2, FNSL, WRKY, और ARF) का कार्यात्मक विश्लेषण करने के लिए वायरस-प्रेरित जीन साइलेंसिंग (VIGS) का उपयोग किया गया था।
- **एक कुशल प्रोटोप्लास्ट अलगाव विधि का विकास:** संभावित प्लास्मिड-मुक्त RNP-आधारित जीनोम एडिटिंग के लिए अपरिपक्व सोयाबीन कॉटाइलडॉन से अच्छी गुणवत्ता और मात्रा के प्रोटोप्लास्ट को अलग करने के लिए एक विधि विकसित की गई थी।
- **बारामती तहसील में सूखे और लवणता-प्रेरित फसल उपज नुकसान का आकलन:** गन्ना के लिए औसत किसान उपज (88.52 t/ha) राज्य और राष्ट्रीय औसत से अधिक थी, लेकिन संभावित उपज

t/ha) exceeded state and national averages but remained substantially below the potential yield (150-200 t/ha). The findings highlighted that marginal and small farmers remain more vulnerable to yield losses than larger farmers.

(150-200 t/ha) से काफी कम रही। निष्कर्षों ने उजागर किया कि सीमांत और छोटे किसान बड़े किसानों की तुलना में उपज के नुकसान के लिए अधिक कमजोर रहते हैं।

- **Development and Multi-Scale Validation of an Integrated Drought Index (IDI):** A structured framework for an IDI was developed using entropy-based methods and Principal Component Analysis to synthesize meteorological, agricultural, and hydrological drought components for regional-scale monitoring.

- **एक एकीकृत सूखा सूचकांक (IDI) का विकास और बहु-स्केल सत्यापन:** क्षेत्रीय-स्केल निगरानी के लिए मौसम संबंधी, कृषि और जल विज्ञान संबंधी सूखा घटकों को संश्लेषित करने के लिए एन्ट्रापी-आधारित विधियों और प्रमुख घटक विश्लेषण का उपयोग करके एक IDI के लिए एक संरचित ढांचा विकसित किया गया था।

- **Tribal Sub Plan (TSP) Activities 2025:** Three Farmers' Interaction Meetings (Kisan Gosthi) were conducted in Nandurbar District with over 900 participants and Input distribution was made to a total of 3,567 beneficiaries, which included items like 2000 kg Paddy seed, 9500 kg NPK (19:19:19) fertilizer, and 63 Domestic flour mills.

- **जनजातीय उप-योजना (TSP) गतिविधियाँ 2025:** नंदुरबार जिले में 900 से अधिक प्रतिभागियों के साथ तीन किसान इंटरैक्शन मीटिंग्स (किसान गोष्ठी) आयोजित की गईं और कुल 3,567 लाभार्थियों को इनपुट वितरण किया गया, जिसमें 2000 किलोग्राम धान के बीज, 9500 किलोग्राम NPK (19:19:19) उर्वरक, और 63 घरेलू आटा मिलें जैसी वस्तुएं शामिल थीं।

- **DAPSC interventions 2025:** Activities benefited almost 1500 farmers and seven self-help groups (SHG) across 20 villages, with 561 women beneficiaries and Interventions included the distribution of various inputs, such as utensil kits (200), sewing machines (14), and a Farming (Water tank) kit to 200 beneficiaries.

- **DAPSC हस्तक्षेप 2025:** गतिविधियों से 20 गांवों में लगभग 1500 किसानों और सात स्वयं सहायता समूहों (SHG) को लाभ हुआ, जिसमें 561 महिला लाभार्थी थीं और हस्तक्षेपों में विभिन्न इनपुट का वितरण शामिल था, जैसे कि बर्तन किट (200), सिलाई मशीनें (14), और 200 लाभार्थियों को एक खेती (पानी की टंकी) किट।

- **Visits of Students, Farmers and Department Officials at ICAR-NIASM (2025):** The institute hosted a total of 3,237 visitors across 91 groups, including 2,005 students, 837 farmers, and 395 department personnel.

- **ICAR-NIASM, बारामती में छात्रों, किसानों और विभागीय अधिकारियों का दौरा (2025):** संस्थान ने 91 समूहों में कुल 3,237 आगंतुकों की मेजबानी की, जिसमें 2,005 छात्र, 837 किसान और 395 विभागीय कर्मी शामिल थे।

ABBREVIATIONS

ACZs	Agro Climatic Zones
Avg. WS	Average Wind Speed
BSS	Bright Sunshine Hours
DAE	Days After Emergence
DAPSC	Developmental Action Plan for Scheduled Castes
ENSO	El Niño-Southern Oscillation
ETc	Evapotranspiration of the crop
FYM	Farmyard Manure
IDI	Integrated Drought Index
IFS	Integrated Farming Systems
IOD	Indian Ocean Dipole
IPTA	Innovative Polygonal Trend Analysis
ITA	Innovative Trend Analysis
K	Potassium
LC	Labile Carbon
LLC	Less Labile Carbon
LMT	Local Mean Time
LPA	Long Period Average
LSA	Lower Slope Area
MK	Mann–Kendall
MSA	Middle Slope Area
MSI	Membrane Stability Index
N	Nitrogen
NDVI	Normalized Difference Vegetation Index
NLC	Non-Labile Carbon
P	Phosphorus
PCA	Principal Component Analysis
PE	Pan Evaporation
RH	Relative Humidity
RNP	Ribonucleoprotein
RWC	Relative Water Content
SC	Scheduled Caste
SHG	Self-Help Group
SPI	Standardized Precipitation Index
TON	Total Organic N
TPE	Total Pan Evaporation
TSP	Tribal Sub Plan
TSQI	Topsoil Quality Index
TSS	Total Soluble Solids
USA	Upper Slope Area
VIGS	Virus-Induced Gene Silencing
VLC	Very Labile Carbon

Contents


ICAR-National Institute of Abiotic Stress Management

Introduction

The accelerating pace of climate change continues to pose unique challenges to global and national food systems. According to recent IPCC assessments, global warming is approaching the 1.5 °C threshold relative to pre-industrial levels, and model projections suggest that this level may be reached in the coming decades under prevailing emission trends, unless rapid and sustained mitigation efforts are undertaken. The Sixth Assessment Report (AR6) highlights that climate-induced extremes- such as heat waves, droughts, floods, salinity intrusion, and emerging pest and disease pressures are intensifying in frequency and magnitude, directly undermining agricultural productivity, ecosystem stability, and rural livelihoods. In India, these stresses are increasingly evident across rainfed, coastal, arid, and semi-arid agro-ecosystems, resulting in yield instability, resource degradation, and heightened vulnerability of farming and livestock-dependent communities. While agricultural productivity has improved through technological advances, climate variability has significantly slowed output growth and amplified production risks. Projections based on current population growth, resource constraints, and climate trajectories indicate that sustaining food and nutritional security will require transformative approaches that enhance resilience while safeguarding agro-ecosystem integrity. In this context, the conservation and efficient functioning of agro-ecosystems over the long term emerges as a national priority. Addressing this challenge necessitates robust scientific understanding of the mechanisms governing resilience and adaptation to abiotic stresses in crops, livestock, fisheries, and allied systems, coupled with innovative, climate-smart management strategies. It was with this vision that the Indian Council of Agricultural Research established the ICAR-National Institute of Abiotic Stress Management (ICAR-NIASM), mandated to generate knowledge, technologies, and policy-relevant solutions for managing abiotic stresses in agriculture. As global discussions increasingly acknowledge both the limits to adaptation and the urgent need for integrated mitigation and adaptation efforts, institute remains committed to interdisciplinary, collaborative, and impact-oriented research. Such timely scientific action is essential to strengthen resilience, enhance farmers' incomes, and secure a sustainable and livable future for agriculture in a changing climate. In coming years, strengthening partnerships across disciplines, institutions, and stakeholders will be critical to translating scientific insights into field-level impact. Through sustained scientific innovation and capacity building, ICAR-NIASM aims to contribute meaningfully to climate-resilient and sustainable agricultural development in India.

Role of the Institute

The institute addresses a wide array of abiotic stresses that increasingly affect agricultural productivity and sustainability, including soil moisture stress, salinity, sodicity, acidity, waterlogging, declining water quality, heat stress, cold waves, floods, seawater inundation, and related climate-induced challenges. It adopts both conventional and cutting-edge approaches in crop improvement, natural resource management, and policy research to develop practical and scalable solutions. To effectively pursue its mandate, institute operates via four schools; Atmospheric Stress Management, Drought Stress Management, Edaphic Stress Management, and Social Sciences and Policy Support, each contributing to a systems-based understanding of abiotic stress resilience in agriculture. These thematic programmes form the backbone of focused research efforts aimed at reducing the adverse impacts of abiotic stresses across diverse agro-ecological regions. Institute actively collaborates with national and international research organizations to strengthen scientific capacity and develop skilled human resources capable of addressing long-term climate and environmental challenges. As an integral part of the National Agricultural Research and Education System (NARES), it contributes to coordinated research and development initiatives with a strong emphasis on mitigation and adaptation to abiotic stressors. In addition to knowledge generation, the institute develops critical intermediate research outputs such as gene constructs, stress-responsive promoters, and related molecular resources, which serve as valuable inputs for downstream innovation. These resources support the development of climate-resilient crops, livestock, fisheries, and allied agricultural systems. Moving forward, the institute aims to enhance translational research, promote the region-specific technologies, and strengthen policy linkages to ensure that scientific advancements effectively reach stakeholders and contribute to resilient, sustainable, and climate-smart agriculture.

Mission:

Managing abiotic stresses for sustainable agriculture.

Mandate

1. Basic and strategic research to manage abiotic stresses in crops, livestock and fisheries.
2. Repository of information on abiotic and biotic stresses, adaptation and mitigation strategies and policies.

3. Building sustainable agriculture in multi-stressed agro-ecosystems.
4. Serve as Center of Academic Excellence in managing multiple stresses in agriculture.

Objectives of the Institute

1. Assess the vulnerability of crops, horticulture, livestock, fisheries and microbes to abiotic stresses.
2. Develop technologies and policies for adaptation and mitigation of atmospheric, water and soil stresses with frontier science.
3. Develop repository of information on abiotic stress management for climate-smart agriculture.
4. Establish Center of Academic Excellence for human resource development to manage multiple stresses in agriculture.

Objectives of the Schools

School of Atmospheric Stress Management

1. Assessing vulnerability of crops, livestock and fisheries to atmospheric stressors.
2. Unravelling the mechanisms and traits for atmospheric stress tolerance in crops and animals.
3. Developing adaptation and mitigation strategies for atmospheric stress management.
4. Developing decision support systems for optimizing input use and climate proofing.

School of Drought Stress Management

1. Unravelling the mechanisms and traits contributing to water stress tolerance in plants.
2. Optimizing novel genetic improvement approaches for enhancing resilience of crops to water stress.
3. Exploring alternative crops and cropping systems for alleviating water stress.
4. Developing precision agriculture for higher water productivity in crop, horticulture, livestock and aquaculture.

School of Edaphic Stress Management

1. Exploring mechanisms and traits of soil stress response in crop, livestock and fisheries.
2. Developing adaptation and mitigation strategies for soil stress management.
3. Mitigating the adverse impacts of nutrient imbalance and pollution in agriculture.
4. Developing integrated farming systems for abiotic-stressed regions.

School of Social Sciences and Policy Support

1. Assessing impacts of abiotic stressors on agricultural income, market and trade.
2. Evaluating techno-economic feasibilities of multiple stress

tolerant adaptation and mitigation technologies.

3. Harnessing information and communication technologies for assessment and dissemination of technologies.

4. Evolving model capacity building programmes for abiotic stress management.

Strategy

Fig. 1.1: Institute's strategy for achieving the mandate

The institute has adopted a six-point, hexagonally interlinked strategy to enhance the efficiency of research, extension, and academic activities. This approach encompasses defining target environments, implementing adaptive techniques, developing mitigation strategies, supporting policy initiatives, and fostering synergies through networking. The institute's operational strategy emphasises fundamental research on abiotic stresses affecting the country, strategic human resource development, the establishment of robust databases, and the development of amelioration approaches using cutting-edge technologies. These efforts are undertaken in collaboration with an extensive network of national and international centres working in the area of abiotic stress management. The institute's comprehensive strategy prioritizes assessing the occurrence and intensity of various abiotic stresses impacting the agricultural sector. This assessment serves as a foundation for essential and strategic research to develop agroecology-specific stress-mitigation and adaptation technologies for crops, horticulture, livestock, and fisheries. Achieving this goal requires sustained efforts to build world-class infrastructure and develop a highly skilled scientific workforce, positioning inputs, optimising their synergistic use, preventing losses, ensuring judicious allocation among competing demands, and developing site-specific technologies. Joint adaptation and mitigation strategies to address climate change should be integrated into land- and water-resource management solutions. Joint adaptation and mitigation actions against climate change can be implemented today across a wide range of land and water resource management solutions. These strategies will provide immediate adaptation benefits while contributing to long-term mitigation efforts.

Status of the Institute

In the XI Five Year Plan, the Union Cabinet approved the proposal of the Ministry of Agriculture, Govt. of India to establish "National Institute of Abiotic Stress Management (NIASM)" with a legal status of Deemed-to-be-University under the Indian Council of Agricultural Research at Gat No. 35, Malegaon Khurd, Baramati, Pune, Maharashtra. After being established as a new institute for abiotic stress management in 2009, NIASM initiated its activities at the camp office at KVK, Sharadanagar, Baramati. The office was then shifted to Gat No. 35, Malegaon, Khurd, on 1st November 2010 after the inauguration of the Engineering Workshop by the Hon'ble Union Minister of Agriculture and Food Processing Industries. Till January 2015, the office and laboratories were housed in this workshop and specialized cabins, which subsequently shifted to the newly constructed Office-cum-Admin block and two school buildings. At the same time, substantial efforts have been made to strengthen its human resources to carry out research and administrative and technical activities. The current year's scientific, technical, and administrative staff strengths are 42, 15, and 10, respectively. Thus, the total filled-up cadre strength is 68 against 118 sanctioned posts (Table 1.1). The institute has initiated research through four schools with a multidisciplinary approach (Fig. 1.2). The institute is also offering academic programmes namely BSc (Hons.) Agriculture and MSc (Environmental Sciences) as IARI-NIASM Academic Hub under the agesis of ICAR-IARI, New Delhi since academic year 2023-24.

Table 1.1: Cadre strength of the institute (as on 31st December 2025)

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	44	6 (12%)
Technical	35	15	20 (57%)
Administrative	32	10	22 (69%)
Grand Total	**118**	**70**	**48 (40.6%)**

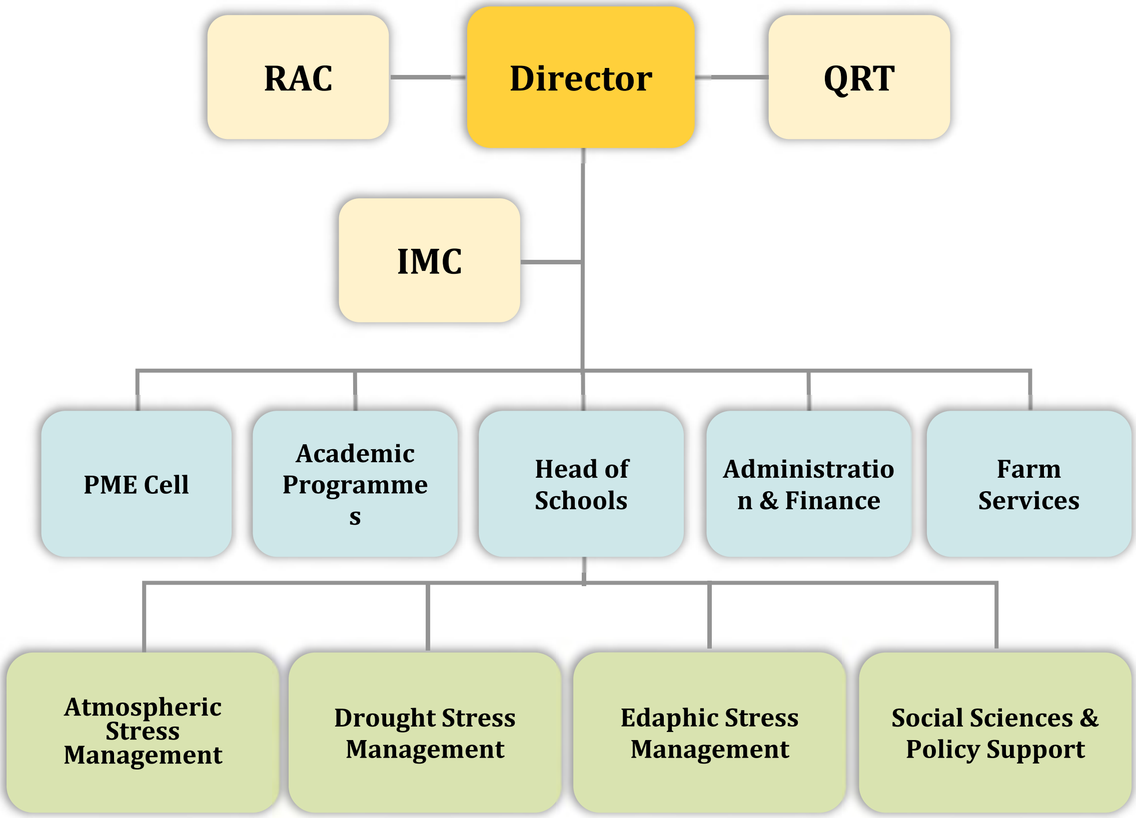


Fig. 1.2: Organogram of the Institute

Institute Infrastructure

Office-cum Administrative Building

It has centralized air-conditioning system and centrally located open-air amphitheatre with a public address system. For safety, the building has a fire detection and alarm system

Auditorium

Institute has a full-fledged auditorium named "Sardar Vallabhbhai Patel Auditorium" with a capacity of 230 seats. It is well equipped with an audio-visual facility, a centralized air condition facility and a spacious stage used to conduct various events at the institute.

Conference Rooms

The institute has four conference rooms equipped with audio-visual systems for conducting parallel sessions of conferences, trainings, meetings, etc.

School Buildings

Two school buildings of School of Drought Stress Management (SDSM) and School of Edaphic Stress Management (SESM) have been built presently. They have reception hallway, two laboratories with a storage room, one HoD room, 12 scientific and 02 technical staff rooms, one class room, one reading room, a pantry, and a record room.

Library

The Institute library has a good collection of books on agriculture, animal husbandry, and basic science subjects, as per the mandate of the institute. Scientists, technical personnel, research associates, students and trainees are regular users of the library. The library maintained its designated services and activities, including the acquisition of books, exchange of literature, circulation, reference services, and documentation. Present library acquisitions include more than 2500 books, as well as newsletters from NAAS/ICAR institutes and other open-source articles and documents.

Guest House

The institute has a well-furnished 'Nira Guest House' with 18 double-bed rooms and three VIP Suites, which together can accommodate about 40 guests at a time. The guest house has a well-equipped kitchen and well-furnished dining halls.

Staff Quarters

Institute has well-constructed quarters, namely, Director's Residence (Type VII quarter) and Type-IV quarters (6 nos.), built on Institute campus. Residential complex of Type VI (4 nos.), Type V (6 nos.), Type IV (8 nos.) and Type III (8 nos.) have been constructed at MIDC, Baramati.

Director residence

Staff quarter (on-campus)

Type V Quarter, MIDC, Baramati

Type VI Quarter, MIDC, Baramati

State-of-the-Art Research Facilities

Plant Phenomics Facility

Established under NICRA programme, Plant Phenomics facility has capacity of 225 pots, is equipped with three imaging sensors viz., Infra-Red (IR), Visible (VIS) and Near-Infra Red (NIR); automated weighing; precise watering stations and conveyor belt system to move plants to and fro from growth chambers.

Genetic Engineering, Molecular Biology and Microbiology Laboratories

Institute has a state of-the-art laboratories with sophisticated equipment's such as Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Stereo zoom Microscope Portable Photosynthesis System, Hyperspectral Spectroradiometer, Atomic Absorption Spectrophotometer (AAS), Microwave Digestion System, Real time Chlorophyll Fluorescence Imaging System, Infrared Thermal Imaging System, CO2 incubator, Gas Chromatography, High-performance liquid chromatography, Nanodrop, Root scanner, Automatic Nitrogen analyzer, Fluorescent microscope, GHG Analyzer, NIR Spectrophotometer, Rain-out Shelter, etc. The Plant Genetic Engineering Laboratory has been developed to conduct basic and strategic research on plants' responses to various abiotic stresses. Molecular Biology Laboratories have been developed to conduct basic and strategic research on the responses of plants, animals, and fish to various abiotic stresses. These laboratories have facilities for genomics and proteomics studies. The laboratory is well equipped with a PCR cycler, Real-time PCR, a Lyophilizer, an Ultra-High-Speed centrifuge, Biosafety cabinets, a Chemiluminescence imaging system, and a Multimode reader for DNA, RNA, and protein quantification. The ROS generated by various types of stress can also be quantified and measured using a multimode reader. A Plant Tissue Culture (PTC) facility has been established, with automated horizontal sterilisers and small and walk-in growth chambers for growing and maintaining transgenic /genetically modified/cisgenic /VIGS and RNAi-silenced plants. The Animal Cell Culture facility is equipped with a CO2 incubator, a biosafety cabinet, and an Inverted microscope.

NABL accreditation Soil Testing laboratory (NSTL)

ICAR-NIASM has accredited the Soil Testing laboratory (NSTL) by NABL on May 19, 2025, Certificate No. TC-16098. The accreditation has been obtained with 13 soil parameters such as pH, EC, Organic Carbon, available Nitrogen, available Potassium, available Phosphorus, available Zinc, available Manganese, available Iron, available Copper, available Boron, available Sulphur. The personnel involved in the NABL laboratory (NSTL): Dr K Sammi Reddy, Director; Dr Kamal Krishna Pal, Head, SDSM and Head of NSTL Laboratory; Dr Rinku Dey, Head SESM and NSTL Technical Manager, Dr Paritosh Kumar, Scientist and NSTL and Dy Quality Manager, Dr Aliza Pradhan, Scientist and NSTL Technical personnel; Dr V Rajagopal, Senior Scientist and NSTL Technical personnel; Dr Hanamant Halli, Scientist and NSTL Technical personnel; Dr Neeraj Kumar, Senior Scientist and NSTL Quality Manager

Greenhouse Facility

There are 4 Hi-tech greenhouses with a total area spanning 240 m^2. Each greenhouse has three chambers measuring 10 m x 8 m. Greenhouses are equipped with a cooling pad and an axial exhaust fan system, with a platform for growing plants. These greenhouses have provision for controlling temperature, photoperiod and humidity.

Research Farm

South and North Block Research Farm

A research farm of about 150 acres is divided into four blocks. The south side farm is divided into six blocks, which have been further sub-divided into 37 rectangular/trapezoidal plots including agro-met observatory. Experiments related to atmospheric, edaphic, and drought stresses are being carried out with crops such as soybean, guar, green gram, etc., during kharif season, and with wheat, jowar, chickpea, sorghum, and sugarcane in rabi season.Additionally, eight new plots have been developed and put under rainfed forages such as marvellous grass, stylo, anjan grass, and irrigated Napier grass. The northeast side farm was terraced and planted with various orchards to evaluate the impact of edaphic and drought stress on horticultural crops. About 4 hectares of the northwest side of the farm include a water-balancing tank, and a playground has been developed. The farm is further subdivided into two blocks with seven experimental plots. A water storage tank of 80 lakh litres is there to provide drip irrigation for orchard crops.

Model Herbal Garden

A model herbal medicinal garden named as 'Sanjeevani Garden' is developed under the financial assistance of NMPB, New Delhi. Medicinal plant species are Bonduc, Bael, Coral tree, Neem, Palash, Simaruba, Skikakayi, Putranjeeva, Soap nut, Shami, Shivan, Terminalia species, Wood apple, Mahua, Hirda, Behda, Curry leaf, Lime, Kutaj, Sesbania, Nirgudi, Henna, Guggal, Eucalyptus, Red Sanders, Parijatha, Jasmine, Gunj, Mapia foetida, Nagkesar, Surangi and aromatic grasses.

Malad Research Farm

About 16 acres of land is rented from the Government of Maharashtra to cater to the needs of diversified research activities. The farm is located at Malad Village, about 12 km from the main campus. A farm pond (50 m x 50 m) has been built to facilitate field experiments at the site.

Nakshatra Udyan

Nakshatra Udyan (Constellation Park) was established with 42 different plant species representing 27 Naxatras, planted in the central triangle of the institute. The Udyan has Vat-vriksha i.e., 'Ficus religosa' plant, Areca Palm and Golden Shower plants, etc.

Experimental Livestock Research Facility

The institute has an experimental livestock facility for conducting experiments related to abiotic stress management in livestock. The facility consists of cattle, goat and poultry sheds. The facility is registered with CCSEA (Committee for Control and Supervision of Experiments on Animals) for research, research for education & in-house Breeding of small and large animals.

Fisheries Research Farm

There is modern fisheries facility consisting of glass aquarium, plastic rectangular and FRP tanks, etc. The wet laboratories have facilities for both ornamental and food fishes. There is a dissection unit for sample collection. The institute has three farm ponds for rearing fish broodstock.

Infrastructure for Academic Programmes

Institute has full-fledged facilities for conducting academic programmes, namely the Undergraduate programme for BSc (Hons) and MSc. ICAR-NIASM has all the necessary infrastructural facilities for teaching, such as classrooms, laboratories, experimental fields, sports facilities, and hostels etc.

Student Classrooms

Four classrooms for UG students and one classroom for PG students. Four classrooms for UG students and one classroom for PG students, equipped with digital audio-visual teaching aids such as Digital interactive boards, projectors, desktop computers, and air conditioners, are present in the School of Drought Stress Management and the School of Edaphic Stress Management, with sufficient seating capacity.

Examination Hall

An examination hall for the conduct of academic examinations for UG and PG students is present in the administrative block. The examination hall has individual seating arrangements and is equipped with a CCTV surveillance system.

Hostels

Well-maintained hostel facilities comprising two hostels (boys and girls) are available on the institute campus. Each hostel has 35 rooms, and each room has an attached toilet and bathroom with 24-hour water supply, a solar water heater, and electricity backup. The hostel rooms are well furnished for students. Each hostel also has a common room for recreational activities. The dining block of these hostels is equipped with a modular-type commercial kitchen and can accommodate about 100 students at a time.

Institute Technology Management Unit (ITMU)

Institutes ITMC wing includes ITMU unit which oversee and facilitates institute technology promotion, technology certification, patent, copyright, and trademark submission. ITMU takes various initiatives to enhance institute's technological landscape. The institute celebrated World Intellectual Property (IP) Day on April 30, 2025. The programme was chaired by Dr K Sammi Reddy, Director, ICAR-NIASM. The event was graced by two experts Dr Kajal Chakraborty, Director, ICAR-National Bureau of Fish Genetic Resources, Lucknow, and Dr Vikram Singh, Senior Scientist, IP&TM Unit, ICAR.

ICAR Technologies Certification

S. No	Title	Developer and Co-developers	Certificate No	Year
1	Trash and nutrient management in ratoon sugarcane for enhancing cane yield, carbon sequestration and reducing GHG emissions	Aliza Pradhan; GC Wakchaure; PS Minhas; AK Biswas; KS Reddy	ICAR-NRM-NIASM-Technology-2025-006)	2025
2	Foliar Application of Thiourea, potassium nitrate and sodium benzoate for crop resilience under water stress conditions	GC Wakchaure; PS Minhas; Satish Kumar; KK Meena; KS Reddy	ICAR-NRM-NIASM-Technology-2025-007)	2025
3	Green Synthesis of selenium Nanoparticles from fisheries waste (First Report)	Neeraj Kumar; Paritosh Kumar. SA Kochewad; Ajay Kumar Singh; KS Reddy	ICAR-NRM-NIASM-Technology-2025-008)	2025

Copyrights Registration

S. No	Application/ Registration No.	Name of copyright	Date of Filing	Date of Grant
1.	LD-32005/2025-CO	Climate Smart Loose Housing System for Goats in Dry Semi-Arid Regions	08.08.2025	25.09.2025
2.	SW-18110/2025-CO	Aqua Ammonia Sense Soft: Embedded software for Arduino-based quantitative ammonia detection in water	07.05.2025	14.08.2025
3.	SW-18195/2025-CO	BESTI: Bruteforce Evaluation and Selection of Two Band Indices	07.05.2025	12.08.2025
4.	15643/2025-CO/L	Identification and Measurement of Flower Bending in Dragon Fruit	22.04.2025	06.08.2025
5.	37060/2024-CO/L	Seed propagation in Dragon Fruit: A Practical Guide for growing Dragon fruit through seed	25.11.2024	08.01.2025
6.	LD-46658/2025-CO	Package of Practices for Quinoa Cultivation in Shallow Basaltic Soils	12.11.2025	
7.	LD-37533/2025-CO	Ambience monitor prototype V 1.0	17.09.2025	
8.	LD-31940/2025-CO	Climate-resilient integrated farming system model for improving farmer's livelihood and nutritional security in semi-arid regions	08.08.2025	
9.	LD-30360/2025-CO	Package of practices for chia (Salvia hispanica L) Cultivation	30.07.2025	
10.	SW-18193/2025-CO	PMETRICS: Precision Planter Metering Evaluation through Rapid Integrated Computer Vision and Software Analysis	07.05.2025	
11.	SW-18192/2025-CO	WARPH: Geospatial database and GUI for Weather Adjusted RPAS Performance Hours	07.05.2025	
12.	SW-18109/2025-CO	IMD Zonal Stat: Software for Calculating Zonal Statistics based on IMD grided datasets	07.05.2025	
13.	1468/2025-CO/L	Pictorial guide to morphological variability of chia (Salvia hispanica L.)	14.01.2025	

Budget Utilization

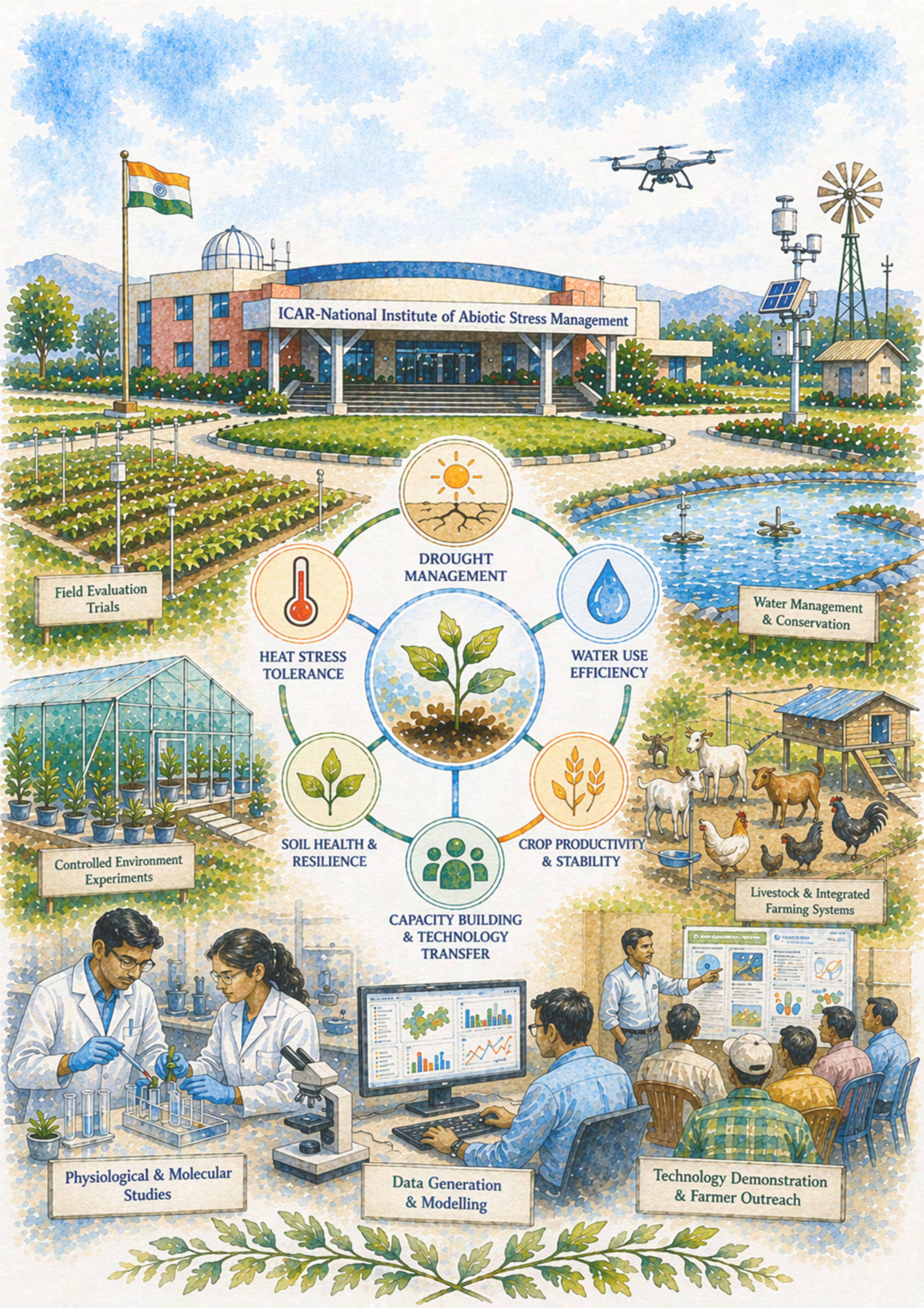
The institutes budget details for the financial year 2024-25 are given in tables below:

Financial statement for financial year 2024–2025

Head /Sub-Head	Allocation (lakh ₹)	Expenditure (lakh ₹)
Grants in aid-Capital		
Office Building		8129904
Works		1000000
Equipment		17025057
Information Technology		967105
Library Books		138324
Furniture and Fixtures		1239610
Sub Total-1	**28500000**	**28500000**
Grants in aid-Salary		
a) Establishment Charges	116138000	116138000
Sub Total-2	**116138000**	**116138000**
Grants in aid-General		
Pension and other retirement Benefits	889387	889387
Travelling Allowance	1200000	1200000
Research and Operational Expenses	15010446	15010446
Administrative Expenses	37677666	1111888
Miscellaneous Expenses	1111888	
Sub Total-3	**55889387**	**55889387**
Tribal Sub-Plan		
Grants in aid-Capital	800000	800000
Grants in aid-General	5500000	5500000
Sub Total-4	**6300000**	**6300000**
Scheduled Castes Sub-Plan		
Grants in aid-Capital	3375000	3375000
Grants in aid-General	6500000	6500000
Sub Total-5	**9875000**	**9875000**
Grand Total	**216702387**	**216702387**

Revenue generated during the financial year 2024–2025

Particulars	Amount (lakh ₹)
Sale of farm produce	1830936
License fee	1959220
Fees from the Candidate	376320
Analytical & Testing Fees	49088
Training Fees	312000
Income generated from internal resource generation	1088043
Miscellaneous receipts	5623
Grand Total	**5621230**


ICAR-National Institute of Abiotic Stress Management
DROUGHT MANAGEMENT
HEAT STRESS TOLERANCE
WATER USE EFFICIENCY
SOIL HEALTH & RESILIENCE
CROP PRODUCTIVITY & STABILITY
CAPACITY BUILDING & TECHNOLOGY TRANSFER
Field Evaluation Trials
Water Management & Conservation
Controlled Environment Experiments
Livestock & Integrated Farming Systems
Physiological & Molecular Studies
Data Generation & Modelling
Technology Demonstration & Farmer Outreach

SCHOOL OF ATMOSPHERIC STRESS MANAGEMENT

The production and productivity of crops and livestock are directly impacted by weather anomalies, mostly caused by atmospheric shifts. Its monitoring and unravelling of underlying adaptive mechanisms are important for making production systems resilient. Accordingly, the research programme on atmospheric stress management has largely concentrated on comprehending the effects of atmospheric stress and developing assessment and management strategies in crops and livestock using monitoring approaches and fundamental research investigations in areas focusing on heat and drought stress. This includes spatio-temporal analysis of rainfall, drought, genome editing approaches for enhancing stress tolerance, and studing thermal stress responses in livestock. The major research findings and progress made are summarized below

Weather at ICAR-NIASM, Baramati

Information on weather is of paramount importance for agriculture production. Observations of weather parameters are being recorded at Institute on regular basis. Observations recorded during January to December 2025 are discussed below.

Temperature

The Long Period Average (LPA) of annual mean temperature of Baramati is 26.0 °C. The monthly mean temperature during different months recorded at ICAR-NIASM is presented in Fig 1. During this year, annual mean temperature was 25.4 °C and the monthly mean temperatures varied between 19.3 °C (December) to 30.5°C (April). The monthly mean temperature increased linearly from January to April followed by reduction during May due to pre monsoon rainfall events and then during June to September due to cooling effect of the monsoon winds, after which it started decreasing and attained a value of 19.3°C in December. Monthly maximum temperature reached its peak in April (39.1°C) and dipped to 28.4°C in December. For minimum temperature, July recorded the maximum (22.8°C) and December recorded the minimum (10.1°C) values (Table 1).

Relative Humidity

Relative humidity measured, at standard hours in the morning (0700 LMT) and afternoon (1400 LMT), during the year 2025 were used for computation of monthly statistics. Monthly mean relative humidity during the different months has been depicted in Fig 1. Relative humidity at morning varied between 61% (March) and 93% (September). On the other hand, variation in afternoon relative humidity was between 16% (April) to 69% (September). The mean morning and afternoon relative humidity was found to be decreasing from January to March, which is due to the effect of increasing temperature, and then it starts increasing in pre monsoon months and reaches to its highest value during monsoon months, and again decreased in post monsoon months. Annual mean relative humidity averaged over the entire year stood at 64 % and ranged between 40 % to 81 %. Higher diurnal ranges (more than 50%) in RH were observed in November, December, January, February and April. The lowest diurnal range was observed in September (24%).

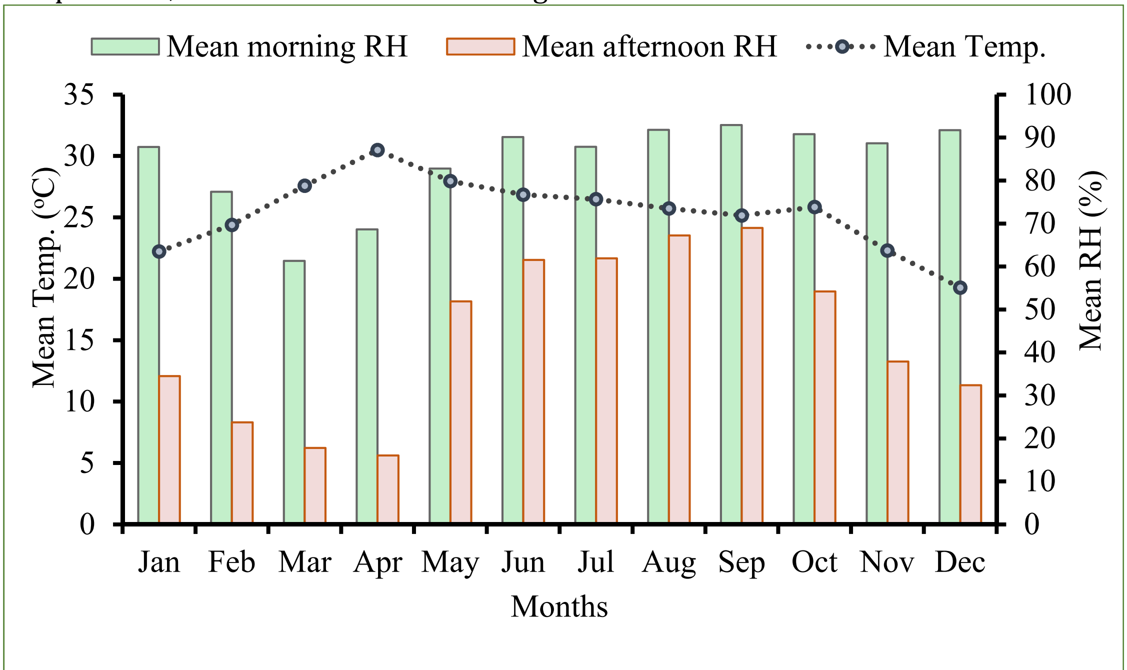


Fig 1. Variations of monthly mean temperature, mean morning and afternoon relative humidity during 2025 at ICAR-NIASM Baramati.

Rainfall

The Long Period Average (LPA) annual total rainfall of Baramati is 576.0 mm with an average of 40 rainy days per year. This year, Baramati received about 125% of its average annual rainfall, distributed among 40 meteorological rainy days, which yielded 756.9 mm of total rainfall. The monthly cumulative rainfall during different months recorded at ICAR-NIASM, Baramati has been given in Fig 2. During the monsoon season the maximum rainfall was received in May (345.9 mm), followed by September (Table 1). In the monsoon season, there were 23 rainy days with total rainfall of 335.2 mm, which is 78% of normal rainfall of the region. Withdrawal of monsoon resulted in incessant rains during October. In the post-monsoon season, highest rainfall occurred in October (71.0 mm) and during the summer season, 348.7 mm of rainfall was received (Fig 2).

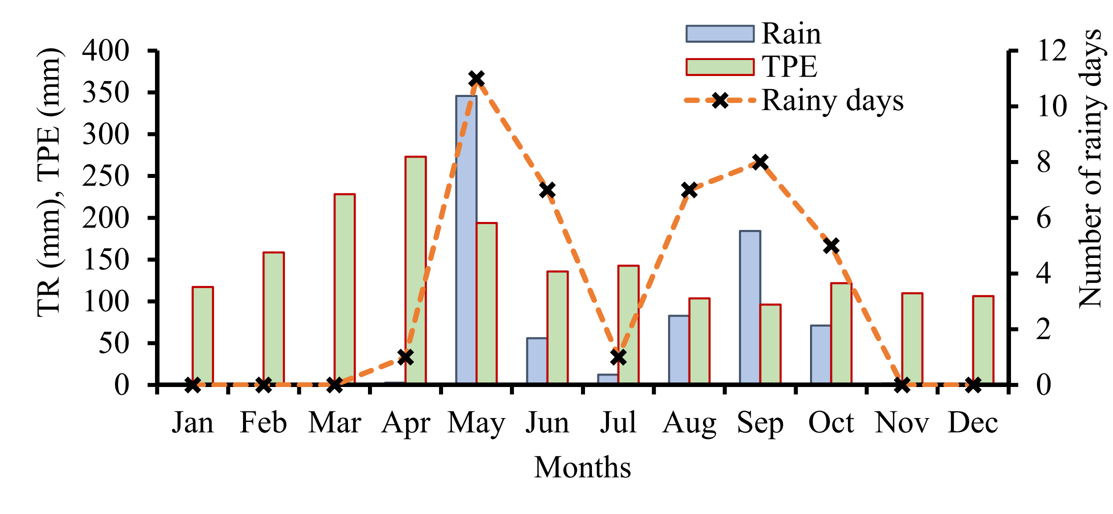


Fig 2. Variations of monthly total rainfall (TR), total pan evaporation (TPE) and number of rainy days during 2025 at ICAR-NIASM Baramati.

Wind speed, Pan Evaporation and Sunshine duration

Monthly averages of the wind speed, pan evaporation and bright sunshine hours recorded in this year at ICAR-NIASM are presented in Fig 3. Monthly average wind speed values have been found to vary from 2.9 (December) to 10.5 kmph (July), and the annual average for the daily wind speed stood at 6.0 kmph. (Table.1). Annual total open pan evaporation (TPE) aggregates to 1786.7 mm, which was around 3 times of the total rainfall of this year. The evaporative demand gradually increased from January and achieved its highest value in April (9.1 mm/d). It declined thereafter to 4.5 mm/d in June and from July to December average daily pan evaporation varied between 3.4 to 4.6 mm/d (Fig 3). The lowest evaporation rate was recorded in September (3.2 mm/d). The annual average of daily PE was 4.8 mm. During the year, the daily average of bright sunshine duration remained 6.0 hrs and monthly average values have been found to vary between 2.4 hrs (July) and 9.4 hrs (February) (Fig 3).

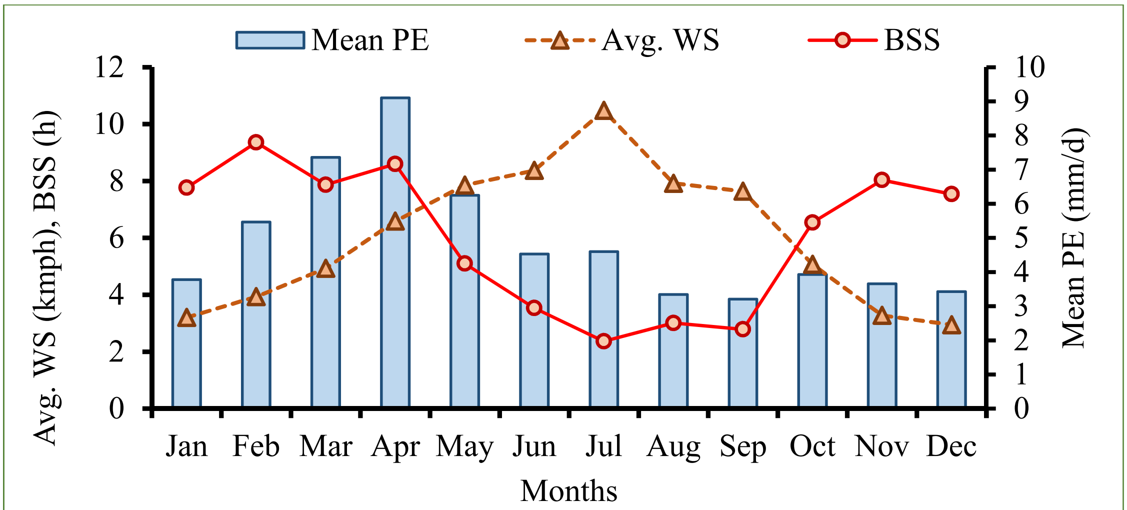


Fig 3. Variations of monthly mean pan evaporation (PE), average wind speed (WS) and mean bright sunshine hours (BSS) during 2025 at ICAR-NIASM Baramati.

Table 1. Mean monthly weather parameters recorded at ICAR-NIASM from Jan-Dec, 2025

Parameter	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmax (°C)	30.5	33.3	36.6	39.1	33.7	31.2	30.2	29.5	29.1	30.9	29.8	28.4
Tmin (°C)	13.9	15.5	18.6	21.8	22.2	22.5	22.8	21.9	21.2	20.8	14.8	10.1
RH I (%)	88	77	61	69	83	90	88	92	93	91	89	92
RH II (%)	35	24	18	16	52	62	62	67	69	54	38	32
Avg. WS (kmph)	3.2	3.9	4.9	6.6	7.9	8.4	10.5	7.9	7.6	5.1	3.3	2.9
BSS (h)	7.8	9.4	7.9	8.6	5.1	3.5	2.4	3.0	2.8	6.5	8.0	7.5
Total rain (mm)	0.0	0.0	0.0	2.8	345.9	55.9	12.3	81.6	184.2	71.0	2.0	0.0
Total rainy days	0	0	0	1	11	7	1	7	8	5	0	0
Mean PE (mm/d)	3.8	5.5	7.4	9.1	6.2	4.5	4.6	3.3	3.2	3.9	3.7	3.4

Extreme weather observation recorded in 2025

The warmest and coldest days in the entire year were obtained based on daily mean temperature data, and it was found that 24th April (32.9°C) and 26th December (18.0°C), were the warmest and coldest days respectively (Table 2). Daily maximum temperature reached up to 41.1°C (24th April), while lowest daily minimum temperature dipped to 7.4 °C (19th December). The warmest and coldest months were calculated based on monthly mean maximum and minimum temperatures, respectively. April (30.5°C) was the warmest and December (19.3°C) was the coldest month during this year (Table 2). The cumulative monthly rainfall was highest in May (345.9 mm). The highest rainfall, pan evaporation and wind speed events were reported on 25th May (130.2 mm), 21st April (11.9 mm/d) and 30th July (17.9 kmph), respectively.

Table 2. Important meteorological events of the year 2025.

Particular of weather parameter	Value	Date
Highest daily mean temperature	32.9 °C	24 April 2025
Lowest daily mean temperature	18.0 °C	26 December 2025
Highest daily maximum temperature	41.1 °C	24 April 2025
Lowest daily minimum temperature	7.4 °C	19 December 2025
Highest monthly mean temperature	30.5 °C	April 2025
Lowest monthly mean temperature	19.3 °C	December 2025
Highest daily rainfall	130.2 mm	25 May 2025
Highest monthly cumulative rainfall	345.9 mm	May 2025
Highest monthly cumulative PE	273.1 mm	April 2025
Highest rate of daily PE	11.9 mm	21 April 2025
Highest daily wind speed	17.9 kmph	30 July 2025

Spatiotemporal analysis of rainfall in agro-climatic zones of India

A long-term spatio-temporal analysis of monthly, seasonal, and annual rainfall across India's agro-climatic zones (1901–2022) was carried out using Innovative Trend Analysis (ITA), Innovative Polygonal Trend Analysis (IPTA), Mann–Kendall/modified Mann–Kendall tests, and Sen's slope. Results indicated a general decline in winter rainfall across most zones, while pre-monsoon rainfall increased in northern India. Monsoon, post-monsoon, and annual rainfall showed decreasing trends over large parts of northern, central, and eastern India, whereas western and southern regions exhibited increasing trends. Traditional MK-based methods detected trends in 16.7% of monthly and 41% of seasonal datasets, while IPTA identified trends in 72% of monthly series. ITA consistently detected significant trends across all time series, with trend directions remaining consistent across methods. The study provides valuable insights for climate-resilient agricultural planning and resource management.

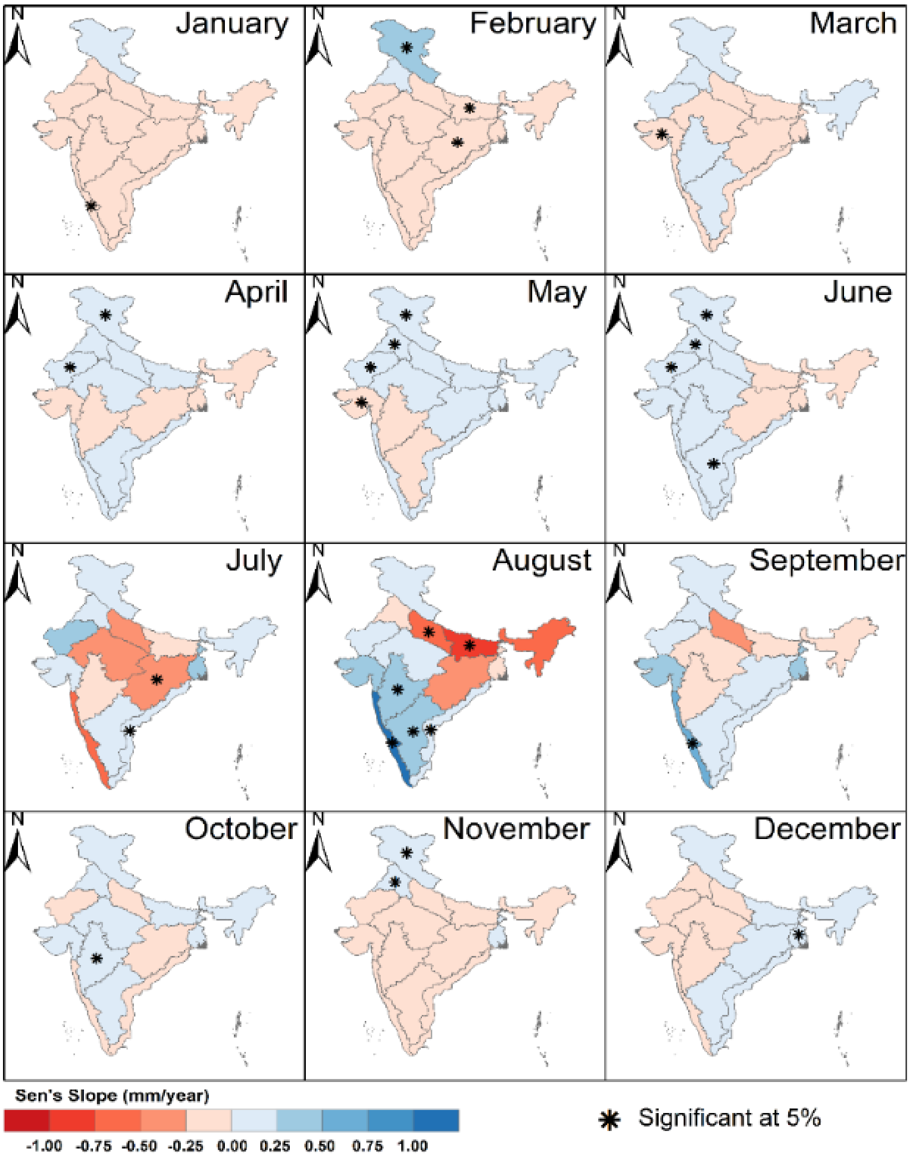


Fig 4. Monthly trends of rainfall and its spatial variation for 1901-2022.

Teleconnections of rainfall with ENSO and IOD in agro-climatic zones of India

Understanding the spatiotemporal teleconnections of rainfall in India is crucial for agricultural planning, water resource management, and climate adaptation. This study investigates the long-term teleconnections of annual and monsoon rainfall with the Indian Ocean Dipole (IOD) and El Niño-Southern Oscillation (ENSO) indices across different Agro Climatic Zones (ACZs) of India from 1901 to 2022. Significant correlations were observed between monsoon and annual rainfall with the JJAS, OND, and annual composite values of ENSO indices, while the correlation with IOD were mostly non -significant. We also identified the best composite indices for each ACZ, highlighting spatial heterogeneity in the influence of ENSO and IOD. By decomposing the analysis into two 60-year periods, we capture dynamic changes in these teleconnections over time. Comparing the periods, 1902-1962 and 1962-2023 revealed evolving teleconnections, suggesting a weakening influence in the western and central ACZs and a strengthening influence in the southern, eastern, and northern ACZs. This comprehensive analysis provides insights into regional climate dynamics and will inform targeted policy recommendations for better planning and management decisions, supporting agriculture under changing climate scenarios ACZ's of India.

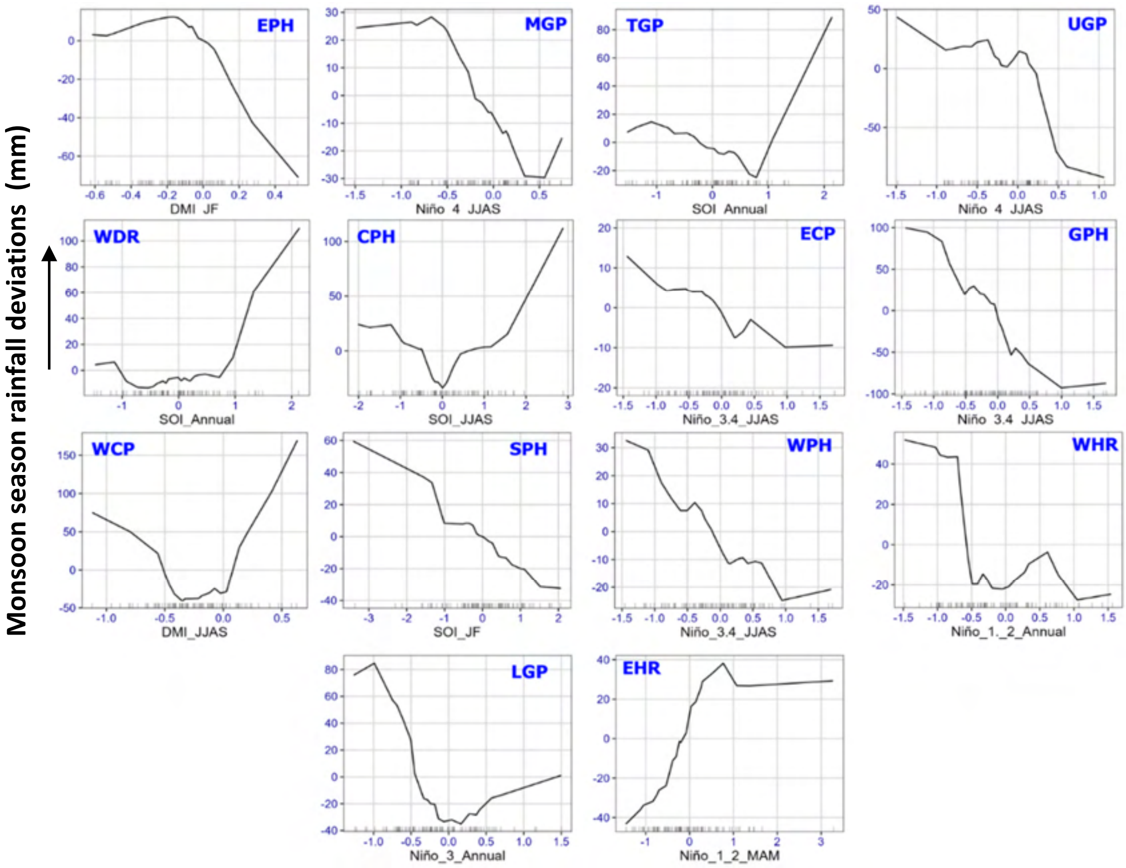


Fig 5. ALE plots of the key climate indicesof each ACZ depicting the variability explained by the respective indice

Spatiotemporal analysis of drought and its teleconnections in agro-climatic zones of India

Understanding long-term spatiotemporal changes of drought and its linkage with climate modes is important from agricultural perspective. Spatiotemporal trends of meteorological drought, quantified using the Standardized Precipitation Index (SPI), over Agro climatic zones (ACZs) of India from 1933–2022 were analyzed using the graphical Innovative Trend Analysis (ITA) along with traditional Mann-Kendall (MK) /modified Mann-Kendall (m-MK), Sen's slope and simple linear regression (Fig 6). This study also analyzed the linkage between El Niño Southern Oscillation (ENSO) and Indian Ocean dipole (IOD) with monsoon season meteorological drought over ACZs for 1903–2022 (Fig 7). Variations in both SPI-4 of September and SPI-12 of December showed almost equal percentage of wet (SPI >0, 49.9%) and dry (SPI < 0, 51.1%) years. Monsoon and annual drought frequencies varied from 12.5–18.3% .The trend slopes of monsoon SPI-4 varied from -0.14–0.11/10a, while the annual SPI-12 varied from -0.14–0.19/10a. Long-term trends of both monsoon SPI-4 and annual SPI-12 showed significantly increasing drying tendencies in the central, northern and eastern parts of the country, while the peninsular India has shown wetting trends, except in western coastal plains, where significant drying is observed. Monsoon SPI-4 in most ACZs was closely linked with ENSO (Niño 3.4 and SOI), while it showed almost no linkage to IOD (DMI). This suggests that the ENSO remains the dominant driver of drought variability in ACZs of India, whereas the IOD's role appears marginal in modulating long-term drought risk. The outcomes of this work gives valuable insights for agricultural planning and water resource management strategies to mitigate drought risks in different ACZs of India.

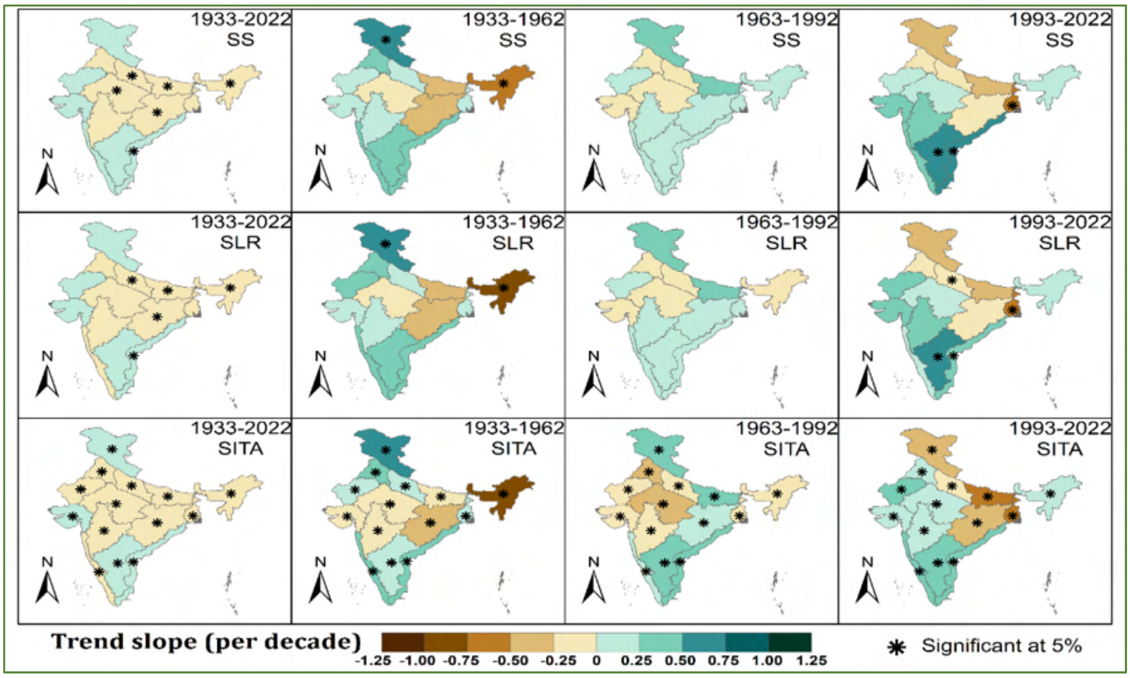


Fig 6. Spatial variations of meteorological drought trends during monsoon season (monsoon SPI-4) using SS, SLR and ITA.

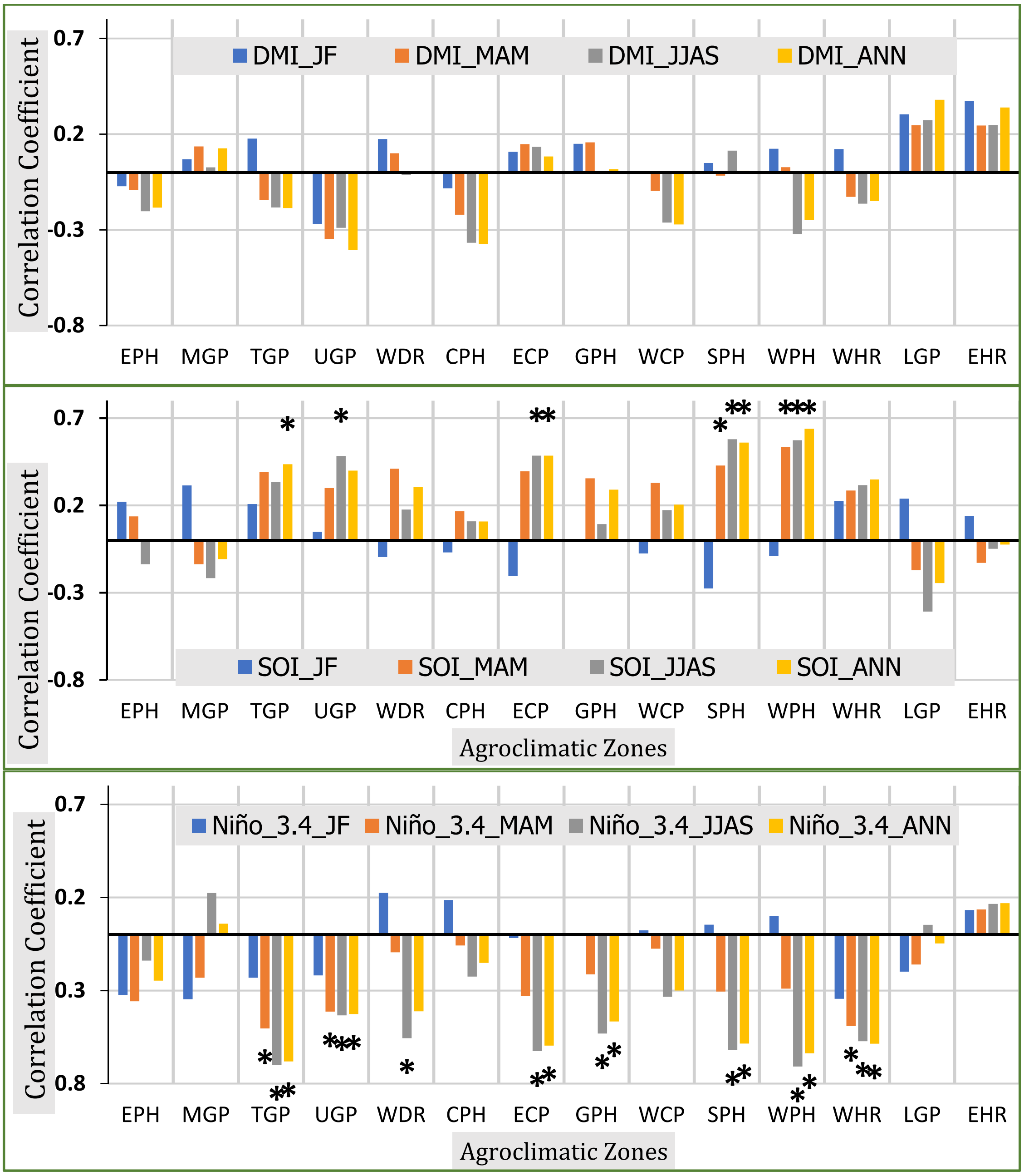
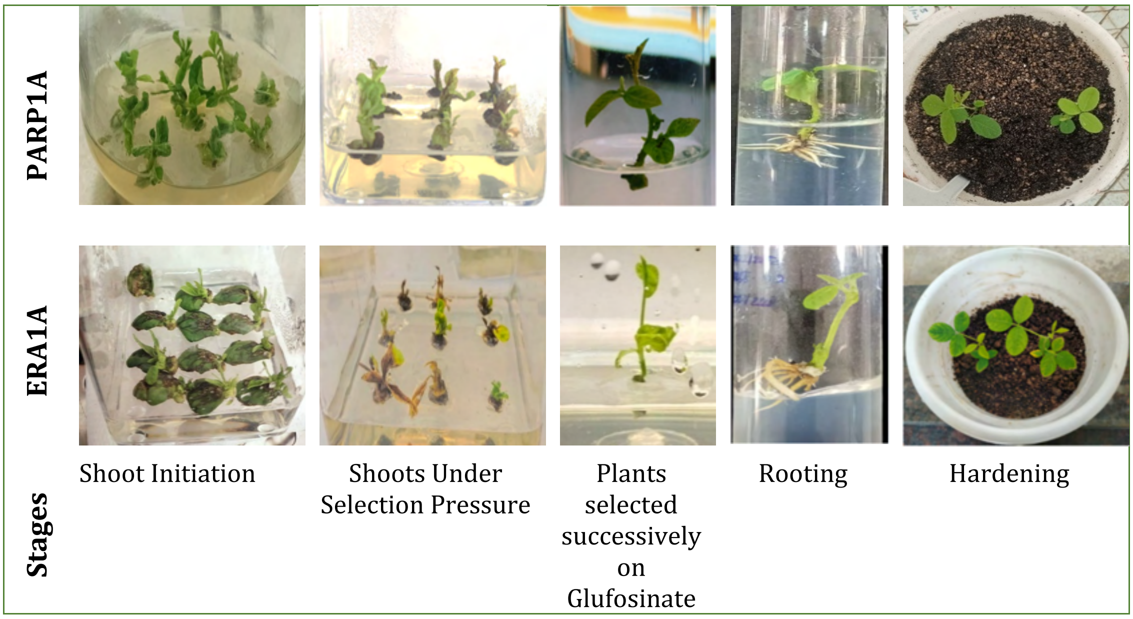


Fig 7. Correlations of monsoon SPI-4 in ACZs of India during *El-Niño* years 1903–2022.

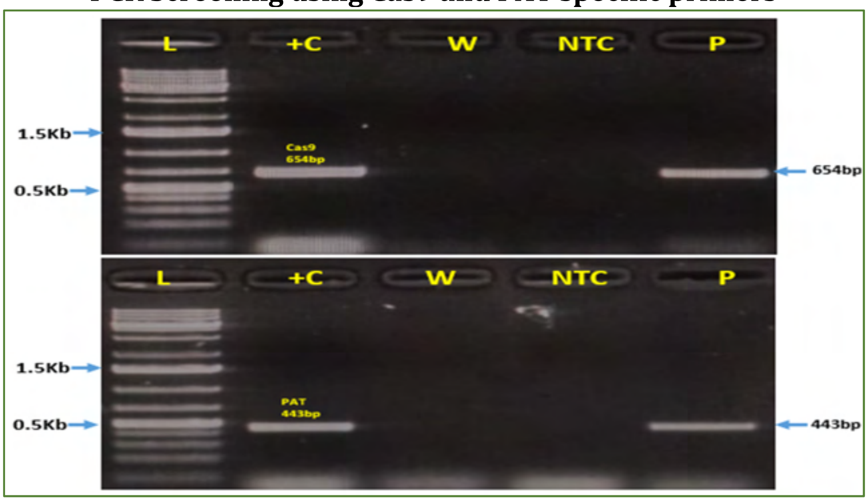
Targeted knockout of PARP and ERA1 genes using genome editing tool to enhance water stress tolerance in soybean

An optimized protocol for *Agrobacterium*-mediated transformation was employed using Cas9 constructs targeting the *PARP1* and *ERA1* genes. Shoots were initiated and selected on media containing glufosinate, then further selected and elongated on shoot initiation and elongation media. Successfully developed shoots were transferred to rooting media containing 1 mg/L IBA, where rooting was induced. Subsequently, the plantlets were acclimatized in Soilrite before being transferred to greenhouse conditions. In parallel, an *in-planta* transformation was performed using mature imbibed seeds and the same Cas9 constructs. Multiple shoots emerging from transformed plants were screened via glufosinate painting and PCR using primers specific to the Cas9 (CasNosFor/CasNosRev) and PAT (PAT For/PAT Rev) sequences. PCR analysis identified four positive plants for the *PARP1A1AE2gRNA1* construct and two plants for the *ERA1AE2gRNA*. The resulting amplicons were confirmed by Sanger sequencing, and mutations were further verified by subsequent Sanger sequencing.



***In Planta* Transformation: Cas9MDC123:PARP1A1BE2gRNA1 and gRNA2**

PCR Screening using Cas9 and PAT specific primers



Silencing of negative regulator genes using VIGS approach for functional characterization of genes of soybean to enhance water and salinity stress tolerance

Water (excess as well as limited) and salinity stresses negatively influence growth, development, and ultimately yield in soybeans. Functional genomics employing genetic manipulation techniques has been utilized to characterize soybean agronomic traits and genes associated with them, but these methods are time-consuming. Rapid functional genomics tools like Virus-Induced Gene Silencing offer precise, rapid, and efficient tools for gene function studies. Various regulatory genes- EIN2, FNSL, WRKY, and ARF were functionally analyzed using a Virus-Induced Gene Silencing (VIGS) approach to improve water and salinity stress tolerance (Fig 8, 9). The BPMV-based viral vectors pHopRNA1 and pG7RNA2 were utilized. A distinct silencing phenotype was obtained for various regulatory genes like EIN2, FNSL, WRKY, and ARF (Fig 10).

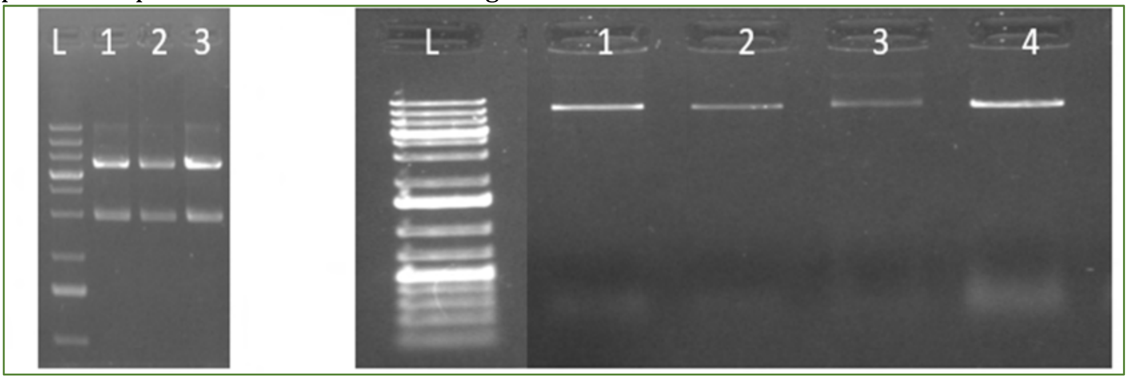


Fig 8. Agarose gel electrophoresis of DNA digestion. Lane L: 1 Kb plus DNA ladder; a). pHoRI digested with *Not*I and *Sal*I; b). Lanes 1–4: pG7R2 digested with *Sal*I

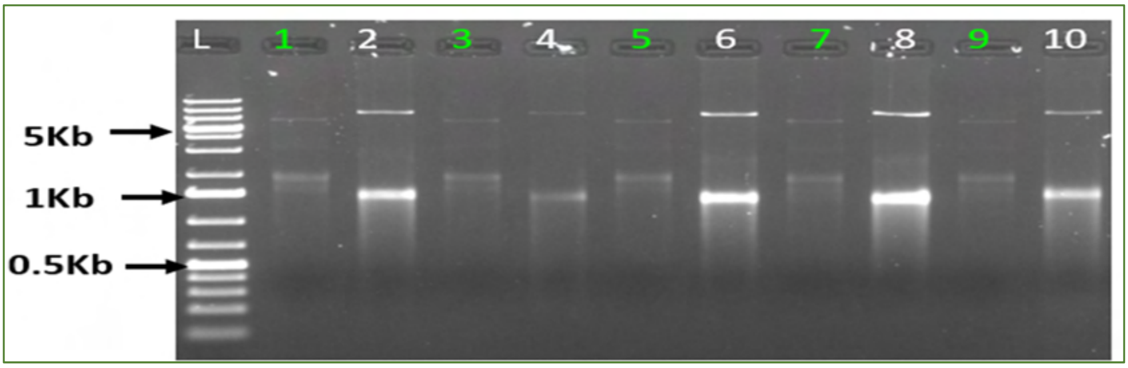


Fig 9. Agarose gel electrophoresis of RNA1 and RNA2 transcript after 1hr incubation at 37°C (Lane L-1Kb plus DNA Ladder; 1, 3, 5, 7, 9-pHopR1 transcript and 2-EIN2 Transcript, 4-WRKY transcript, 6-FNSL transcript, 8-ACS transcript, 10-ARF transcript)

Fig 10. In vitro transcripts from the native pHopR1-RNA1 and recombinant pG7R2-RNA2 together rub-inoculated for gene silencing. The native pG7R2 transcript serves as a positive control-2, while a mock control (phosphate buffer) and each construct (3-6) were also included.

Development of an Efficient Protoplast Isolation Method from Immature Soybean Cotyledons for Plasmid-Free RNP-Based Genome Editing

The procedure commenced with the physical isolation of immature soybean cotyledons, which were sectioned into approximately 0.5 mm segments in SoyPIS solution to enhance enzymatic accessibility by increasing surface area. The tissue fragments were subsequently incubated for five hours in a digestion mixture containing cellulase and macerozyme prepared in SoyPIS solution. These enzymes hydrolyze the polysaccharide components of the cell wall, facilitating the release of intact, cell wall–free protoplasts into the surrounding medium. Following enzymatic digestion, the suspension was centrifuged to concentrate the released cellular material, and the resulting pellet was gently resuspended in washing buffer (WB-N) to terminate enzymatic activity and remove residual debris. For purification and recovery of high-quality protoplasts, the suspension was carefully layered onto a sucrose gradient, enabling density-based separation. Intact and viable protoplasts were collected from the interphase, effectively separating them from vascular debris and damaged cells. The yield, integrity, and concentration of the isolated protoplasts were subsequently confirmed through microscopic examination. Fig. 11 demonstrates methodology developed to isolate good quality and quantity of protoplasts isolated from immature soybean cotyledons.

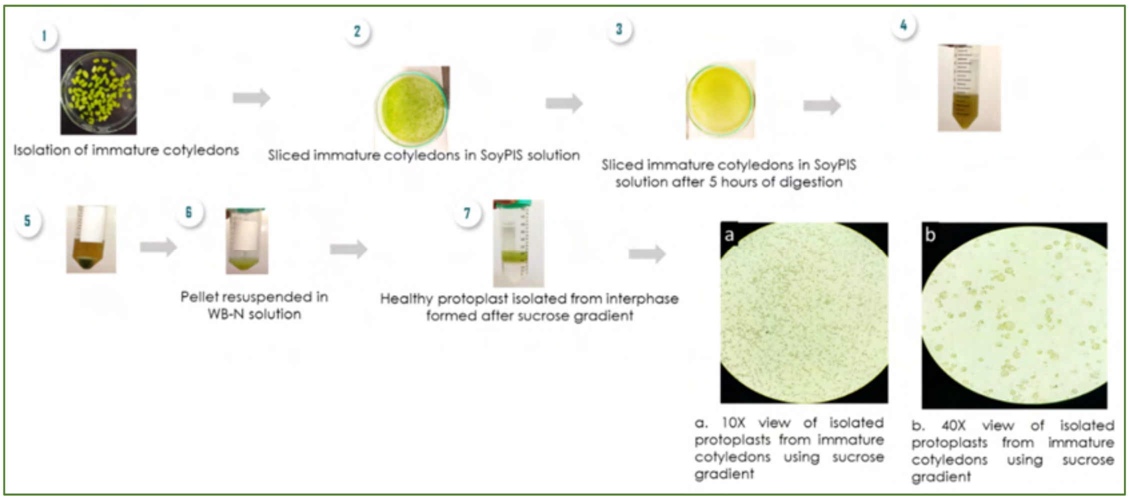
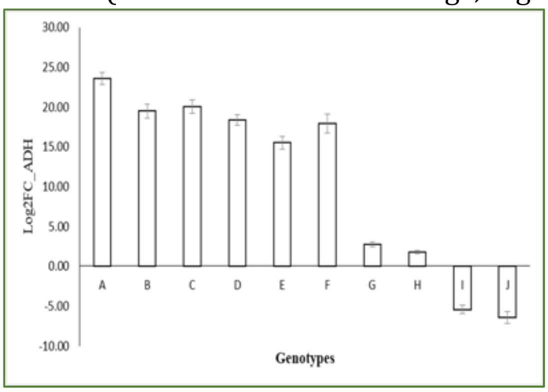


Fig 11. Methodology developed to isolate good quality and quantity of protoplasts.

Expression Profiling of Fermentative and Stress-Responsive Genes in Pigeon Pea Genotypes under Waterlogging Stress

Eight genotypes, viz., ICP 12410, ICP 2405 ICP 10228, ICP 8941, ICP 10094, ICP 14701, ICP 8152, ICP 8255, along with IPAV-16-1 as a tolerant check and IPAC-79 as a susceptible check, were selected for this study that were identified as reproductive stage drought stress tolerant in the field experiment. These genotypes were evaluated for waterlogging stress tolerance at the knee-height stage using waterlogging tanks (for 7 days with 6 cm water above the soil surface). At the end of the stress period, sampling was done for expression studies through qRT-PCR analysis for a few selected stress-responsive genes, viz., *CaADH, CaLDH, CcaABC, CcaGNOM1, CcaPIN1, CcaLSD1, CcaPDC, CcaEIN2,* and *CcaACS1.* Quantitative RT-PCR analysis across ten genotypes revealed pronounced genotype-dependent variation in the expression of the fermentative pathway genes alcohol dehydrogenase (ADH) and lactate dehydrogenase (LDH) under waterlogging stress (Fig. 12a, 12b), with normalization performed against Actin (internal control). Among which the strongest induction was observed for CcADH1 (23.54 to 18.33 fold change, Fig 12) in tolerant genotypes (ICP 12410, ICP 2405 ICP 10228, ICP 8941, ICP 10094 and IPAV-16-1) whereas in the susceptible genotype (ICP 14701, ICP 8152, ICP 8255 and IPAC- 79) only mild induction of CcaADH gene, ranging between 2.75 to 1.83 FC was observed. In contrast, there was downregulation of CcL-LDH (isoform A) gene (0.47 to 0.33 fold, Fig 12b) in the susceptible genotypes, whereas in the tolerant genotype- ICP 12410, there was a strong upregulation (4.67 FC) of this gene, which is at par with a tolerant check-IPAV-16-1 (4.69). These findings, together with the expression profiling of additional waterlogging-stress responsive genes, highlight substantial genotypic diversity in molecular responses to waterlogging (hypoxic) stress and provide a basis for identifying stress-tolerant pigeon pea genotypes for further functional characterization and crop improvement.Relative expression was calculated using the $2^{-\Delta\Delta Ct}$ method with Actin as the reference gene and expressed as $\log_2$ fold change (logFC) compared with genotype-specific controls. Bars represent mean values from three biological replicates



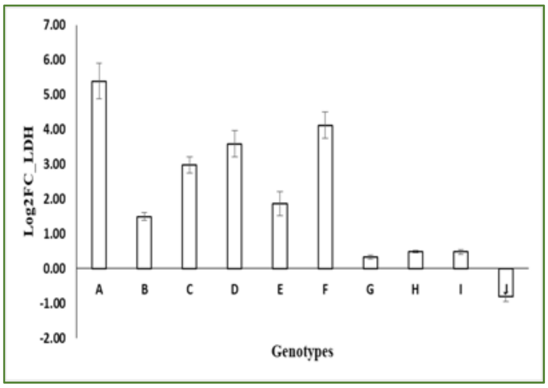


Fig 12. Log_2 fold-change expression of *CcaADH* (a) and *CcaLDH* (b) across genotypes under waterlogging stress.

Adaptive Responses of Indigenous Goat Breeds to Seasonal Thermal Stress in Semi-Arid Regions.

The present study was undertaken to evaluate the influence of seasonal variation on physiological responses and energy-related metabolic traits in three indigenous goat breeds, namely Osmanabadi, Sangamneri, and Konkan Kanyal, reared under semi-arid climatic conditions. A total of 30 animals were included in the study, and observations were recorded across three distinct seasons, summer, monsoon, and winter, to capture the effects of fluctuating environmental stressors. Indigenous goats play a crucial role in sustaining livestock-based livelihoods in semi-arid regions, and understanding their adaptive responses to climatic variability is essential for improving productivity and welfare under changing climate scenarios. Physiological parameters such as respiration rate (RR), rectal temperature (RT), and heart rate (HR) were recorded as indicators of thermoregulatory stress, while energy-metabolic status was assessed through serum glucose (GL) and total cholesterol (TCH) levels. Concurrently, ambient temperature and relative humidity were continuously monitored to calculate the temperature–humidity index (THI), which served as an integrated measure of environmental heat load (Fig 13). Seasonal analysis of THI revealed that summer imposed the most severe thermal stress on the animals, followed by monsoon, whereas winter conditions were comparatively thermally comfortable. A significant increase ($p < 0.05$) in RR, RT, and HR was observed during summer and monsoon seasons across all three breeds, reflecting activation of physiological mechanisms aimed at dissipating excess body heat. Elevated respiration rates facilitate evaporative cooling, while increases in rectal temperature and heart rate indicate heightened metabolic and circulatory demands under heat stress. These findings clearly demonstrate that goats experience considerable thermal strain during warmer seasons in semi-arid environments. In contrast to physiological responses, energy-metabolic parameters exhibited an inverse seasonal pattern. Serum glucose and total cholesterol concentrations were lowest during summer, intermediate during monsoon, and highest in winter (Fig 13). This decline in energy metabolites during periods of heat stress suggests diversion of energy toward thermoregulation and maintenance processes, along with possible reductions in feed intake and altered metabolic efficiency. Such metabolic adjustments are commonly reported in livestock exposed to prolonged thermal stress. Correlation analysis further supported these observations, revealing strong positive associations between THI and physiological parameters, while THI showed negative correlations with energy-metabolic traits across all breeds and seasons. These relationships confirm that increasing environmental heat load directly intensifies physiological strain while simultaneously suppressing metabolic energy reserves. Breed-wise comparisons indicated notable differences in adaptive capacity. Under heat stress conditions, Sangamneri goats exhibited the least deviation from baseline physiological values, followed by

Konkan Kanyal and Osmanabadi breeds. Additionally, Sangamneri goats maintained relatively higher serum glucose levels during stressful periods, whereas Konkan Kanyal goats showed comparatively elevated cholesterol concentrations, suggesting breed-specific metabolic coping strategies. Overall, the study highlights distinct adaptive responses among indigenous goat breeds to seasonal climatic variation under semi-arid conditions. Sangamneri goats demonstrated greater physiological and metabolic stability across seasons, indicating superior thermotolerance. The findings emphasize that seasonal fluctuations significantly influence both physiological and energy-metabolic processes in goats, underscoring the need for targeted management and ameliorative interventions during heat stress periods, particularly in summer and monsoon seasons, to enhance animal resilience and productivity.

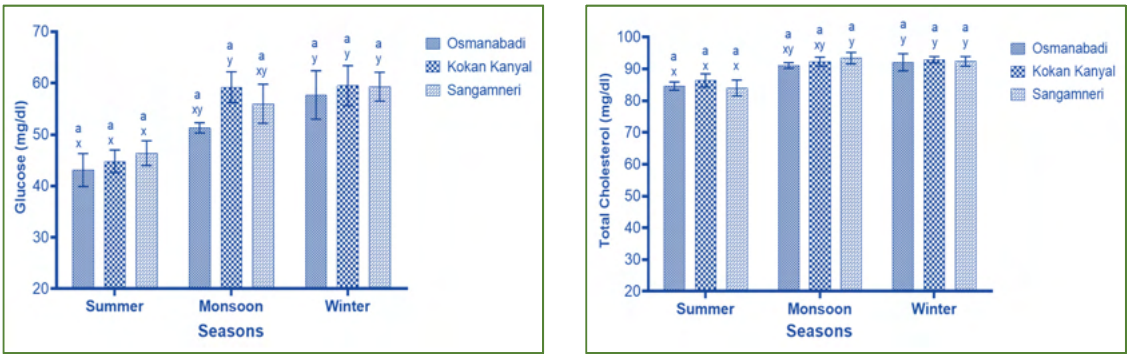


Fig 13. Mean (±SEM) serum glucose and total cholesterol (mg/dl) in Osmanabadi, Konkan Kanyal and Sangamneri goats across seasons.

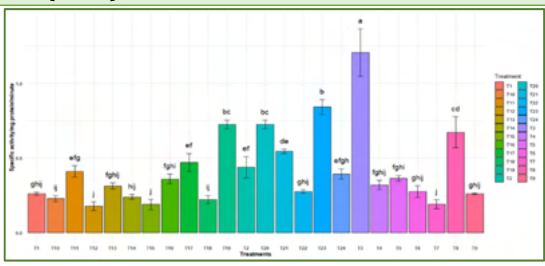
SCHOOL OF DROUGHT STRESS MANAGEMENT

Application of Endophytes for Alleviation of Moisture-Deficit Stress in Groundnut

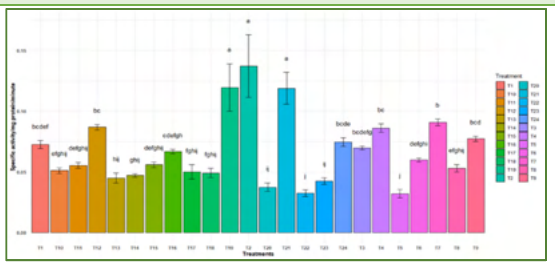
From plant samples collected in drought-prone and salinity-affected groundnut-growing areas, 21 distinct morphotypes of nodule-inhabiting bacteria (including rhizobia) and 126 additional endophytic isolates were obtained. All isolates were screened for tolerance to salinity and moisture-deficit stress using NaCl and PEG-6000 gradients, respectively. Pair-wise in vitro compatibility testing was conducted for all isolates. Based on compatibility results, 20 of the 126 endophytes and 10 of the 21 nodule-inhabiting endophytes (including rhizobia) were shortlisted. Their intrinsic antibiotic resistance patterns were determined, and 23 compatible consortial combinations were formulated for further evaluation under pot conditions in a greenhouse and subsequently under field conditions using the groundnut cultivar Phule Unnati to assess their role in alleviating moisture-deficit stress. A trial conducted during the rabi–summer 2024 season evaluated the efficacy of these consortia under drought stress imposed by withholding irrigation for 25 days post-flowering. The study aimed to assess their impact on drought alleviation, plant growth, yield, and modulation of physiological and biochemical parameters. Application of selected endophytic consortia-comprising Enterobacter cloacae GR4 and Heyndrickxia sporothermodurans GE17; Rhizobium calliandrae GR2 + Bacillus paramycoides GE7; Enterobacter cloacae subsp. dissolvens GR19 + Bacillus safensis GE30; and Enterobacter cloacae subsp. dissolvens GR19 + Bacillus sp. GE99 significantly enhanced pod yield of groundnut (cv. Phule Unnati) under imposed drought stress (Table 1). In addition, the consortial application modulated the activity of key reactive oxygen species (ROS)-scavenging enzymes, including superoxide dismutase (SOD), ascorbate peroxidase (APX), catalase (CAT), peroxidase, and glutathione reductase, indicating improved physiological resilience during stress alleviation (Fig 1).

Table 1. Evaluation of endophytes for alleviation of moisture-deficit stress in groundnut (Cv. Phlue Unnati) during summer 2025

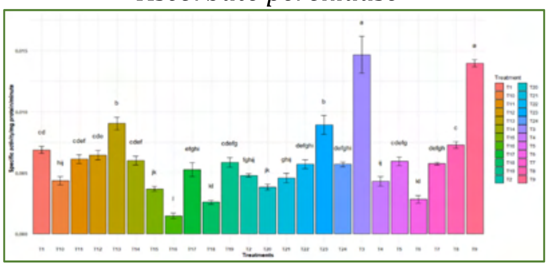
Treatments	Haulm Yield (kg/ha)	Pod Yield (kg/ha)
Control	4053	2590
Acinetobacter sp. GR7 + *B. xiamenensis* GE19	4090	2840
Acinetobacter sp. GR7 + *H. vini* GE68	4037	2803
E. cloacae GR4 + *H. sporothermodurans* GE17	4420	2957
E. cloacae GR4 + *Bacillus* sp. GE63	4333	2403
A. pittii GR25 + *B. albus* GE31	3940	2713
A. pittii GR25 + *Exi. acetylicum* GE8	4027	2813
GR21 + *Exi acetylicum* GE8	4327	2547
GR21 + *B. paramycoides* GE35	4110	2870
R. calliandrae GR2 + *B. paramycoides* GE7	3980	2973
R. calliandrae GR2 + *B. clarus* GE33	4490	2807
R. calliandrae GR2 + *B. albus* GE31	4120	2827
E. cloacae subsp. *dissolvens* GR19 + *B. safensis* GE30	4523	2980
Enterobacter cloacae subsp. *dissolvens* GR19 + *Bacillus* sp. GE99	4493	2937
Si. xinjiangense GR16 + *Pri. filamentosa* GE18	4317	2730
S. xinjiangense GR16 + *B. paramycoides* GE67	4043	2857
S. xinjiangense GR16 + *K. flava* GE123	3973	2497
GR12 + *B. velezensis* GE26	3877	2673
GR12 + *B. mobilis* GE101	4473	2877
Ochrobactrum sp. GR11 + *B. paramycoides* GE20	3937	2810
Ochrobactrum sp. GR11 + *B. paramycoides* GE32	4153	2973
Ochrobactrum sp. GR11 + GE99	4457	2603
E. cloacae GR10 + *B. safensis* GE30	4060	2697
E. cloacae GR10 + *B. proteolyticus* GE103	4303	2477
CD (0.05)	405	311



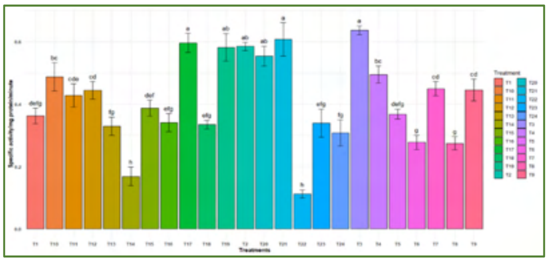
Ascorbate peroxidase



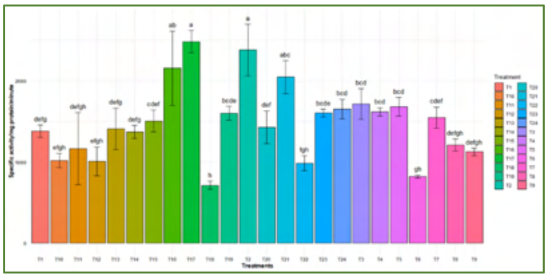
Catalase



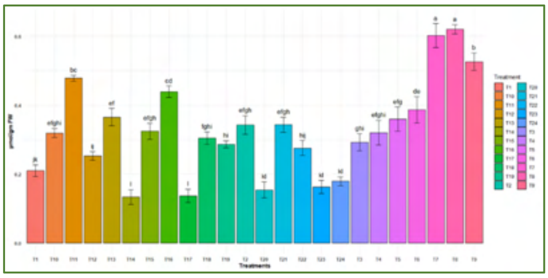
Glutathione reductase



Peroxidase



Superoxide dismutase



Proline

Fig 1. Modulation in biochemical parameters upon inoculation of endophytes in groundnut during *rabi-summer* 2024-25

In addition, genome of a fluorescent pseudomonad QZn-1 (genome size: 6.625 MB; GC content 65.9%), having capacity to solubilize P, K, Zn, Mn, etc., has been sequenced with 140x coverage to understand the genes/pathways (Fig 2) involved in the mineral solubilization and enhancing yield of groundnut.

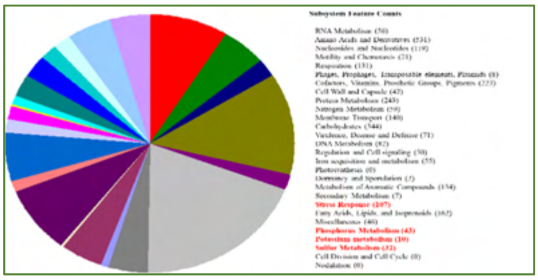


Fig 2. Sub-system feature of *Pseudomonas sp.* QZn-1

A total of forty-nine well characterized and multiple abiotic stress tolerant plant growth promoting rhizobacteria were submitted to the NAIMCC-type culture collection (an IDE depository) at NBAIM, Mau and accession number obtained (Table 2). Besides, 16S rRNA sequence of all these cultures were submitted to the NCBI genbank and accession number obtained.

Table 2. Consolidated list of agriculturally important abiotic stress tolerant and plant growth promoting rhizobacteria deposited at the NAIMCC, an IDE depository

Name of Culture(s)		Accession Number	
		NCBI	NAIMCC
Crop: Groundnut			
1.	*Bacillus paralicheniformis* GE125	PV590275	NAIMCC-B-04791
2.	*Bacillus paramycoides* GE67	PV590270	NAIMCC-B-04792
3.	*Bacillus stercoris* GE40	PV590269	NAIMCC-B-04793
4.	*Enterobacter cloacae* subsp. *Dissolvens* GR19	PV590281	NAIMCC-B-04794
5.	*Exiguobacterium acetylicum* GE8	PV590260	NAIMCC-B-04795
6.	*Kocuria fʃava* GE123	PV590274	NAIMCC-B-04796
7.	*Paenibacillus barcinonensis* GR9	PV590278	NAIMCC-B-04797
8.	*Bacillus albus* GE31	PV590265	NAIMCC-B-04606
9.	*Bacillus clarus* GE33	PV590267	NAIMCC-B-04607
10.	*Bacillus paramycoides* GE7	PV590259	NAIMCC-B-04608
11.	*Bacillus paramycoides* GE20	PV590262	NAIMCC-B-04609
12.	*Bacillus paramycoides* GE32	PV590266	NAIMCC-B-04610
13.	*Bacillus paramycoides* GE35	PV590268	NAIMCC-B-04611
14.	*Bacillus safensis* GE30	PV590264	NAIMCC-B-04612
15.	*Bacillus velezensis* GE26	PV590263	NAIMCC-B-04613
16.	*Bacillus xiamenensis* GE19	PV590261	NAIMCC-B-04614

Name of Culture(s)		Accession Number	
		NCBI	NAIMCC
17.	*Enterobacter cloacae* GR4	PV590277	NAIMCC-B-04615
18.	*Enterobacter cloacae* GRl0	PV590279	NAIMCC-B-04616
19.	*Heyndrickxia sporothermodurans* GE6	PV590258	NAIMCC-B-04617
20.	*Heyndrickxia vini* GE68	PV590271	NAIMCC-B-04618
21.	*Rhizobium callindrae* GR2	PV590276	NAIMCC-B-04619
22.	*Sinorhizobium xinjiangense* GR16	PV590280	NAIMCC-B-04620
23.	*Bacillus mobilis* GE101	PV590272	NAIMCC-B-04783
Crop: Quinoa			
24.	*Bacillus tropicus* QP9	PP851813	NAIMCC-B-04798
25.	*Enterobacter cloacae* subsp. *dissolvens* QP4	PP851811	NAIMCC-B-04799
26.	*Enterobacter cloacae* subsp. *dissolvens* QPE7	PP853562	NAIMCC-B-04800
27.	*Enterobacter hormaechei* subsp. *xianefangensis* QP2	PP854411	NAIMCC-B-04801
28.	*Enterobacter quasihomaechi* QZn30	PP854419	NAIMCC-B-04802
29.	*Klebsiella pasteurii* QP62	PP851815	NAIMCC-B-04803

Name of Culture(s)		Accession Number	
		NCBI	NAIMCC
30.	*Kosakonia orvzendovhvtica* QP63	PP853563	NAIMCC-B-04804
31.	*Kosakonia oryzendophytica* QP68	PP854413	NAIMCC-B-04805
32.	*Pantoea agglomerans* QP1	PP854410	NAIMCC-B-04806
33.	*Pantoea agglomerans* QP6	PP851812	NAIMCC-B-04807
34.	*Pantoea aggloomerans* QSE6	PP853565	NAIMCC-B-04808
35.	*Pantoea agglomerans* QZn31	PP854422	NAIMCC-B-04809
36.	*Pantoea anthophila* QK7	PP854416	NAIMCC-B-04810
37.	*Pseudenterobacter timonensis* QP64	PP854412	NAIMCC-B-04811
38.	*Pseudomonas allii* QK28	PP854415	NAIMCC-B-04812
39.	*Pseudomonas cedrina* QZn38	PP854420	NAIMCC-B-04813
Crop: Sugarcane			
40.	*Acinetobacter pittii* SE19	PV590283	NAIMCC-B-04780
41.	*Acinetobacterggeminorum* SE21	PV590284	NAIMCC-B-04781
42.	*Acinetobacter lactucae* SE18	PV590282	NAIMCC-B-04782
43.	*Chryseobacterium cucumeris* SR46	PV590286	NAIMCC-B-04 784
44.	*Enterobacter asburiae* SR44	PV590285	NAIMCC-B-04785
45.	*Enterobacter asburiae* SR48	PV590287	NAIMCC-B-04786
46.	*Enterobacter quasihormaechei* SE129	PV590256	NAIMCC-B-04787
47.	*Novosphingobium pokkalii* SE46	PV590253	NAIMCC-B-04788
48.	*Priestia f[exa* SE145	PV590257	NAIMCC-B-04789
49.	*Serratia marcescens* SE 119	PV590255	NAIMCC-B-04790

Exploring Possibility of Finding CAM-photosynthetic Transition in Drought Stressed Chickpea, Pigeon Pea and Soybean

The possibility of a CAM-like photosynthetic transition as a mechanism to impart drought tolerance in chickpea, pigeonpea, and soybean was investigated. A functional shift from C_3 to CAM-type photosynthesis under drought stress was identified in chickpea genotypes/ accessions ICC4958, BDG75, and JG16 (Fig 3). Gene expression analysis revealed upregulation of transcripts associated with the night-time carboxylation module, including β-carbonic anhydrase, phosphoenolpyruvate carboxylase (PEPC), phosphoenolpyruvate carboxylase kinase (PPCK), malate dehydrogenase, aluminum-activated malate transporter (ALMT), and V-type proton ATPase. Similarly, genes involved in daytime decarboxylation-such as tonoplast dicarboxylate transporter, phosphoenol-pyruvate carboxykinase (PEPCK), NADP-dependent malic enzyme (NADP-ME), and pyruvate phosphate dikinase (PPDK)- were quantified. Transcripts associated with the CAM transition in drought-stressed chickpea were sequenced, and corresponding protein accession numbers were obtained. The tolerant genotypes (ICC4958, BDG75, and JG16) exhibited characteristic CAM-like features under drought stress, including enhanced night-time carboxylation (approximately 14 μmol m^{-2} s^{-1}) and inverted stomatal behaviour, indicating functional C_3-to-CAM transition.\To investigate the occurrence of CAM photosynthetic transition in diverse germplasm, 189 chickpea accessions obtained from ICRISAT were evaluated under field conditions. Among these, ten accessions (ICC 2580, ICC 11879, ICC 5613, ICC 14098, ICC 8621, ICC 7255, ICC 12028, ICC 15868, ICC 11121, and ICC 8350) exhibited CAM-like transition under drought stress, concomitant with improved drought tolerance. Detailed physiological and molecular analyses of these accessions are currently underway. Similarly, 23 pigeonpea germplasm accessions representing the primary, secondary, and tertiary gene pools were procured from ICRISAT under a Material Transfer Agreement (MTA) to assess CAM photosynthetic transition under drought stress. Evaluation indicated the presence of CAM-like transition in drought-stressed wild pigeonpea germplasm, notably accession ICP 15771. The investigation was further extended to soybean. A total of 80 selected genotypes/accessions/released varieties obtained from ICAR-Indian Institute of Soybean Research, Indore under MTA were evaluated under field conditions to identify suitable photo-insensitive genotypes for studying CAM photosynthetic transition under drought stress. CAM-like features were observed in six soybean genotypes under moisture-deficit conditions. Coding sequences (CDSs) of genes associated with CAM photosynthetic transition in soybean have been obtained, and isoform-specific primers are being designed to elucidate the involvement of specific gene variants in the transition process. The identified soybean genotypes exhibited night-time carboxylation rates of approximately 7.5 μmol m^{-2} s^{-1} along with inverted stomatal behaviour, supporting the occurrence of CAM-like photosynthetic adaptation under drought stress.

Fig 3. Evaluation of CAM transition in chickpea (left: no irrigation after emergence; right: irrigated check; 70 DAE; black soil; arrows indicate CAM transited tolerant genotypes)

Study on PRD Irrigation Strategies and Shifting Frequencies on High-Density Mango (Cv. Kesar) Grown in Shallow Basaltic Soils Under Semi-arid Conditions

A field study was carried out at the ICAR–NIASM, Baramati, Maharashtra, India, to assess the effects of PRD irrigation strategies and shifting frequencies on high-density mango (Cv. Kesar) grown in shallow basaltic soils under semi-arid conditions. Mango trees were irrigated using a surface drip system at three levels (50%, 75%, and 100% ETc), with PRD treatments alternating the wetting and drying sides of the root zone at frequencies of 0 (fixed), 7, 14, and 21 days. Total fruit yield per plant varied significantly across treatments, ranging from 16.46 to 32.33 kg plant^{-1}. The highest plant yield of 32.33 kg was obtained in fully irrigated control (T9) followed closely by T1 (PRD 7 75%) and T2 (PRD 14 75%), with 31.9 kg and 31.68 kg, respectively, which were at par with control, indicating that frequent alternation under moderate deficit irrigation can maintain yields comparable to full irrigation. Yield obtained from plants subjected to treatments PRD 7 50%, PRD 21 50%, PRD 14 50%, and FX 75% were found to be at par, reflecting the importance of shifting dry side. The lowest yield was observed in T7 (FX 50%) at 16.46 kg, reflecting the impact of fixed low-volume irrigation applied on one side. The number of fruits per plant varied significantly across treatments, ranging from 73.12 to 130.12 (Table 3). The highest fruit number was recorded in T9 (FU 100%) with 130.12 fruits, followed closely by T1 (PRD 7 75%) with 126.25 and T2 (PRD 14 75%) with 122 fruits, indicating that frequent alternation of dry side in PRD at 75% ETc supports fruit retention comparable to full irrigation. Lowest fruit count was recorded in T7 (FX 50%) with 73.12 fruits. Water use efficiency differed significantly across treatments, ranging from 4.27 to 6.54 kg m^{-3} (Table 3). The highest WUE was observed in PRD 7 50% at 6.54 kg m^{-3} which was found to be at par with PRD 21 50% (6.37 kg m^{-3}), PRD 7 75% (6.12 kg m^{-3}), PRD 14 75% (6.08 kg m^{-3}) and PRD 14 50% (5.94 kg m^{-3}). PRD 21 75% showed slightly lower WUE (5.44 kg m^{-3}), while FX 75% (4.27 kg m^{-3}), FU 100% (4.66 kg m^{-3}), and FX 50% (4.74 kg m^{-3}) recorded the lowest WUE values. The highest phenol and flavonoid contents were observed in PRD 7 75%, suggesting activated biochemical defences against oxidative stress. Maximum FRAP and DPPH activities, along with elevated ascorbic acid levels, were recorded in PRD 21 50% and FX 50%. The highest pulp weight was observed under PRD 7 75%, which was 1.86% higher than FU 100%, while peel and stone weights increased by 22.9% and 13.1%, respectively, in PRD 21 50% as compared to control. Overall, PRD irrigation strategy with 75 % ETc with alternating frequency of 7 days and 14 days improved mango fruit yield, fruit quality and water use efficiency in the high-density mango orchard grown in shallow basaltic soil under limited water resources.

Table 3. Effect of different irrigation treatments on yield attributes & water use efficiency

Treatment details	Yield (kg plant^{-1})	No. of plant per ha	Yield (kg ha^{-1})	Water applied (L Plant^{-1})	WUE (kgm^{-3})
PRD 7 75%	31.9	787	25105.3	5208	6.12 ± 0.2 ^{ab}
PRD 14 75%	31.68	787	24932.16	5208	6.08 ± 0.31 ^{ab}
PRD 21 75%	28.31	787	22279.97	5208	5.44 ± 0.32 ^{bc}
PRD 7 50%	22.71	787	17872.77	3472	6.54 ± 0.07 ^{a}
PRD 14 50%	20.62	787	16227.94	3472	5.94 ± 0.1 ^{ab}
PRD 21 50%	22.12	787	17408.44	3472	6.37 ± 0.42 ^{a}
FX 50%	16.46	787	12954.02	3472	4.74 ± 0.28 ^{cd}
FX 75%	22.26	787	17518.62	5208	4.27 ± 0.13 ^{d}
FU 100%	32.33	787	25443.71	6944	4.66 ± 0.16 ^{d}
SEM	1.15				0.25
SED	1.62				0.36
CD *(p<0.05)*	3.34				0.74
CV (%)	9.03				9.06

**** Treatments with similar alphabets are at par at 5% level of significance***

Quality Assessment of Microwave Vacuum-dried Slices of Dragon Fruit Pulp and Peel

A laboratory study optimised microwave vacuum drying (MWVD) of dragon fruit pulp (3, 6, 9 mm) and peel (4, 8, 12 mm) at 300–600 W (Fig 4). Drying occurred in the falling-rate period, with the moisture ratio and drying rate decreasing over time. Among 13 thin-layer models, the Midilli–Kucuk model best described drying kinetics for both pulp ($R^2 > 0.999$) and peel ($R^2 > 0.996$). Effective moisture diffusivity ranged from 1.17×10^{-10} to 8.79×10^{-10} m^2 s^{-1} in pulp and 6.08×10^{-10} to 1.51×10^{-8} m^2 s^{-1} in peel. Slice thickness and microwave power significantly ($p \leq 0.05$) affected bioactive compounds, antioxidant activity, proximate composition, colour, and texture. Moderate power (400–500W) with intermediate thickness (6 mm pulp, 8 mm peel) gave the best retention of nutrients and product quality. Overall, MWVD was effective for producing high-quality, value-added dragon fruit pulp and peel with improved drying efficiency and nutrient preservation.

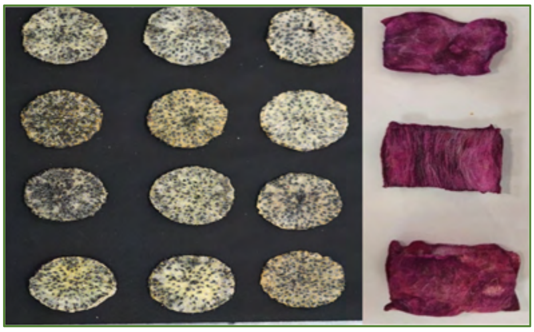


Fig 4. Optimization of microwave vacuum drying (MWVD) conditions for dragon fruit pulp and peel.

Effect of Coating Materials and Temperatures on the Storage Quality of Custard Apple

Custard apple (*Annona squamosa L.*) is a nutritionally rich subtropical fruit with high medicinal and functional value, but it's very short shelf life (2–3 days) results in severe postharvest losses of 35–40% due to rapid respiration, moisture loss, softening, and fungal decay. Therefore, a lab experiment was conducted to evaluate the effectiveness of edible coatings combined with storage temperature in extending the shelf life and maintaining the quality of custard apple (cv. Balanagar). Fruits were characterised for physicochemical attributes and screened using guar gum (GG), irradiated chitosan (IC), glycerol (GL), and polyvinyl alcohol (PVA) at three concentrations (1.0, 1.5, and 2.0%). The optimal concentrations (GG 1.5%, IC 1.0%, GL 1.5%, and PVA 1.0%) were tested under four storage temperatures (8, 12, 16, and ~26 °C) in a factorial CRD for 16 days (Fig 5). Fruits were evaluated every four days for physical (physiological weight loss and firmness) and biochemical (TSS, titratable acidity, phenolics, flavonoids, ascorbic acid, and antioxidant activity) parameters. The fruits (150.5 g) had high sphericity (0.90) and a pulp-to-peel ratio of 0.82, supporting their suitability for storage. Coating–temperature combinations significantly ($p \leq 0.05$) influenced all quality attributes. GG (1.5%) and IC (1.0%) were most effective in reducing weight loss (~10.8%), delaying softening, slowing the increase in TSS (27.2–27.3 °Brix), and preserving nutritional and antioxidant properties. Storage at 12 °C provided the best balance between reduced metabolic activity and avoidance of chilling injury. Overall, combining GG (1.5%) or IC (1.0%) with 12 °C storage effectively extended shelf life and improved the postharvest quality of custard apple.

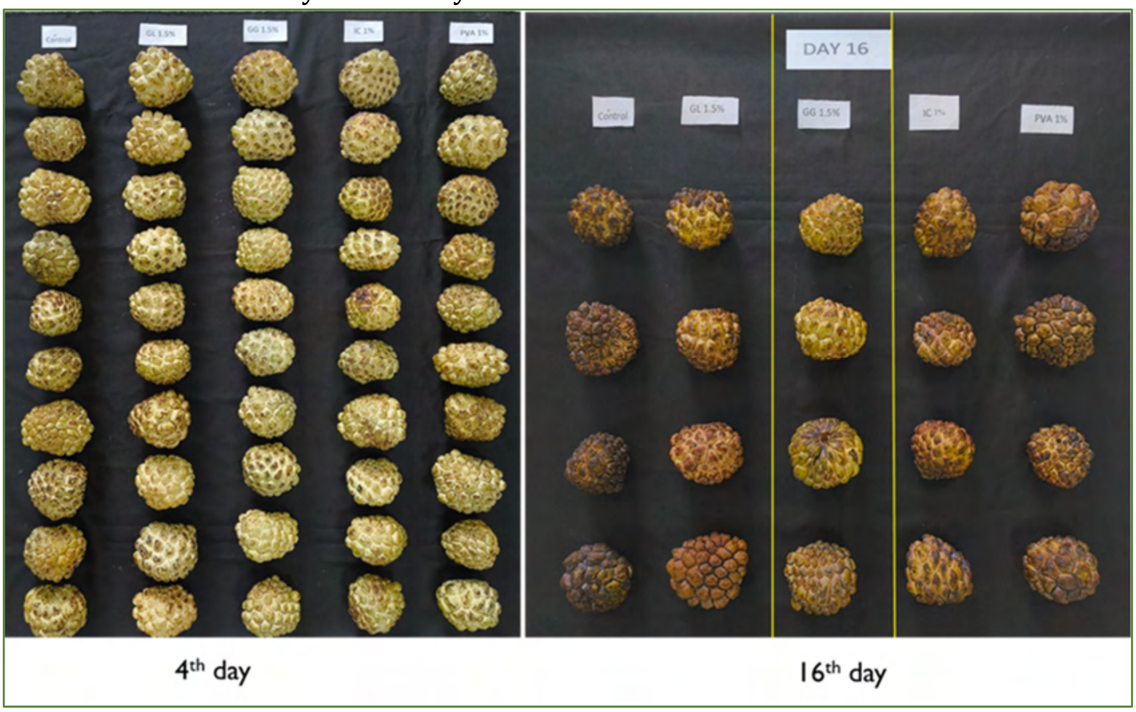


Fig 5. Changes in the quality of custard apple under varied coating materials during storag

Plant Growth Regulators and Potato Cultivars' Responses to Alleviating Drought Stress

A field experiment was conducted in 2025 to evaluate the responses of plant growth regulators and other chemicals (salicylic acid, thiourea, seaweed extract, irradiated chitosan, nano urea, and a control, along with the CRRI VV Guard formulation) under varying deficit irrigation levels (100%, 80%, 60%, 40%, and 20% ET) using a line-source sprinkler (LSS) system (Fig 6). Preliminary results indicated that foliar application of seaweed extract, irradiated chitosan, and CRRI VV Guard was most effective in alleviating water stress. A second-year field trial was conducted to reconfirm the responses of potato cultivars (cv. Kufri Daksha, Kufri Ganga, Kufri Kiran, Kufri Thar-1, Kufri Thar-II, and Kufri Thar-III). Among these, cv. Kufri Kiran outperformed the others and was found to be a suitable alternative to Kufri Pukhraj for cultivation in the semi-arid Deccan Plateau, achieving about 20% water savings while maintaining quality attributes.

Fig 6. Plant bio-regulators for alleviating water stress under field conditions

Conservation Agriculture for Enhancing Resource-Use Efficiency, Environmental Quality and Productivity of Sugarcane Cropping System

In 2025, three reconfirmation field trials were conducted to: (i) evaluate the long-term effects of tillage, residue, and nutrient management in laser-levelled plots under a drip irrigation system; (ii) study the effects of deficit irrigation (DI), foliar application of plant growth regulators (PGRs), and surface trash retention on sugarcane productivity; and (iii) assess the interactive effects of tillage, intercropping, and soil-surface crop residue management in the sugarcane cropping system. In 2025, a fourth ratoon crop field trial was harvested to assess the long-term effects of tillage, residue, and nutrient management in laser-levelled, drip-irrigated sugarcane (cv. Co-86032). The experiment followed a split–split plot design (Fig 7). Main plot treatments included three tillage, and nutrient management options: M_1 (LLL + conventional tillage with 10% RDF basal and 90% via fertigation), M_2 (LLL + minimum tillage with 25% RDF basal and 75% via fertigation), and M_3 (LLL + reduced tillage with 15% RDF basal, 20% at 60 days, and 65% via fertigation). Subplots comprised two residue management practices, mulching (S_1) and non-mulching/burning (S_2). Sub-sub plots included three nutrient schedules using the SORF drill: N_1 (10% RDF basal), N_2 (25% RDF basal), and N_3 (15% RDF basal + 20% at 60 days, with the remainder through fertigation). Results showed that the $M_3 + S_1 + N_3$ combination produced the highest ratoon yield, with a 36.6% increase over conventional practices. Mulching further enhanced cane yield by 5.4–15.1% compared with residue burning. During 2025, second ratoon crop of sugarcane (cv. Co-86032) was harvested to evaluate the effects of deficit irrigation (DI), exogenous plant growth regulators (PGRs), and surface trash retention under conservation tillage. The trial was laid out in a split–split plot design with three replications.

Main plots comprised three irrigation levels, 50%, 75%, and 100% ETc, applied through drip irrigation. Subplots included four PGRs: thiourea (1800 ppm), irradiated chitosan (10 ml L^{-1}), nanourea (4 ml L^{-1}), and salicylic acid (25 μM), along with a control. Sub-sub plots consisted of mulching (S_1) and no mulching/burning (S_2). The highest ratoon cane yield (147.8 t ha^{-1}) was recorded under 75% ET combined with irradiated chitosan and surface mulching, comparable to the plant crop yield (157.1 t ha^{-1}). PGR application enhanced ratoon yields by 3.9–13.4%, 11.6–31.1%, and 15.9–33.9% under 100%, 75%, and 50% ET, respectively. Mulching further increased yields by 7.4–40.6% across irrigation levels. Integrated use of 75% ET, irradiated chitosan, and mulching reduced the plant–ratoon yield gap to 5.9% while saving 25% irrigation water over farmers' practice (Fig 8). Another field experiment was conducted to evaluate the interactive effects of tillage, intercropping, and soil-surface crop-residue management on sugarcane (cv. Co-86032). Sixteen treatment combinations were arranged in a split–split plot design, with tillage systems [reduced tillage (RT) and conventional tillage (CT)] as main plots, intercrops [potato (cv. Kufri Pukhraj), onion (cv. Bhima Shakti), beetroot (cv. Lalima), and a control] as sub-plots, and surface trash retention [mulching (M) and non-mulching (NM)] as sub-sub plots (Fig 9). Average intercrop yields were 64.4 Mg ha^{-1} for onion, 34.8 Mg ha^{-1} for beetroot, and 20.0 Mg ha^{-1} for potato. Preliminary results showed that RT increased beetroot, potato, and onion yields by 25.6%, 7.8%, and 22.5%, respectively, over CT. Sugarcane yield data are under analysis, and the ratoon crop trial is ongoing.

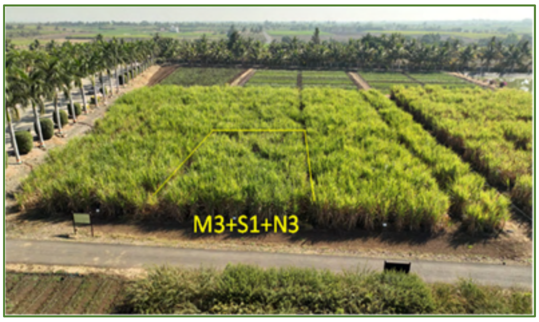
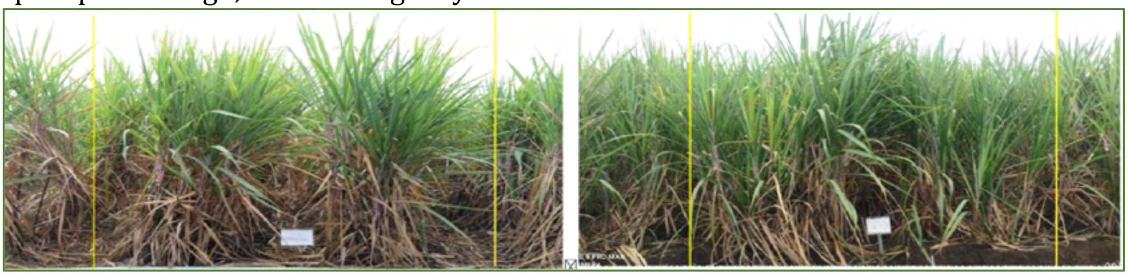


Fig 7. Long term effect of reduced tillage (RT) with SORF, involving 15% RDF as basal, 20% at 60 days after planting, and 65% through fertigation in a trash retained treatment (M_3+S_1+N_3).



Plant crop (10 ml/L irradiated chitosan) *2nd ratoon (10 ml/L irradiated chitosan)*

Fig 8. Effect of irradiated chitosan on plant and ratoon crop under conservation tillage (DI at 75% ET_C and trash mulching)

Sugarcane+ potato *Sugarcane+ beetroot* *Sugarcane+ onion*

Fig 9. CA based intercrop improvement under the plant sugarcane system

Validation and Characterization of Promising Foxtail Millet Germplasm Under Low N Soils

Based on multi-year field evaluations conducted during *kharif* 2022 to 2024, nitrogen-efficient foxtail millet accessions were identified and subsequently validated through a pot experiment at ICAR–NIASM, Baramati under controlled nitrogen (N) regimes (T_0: no N; T_{50}:50% N RDF), and T_{100}:100% N RDF). The experiment enabled precise assessment of nitrogen-use efficiency by minimizing environmental variability and facilitated detailed characterization of key adaptive traits. The selected accessions consistently outperformed the check and nitrogen-sensitive lines under low nitrogen conditions, confirming the reliability of field-based selection. Superior performance under nitrogen stress was closely associated with improved root architectural traits, including greater root length, volume, biomass, and surface area, along with enhanced physiological attributes such as higher chlorophyll content, vigorous growth, and improved photosynthetic efficiency. Preliminary plant nitrogen analysis under T_0, T_{50}, and T_{100} further substantiated the differential response of the germplasm. Under T_0, accessions Ise 1805, Ise 1575, and Ise 254 recorded higher plant nitrogen content than the check, indicating superior nitrogen acquisition and utilization under nitrogen-deficient conditions. At T_{50}, accessions Ise 1704, Ise 254, Ise 1805, and Ise 1575 accumulated significantly higher plant nitrogen compared to the check, while nitrogen-sensitive lines such as Ise 1419 exhibited poor nitrogen uptake. Although Ise 1419 showed high nitrogen accumulation under T_{100}, it failed to perform under reduced nitrogen, confirming its nitrogen-sensitive nature. Overall, Ise 1805 and Ise 1704 emerged as the most consistent performers across nitrogen levels, maintaining higher plant nitrogen content under no-N, reduced-N, and recommended dose of fertilizer conditions. Integration of multi-year field data with controlled pot experiments demonstrated that efficient root architecture (Fig 10), coupled with enhanced physiological efficiency, highlights superior nitrogen-use efficiency (NUE) in these accessions. Consequently, Ise 1805, Ise 1704, Ise 1575, and Ise 254 were identified as promising nitrogen-use-efficient foxtail millet lines, suitable for genetic stock registration and utilization in breeding programs targeting low-input and nitrogen-deficient soils. It is evident that these lines capable of extending their root length under low soil N status to absorb the N from deeper soil layers (Fig 10). In contrast, germplasm lines such as Ise 254, Ise 1511, and Ise 1162 showed a high response to nitrogen. However, despite performing well under low-N conditions, Ise 254 realized its full yield potential only under sufficient nitrogen; therefore, it should not be recommended for rainfed or low-N soils due to its long duration and high input requirements.

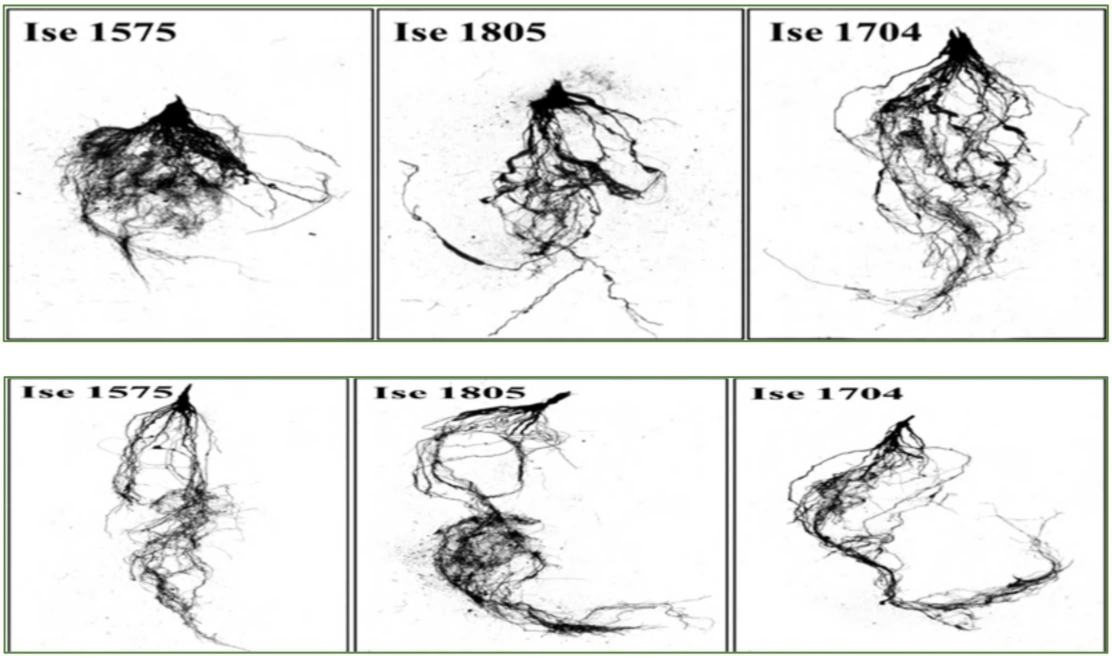


Fig 10. Root architecture of promising foxtail millet lines under low nitrogen (RDF–N; upper panel) and recommended nitrogen (RDF/100% N; lower panel) conditions

Adaptive Evaluation Trial of Advanced and Initial Varietal Entries of Quinoa at ICAR-NIASM Baramati

An adaptive evaluation trial was conducted at Baramati during *kharif* 2025 to assess the performance and adaptability of advanced and initial varietal entries under local agro-climatic conditions. The trial comprised 13 entries under IVT (VLQ-3 and VLQ-4 from Almora; RMQ-2501, RMQ-2502 and RMQ-2503 from Mandor; and EC896208, EC896212, EC896206, EC896076, EC896205, EC896061, EC896066 and EC896068 from Shimla), along with one entry under AVT-I (VLQ-1, Almora). The released variety Him Shakti (Shimla) was included as the standard check. Most entries, including EC896208, EC896212, EC896206, EC896066, VLQ-3, VLQ-4, VLQ-1 (AVT-I) and the check Him Shakti, exhibited very good plant stand and germination. In contrast, RMQ-2501 and RMQ-2502 showed poor germination, while RMQ-2503 recorded very poor establishment, indicating poor seed viability and hence was not considered for further evaluation. Further, four entries *viz*., EC896205, EC896061, EC896066 and EC896068 were very late and unable to seed set because of their longer vegetative and photo sensitive nature. This indicates all quinoa genotypes may not be suitable for *kharif* season and concluding the importance of the entries evaluation for sowing window identification or season suitability. Data were systematically recorded on key agro-morphological, phenological and yield-related traits, including plant height, number of branches per plant, days to 50% flowering, inflorescence length, number of spikelets per plant, days to 80% maturity, plant stand at harvest, grain yield, seed volume weight, and incidence of major diseases and pests. The results provided valuable insights into the adaptability, stability and yield potential of the tested entries under peninsular Indian conditions, complementing observations generated from traditional hill locations.

Selection and Advancement of Mutant Generations (M3 and M4) in Groundnut

Gamma-based mutation was induced during summer 2024 to improve pod and kernel quality, seed viability, germination, and taste, with the objective of overcoming the inherent limitations of the newly released high yielding and drought tolerant variety Kadri Lepakshi, namely bitter kernels, constricted pods, and poor seed quality. During summer 2025, M_3 progenies derived from selected M_2 plants were evaluated in progeny rows (Fig 11) to assess trait stability, uniformity, and heritability. Within- and between-progeny row variations were critically examined for key morphological (size/shape and colour of foliage) and yield-related traits, including plant architecture (erect/spreading and plant height), pod and kernel attributes, and seed quality (Table 4). Several unique mutants were identified, including a dwarf mutant line with chlorosis; pinnate leaf mutants with small leaflets; dark green foliage mutants; dark green mutants with bold and highly reticulated pod types; and a partially sterile mutant characterized by dwarf stature, sturdy stem, dark green foliage, and profuse branching (Fig 12, 13). Selected and stabilized M_3 progenies are being advanced to the M_4 generation during *kharif* 2025, which will be harvested during January–February 2026. Evaluation at this stage will focus on phenotypic uniformity, agronomic and yield performance, and disease response under field conditions. Continued use of the plant-to-progeny method at this stage will facilitate fixation of mutant traits, development of genetically uniform lines, and identification of promising mutants suitable for further multi-location evaluation (2026) and possible utilization in groundnut improvement programmes.

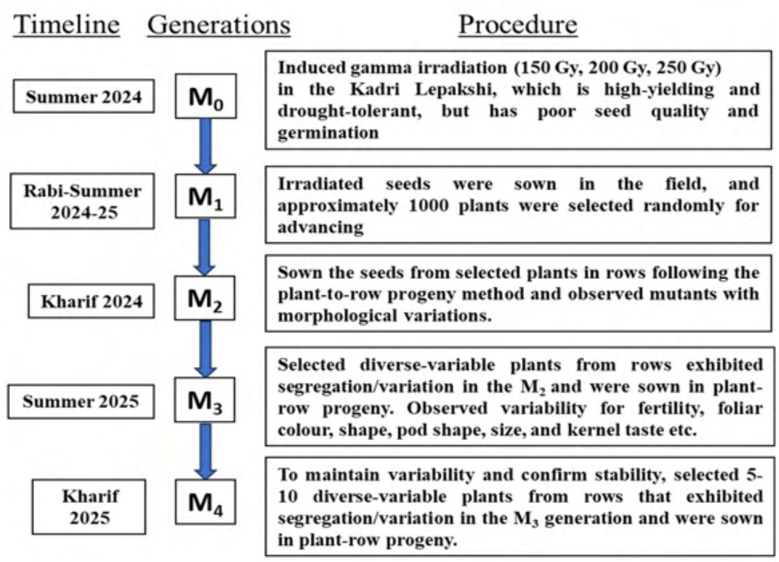


Fig 11. The procedure of mutation breeding (development, selection and advancement of mutant lines) in groundnut

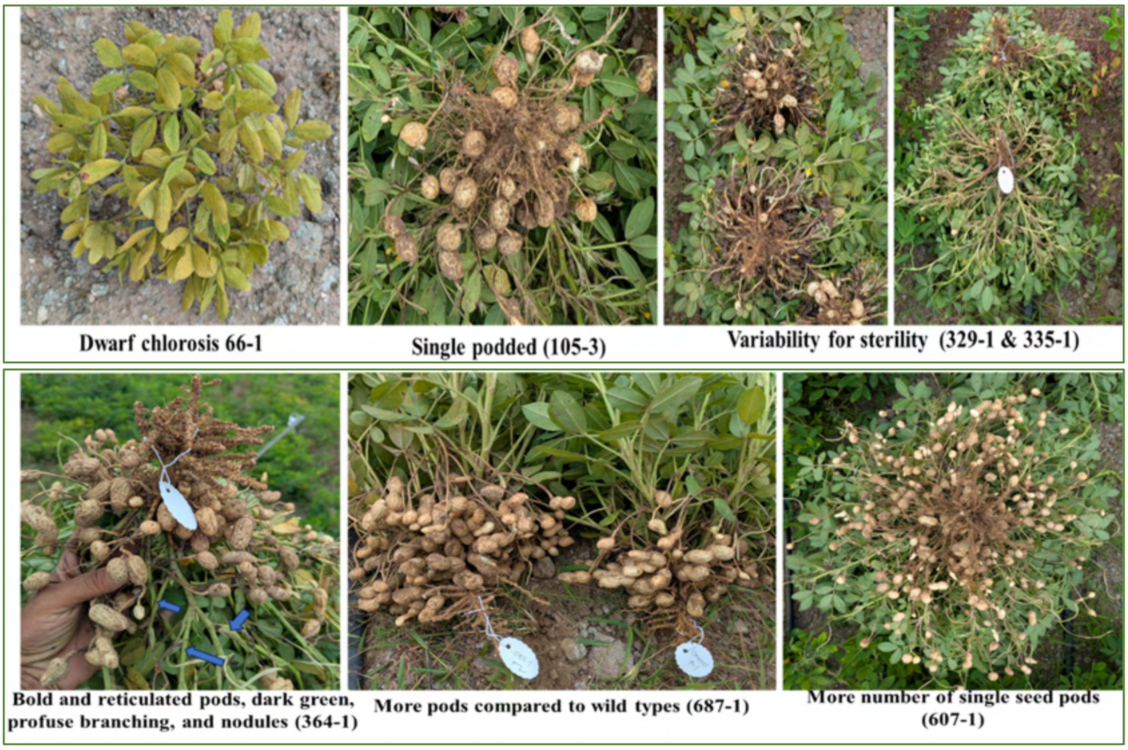


Fig 12. Observed variability for key morphological (size/shape and colour of foliage) and yield-related traits (pod number shape) in M_3 generation

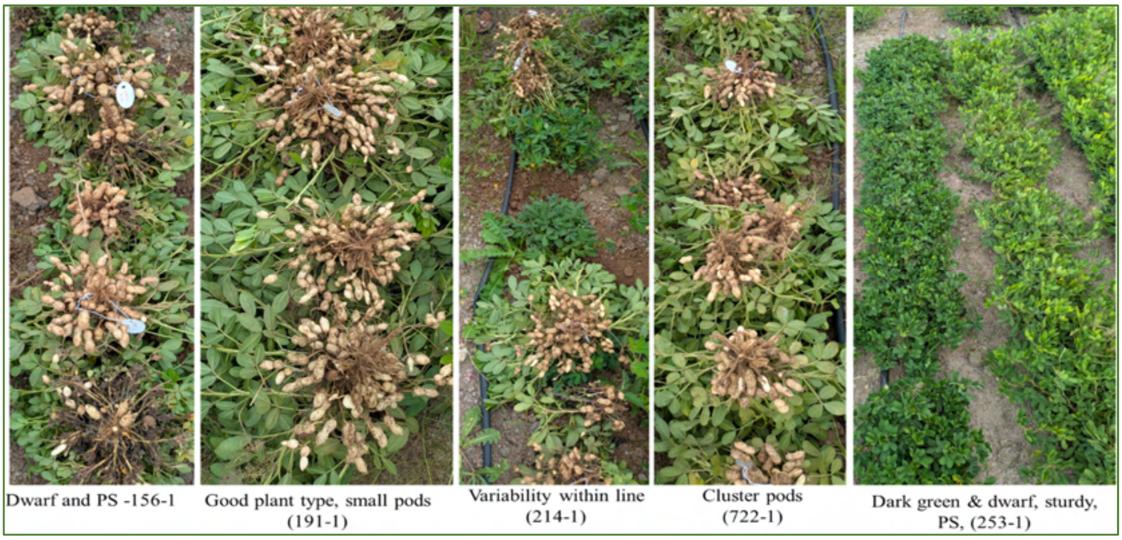


Fig 13. Uniformity and variability observed within few mutant lines in M_3 generation

Table 4. Variability observed for different traits in M_3 generation of groundnut

Traits	Lines
Good/ideal plant type	325-1, 331-3, 229-1, 194-3, 116-5, 229-1, 130-1, 274-1,98-1, 223-2, 172-1, 262-1, 191-1, 355-1, 109-2, 350-2, 32-3, 232-1, 120-1, 204-1, 113-2, 401-2, 477-1, 455-1, 788-4, 219, 297, 235, 276, 429, 420, 431, 826, 391
Secondary and tertiary branching/ good branching	331-3, 164-1, 364-1, 368-1, 607-1, 488, 878-1

Traits	Lines
Vigorous	401-2, 636-1
Good pod number	286-3, 526-1, 492-2, 687-1, 368-3, 624-3, 607-1, 722-1,690-1, 592, 391,
Single podded	492-2, 607-1
Dwarf plant, dwarf and dark green	60-1, 253-1, 255-2, 52-1, 59-1, 322-1, 156-1, 28-2, 355-1, 186-2, 214-1, 120-1, 548-1, 655-2, 388-1, 519-1, 369-1, 373-1, 462-2, 555-1, 722-1, 726-1, 588-1, 481-1, 577-1, 572-2, 723-2, 751-4, 321, 24-1, 601-1
Very dark &dwarf, sturdy, partial sterile	253-1
Dark green	687-1, 364-1, 405-1,
Light green	171-1, 616-1, 482, 772,
Chlorosis	30-4, 66-1, 204-2, 492-1, 368-1, 723-2, 713-1,
Dotted leaf	601-1,
Leaf rolling	878-2,
Variegated plant	194-2, 520-1
Good flowering/ pegging	329-1, 258-4, 492-2, 410-2, 690-1, 750-1, 777-1, 693-1, 219,325, 306, 239, 418,
Spreading habit	318-1, 376-1, 373-1, 577-1, 878-1
Erect foliage, erect plant	196-2, 322-1, 405-1, 655-2, 418-1,
Selected for reproductive efficiency confirmation	317-1
Narrow foliage/ pinnate	105-3, 448-1, 418-1, 645-1, 772
Early	518-1 (sterile plant?), 481-2
Late	518-1, 695-1, 637-1, 595-1, 541-1, 376-1, 455-1, 758-1
Pod shape good/ changed, Bold/ small,	687-1, 138-1, 651-1, 364-1, 388-1, 555, 481-2, 411-1, 214-1, 105-3, 492-2, 607-1, 286-2
Small podded	655-2, 462-2, 396-1, 481-1, 592
Variability for traits (mutation)	102-1, 214-3, 149-2, 321-2, 278-1, 142-1, 277-1, 481-3, 368-1, 171-1, 54-1, 524-1, 481-2, 480-3, 481-2, 626-1, 505-2, 369-3, 571-2, 758-1, 555-1, 562-3, 572-1, 588-1, 882-1, 878-1, 671-1, 751-4, 683-1, 795-1, 788-4, 812-1, 777-1, 227, 104, 321, 78, 325, 592,639, 516, 572, 530,
No bitter taste	313-1, 214-3, 120-1, 388, 687-1, 651-1, 364-1, 481-2, 475-1, 690-1, 227, 104, 235, 276, 420,
Sterile/ partial sterile	329-1, 355-1, 335-1, 8-3, 204-2, 526-1, 637-1, 595-1, 518-1, 401-2, 481-2, 373-1, 321, 548-1, 376-1, 462-2, 616-1, 588-1, 423-1, 530, 325-1
Selected	125-2, 250-3, 296-1, 173-1, 279-1, 194-1, 320-1, 180-1, 134-2, 104-1, 128-1, 315-1, 234-1, 108-1, 24-1, 43-3, 376-2, 480-4, 594-1, 624-3, 477-1, 481-2, 411-1, 455-1, 475-1, 543-1, 516-1, 471-1, 480-3, 598-4, 659-3, 369-1, 504-2, 854-1, 861-1, 239, 780-1, 173, 451, 650, 528,
Susceptible to LLS	481-3
Susceptible to leaf blight	401-1, 592-3
Parental reversion	660-2, 792-2,
Cluster pods	722-1,
Stay green	239, 253-1, 364-1

Preliminary Characterization of Germplasm Collections and Hybrids of Dragon Fruit for Reproduction Behaviour and Fruit Morphological Traits

Characterization of 25 dragon fruit germplasm collections (most of them from framers' orchards) revealed considerable variability in pollination response, fruit set, fruit weight, and pulp colour (Table 6). Most red-fleshed genotypes were self-compatible and exhibited fruit set under open, self-, cross- and bagging conditions, whereas certain accessions such as NDFR-1 (Selection from CIARI, Andaman) and yellow types - NDFY-1&2 (Collections from farmers field) showed self-incompatibility, requiring cross-pollination for fruit set. Manual cross-pollination, particularly using NDFW-1 (Neera A) as a pollen source, significantly enhanced fruit weight, with maximum fruit size exceeding 600 g in some white-fleshed types. Based on peel and pulp colour, the collections were grouped into red-red, red-white, yellow-white, and red-purple types. The wide variation in fruit weight (≈148 g to >600 g) and pollination behaviour indicates substantial genetic diversity, providing valuable material for breeding (parents with diverse fruit traits) and pollination management (pollen source). For instance, the use of NDFR-1 (Neera C) as a pollen source in cross-pollination significantly enhanced fruit weight and quality in NDFW-1. This intervention—utilizing pollen from white-fleshed clones for supplementary pollination—resulted in increased productivity (via fruit weight increment) in farmers' orchards, as evidenced during on-field demonstrations conducted in 2025. Further the collected clones are being used as parents in development of hybrids. More than 10 hybrids were developed by making crossing between different clones (Table 5).

Table 5. Dragon fruit hybrids developed at ICAR-NIASM and their fruit attributes

S.N.	Cross/ hybrid	Fruit attributes in F_1
1.	NDFW-1×NDFR-1	Some progenies exhibited both red and white pulp coloration. Additionally, a few progenies showed a blended pattern of red and white pulp.
2.	NDFR-1 × NDFW-1	All progenies showed red pulp colour indicating strong maternal influence in the inheritance of pulp color.
3.	NDFR-1×NDFW-2	All progenies expressing red pulp color from maternal origin.
4.	NDFW-2×NDFR-1	White pulp expression was consistently observed in progenies derived from white-fleshed maternal lines.
5.	NDFR-1×ND2	Red-fleshed maternal parents consistently produced red pulp-expressing progenies.
6.	NDFW-1×ND2	All progenies showed white-fleshed maternal lines, pointing to a strong maternal effect on this trait.
7.	NDFW-8 × NDFR-1	Planted in main field during February 2026 and waiting for fruiting.
8.	NDFW-8 × NDFR-11	
9.	NDFW-1× NDFR-10	
10.	NDFW-1× NDFR-11	

Table 6: Characterization of dragon fruit germplasm collections based on pollination response, fruit set, fruit weight, and flesh colour

S. N.	Code	Name	Pollination treatment								Skin color	Flesh color	Source/location
			Open / Natural pollination		Manual cross pollination		Manual Self-pollination		Bagging				
			Fruit Set	Weight (g)	Fruit Set (Pollen source)	Weight (g)	Fruit Set	Weight (g)	Fruit Set	Weight (g)			
1.	Neera C#	NDFR-1	NFS	-	FS (NDFW-1)	189-410	NFS	-	NFS	-	Red	Red	Selections from clones of CIARI, Andaman collection
2.	SDRR	NDFR-2	FS	234-329	FS (NDFW-1)	196-224	FS	250-268	FS	79-109	Red	Red	Pimpale, Indapur
3.	DKRR	NDFR-3	FS	198-220	FS (NDFW-1)	170-239	FS	198-259	FS	77-102	Red	Red	Nimgaon Ketki, Indapur
4.	GTJR	NDFR-4	FS	226-240	FS (NDFW-1)	245-266	FS	359-375	FS	99-115	Red	Red	Gotandi, Indapur
5.	NGRR	NDFR-5	FS	219-232	FS (NDFW-1)	198-210	FS	210-239	FS	85-98	Red	Red	Tembhurni, Solapur
6.	NGRR	NDFR-6	FS	221-250	FS (NDFW-1)	225-249	FS	249-268	FS	88-105	Red	Red	Tembhurni, Solapur
7.	MARR	NDFR-7	FS	231-255	FS (NDFW-1)	185-241	FS	237-260	FS	79-101	Red	Red	Akola, Solapur
8.	MAJR	NDFR-8	FS	310-328	FS (NDFW-1)	256-298	FS	360-381	FS	98-119	Red	Red	Akola, Solapur
9.	MPRR	NDFR-9	FS	199-236	FS (NDFW-1)	209-220	FS	220-245	FS	89-110	Red	Red	MPKV, Rahuri
10.	BGRR	NDFR-10	FS	226-240	FS (NDFW-1)	198-212	FS	249-267	FS	71-100	Red	Red	Sawal, Baramati
11.	BGJR	NDFR-11	FS	325-356	FS (NDFW-1)	259-285	FS	350-377	FS	94-114	Red	Red	Sawal, Baramati
12.	Neera A#	NDFW-1	FS	174-257	FS (NDFR-1)	588-613	FS	289-351	FS	89-105	Red	White	Malegaon Khurd, Baramati
13.	Neera B#	NDFW-2	FS	150-177	FS (NDFR-1)	319-498	FS	299-348	FS	78-102	Red	White	Malegaon Khurd, Baramati

S. N.	Code	Name	Pollination treatment								Skin color	Flesh color	Source/location
			Open / Natural pollination		Manual cross pollination		Manual Self-pollination		Bagging				
			Fruit Set	Weight (g)	Fruit Set (Pollen source)	Weight (g)	Fruit Set	Weight (g)	Fruit Set	Weight (g)			
14.	ADRW-1	NDFW-3	FS	179-213	FS (NDFR-1)	529-601	FS	301-320	FS	90-117	Red	White	ICAR-CIARI, Andaman
15.	ADRW-2	NDFW-4	FS	184-228	FS (NDFR-1)	498-553	FS	277-218	FS	84-102	Red	White	ICAR-CIARI, Andaman
16.	SDRW	NDFW-5	FS	189-235	FS (NDFR-1)	485-516	FS	289-309	FS	98-110	Red	White	Pimpale, Indapur
17.	DKRW	NDFW-6	FS	176-224	FS (NDFR-1)	506-527	FS	299-320	FS	84-96	Red	White	Nimgaon Ketki, Indapur
18.	MPRW	NDFW-7	FS	149-198	FS (NDFR-1)	478-499	FS	258-301	FS	95-111	Red	White	Rahuri
19.	BGRW	NDFW-8	FS	148-209	FS (NDFR-1)	481-501	FS	348-388	FS	102-118	Red	White	Sawal, Baramati
20.	ADY	NDFY-1	NFS	-	FS (NDRW-1)	301-347	NFS	-	NFS	-	Yellow	White	ICAR-CIARI, Andaman
21.	MAY	NDFY-2	NFS	-	FS (NDFW-1)	295-310	NFS	-	NFS	-	Yellow	White	Akola, Solapur
22.	CT	C-Type	FS	231-269	FS (NDFW-1)	220-254	FS	275-274	FS	85-102	Red	Red	Akola (Decon exotic, Hyd)
23.	BM	Blood Mary	FS	184-241	FS (NDFW-1)	199-259	FS	190-243	FS	84-97	Red	Red	CoEF, Hyderabad
24.	HW	Harpura white	FS	250-268	FS (NDFR-1)	299-315	FS	488-501	FS	79-93	Red	White	CoEF, Hyderabad
25	PP	Purple pink	FS	274-301	FS (NDFR-1)	289-310	FS	329-350	FS	77-98	Red	Purple	CoEF, Hyderabad

Collection, Multiplication and Evaluation of the Germplasm for Different Abiotic Stresses

Under umbrella project on "Genetic garden and gene bank for abiotic stress tolerant plants, animals and fisheries for food security and sustainability" and other research projects about 2500 germplasm/ genotypes/ accessions (as on December, 2025) of different crops (Table 7) have been collected during 2020-25 from different organizations. The seed/planting materials of collected germplasm maintained and being utilized for basic research and screening for different abiotic stress tolerance.

Table 7. Germplasm collected and maintained under genetic garden at ICAR-NIASM

Crops	Number of germplasms	Abiotic stress	Source	Scientist involved
Safflower	3 varieties	Drought	NARI, Phaltan	Boraiah KM
Sweet Sorghum	3 varieties	Drought		Boraiah KM
Stylo	2 varieties	Drought		Boraiah KM
Subabul	2 varieties	-		Boraiah KM
Wheat	10 breeding lines	Salinity	ICAR-CSSRI, Karnal	Boraiah KM
	10 promising lines	Drought	ICAR-NIASM	AK Singh
Pigeon pea	4 genotypes	Water logging	ICRISAT, Hyderabad	Basvaraj PS
Soybean	6 genotypes	Drought	ICAR-IISR, Indore	AK Singh
	2 genotypes	Water logging		AK Singh
	19 genotypes	Drought	ICAR-IISR	K K Pal
Quinoa	14 genotypes	Multiplication and evaluation/screening for different abiotic stresses under progress	MPKV, Rahuri	Boraiah KM
Turmeric	16 genotypes		ICAR/SAUs	CB Harisha
Brinjal	14 wild species		IIHR, Bengaluru and local collection	PS Khapte
	30 local varieties			
Fenugreek	17 Genotypes		NRCSS, Ajmeer	CB Harisha
Fennel	43 mutants		NRCSS, Ajmeer	CB Harisha
Pigeonpea	193 accessions		ICAR-IIPR, Kanpur	Prashantkumar S Hanjagi
	500 advanced breeding lines		ICAR-IIPR, Kanpur	
	315 genotypes		ICRISAT, Hyderabad and UAS, Raichur	Basvaraj PS Boraiah KM KK Pal
	23 wild species			
Groundnut	174 Accessions			
Foxtail millet	118 Accessions			
Finger millet	77 Accessions			

Crops	Number of germplasms	Abiotic stress	Source	Scientist involved
Cow pea	500 Accessions			
Mungbean	296 Accessions		WVC, Taiwan	Basvaraj PS
Tomato	122 Accessions		NBPGR, New Delhi and WVC, Taiwan	PS Khapte
Chilli	22 Accessions		IIHR, Bengaluru and WVC, Taiwan	PS Khapte
Ajwain	12 genotypes		NRCSS, Ajmeer	CB Harisha
Chickpea	10 Wild species		ICRISAT, Hyderabad	Basvaraj PS
	192 Accessions (Minicore)			KK Pal
	132 ABLs			K. K. Pal & Rafat Sultana
Lentil	32 genotypes		IIPR, Kanpur	Gurumurthy S
	26 ABLs		ICARDA, Bhopal	Rafat Sultana
Groundnut	8 varieties		UAS, (R) & (D)	Boraiah KM
Finger millet	35 wild Sp. & varieties		ICAR-IISS, Mau	Boraiah KM
Avocado	15		ICAR-IIHR, RS, Chettali	VD Kakade
Dragon fruit	25	Characterization for fruit traits and mode of pollination	Farmers' fields	Boraiah KM
Rice	16	Wild accessions	IIIR, Hyderabad	K K Pal Sushil Changan Basavaraj PS

Advancing (M6/M7) and Evaluation (Stable) of Chia Mutants

The promising and stable mutant lines identified in the M_6/M_7 generations were evaluated for yield performance under preliminary station trials (Table 8). Most of the selected lines outperformed both the checks, including the wild type (CB). Notably, lines 94-3-1, 94-3-3 and 94-1-1 recorded nearly 20% higher yield compared to the best check, with 94-1-1 exhibiting the maximum yield advantage (28.52% over CB and 80.68% over CW). These results indicate substantial improvement in yield potential without marked delay in maturity. The promising macro-mutants, distinguished based on morphological, pigmentation and seed-related traits, are currently being evaluated and characterized under multi-location trials (Table 9) during *rabi* 2025-26 to validate the stability and uniform expression of traits. The trials are being conducted at four locations, namely ICAR-NIASM, Baramati; ICAR-CRIDA, Hyderabad; UAS, Raichur; and ICAR-

NISST RS, Bengaluru (Fig 14). The expression of morphological traits remained consistent across all locations, demonstrating environmental stability of the selected mutants. Further, seeds of an extra-early mutant line (141-1-1-P_2), presumed to possess photo-insensitivity, were sown in pots under long-day conditions on 13 May 2025 to validate the trait. Panicle initiation was observed approximately two months after sowing (15 July 2025), first flowering occurred by the end of July, complete flowering was recorded by 26 August 2025, and physiological maturity was attained by 17 September 2025 (Fig 15). In contrast, earlier sowing experiments with the wild type consistently showed panicle initiation only from mid-September onwards, irrespective of sowing date. This differential response strongly suggests that the identified mutant is photo-insensitive. However, confirmation will be done through year-round staggered sowings at 15-day intervals in the coming season.

Table 8. The yield gain (%) in promising stable mutant lines over checks

Entries	Plot yield (kg) (22.5 m²)	Yield per ha (Kg/ha)	Yield increment over check 2 (%)	Yield increment over check 1 (%)	Maturity (Days)
94-2-3	2.02	895.56	47.80	5.13	108
94-2-1	2.17	965.19	59.29	13.30	111
94-3-1	2.29	1019.26	68.22	19.65	112
94-3-3	2.31	1026.67	69.44	20.52	111
94-3-5	2.24	997.04	64.55	17.04	113
94-1-3	2.26	1004.44	65.77	17.91	104
94-1-1	2.46	1094.81	80.68	28.52	104
CB (check 1)	1.92	851.85	-	-	115
CW (check 2)	1.36	605.93	-	-	117

Table 9. Shortlisted trait-specific mutants being characterized at multi-location during *rabi*-2025

Trait	Mutant Codes (Pedigree / Line No.)
Pigmented tall	NC-1 (94-2-1); NC-2 (94-3-1); NC-3 (94-3-3); NC-4 (94-3-5); NC-5 (94-1-3); NC-6 (94-1-1)
Pigmented and bold seed	NC-7 (125-1-4); NC-8 (125-1-3); NC-9 (125-2-6); NC-10 (125-2-7); NC-11 (125-1-5-3); NC-12 (125-1-8 to 15)
Dwarf plant	NC-13 (52-3-5); NC-14 (52-3-6-4); NC-15 (52-3-6-4)
Crinkled leaf	NC-16 (148-2-4-1); NC-17 (148-2-3-2); NC-18 (148-2-2-2)
Chlorotic	NC-19 (31-1-15-1); NC-20 (31-1-15-1)
Early flowering	NC-21 (11-1-3-2); NC-22 (11-1-4-2)
Extra early flowering	NC-23 (141-1-1-2)
Tall & natural phyllody	NC-24 (75-1-6); NC-25 (75-1-6)
Round panicle	NC-26 (204-1-5, P3)
Wild type white variety	NC-27 (Champion)
Wild type black variety	NC-28 (Local selection)

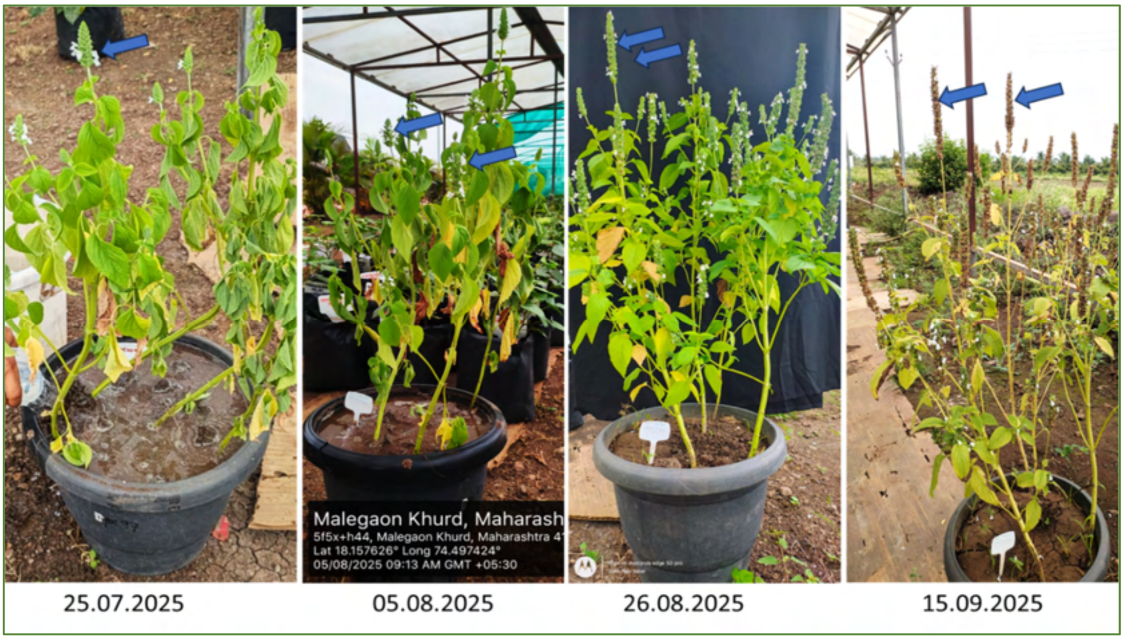


Fig 14. Different phenological stages of early and photo-insensitive mutant line (141-1-1) growing during long day condition. Flowering onset during July months indicated photo-insensitive nature of the mutant

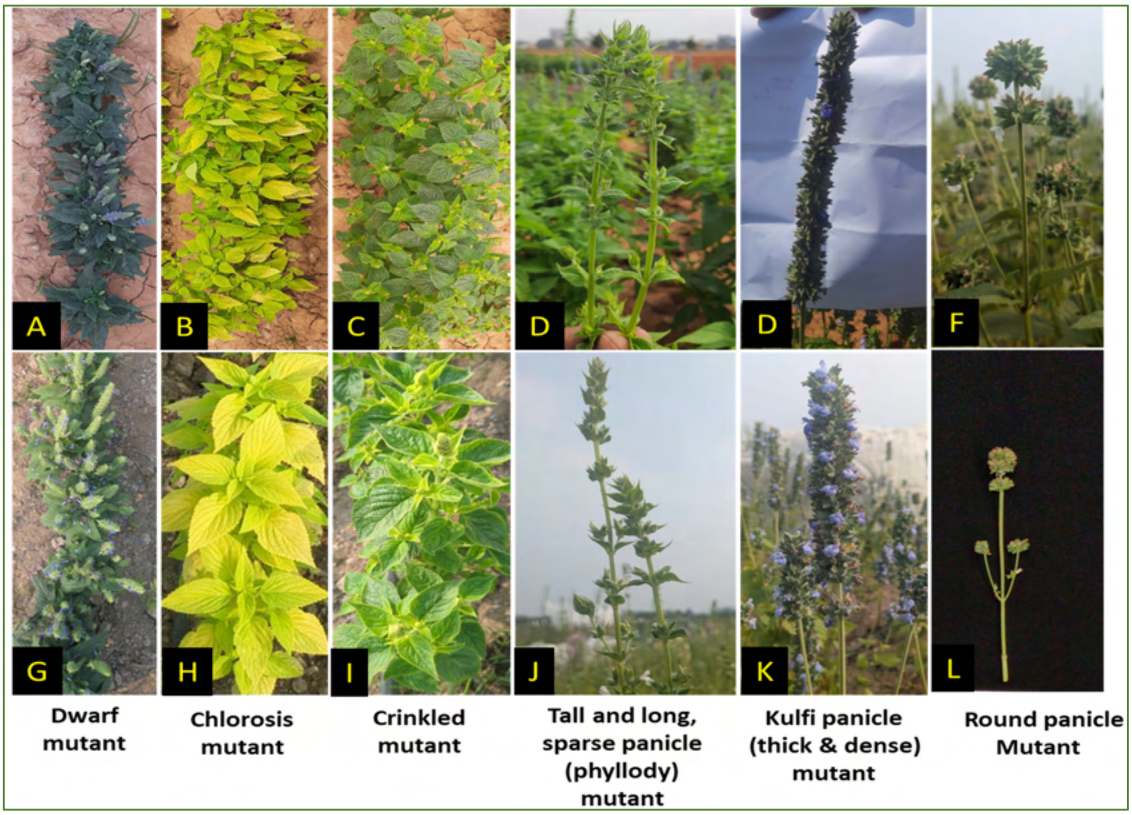


Fig 15. Identification and multi-location trials of macro mutants (different morpho types) Top row indicates the mutant lines from ICAR-NISST, Reginal station, Bengaluru (A-F) and bottom row mutants from ICAR-NIASM, Baramati

Screening and Identification of Waterlogging and Drought Tolerant Tomato Germplasm

In the waterlogging experiment conducted during July to October 2024, 42 tomato accessions collected from ICAR-NBPGR, ICAR-IIHR, and WVC, Taiwan were screened. Waterlogging stress was imposed 20 days after transplanting by submerging the pots to 1 inch above the soil surface for six days. The results showed that most accessions (64.28%) exhibited low survival (≤60%), while only 14.29% achieved 100% survival after six days of waterlogging (Fig 16). Among the screened genotypes, those with more than 90% survival are presented in Table xx. Out of these, only five genotypes three *S. lycopersicum* accessions (G102, G104, and G106), two *S. pimpinellifolium* accessions (G9 and G59), and the tomato F1 hybrid 'Yogi-35' were identified as completely tolerant (100%) based on shoot, root, and physiological traits (Table 10). The tolerance observed in *S. lycopersicum* accessions can be attributed to the development of a high number of adventitious roots, an adaptive mechanism that enhances oxygen uptake and sustains root function under hypoxic stress. In contrast, *S. pimpinellifolium* accessions did not produce adventitious roots, suggesting that their tolerance may be governed by alternative mechanisms.

Table 10. Effect of waterlogging on morpho-physiological traits of tomato genotypes

Treatment	Plant height (cm/p)	Stem diameter (mm/p)	Root dry mass (g/p)	Shoot dry mass (g/p)	Root volume (cc/p)	SPAD	NDVI
Stress (S)							
Control	83.96a	6.05a	27.29a	32.82a	32.77a	55.70a	0.68a
Waterlogging	61.77b	4.75b	20.05b	27.15b	6.03b	52.62b	0.30b
LSD P<0.05	***	***	*	***	**	***	**
Genotypes (G)							
T2	49.34i	5.9abc	21.92bc	30.3bc	25.67a	53.4cde	0.46bc
T5	62.67f	4.51de	22.06bc	28.94bc	24.34ab	57.15bc	0.46bc
T6	55.84h	4.88de	22.72bc	30.69bc	15.50d	48.62f	0.41c
T7	60.50fg	4.81de	25.72ab	26.77bc	24.84ab	58.92ab	0.43c
T9	100.67a	4.44de	22.63bc	29.96bc	21.67a-d	55.55bc	0.58ab
T58	66.84e	4.34e	22.06bc	26.05c	15.00d	61.52a	0.66a
T88	57.17gh	6.36a	29.44a	30.51bc	14.50d	54.07cd	0.47bc
T102	62.50f	6.17abc	25.34abc	27.58bc	16.00cd	54.94c	0.49bc
T104	80.84c	6.26ab	26.19ab	31.16bc	23.34abc	54.9c	0.5bc
T105	73.67d	5.61c	25.56ab	31.74b	16.67cd	56.17bc	0.51bc
T106	79.34c	5.72bc	23.98bc	28.58bc	18.50a-d	50.12ef	0.47bc
T108	71.34d	4.97d	21.1bc	28.76bc	14.84d	54.08cd	0.46bc
T115	102.84a	5.76bc	22.58bc	38.25a	23.34abc	48.09f	0.43c
Yogi-35 (F_1)	96.50b	5.84abc	20.04c	30.52bc	17.34bcd	50.65def	0.53bc
LSD P<0.05	***	***	***	***	***	***	***
LSD P<0.05 (S × G)	***	***	NS	NS	NS	***	**

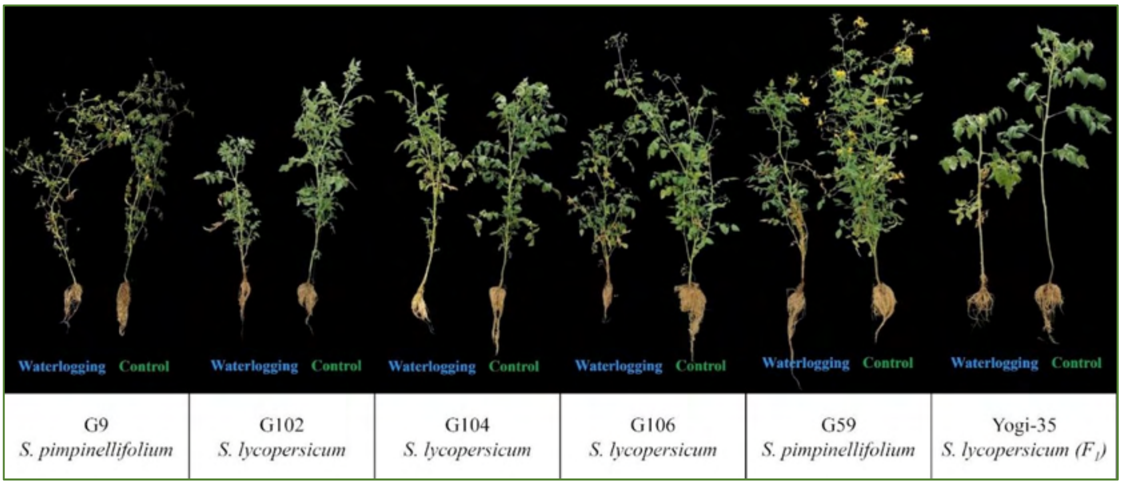


Fig 16. Waterlogging tolerant tomato germplasm

The drought screening experiment was conducted in pots under greenhouse conditions from November 2024 to March 2025 to evaluate the tolerance of tomato germplasm accessions. Drought stress was imposed by withholding irrigation for 10 days after seedling establishment at 20 days after transplanting. On the 10th day of stress, the volumetric soil moisture content was 12–13% in the drought treatment, while it was maintained at 40–42% in the control. Screening of 72 accessions, comprising cultivated and wild species, resulted in the complete recovery of 19 genotypes, with limited tolerance in *S. lycopersicum* (9 of 62 accessions, 15%). In contrast, all accessions of the wild species- *S. pimpinellifolium* (5/5), S. habrochaites (3/3), *S. peruvianum* (1/1), and *S. pennellii* (1/1) showed complete recovery, highlighting the greater drought resilience of wild relatives compared to cultivated tomato (Table 11 and Fig 17).

Table 11. Effect of drought on morpho-physiological traits of tomato genotypes

Treatment	Plant height (cm/p)	Stem diameter (mm/p)	SPAD	Shoot DW (g/p)	Root DW (g/p)	Root length (cm/p)
Stress (S)						
Control	88.09a	4.61a	46.64a	26.44a	18.13a	18.87a
Drought	68.46b	4.34b	37.72b	22.31b	17.64b	15.43b
LSD P<0.05	**	**	**	**	**	**
Genotypes (G)						
T1	77.42e-i	4.27e-j	46.4abc	22.87fgh	16.51f	12.55i
T2	50.76k	5.18b	46.04a-d	23.77efg	18.37a-d	12.72i
T7	67.97hij	5.04bcd	45.19a-d	23.47fgh	18.42a-d	26.47b
T9	105.1a	3.77i-l	36.04ef	27.6ab	17.41b-f	21.92c
T11	84.12cde	4.55c-h	47.2abc	27.39abc	19.62a	20.67cd
T12	84.45cde	4.45d-h	38.75c-f	25.56cde	18.77ab	19.88c-f
T13	80.9d-g	4.18gh-k	41.97a-f	25.83a-d	18.57abc	18.92c-g
T14	95.45b	3.36l	39.42b-f	25.71b-e	18.14a-e	13.37hi
T15	66.8ij	4.84b-f	48.82a	24.05d-g	18.58abc	32a
T19	63.99j	5.78a	40.74ab-f	27.69a	18.45a-d	16.12d-i
T42	78.67d-h	3.7jkl	47.89ab	23.14fgh	18.57abc	22.4bc
T46	68.59hij	5.03bcd	39.95b-f	27.52ab	17.06c-f	14.17ghi

Treatment	Plant height (cm/p)	Stem diameter (mm/p)	SPAD	Shoot DW (g/p)	Root DW (g/p)	Root length (cm/p)
T52	92.92bc	4.43d-h	42.95a-e	22.9fgh	18.6abc	16.52d-i
T53	85.07b-e	4h-k	36.24ef	24.41d-g	17.31b-f	15f-i
T54	87.04b-e	5.13bc	34.27f	24.4defg	17.8bc-f	15.48e-i
T56	72.49f-j	4.64b-g	38.99c-f	22.37gh	18.26a-d	13.34hi
T57	76.1e-i	4.28e-j	37.7def	22.91fgh	17.17c-f	13.22i
T58	71.14g-j	4.23f-k	44abcde	21.56hi	17.51bc-f	14.68ghi
T66	89.19bcd	4.38e-i	44.35a-e	23.08fgh	17.45bc-f	20.42cde
T72	67.37ij	3.63kl	42.75a-e	20.53i	17.03def	4.72j
T127	83.5cde	4.9b-e	40.42a-f	24.55def	17.81b-f	19.68c-f
T6242 (F_1)	67.99hij	4.54c-h	44.89a-d	25.75b-e	17.28b-f	18.35c-h
ADV12198 (F_1)	83.22cdef	4.55c-h	45.19a-d	23.59fg	16.66ef	11.8i
LSD P<0.05	**	**	**	**	*	**
LSD P<0.05 (S × G)	**	**	**	**	NS	**

Fig 17. Screening of tomato germplasm for drought tolerance in greenhouse

Screening and Identification of Waterlogging Tolerant Brinjal Germplasm

In eggplant, waterlogging stress was imposed 20 days after transplanting by submerging the pots to 1 inch above the soil surface for six days. During July to October 2024, a total of 35 accessions collected through local exploration, ICAR-IIHR, and WVC, Taiwan were screened for waterlogging tolerance. The results revealed a high level of tolerance, with more than half of the population (51.42%) maintaining 100% survival after six days of waterlogging (Fig 18). Notably, accessions B27, B31, B32, B34, B37, B38, and B41 exhibited better tolerance, which could be attributed to their robust root system and superior physiological traits that collectively enhanced survival under hypoxic conditions (Table 12).

Table 12. Effect of waterlogging on morpho-physiological traits of brinjal

Treatment	Plant height (cm/p)	Stem diameter (mm/p)	Shoot dry mass (g/p)	Root dry mass (g/p)	Root volume (cc/p)	SPAD	NDVI
Stress (S)							
WW	39.73a	6.40a	25.28a	21.50a	22.49a	53.90	0.67a
WL	29.26b	5.69b	21.12b	18.27b	9.45b	53.03	0.30b
LSD P<0.05	***	***	***	***	***	ns	***
Genotypes (G)							
B1	30.5gh	5.62efg	22.29	19.36	15.34d-g	54.5bcd	0.4g
B8	33.67def	6.18b-e	24.61	21.19	14.5efg	54.49bcd	0.36h
B17	33.84def	5.66def	23.27	19.81	13.50g	48.87g	0.48c-f
B23	35.34bcd	5.47fg	23.04	21.79	15.67c-g	48.55g	0.48def
B24	36.67b	6.21a-d	24.36	19.81	13.84fg	50.3efg	0.52ab
B25	34.17c-f	6.11cde	24.23	21.87	13.67fg	48.35g	0.48c-f
B26	32.17fg	6.1cde	23.74	20.46	15.34d-g	52.82def	0.5b-e
B27	32.84ef	6.18b-e	21.86	19.54	17.17a-d	49.69fg	0.49b-e
B29	41.34a	6.15b-e	22.93	19.85	14.84d-g	49.8efg	0.52ab
B31	35.50bcd	6.07cde	24.64	20.15	18.17abc	54.7bcd	0.45f
B32	40.00a	5.12g	21.17	17.99	18.34ab	49.49fg	0.47ef
B33	34.67b-e	6.53abc	23.73	18.51	15.5d-g	57.47b	0.51a-d
B34	35.17bcd	6.74a	24.23	20.19	16.5a-e	56.69bc	0.46ef
B37	32.5efg	6.43abc	23.52	21.40	16.84a-e	53.49cde	0.47def
B38	28.67h	6.69ab	22.52	19.60	18.84a	52.02d-g	0.51abc
B39	33.84def	6.24abc	22.12	18.77	14.84d-g	61.8a	0.53a
B40	36.17bc	5.67def	22.53	18.34	16.17b-f	61.39a	0.53a
B41	33.84def	5.63efg	22.86	19.35	18.34ab	57.97b	0.49cde
LSD P<0.05	***	***	NS	NS	***	***	***
LSD P<0.05 (S × G)	***	***	NS	NS	***	***	***

Fig 18. Eggplant accessions tolerant of six days of waterlogging (left) compared with control plants (right).

Collection, Conservation and Maintenance of Vegetable Germplasm (Tomato, Eggplant and Capsicum)

A total of 113 tomato, 63 eggplant, and 23 capsicum genotypes, including wild species, were collected through local exploration and from international and national institutes during 2020–2025 (Fig 19). The material was purified through self-pollination and maintained under field and greenhouse conditions. These genetic resources are currently being utilized for screening against multiple abiotic and biotic stresses.

Fig 19. Tomato, eggplant and capsicum germplasm being maintained in field conditions

Phenotyping Pigeon Pea Genotypes for Reproductive Stage Drought Stress Tolerance in Field Conditions

Whole-genome re-sequenced panel of 193 pigeon pea genotypes was evaluated for reproductive-stage drought stress tolerance under field conditions during *kharif* 2024 season (Fig 20). Multi-trait assessment identified ten drought-tolerant genotypes (ICP 12410, ICP 2405, ICP 10228, ICP 8941, ICP 10094, ICP

14701, ICP 8152, ICP 8255, ICP 7803 and ICP 7266) from the field experiment. Key morphological and physiological parameters such as defoliation, SPAD chlorophyll index, photosynthetic efficiency, electron transport rate (ETR), leaf thickness, stomatal conductance (gsw), flower drop, test weight, and pod yield were characterized. Increased defoliation was one of the clear drought stress symptoms, wherein the tolerant genotypes had lower defoliation, which can serve as a quick visual trait in screening pigeon pea genotypes for reproductive stage drought stress tolerance. Heatmap clustering of these tolerant pigeon pea genotypes based on PhiPS2, gas exchange, and ETR revealed distinct physiological response groups under reproductive-stage drought stress (Fig 21). ICP-14491 and ICP-7003 showed superior performance with high ETR, moderate-to-high gsw, and elevated PhiPS2, indicating effective photosynthetic electron transport and carbon assimilation capacity; ICP-6152 exhibited intermediate performance across parameters, while ICP-7266 and ICP-8943 displayed lower ETR compensated by high PhiPS2 and moderate gsw, suggesting alternative physiological adaptations. This panel along with 80 additional diverse pigeonpea genotypes was evaluated for terminal stage reproductive drought stress tolerance in *kharif* 2025 season to validate the 193 genotypes and screen the additional 80 genotypes

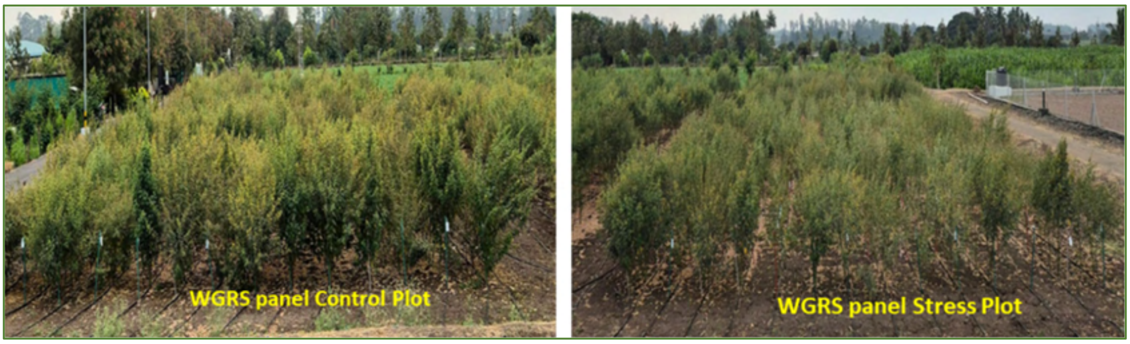


Fig 20. Field experimental setup for phenotyping 193 whole-genome re-sequenced pigeon pea genotypes for reproductive-stage drought stress tolerance

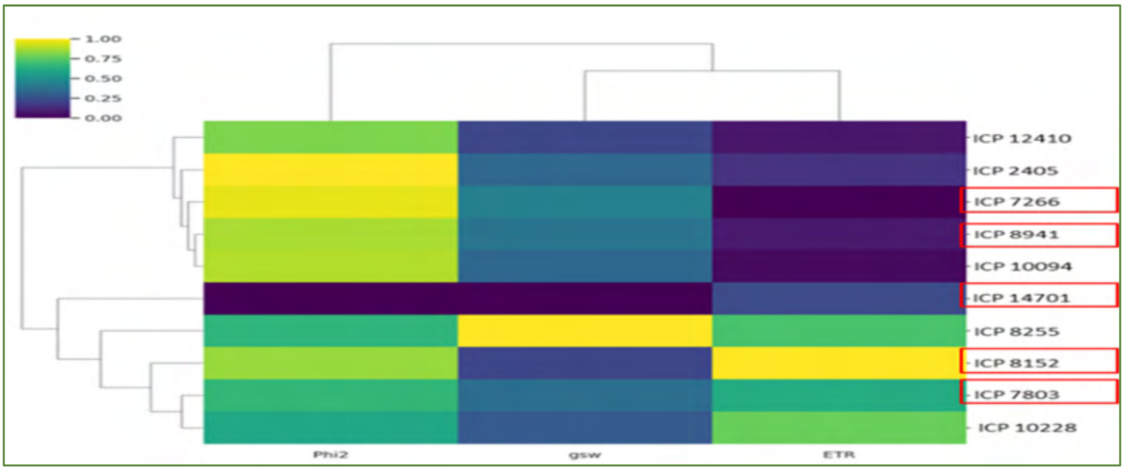


Fig 21. Heat map and hierarchical clustering of drought-tolerant pigeon pea genotypes based on PhiPS2, stomatal conductance (gsw), and electron transport rate (ETR) under reproductive-stage drought stress

Identification of Multiple Abiotic Stress Tolerant Pigeon Pea Genotypes

To identify pigeon pea genotypes tolerant to multiple abiotic stresses, eight drought-tolerant genotypes—ICP 12410 (A), ICP 2405 (B), ICP 10228 (C), ICP 8941 (D), ICP 10094 (E), ICP 14701 (F), ICP 8152 (G), and ICP 8255 (H)—previously identified during reproductive-stage drought phenotyping in *kharif* 2024 were further evaluated for waterlogging (WL) tolerance at the knee-height vegetative stage (40 days after germination) during July 2025. A susceptible check (SC: IPAC-79, I) and a tolerant check (TC: IPAV-16-1, J) were included for comparison. Waterlogging stress was imposed in experimental tanks by maintaining 6 cm of standing water above the soil surface for 7 days to simulate field flooding conditions typical of rainfed pigeon pea systems. Histochemical assays (NBT and DAB) revealed differential accumulation of reactive oxygen species (ROS) under waterlogging stress (Fig 22a), while anatomical observations confirmed the presence of aerenchyma in the roots of tolerant genotypes as a key adaptive mechanism (Fig 22b). Among the genotypes tested, ICP 12410 (A), ICP 2405 (B), ICP 10228 (C), and ICP 8941 (D) exhibited clear tolerance to waterlogging at the knee-height stage. Thus, these four genotypes *viz*., ICP 12410 (A), ICP 2405 (B), ICP 10228 (C), and ICP 8941 (D) were identified to be tolerant to water logging stress tolerance at knee height stage and reproductive stage drought stress tolerance making them potential donors for multiple abiotic stress tolerance.

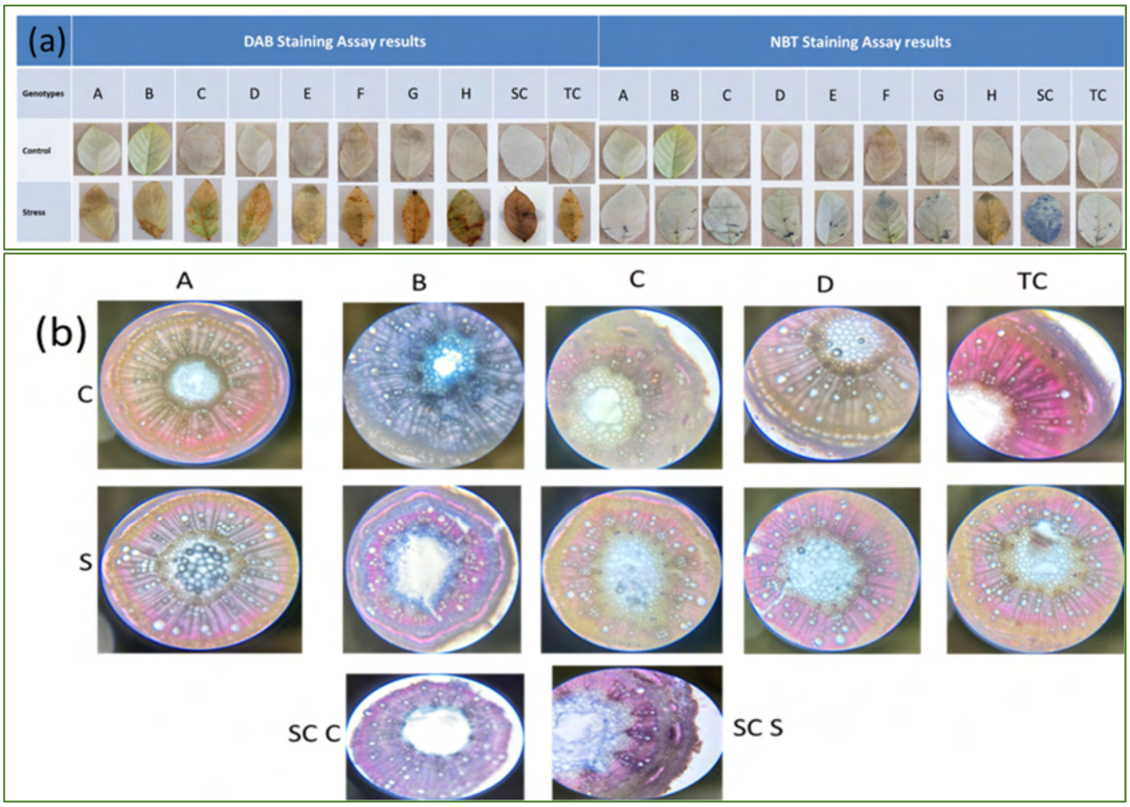


Fig 22. Histochemical assays showing differential staining patterns in tolerant and susceptible pigeon pea genotypes using DAB and NBT assays (a). Root cross-sections of tolerant and susceptible genotypes (b) depicting anatomically visible aerenchyma formation in the roots of tolerant genotypes

High throughput Screening of Pigeon Pea Genotypes to Stress Tolerance at Cellular Level Using Temperature Induction Response Technique

Eighty-seven pigeon pea (*Cajanus cajan* (L.) Millsp.) genotypes were screened for cellular-level heat tolerance using the Temperature Induction Response (TIR) technique: 2-day-old seedlings underwent gradual induction heating (30–42°Cover 3 h), followed by a lethal challenge (51°C for 3 h). Pre-induced seedlings exhibited superior recovery growth versus direct challenge, indicating significant genotypic variation; 46 genotypes showed high survivability and recovery. Ten promising genotypes advanced to reproductive-stage drought tolerance screening under soil moisture stress (40% FC, gravimetric method), where FLIR IR thermal imaging identified tolerant lines maintaining cooler canopies (Fig 23). Cooler canopies signify drought avoidance through higher water-use efficiency and stress signaling; these ICP lines (from prior TIR screening) validate combined heat-drought resilience for breeding resilient varieties.

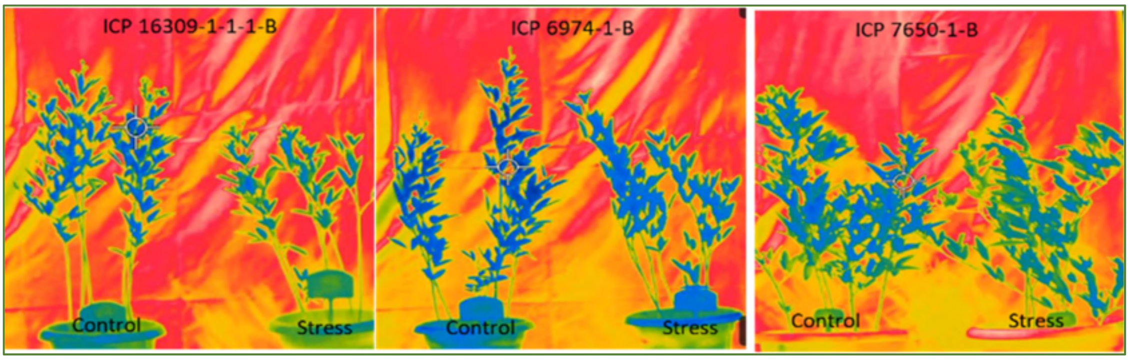


Fig 23. Thermal images of pigeon pea genotypes with cooler canopy temperature under drought stress

Chlorophyll Fluorescence-based Signatures of Desiccation Tolerance in wild Tomato Species

Desiccation tolerance is a crucial adaptive trait that allows plants to survive extreme water loss; however, its underlying physiological mechanisms remain inadequately characterized in tomato and its wild relatives. In the present study, chlorophyll *a* fluorescence (ChlaF) imaging was used as a non-invasive, high-resolution phenotyping tool to investigate photosystem II (PSII) responses to progressive desiccation in cultivated tomato (*Solanum lycopersicum*) and five wild species (*S. chilense, S. habrochaites, S. peruvianum, S. pimpinellifolium,* and *S. pennellii*) (Fig 24). Detached leaves were subjected to controlled desiccation for up to 50 h, during which tissue moisture content (TMC), relative water content (RWC), PSII photochemical efficiency (Fv/Fm; QY_{max}), minimal fluorescence (F_0), maximal fluorescence (F_m), and variable fluorescence (F_v) were quantified, along with histochemical detection of reactive oxygen species (ROS). Progressive desiccation caused a pronounced, moisture-dependent decline in PSII performance across all species, characterized by significant increases in F_0 and concomitant reductions in F_m, F_v, and QY_{max} as TMC decreased ($P \leq 0.001$).

QY_{max} exhibited a strong linear relationship with RWC (R^2 = 0.80–0.90), underscoring PSII efficiency as a sensitive indicator of dehydration stress. Marked interspecific variation was evident: *S. chilense, S. habrochaites, S. peruvianum,* and *S. pimpinellifolium* displayed rapid PSII impairment, reaching a 50% reduction in QY_{max} at relatively high RWC levels (45–55%), whereas *S. lycopersicum* showed intermediate tolerance. In contrast, *S. pennellii* demonstrated exceptional PSII stability, maintaining high QY_{max} values even under severe dehydration, with a 50% loss of PSII efficiency occurring only at substantially lower RWC (30–35%). Histochemical analyses further revealed lower accumulation of H_2O_2 and O_2 in *S. pennellii*, indicating enhanced oxidative stress regulation as a key determinant of its desiccation tolerance. Collectively, these findings demonstrate that chlorophyll fluorescence-based traits effectively capture functional diversity in desiccation tolerance among tomato species. The superior PSII stability and oxidative resilience of *S. pennellii* highlight its value as a promising genetic resource for enhancing drought and desiccation tolerance in cultivated tomato through breeding and biotechnological approaches.

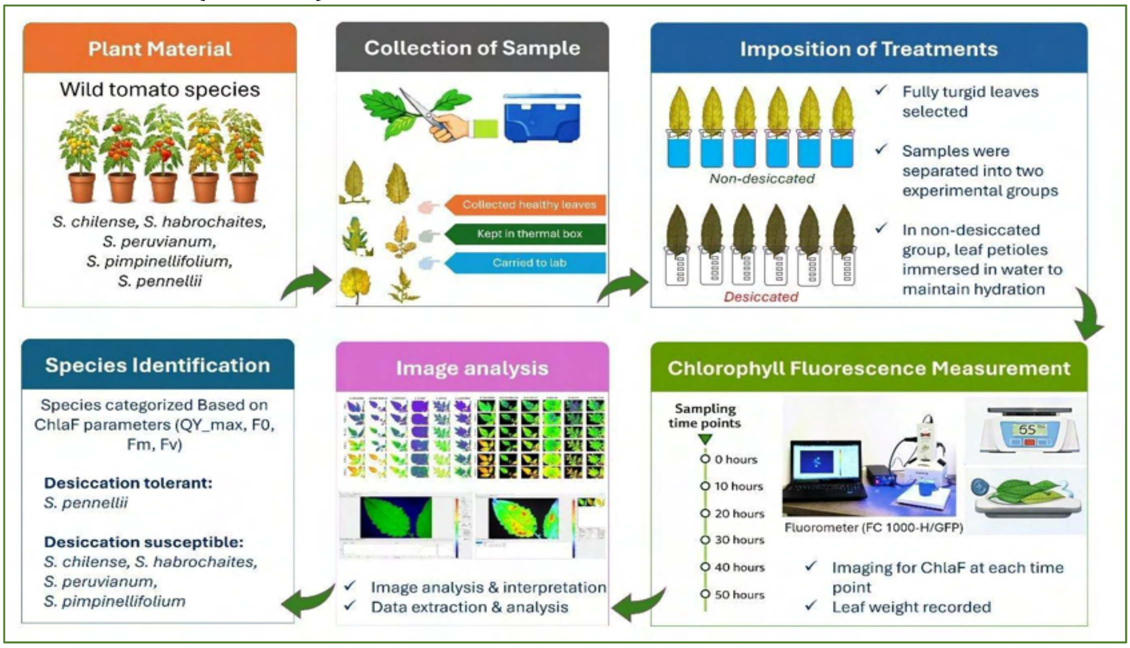


Fig 24. Schematic diagram depicting the overview of experimental workflow

Effect of Tillage, Trash, and Nutrient Management on Water Stable Macro-Aggregates, Micro-Aggregates and Aggregate Ratio in Sugarcane Cropping System

A field experiment was conducted in sugarcane during 2021–2025 to evaluate the effects of tillage, trash retention, and nutrient management practices on soil physical and carbon-related properties. The experiment was laid out in a split–split plot design with three tillage practices—conventional tillage (CT), minimum tillage (MT), and reduced tillage (RT)—assigned to the main plots. Two trash retention practices, surface trash retention (M) and no trash retention

(NM), were allocated to subplots, while three nutrient management practices were assigned to sub-subplots: N1, 10% of the recommended dose of fertilizers (RDF) applied as basal and the remaining 90% through fertigation; N2, 25% RDF as basal and 75% through fertigation; and N3, 15% RDF as basal, 20% RDF applied at 60 days after planting, and the remaining 65% through fertigation. The treatments were replicated three times. In the plant crop, basal fertilizers were broadcasted under CT, whereas they were drilled under MT and RT. In the subsequent ratoon crops, basal fertilizer application was carried out using a multifunctional ratoon drill (MRD). After completion of one plant and three ratoon crops, soil samples were collected from depths of 0–15, 15–30, and 30–45 cm and analyzed for water-stable aggregates (WSA). The distribution of WSA and aggregate ratio (AR) was significantly influenced by tillage, trash retention, and nutrient management practices (Table 13). Among tillage treatments, both minimum and reduced tillage significantly increased the proportion of macro-aggregates (>2000 μm and 250–2000 μm) and reduced micro-aggregates (<53 μm) compared with conventional tillage (CT). Consequently, MT recorded the highest total WSA (54.10%) and aggregate ratio (18.30), closely followed by reduced tillage (RT), whereas CT exhibited the lowest total WSA (41.75%) and AR (10.99), indicating poorer aggregate stability. Trash retention exerted a strong positive effect on soil aggregation. Retained trash (M) significantly enhanced macro-aggregate fractions and total WSA (59.96%) compared with no mulch (NM), which showed a dominance of micro-aggregates and the lowest aggregate ratio (11.65). Nutrient management also significantly altered aggregate distribution; higher nutrient inputs (N3) increased macro-aggregate associated WSA and total WSA (55.48%), resulting in a greater aggregate ratio (17.60) than lower nutrient levels (N1). The trend was found to be similar for both 15-30 and 30-45 cm depths but with lower values.

Table 13. Effect of tillage, trash, and nutrient management on distribution of water stable macro-aggregates, micro-aggregates, total WSA and aggregate ratio in sugarcane cropping system for 0-15 cm soil depth

Treatments	Water stable aggregates (WSA) (g aggregate 100 g^{-1} dry soil)				(WSMa)	(WSMi)	Total WSA	Aggregate Ratio (AR)
	>2000 µm	250-2000 µm	53-250 µm	<53 µm	(g aggregate 100 g^{-1} dry soil)	(g aggregate 100 g^{-1} dry soil)	(g aggregate 100 g^{-1} dry soil)	
Tillage (T)								
CT	6.98	31.27	3.50	58.25	38.25	3.50	41.75	10.99
MT	15.79	35.31	3.00	45.90	51.09	3.00	54.10	18.30
RT	13.36	33.4	2.75	50.51	46.75	2.75	49.49	18.12
Trash retention (R)								

Treatments	Water stable aggregates (WSA) (g aggregate 100 g^{-1} dry soil)				(WSMa)	(WSMi)	Total WSA	Aggregate Ratio (AR)
	>2000 µm	250-2000 µm	53-250 µm	<53 µm	(g aggregate 100 g^{-1} dry soil)	(g aggregate 100 g^{-1} dry soil)	(g aggregate 100 g^{-1} dry soil)	
M	17.39	39.42	3.15	40.04	56.81	3.15	59.96	19.96
NM	6.69	27.22	3.01	63.07	33.92	3.01	36.93	11.65
Nutrient (N)								
N1	10.85	27.89	3.17	58.09	38.74	3.17	41.91	13.17
N2	12.34	32.74	2.86	52.06	45.08	2.86	47.94	16.65
N3	12.94	39.34	3.21	44.52	52.28	3.21	55.48	17.60
LSD ($p \leq 0.05$)								
Tillage (T)	1.78*	0.66*	0.20*	1.13*	1.24*	0.20*	1.13*	2.90*
Trash retention (R)	1.71*	1.01*	0.14ns	2.13*	2.10*	0.14ns	2.13*	1.64*
Nutrient (N)	1.31*	1.33*	0.28*	2.32*	2.26*	0.28*	2.32*	1.56*
T × R	2.97*	1.76ns	0.25*	3.70*	3.64*	0.25*	3.70*	2.85*
T × N	2.27ns	2.30ns	0.48ns	4.02ns	3.92ns	0.48ns	4.02ns	2.70ns
R × N	1.86*	1.88*	0.40ns	3.29*	3.20*	0.40ns	3.29*	2.20ns
T × R × N	3.22ns	3.25ns	0.69*	5.69ns	5.54ns	0.69*	5.69ns	3.82*

CT: conventional tillage; MT: Minimum tillage; RT: reduced tillage; M: trash retention; NM: no trash retention; N1:10% RDF basal+ 90% fertigation; N2: 25% RDF basal+75% by fertigation; N3: 15% RDF as basal+20% at 60 DAP+ 65% fertigation; WSMa: water stable macro-aggregates; WSMi: water stable micro-aggregates; at the $p \leq 0.05$ level,*indicates the significant and ns non-significant differences in the mean values

Identification of Trait Specific Abiotic Stress Tolerant Pulse Genotypes

The following germplasm resources were identified after screening for more than four seasons under a managed stress environment.

Crop	Abiotic Stress	No. of germplasms screened	Name of the Germplasms	Adoptive trait(s)
Pigeonpea	Terminal drought stress < 10% soil moisture content (pre-flowering to maturity for 45-50 days)	450	ICPX 140205-B-1, ICPX140217-B1 and IC-73993	Highly drought tolerant, stable yield across different water regimes, WUE, MSI, RWC, NDIVI, etc.
Pigeonpea	Waterlogging (Seed, seedling <30 days old and reproductive stage)	450	ICP-16309, ICP-7148, ICP-8255, ICP-6845, ICP-6815, ICP-10228, ICP-6370, ICP-10397, ICP-4903, ICP-7869, and ICP-7507, ICP 14840, ICP 14830, ICP 16234, and ICP 16161	Higher survival (>80%) and recovery after stress, Adventitious roots, Lenticels, PSII efficiency, etc.
Mungbean	Drought (Reproductive stage) < 10% soil moisture content from pre-flowering to completion of physiological maturity	315	VI003685AG, VI002051BG, VI000852AG, VI002402BG, and VI003957AG	WUE, RSA, CT, High PSII, Phenomics parameters (NIR reflectance, CL, CHA, DA), high anti-oxidant defence mechanism, etc.
Cowpea	High temperature	500	EC240920, IC488085 IC488270, EC244046, EC244057, EC528691, IC311929	Photo-thermo insensitive and flowering and stable yield even under >45^{0}C temperature (10-15 days), PSII efficiency, Pollen viability, Cooler canopy of 2-4 ^{0}C than check varieties

Identification of Drought Tolerant Mungbean Genotypes

A total of 310 mungbean genotypes were screened for drought stress tolerance under both field and controlled pot experiments (Fig 25). Drought stress was imposed during the reproductive stage by withholding irrigation, with moisture levels maintained at drought stress (DS) (14-17% soil moisture content) and well-watered (WW) (26-28% soil moisture content) (Fig 26). The experiment focused on identifying drought-adaptive traits such as superior root system architecture, high antioxidant levels, and a high flower-to-pod ratio under drought conditions. Genotypes VI000852AG, VI001557BG, VI002051BG, and VI003685AG performed best across multiple morpho-physiological, biochemical, and root traits (Fig 27). These genotypes can therefore be recommended as parents in breeding programs aimed at improving drought stress (DS) tolerance in mungbean.

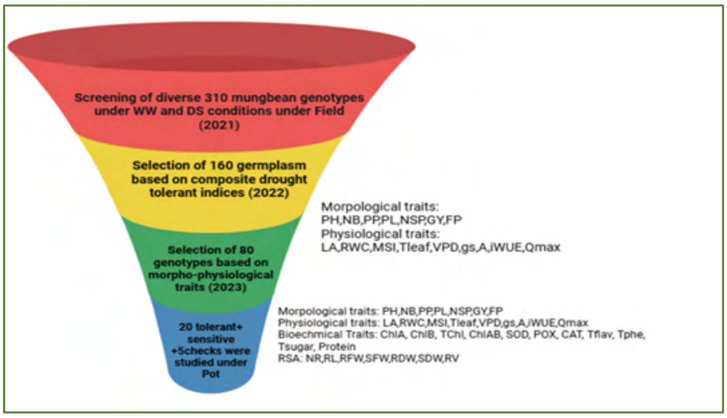


Fig 25. Work-flow of screening process of mungbean germplasm for drought stress from 2021-2025

Fig 26. Performance of potential genotypes under well-watered (WW) and drought stress (DS) conditions

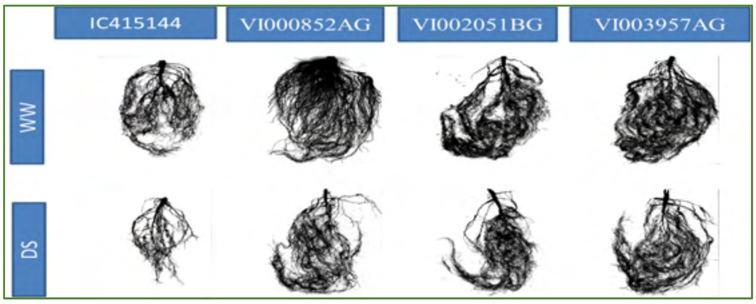


Fig 27. Root system architectural traits of potential genotypes under WW and DS conditions.

Identification of High Temperature Stress Tolerant Cowpea Genotypes

A panel of 250 cowpea germplasms was phenotyped for high-temperature stress adaptive traits under multi-environment field trials (MET) conducted from 2022 to 2025 (Fig 28). The objective was to identify trait-specific, heat-tolerant germplasms. These accessions, along with check genotypes, were characterized using key stress-adaptive morpho-physiological traits across environments. After thorough screening and validation, six germplasm accessions viz., IC488270, EC240920, IC488085, EC240868, EC243927, and IC402161 were identified as superior performers for multiple heat stress tolerance traits. These accessions exhibited high pollen viability (>90%), cooler canopy temperature (2–4°C lower than checks), higher photosynthetic rates, higher PSII efficiency, high and stable grain yield even under temperatures exceeding 45°C across locations. Therefore, these germplasms can serve as potential donor lines for incorporation of high-temperature stress tolerance in cowpea breeding programs (Fig 29).

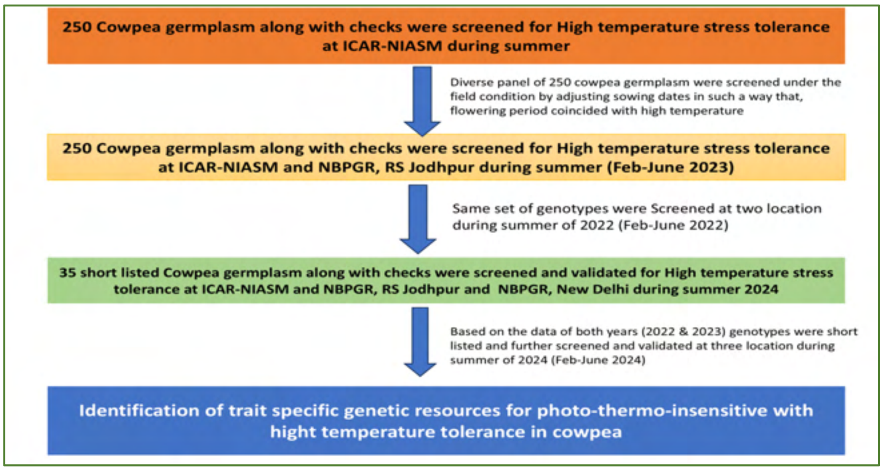


Fig 28. workflow of screening and validation of cowpea germplasm for high temperature stress tolerance across multiple locations and seasons

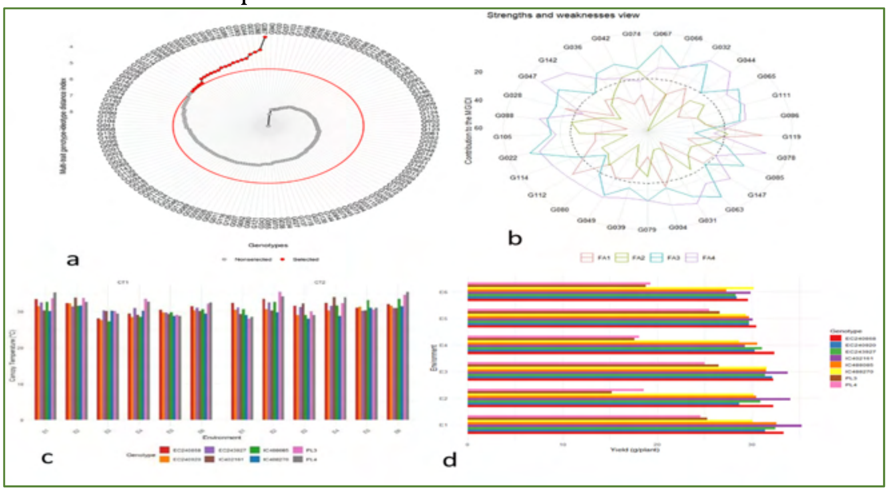
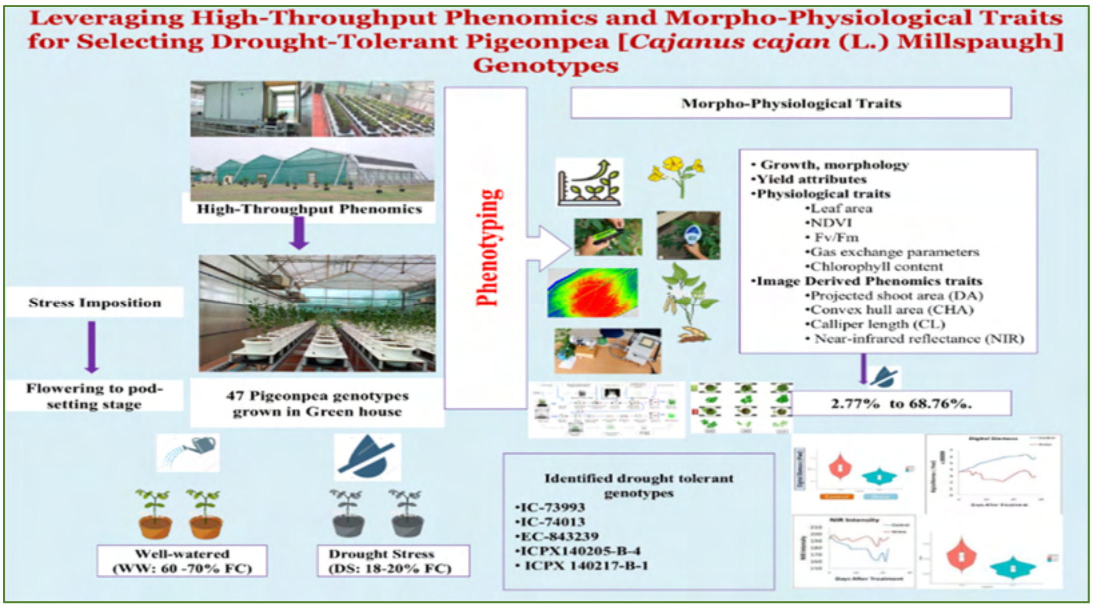


Fig 29. a: Selection of high-temperature stress tolerant cowpea genotypes based on multi-trait superiority **b:** Strength and weakness view of selected genotypes **c:** Performance of selected candidate genotypes for canopy temperature trait under multi-environmental phenotyping **d:** Performance of selected candidate genotypes for yield trait under multi-environmental phenotyping.

Integrating High-Throughput Phenomics and Morpho-Physiological Traits for Selecting Drought-Tolerant Pigeonpea Genotypes

Drought stress poses a significant global challenge to food security, affecting about 66% of arable land and causing economic losses of approximately USD 37 billion annually, with further increases expected due to climate change. Pigeonpea (*Cajanus cajan*), a key legume in semi-arid tropics, often faces yield reductions of 40–50% under drought conditions. Understanding the genetic basis of drought tolerance is crucial for selecting diverse parental lines and developing effective crop improvement strategies. In this study, 47 pigeonpea genotypes were evaluated under both well-watered (WW) and drought-stressed (DS) conditions in a controlled greenhouse. Drought stress was imposed during the flowering to pod-setting stage by withholding irrigation for 80–120 days. The study revealed that drought stress significantly reduced most morpho-physiological traits (by 2.8–68.8%) while increasing vapour pressure deficit and proline accumulation. High-throughput phenomic traits, such as digital shoot area, calliper length, and near-infrared reflectance, were effective in distinguishing drought-tolerant genotypes from sensitive ones. Nine genotypes (ICPX140196-B-1, ICPX140203-B-1, ICPX140213-B-3, ICPX140203-B-1-5, ICPX140203-B-2, ICPX140205-B-4, ICPX140217-B-1, IC-73993 and IC-74013) were identified as drought-tolerant, exhibiting superior photosynthetic efficiency, favourable tissue water status, and minimal yield reduction. The study also found that leaf temperature negatively correlated with grain yield and highlighted the importance of photosynthetic parameters in predicting yield under stress. The high genetic variability and moderate heritability of these traits suggest their potential as selection indices. The results demonstrate the effectiveness of integrating high-throughput phenomics with traditional morpho-physiological traits for rapid and precise identification of drought-tolerant pigeonpea genotypes, which could be used in breeding and genetic enhancement programs focused on improving drought tolerance.



Mapping of Water Status Proxies for Vidarbha Region using Sentinel-1 SAR data

To quantify the water status of the Vidarbha region in Maharashtra, spatial maps were generated using Sentinel-1 Synthetic Aperture Radar (SAR) data for July 2025. The analysis was based on VV backscatter and the derivation of a Soil Moisture Index (SMI) from it (Fig 30, 31). The SMI was estimated from Sentinel-1 VV backscatter using a normalization approach scaling the observed backscatter between dry and wet reference conditions, thereby expressing soil moisture in relative terms. Speckle noise reduction was performed using two different filtering approaches, namely Refined Lee filter (spatial filtering method), and multi-temporal median compositing (temporal filtering method). Corresponding SMI maps were generated for both approaches.

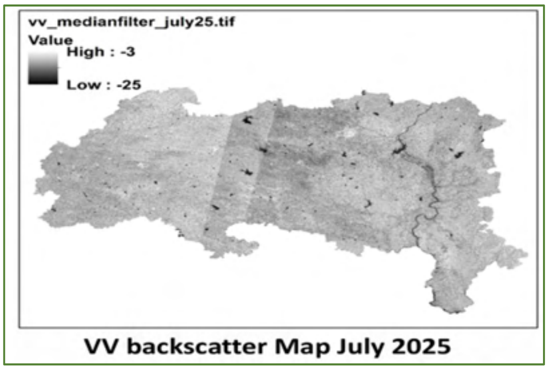


Fig 30. VV backscatter map of Vidarbha for July 2025

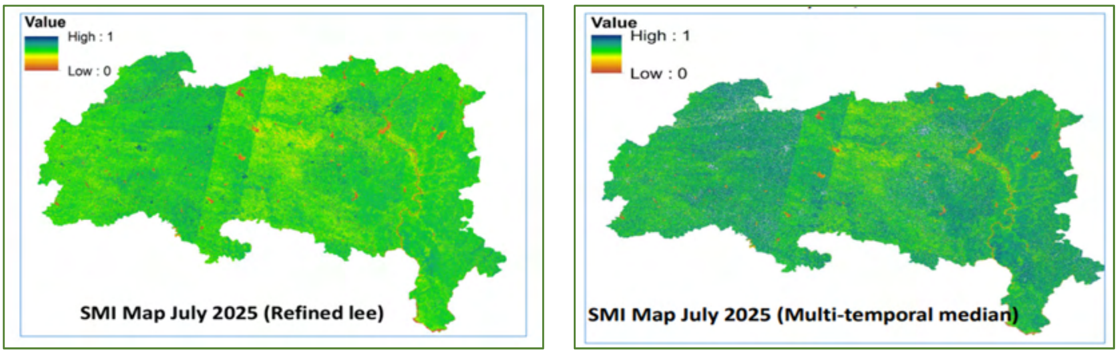


Fig 31. Soil Moisture Index Map of Vidarbha for July 2025 using two speckle filtering methods

SCHOOL OF EDAPHIC STRESS MANAGEMENT

Identification of salt-tolerant and salt-sensitive local mango genotypes based on plant morpho-physiological responses

Local genotypes 'Medad-1' and 'Pandare-2' exhibited highest seedling vigour, as indicated by greater seedling height, collar diameter, number of leaves, and leaf area. In contrast, poly-embryonic genotypes required more than 40 days for germination and displayed lower seedling vigour. Fourteen genotypes were evaluated for salinity tolerance under pot culture conditions using three irrigation treatments (0, 50, and 100 mM NaCl) during Feb-Apr 2025. Salinity stress led to significant reductions in leaf number, leaf, shoot, and root biomass, normalized difference vegetation index (NDVI), leaf relative water content (RWC), membrane stability index (MSI), and chlorophyll content across genotypes. Plant height and collar diameter showed a declining trend with increasing salinity levels; however, the genotype × salinity interaction for these traits was not statistically significant. Higher leaf injury index values were recorded in 'Kesar' and 'Mulgoa', whereas 'Olour', 'Musti 10', 'Malegaon 1', and 'Malegaon 2' exhibited comparatively lower leaf injury at 50 mM NaCl irrigation (Fig 1). Based on observed morphological and physiological responses, 'Musti 10', 'Malegaon 1', and 'Malegaon 2' were relatively more salt tolerant, while 'Kesar' and 'Mulgoa' were identified as salt-sensitive genotypes (Fig 2).

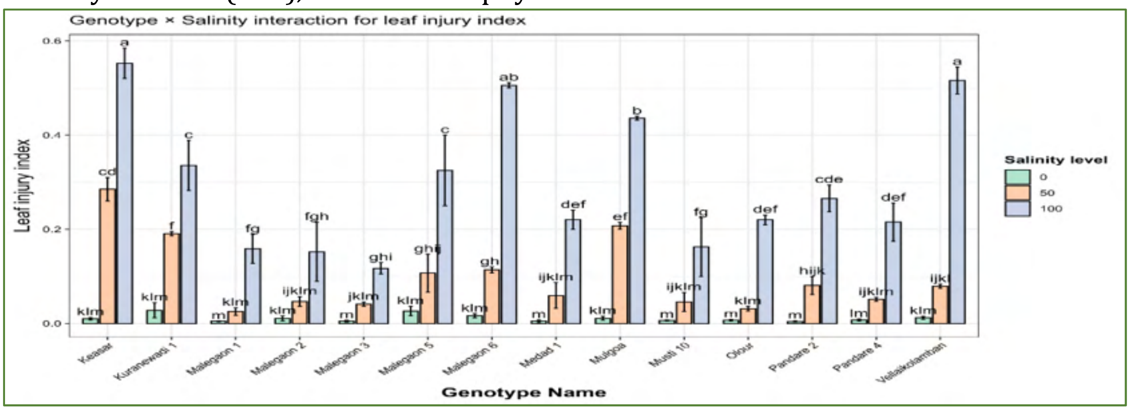


Fig 1. Effect of salinity stress on leaf injury index in local mango genotypes

Fig 2. Performance of local mango genotypes at 0, 50 and 100 mM NaCl saline irrigation

Performance of Ambronics Pot under Deficit Irrigation in Tomato Cultivation

A second field trial with an identical treatment structure was conducted during the summer 2025 season as part of this contract research project. The number of fruits and total fruit yield (t ha^{-1}) were statistically comparable under 100% and 75% irrigation levels. Among the cultivation systems, mulching recorded the highest fruit yield (40.63 t ha^{-1}), followed by the Talia tray system (38.63 t ha^{-1}). Pot cultivation under 75% ETc irrigation resulted in a fruit yield of 36.98 t ha^{-1}, which was statistically superior to the control treatment receiving 100% ETc. Planting systems had a non-significant influence on flowering, fruit set, internodal distance, and collar diameter at the flowering stage. Soil temperature at the plant base during flowering was significantly reduced, particularly under the mulching system. Mulching also recorded the lowest leaf moisture percentage, likely due to prevailing heat stress conditions. Fruit quality parameters were not affected by planting systems; however, irrigation levels significantly influenced total soluble solids (TSS), fruit size, and fruit dimensions. Root fresh and dry biomass were lowest under the pot cultivation system.

Mitigating waterlogging stress in maize through foliar application of nitrogen sources and growth regulators

Waterlogging at 15 days after emergence (DAE) was found to be the most sensitive, resulting in poor root morphological features, impaired physiological activities, and the highest grain yield reduction (46.01%) in maize. Whereas maize plants exhibited higher tolerance to waterlogging at 25 DAE. Similarly, increasing waterlogging duration from 3 to 15 days consistently reduced maize growth and grain yield. Regarding mitigation strategies, foliar application of urea (2%) improved stomatal conductance by 41.32%, net photosynthetic rate by 36.03%, and dry matter accumulation compared to water-sprayed plants. Consequently, it increased grain yield by 17.37%, enhancing stress tolerance and yield stability. Notably, urea spray (2%) on plants subjected to 3–5 days of waterlogging at 25 DAE effectively prevented the negative impacts of waterlogging on grain yield by promoting superior growth and yield-determining traits. Thus, foliar application of 2% urea was found to be an effective and practical strategy to minimize waterlogging-induced yield losses by enhancing stress recovery and tolerance in maize (Fig 3).

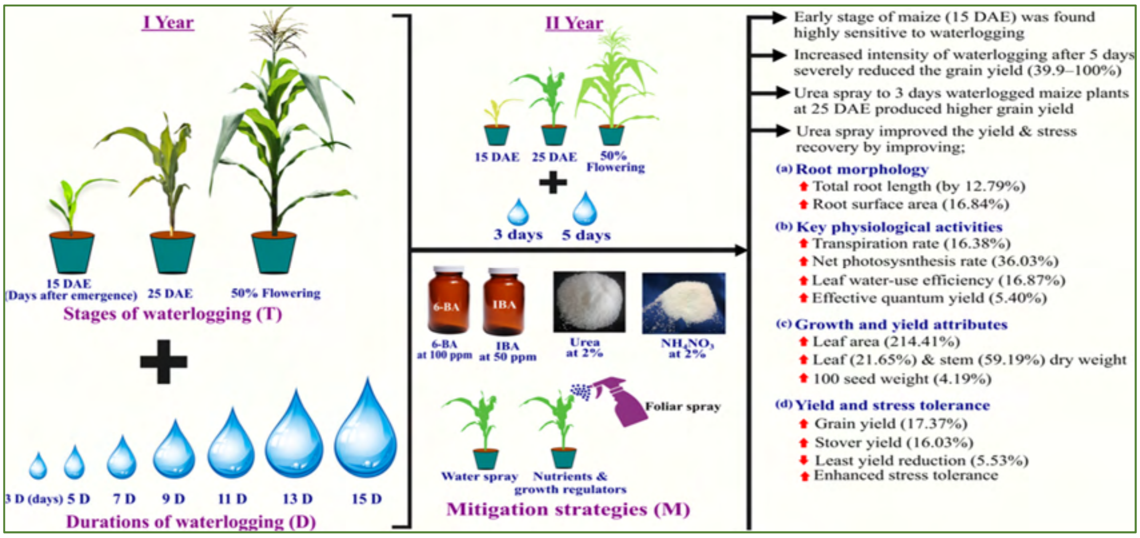
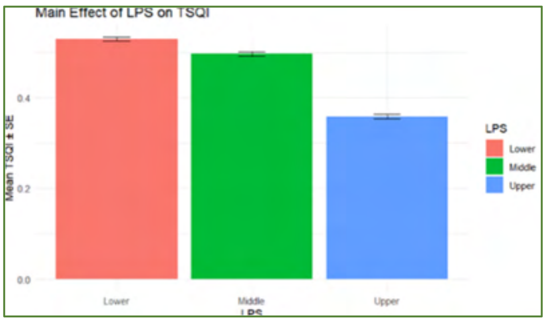


Fig 3. Maize reponse to waterlogging stress and its mitigation at different growth stages.

Soil Quality status of rice growing areas at different landscape positions of the high rainfall region

The lower slope area (LSA) reflects the best soil quality, as it tends to accumulate nutrients, organic matter, and moisture from upper landscape positions, creating more favourable conditions for fertility and biological processes. The middle slope area (MSA) shows moderate soil quality, with some retention of nutrients and water but less benefit from deposition compared to LSA. In contrast, the upper slope area (USA) has the poorest soil quality, where erosion, runoff, and organic matter loss reduce nutrient availability and soil productivity. Topsoil (0-15 cm) has the highest TSQI, suggesting better soil quality in surface layers. TSQI decreases with depth, indicating possible changes in soil organic matter, microbial activity, or nutrient availability as depth increases (Fig 4).



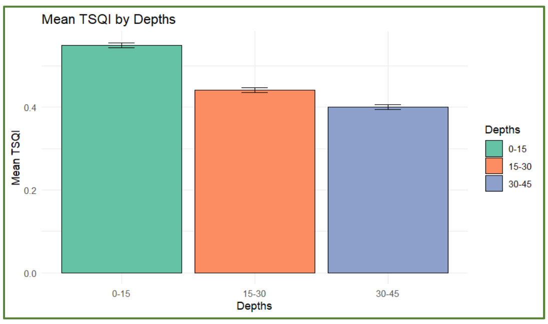


Fig 4. Main effect of LPS on TSQI and mean TSQI by depths.

Chemical Characterization of Nutrient Inputs Used in the Nutrient Management System

The chemical properties of FYM, biochar, and Bioprom showed clear contrasts in stability, nutrient content, and soil amendment potential. Moisture content was higher in FYM (28–33%) and Bioprom (27–30%) than in biochar (14–20%), indicating faster decomposition and short-term nutrient release from FYM and Bioprom, while biochar remained comparatively stable.

Biochar was strongly alkaline (pH 9.2–9.6), FYM near neutral (pH 7.2–7.5), and Bioprom slightly acidic (pH 6.7), suggesting their differential suitability for correcting acidic soils (biochar), buffering soil reaction (FYM), and use in alkaline soils (Bioprom). Total organic carbon was highest in biochar (36–38%), followed by Bioprom (26–28%) and FYM (12–13%). The higher C:N ratio of biochar (27–28) compared to Bioprom (23–26) and FYM (22–25) confirms its slower decomposition and long-term carbon sequestration potential.

Among macronutrients, nitrogen content was higher in biochar (1.3–1.4%) and Bioprom (1.0–1.2%) than in FYM (0.5–0.6%). Bioprom contained exceptionally high phosphorus (2.5–2.7%) and potassium (1.8–2.1%), whereas FYM and biochar supplied lower amounts. Bioprom also recorded the highest micronutrient concentrations (Fe, Mn, Zn, and Cu), followed by biochar and FYM.

Cation exchange capacity was greatest in biochar (41–46 cmol kg^{-1}), moderate in FYM (32–38 cmol kg^{-1}), and lowest in Bioprom (29–31 cmol kg^{-1}), indicating superior nutrient retention by biochar. Overall, biochar supports long-term soil health and nutrient retention, FYM improves soil fertility and physical condition, and Bioprom serves as a nutrient-dense bio-input for enhancing immediate crop nutrition under the nutrient management system.

Long term effect of land use change on vertical distribution of soil carbon and nitrogen pools in the gravelly barren land

Introduction of arable crops at the initial period of rocky barren land transformation could accelerate soil development compared to the perennial field crops and fruit orchards. The results clearly showed that the introduction of arable crops, particularly the wheat–soybean system, provided the highest soil cover (up to 60% at the surface and 45% even in deeper layers), demonstrating their strong potential to accelerate soil development during the initial phase of rocky barren land transformation. In contrast, perennial crops like Napier grass and sugarcane achieved moderately high soil cover (≈50%) and fruit orchards such as mango, sapota, and grapes showed only gradual improvement, while barren land maintained the lowest cover (<35%) across all depths due to continued erosion and lack of vegetation. These findings confirm that land use systems strongly influence soil protection and organic matter buildup, with faster canopy closure and residue return from arable crops driving quicker gains in soil cover (Fig 5). Therefore, arable crops should be recommended in the early stages of land transformation for rapid improvement, followed by integration of perennial field crops and fruit orchards to sustain soil cover, enhance subsurface soil quality, and ensure long-term stability and productivity (Fig 6, 7).

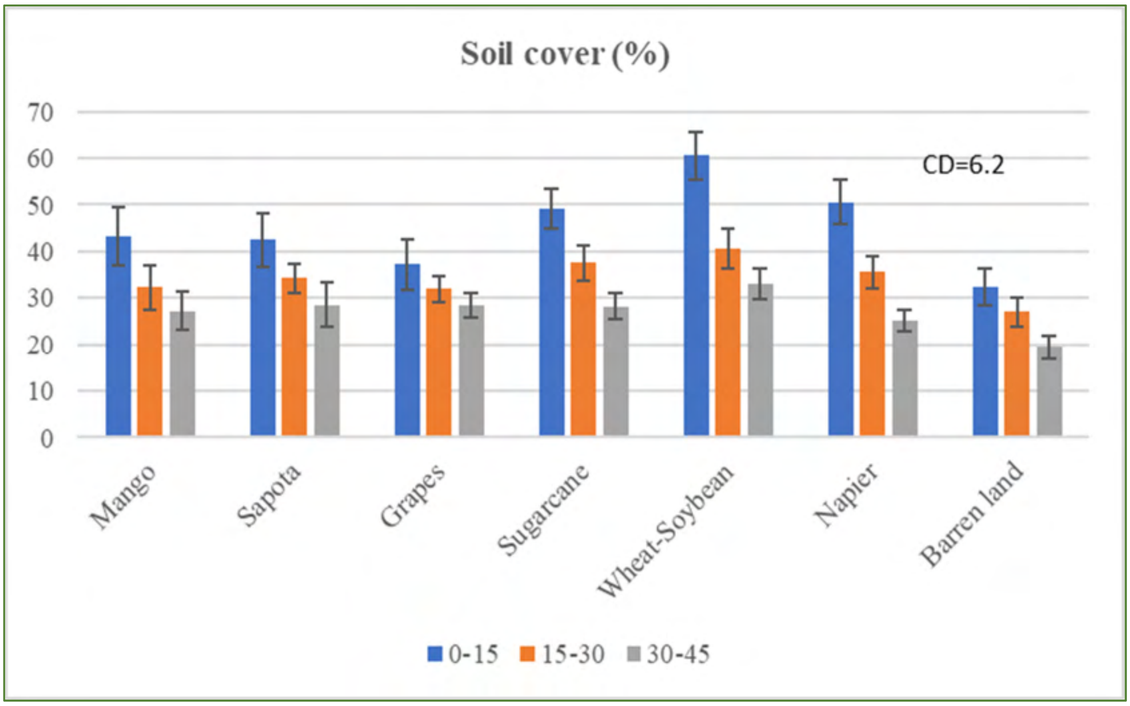


Fig 5. Effect of land use system on soil cover (w/w, on dry weight basis) at different soil depths

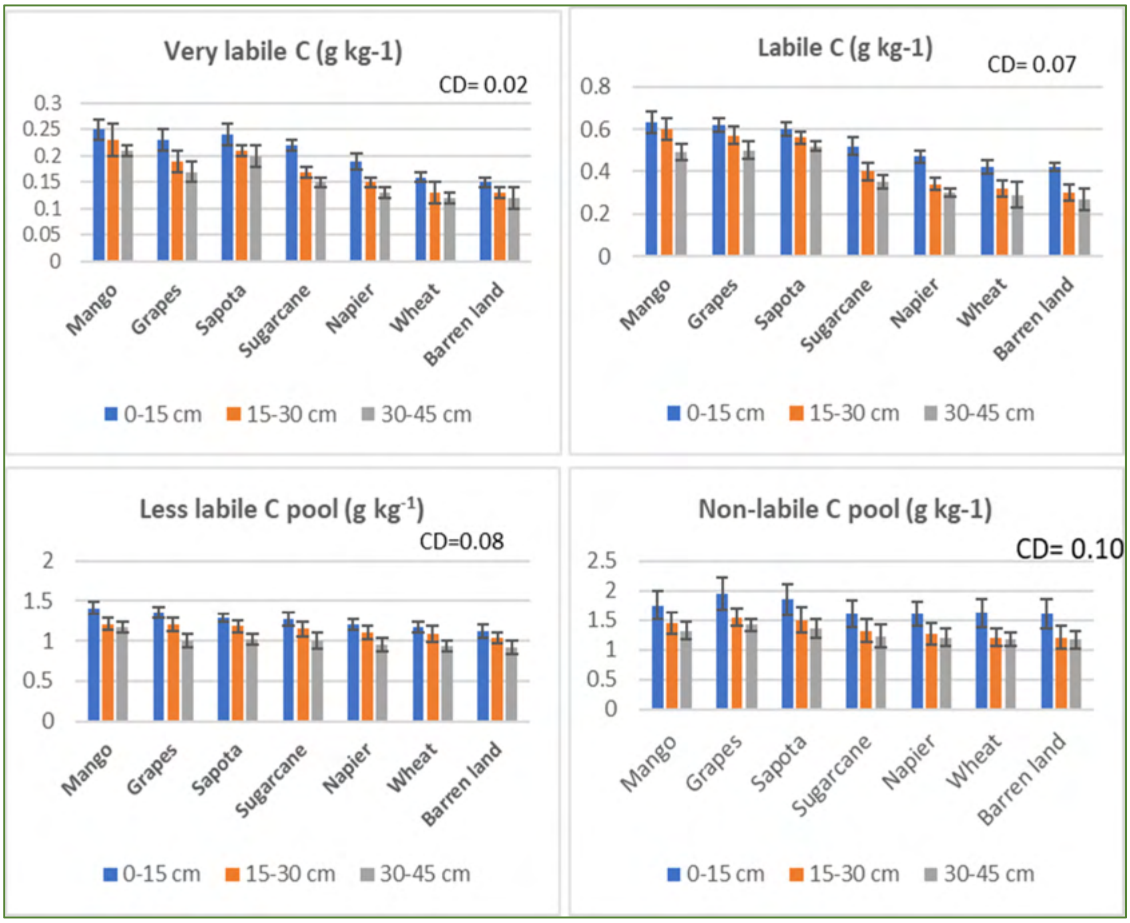


Fig 6. Long term effect of different land use systems on soil carbon dynamics of the surface (0-15 cm) and subsurface layers (15-45cm) of the shallow gravelly barren land

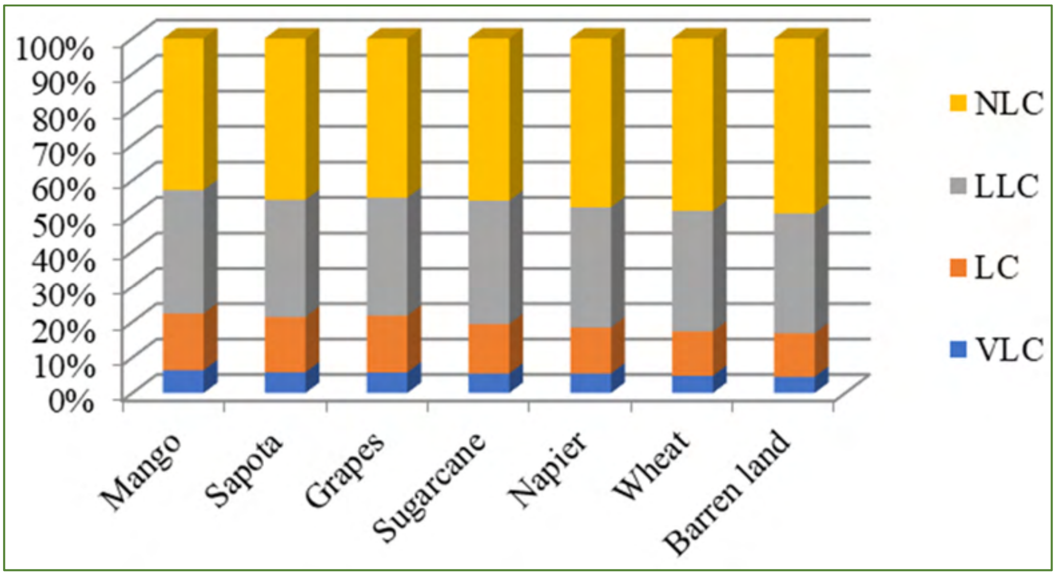


Fig 7. The relative proportions of different carbon pools (Very Labile C – VLC, Labile C – LC, Less Labile C – LLC, Non-Labile C – NLC) across land use systems

Land use system impact on carbon pools at different soil depths after 10 years on the shallow and gravelly land

Across all land use systems, the non-labile carbon pool (39–42%) dominates, followed by less labile carbon (34–37%), with labile carbon (≈18%) and very labile carbon (5–6%) forming smaller fractions. This depth-wise pattern reflects enrichment of all carbon fractions at the surface due to litter input and microbial activity, with progressive depletion at subsurface layers where organic matter inputs are minimal. The nirtogen pools for land use systems followed in the order of Fruit orchards (mango, grapes, sapota) > Perennial field crops (sugarcane, Napier) > Annual crop (wheat) > Barren land. This pattern shows that perennial systems enrich both active (very labile, labile) and stable (less labile, non-labile) carbon pools, while barren land remains depleted due to lack of organic inputs and erosion. In perennial systems, mango was best for very labile, labile, and less labile pools, while Grapes excelled in non-labile carbon storage. Compared to barren land, these systems improved carbon pools by 23–77%, with strongest benefits at the surface but also meaningful gains at subsurface depths due to perennial root inputs. The transformation of barren land into perennial or diversified systems not only boosts fertility but also enhances soil resilience, structure, and carbon sequestration potential.

Land use systems effect on soil N dynamics over the period of 10 years under the stony land situations

After 12 years of land use conversion on stony soils (40–60% gravel), orchard systems showed striking improvements in all nitrogen pools compared to barren land. For mineral N, mango and grape orchards recorded the highest values (23–25 kg ha^{-1} at 0–15 cm) compared to barren land (12–15 kg ha^{-1}), nearly doubling available inorganic N. In terms of total organic N (TON), mango and sapota maintained the largest pools (880–900 kg ha^{-1} at 0–15 cm) against barren land (320 kg ha^{-1}), a nearly threefold increase, while still retaining higher contents at subsurface layers (500 vs 210 kg ha^{-1} at 30–45 cm). The non-hydrolysable N fraction, representing long-term reserves, was also highest under mango orchards (290 kg ha^{-1} at surface vs 120 kg ha^{-1} in barren soils), showing the strong stabilization effect of perennial litter and woody residues. Within hydrolysable organic N sub-fractions, mango orchards led with amino acid N (200 vs 68 kg ha^{-1} in barren soils), amino sugar N (104 vs 22 kg ha^{-1}), and hydrolysable NH_3-N (122 vs 40 kg ha^{-1}), while grapes had the greatest hydrolysable unknown N (320 vs 63 kg ha^{-1}). These results highlight that hydrolysable fractions, especially amino sugar N and hydrolysable unknown N, are the most sensitive pools to land use changes in stony soils, as they directly reflect microbial turnover and absence of organic input diversity in barren systems. Across all systems, nitrogen pools declined with depth (0–15 > 15–30 > 30–45 cm), yet orchards sustained significantly greater amounts than barren land even at 30–45 cm (e.g., TON, 500 vs 210 kg ha^{-1}; non-hydrolysable N, 160 vs 85 kg ha^{-1}), emphasizing the importance of subsoil pools as long-term nutrient reservoirs in these fragile landscapes.

From a practical standpoint, enhancing both labile pools (amino acid, amino sugar, hydrolysable NH_3-N) and stable pools (non-hydrolysable N, hydrolysable unknown N) under orchards translates to improved soil quality through better structure, aggregation, and microbial activity, greater soil fertility via a steady mineralizable N supply, and sustainability by reducing nutrient losses and building long-term resilience in shallow, gravelly soils**.** The data is presented in Table 1, 2, 3, 4.

Table 1. Long term impact of land use systems on soil mineral N fractions of the stonny land

Land use	NH_4-N(kg ha^{-1})				NO_3-N (kg ha^{-1})			
	0-15 cm	**15-30 cm**	**30-45 cm**	**Mean**	**0-15 cm**	**15-30 cm**	**30-45 cm**	**Mean**
Mango	7.5±0.8	6.2±0.54	5.3±0.60	6.3±0.70	23.6±2.1	13.2±1.3	5.7±1.3	14.2±1.1
Sapota	7.2±0.7	5.9±0.61	4.6±0.50	5.9±0.60	18.3±2.0	12.8±1.3	6.1±0.6	12.4±1.0
Grapes	7.9±1.1	7.0±.72	5.8±0.61	6.9±0.70	15.3±1.3	12.5±1.3	5.6±1.1	11.1±0.7
Sugarcane	10.2±0.8	6.7±.60	5.7±0.51	7.5±0.80	13.8±1.1	10.5±1.7	8.2±1.1	10.8±0.8
Napier	9.1±0.7	6.5±.62	5.8±0.45	7.1±0.73	12.5±1.5	8.5±1.7	7.5±1.3	9.5±0.7
Wheat	9.2±0.8	6.4±.60	5.7±0.60	7.1±0.75	12.5±1.2	9.2±0.9	7.8±1.1	9.8±1.0
Barren land	6.3±0.7	5.2±0.54	3.9±0.45	5.1±0.62	12.2±1.1	7.0±0.7	4.8±0.9	8.0±0.6
Mean	8.2±1.21	6.3±0.8	5.2±0.65		15.5±2.6	10.5±2.0	6.5±1.5	

Sources	Sig (0.05)	CD value			Sig (0.05)	CD value		
Land use	0.007	0.61			0.005	1.2		
Depth	0.000	1.52			0.0003	3.5		

Land use X Depth	0.023	1.1	0.000	1.9

Table 2. Long term impact of land use systems on soil total organic N and hydrolysable N fractions

Land use	Total Organic N fraction (kg ha-1)				Hydrolysable N (kg ha-1)			
	0-15 cm	15-30 cm	30-45 cm	Mean	0-15 cm	15-30 cm	30-45 cm	Mean
Mango	906.2±64.5	620.0±47.0	372.1±36.2	632.8±65.2	616.2±43.1	390.1±38.2	202.2±42.1	402.8±40.6
Sapota	900.0±59.1	595.0±44.0	382.1±41.3	625.7±61.2	611.3±52.5	362.5±42.1	200.0±23.5	391.3±45.1
Grapes	865.5±52.1	620.0±42.1	386.5±35.2	624.0±52.3	584.0±58.4	415.2±41.5	198.2±35.6	399.1±45.2
Sugarcane	565.2±60.3	475.6±40.0	305.6±30.2	448.8±44.9	355.0±35.2	282.0±30.0	152.1±15.2	263.0±37.2
Napier	600.0±62.1	445.0±36.1	345.6±34.6	463.5±41.1	382.1±38.2	260.0±30.2	165.5±18.2	269.2±28.6
Wheat	375.6±42.1	285.3±34.6	230.0±41.0	297.0±36.5	145.2±14.5	135.2±20.1	95.2±16.2	125.2±25.4
Barren land	300.6±40.1	225.5±31.2	210.0±30.5	245.4±35.2	115.6±10.6	95.2±20.0	90.2±15.6	100.3±16.5
Mean	644.7±68.2	466.6±53.4	318.8±46.2		401.3±46.2	277.2±41.3	157.6±30.6	
Sources	Sig (0.05)	CD value			Sig (0.05)	CD value		
Land use	0.006	81.3			0.000	25.0		
Depth	0.000	25.2			0.008	72.5		
Land use X Depth	0.003	60.5			0.003	45.2		

Table 3. Effect of land use systems on amino acid -N and amino sugar N of the stony barren land at surface, subsurface and deep layers

Land use	Amino acid-N (kg ha-1)				Amino sugar-N (kg ha-1)			
	0-15 cm	15-30 cm	30-45 cm	Mean	0-15 cm	15-30 cm	30-45 cm	Mean
Mango	200.3±17.2	119.0±14.2	59.9±10.2	126.4±16.2	104.2±8.2	50.8±6.2	26.8±3.2	60.6±11.2
Sapota	172.8±19.1	96.4±12.5	55.4±9.1	108.2±18.5	86.4±6.4	44.6±6.7	23.3±3.9	51.4±8.6
Grapes	140.2±16.1	94.2±12.1	52.2±8.6	95.5±15.1	61.5±5.3	37.3±4.2	19.7±4.6	39.5±6.2
Sugarcane	80.3±11.2	37.1±7.6	17.1±6.1	44.8±9.2	35.0±3.5	16.6±2.4	6.4±1.8	19.4±5.2
Napier	97.8±12.2	45.4±8.2	28.0±6.3	57.1±10.1	51.6±4.2	22.7±2.3	11.1±1.5	28.5±5.0
Wheat	38.310.5	18.5±6.2	9.7±6.1	22.2±7.8	19.9±2.1	9.1±1.2	4.8±1.3	11.3±4.3
Barren land	21.3±6.8	11.5±5.8	6.3±5.8	13.0±4.1	12.3±1.0	5.6±0.9	3.8±0.9	7.2±2.1
Mean	107.3±18.2	60.3±11.2	32.7±8.5		53.0±6.0	26.7±4.9	13.7±4.5	

Sources	Sig (0.05)	CD value	Sig (0.05)	CD value
Land use	0.002	20.3	0.006	7.3
Depth	0.00	25.2	0.004	10.5
Land use X Depth	0.006	8.5	0.003	12.3

Table 4. Effect of land use systems on Hydrolysable NH3 -N and Hydrolysable unknown N content of the stony barren land at surface, subsurface and deep layers

Land use	Hydrolysable NH_3-N (kg ha^{-1})				Hydrolysable unknown N (kg ha^{-1})			
	0-15 cm	15-30 cm	30-45 cm	Mean	0-15 cm	15-30 cm	30-45 cm	Mean
Mango	122.3±8.1	57.0±5.6	29.8±3.5	69.7±6.3	189.4±25.6	163.3±26.2	85.7±22.1	146.1±43.6
Sapota	91.8±6.7	50.6±4.7	26.0±2.2	56.1±4.5	260.3±32.3	170.9±30.1	95.3±27.5	175.5±40.2
Grapes	62.3±6.0	44.0±4.2	21.6±3.0	42.7±4.2	320±28.6	239.7±35.6	104.7±31.1	221.5±45.6
Sugarcane	46.3±4.2	18.1±2.3	8.6±1.2	24.3±2.7	193.4±26.2	210.2±29.2	120±39.2	174.5±36.9
Napier	63.0±5.5	32.0±2.5	17.6±1.5	37.6±3.1	169.7±19.3	159.9±19.2	1108.8±25.6	146.1±32.5
Wheat	27.0±2.7	10.0±1.2	5.8±1.0	14.3±1.9	60±22.3	97.6±20.6	104.9±20.6	87.5±23.8
Barren land	18.6±1.9	7.9±1.0	4.2±1.2	10.2±1.2	63.4±27.6	70.2±19.2	72.5±17.5	68.7±20.6
Mean	61.6±8.5	31.4±6.0	16.2±4.1		179.5±29.3	158.8±25.2	98.8±16.5	
Sources	Sig (0.05)	CD value			Sig (0.05)	CD value		
Land use	0.003	3.6			0.002	36.2		
Depth	0.000	12.4			0.01	25.4		
Land use X Depth	0.005	3.0			0.03	38.9		

Characterization and Evaluation of microbes from Soybean Rhizosphere and Endo-rhizosphere

Bacteria isolated from rhizosphere and endorhizosphere of soybean plants were characterized for different plant growth promoting traits, including P- and K-solubilization, IAA production, ACC deaminase activity, etc. (Table 5, 6). Selected isolates were also screened for moisture-deficit- and salinity- stress tolerance under *in vitro* conditions. A total of 25 isolates (showing PGP traits and relatively tolerant to moisture-deficit- and salinity- stress) were finally selected for evaluating the inoculation effects on soybean growth and yield under pot condition. Soybean cultivar NRC37 was used for the pot trial conducted during *kharif* 2025. Application of water was withheld for 10 days (from 45 to 55 days after emergence; soil moisture was between 8-11% on 55 DAE). At the time of harvest, plant height, pod number, plant biomass, pod and seed weight were recorded. Out of the 25 isolates screened, 11 isolates could improve plant growth and yield under moisture-deficit stress condition. These isolates enhanced the number of pods per plant, pod yield (g/plant), and seed yield (g/plant) significantly. The other isolates, TS73 and TS77 were also found promising in terms of higher pod yield. These isolates were processed for sequencing of 16S rRNA for establishing their identities. The nutrient uptake in these treatments is being studied. The few promising isolates emerging from this study will be further evaluated in field condition under moisture-deficit stress.

Table 5. Evaluation of selected bacterial isolates isolated from rhizotic zones and internal tissues of soybean for different nutrient solubilization (*in vitro*, 28^{o}C)

Isolate	TCP solu. (mg/100 ml broth)	pH	Isolate	K-solubilization (mg/100 ml broth)	pH
Control	-	6.51 (±0.07)	**Control**	-	7.84 (±0.02)
P7	15.87 (±1.25)	3.71 (±0.01)	**SS11**	3.47 (±0.02)	7.62 (±0.01)
SS1	15.39 (±1.28)	4.35 (±0.01)	**SS13**	2.93 (±0.03)	6.94 (±0.01)
SS10	29.89 (±2.13)	3.93 (±0.04)	**SS14**	0.87 (±0.01)	7.67 (±0.02)
SS11	21.73 (±0.67)	4.23 (±0.03)	**SS15**	1.00 (±0.04)	7.61 (±0.04)
SS13	35.00 (±0.71)	4.11 (±0.02)	**SS22**	1.20 (±0.06)	7.37 (±0.03)
SS14	24.89 (±1.21)	3.74 (±0.06)	**SS24**	0.67 (±0.02)	7.69 (±0.02)
SS15	26.65 (±1.25)	4.90 (±0.09)	**SS3**	2.6 (±0.04)	6.91 (±0.01)
SS17	16.32 (±1.61)	3.74 (±0.04)	**SS31**	2.80 (±0.02)	6.83 (±0.01)
SS25	23.82 (±1.21)	3.57 (±0.02)	**SS33**	1.87 (±0.04)	6.85 (±0.02)
SS29	18.65 (±1.17)	3.56 (±0.01)	**SS36**	1.40 (±0.07)	6.47 (±0.02)
SS30	64.02 (±2.51)	4.16 (±0.05)	**SS38**	1.93 (±0.01)	6.64 (±0.04)
SS37	12.50 (±1.02)	4.63 (±0.02)	**SS41**	2.07 (±0.05)	6.88 (±0.02)

SS5	60.89 (±2.17)	3.94 (±0.01)
TS7	29.31 (±0.23)	3.85 (±0.03)
TS71	17.40 (±0.09)	3.80 (±0.02)

Table 6. Evaluation of the effect of multiple abiotic stress tolerant plant growth promoting rhizobacteria/endophytes in alleviation of moisture-deficit stress and enhancing yield of soybean under potted condition (Cv. NRC37; tolerance of isolates to salinity: 1.5 M and to moisture-deficit stress: -0.5 MPa) during *kharif* 2025*

Treatments	IAA Production	ACC deaminase activity	Nutrient solubilization			Plant height (cm/p)	Pod number /p	Pod dry weight (g/p)	Seed dry weight (g/p)
			P	Zn	K				
Control	-	-	-	-	-	38.50	12.07	13.34	7.88
RZ1	+	+	+	-	-	45.76	14.96	17.30	9.54
RZ10	+	+	+	+	-	41.13	12.10	12.56	7.29
RZ13	+	+	+	-	-	37.43	10.69	14.29	7.71
RZ17	+	+	+	+	-	44.50	20.35	18.70	9.36
RZ2	+	+	+	+	-	44.19	11.66	13.58	6.07
RZ33	+	+	+	-	-	42.93	17.38	16.67	9.23
SS10	+	+	-	+	+	42.39	12.46	13.92	7.79
SS14	-	-	+	+	+	38.03	17.84	16.33	7.81
SS17	-	-	+	+	+	43.41	19.74	15.66	9.64
SS27	+	+	+	+	-	36.04	12.83	15.84	7.20
SS43	+	+	+	+	+	42.53	13.62	15.72	7.96
SS48	+	+	+	+	-	40.73	13.42	13.57	6.95
SS49	+	+	+	+	-	45.73	18.69	15.32	9.41
SS51	+	+	+	-	+	40.67	12.17	13.13	7.27
TS38	+	+	+	-	-	43.81	19.46	16.20	9.39
TS52	+	+	+	-	+	41.90	13.47	13.83	7.49
TS54	+	+	-	+	-	36.51	13.17	12.81	7.15
TS65	+	+	+	+	-	45.17	20.71	17.92	10.41
TS67	+	+	+	-	-	45.01	19.62	16.36	9.84
TS69	+	+	+	-	-	39.29	12.93	14.73	8.05
TS71	+	+	-	-	+	38.12	12.04	14.43	7.58
TS72	+	+	+	+	+	41.06	13.52	14.18	8.11
TS73	+	+	+	+	-	47.12	16.44	17.33	10.00
TS77	+	+	+	-	-	46.20	20.20	19.35	10.62

Treatments	IAA Production	ACC deaminase activity	Nutrient solubilization			Plant height (cm/p)	Pod number /p	Pod dry weight (g/p)	Seed dry weight (g/p)
			P	Zn	K				
TS81	+	+	+	-	+	46.39	20.37	20.37	10.65
CV (%)	-	-	-	-	-	**6.73**	**8.70**	**9.37**	**8.48**
CD (0.05)	-	-	-	-	-	**4.64**	**2.20**	**2.38**	**1.18**

*Withholding application of water for 10 days (during 45 to 55 days after emergence); moisture in the rhizosphere at 55 DAE: 8-11%)

Effect of inoculation of isolate RZ33 and SS49 on growth of soybean

Effect of inoculation of isolate TS38 and TS77 on growth of soybean

Response of geranium varieties to salinity stress and its alleviation by foliar application of KNO3

Rose-scented geranium (*Pelargonium graveolens*) is an important aromatic plant suitable for cultivation in shallow and medium black soils of semi-arid regions. The present study evaluated the effects of saline irrigation and foliar application of potassium nitrate (KNO_3) on herb yield, essential oil content and yield of four geranium varieties (Kelkar, Bio-G-171, CIM-Pawan, and CIM-Bharat) (Fig 7). The experiment was conducted with four salinity levels (0, 3, 6, and 9 dS m^{-1}) and three KNO_3 concentrations (0, 0.25, and 0.5%). The results showed that increasing salinity levels significantly reduced plant growth, herb yield, and essential oil content, while enhancing sodium and chloride accumulation, canopy temperature. Among the tested varieties, Kelkar exhibited the highest salinity tolerance, maintaining superior growth, herb yield (109.3 g plant^{-1}), and oil yield (0.36 ml plant^{-1}) under saline conditions. Foliar application of 0.5% KNO_3 significantly improved physiological attributes, thereby increased the growth and yield attributes. Under moderate salinity (3 dS m^{-1}), application of 0.5% KNO_3 resulted in a higher herb yield (101.9 g plant^{-1}), which was comparable to the control treatment (106.2 g plant^{-1} at 0 dS m^{-1} without KNO_3). The findings indicate that the integration of the salinity-tolerant variety Kelkar with foliar application of 0.5% KNO_3 is an effective strategy for sustaining geranium productivity under salinity stress up to 3 dS m^{-1} without yield penalty.

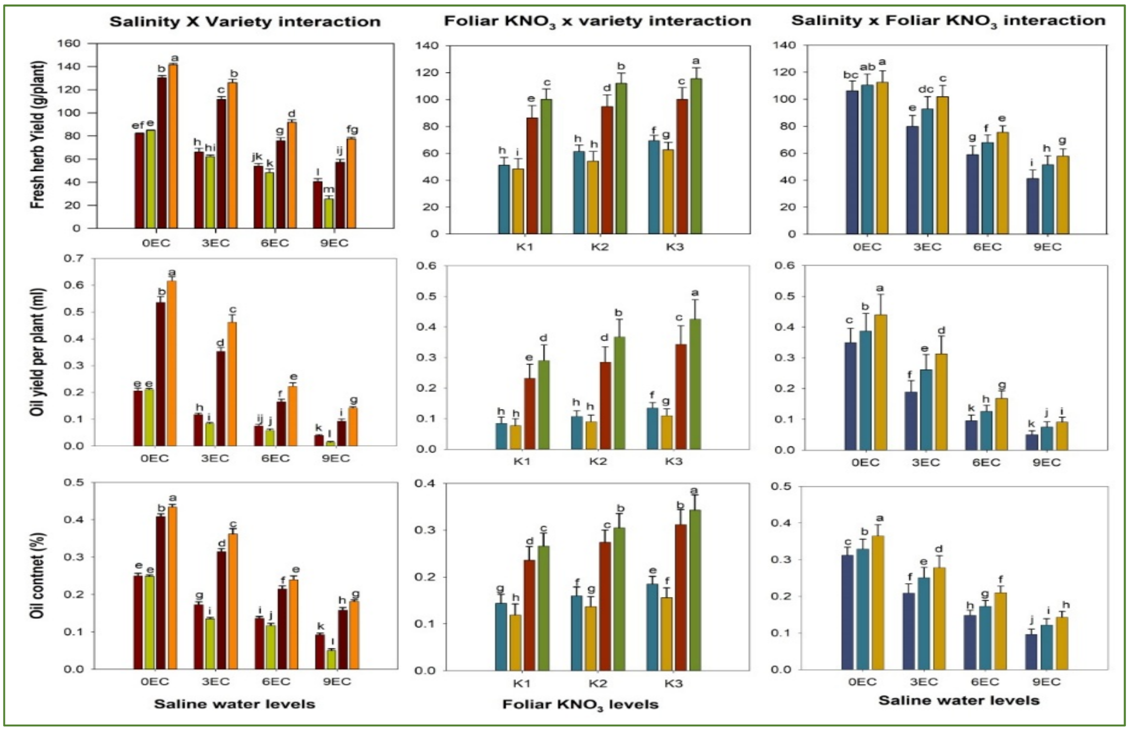


Fig 7. Effect of saline water and KNO_3 spray on herb and oil yield of geranium

Climate resilient integrated farming system for semi-arid regions

The agricultural sector is under increasing pressure to produce higher outputs from shrinking agricultural land to meet the needs of a growing population amid changing climatic conditions. In response to these challenges, a project has been initiated to optimize Integrated Farming System (IFS) components for improved productivity, profitability, and climate resilience, as well as to assess the water, energy, and carbon footprints of climate-smart IFS. The components of the Climate-Smart Integrated Farming System (CIFS) are outlined below.

1. Crop-6250 sq.m
2. Horticulture-3000 sq.m
3. Livestock- Indigenous cow-02, Goats-10, Native poultry birds-50 no.
4. Fisheries-400 sq.m
5. Agroforestry (boundary plantations)

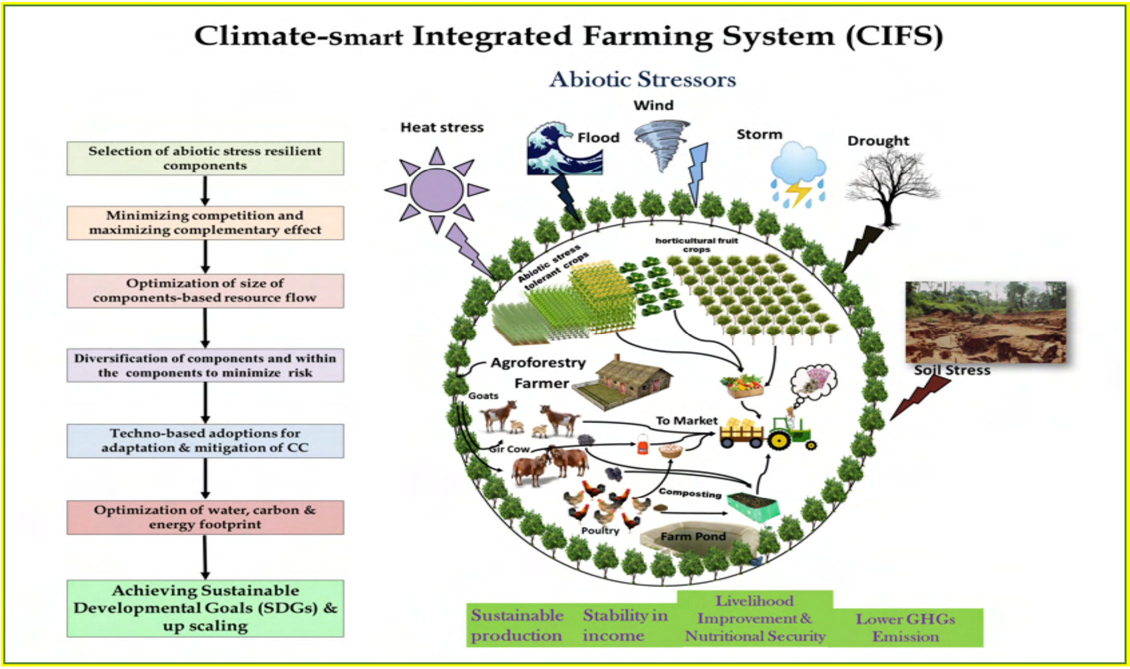


Fig 8. Methodology for developing CIFS model

Table 7. Economics of Crop components in CIFS

Cropping systems	Gross income (Rs)	Cost of cultivation (Rs)	Net Income (Rs)	B:C Ratio
Pearl millet-Chickpea (0.1 ha)	16782	9313	7468	1.80
Green gram-Sorghum (0.1 ha)	15660	9824	5835	1.59
Sorghum- Safflower	7825	6864	960	1.14
Black gram-Groundnut (0.1 ha)	18280	10997	7282	1.66
Redgram+Sorghum-Cluster bean (0.1 ha)	9380	9745	-365	0.96
Hybrid Napeir +Drumstick (0.12 ha)	7560	2912	4647	2.60
Total	75487	49658	25828	1.52

The economics of different crop components under the CIFS, highlighting gross income, cost of cultivation, net income, and benefit cost (B:C) ratio for each cropping system is presented in table 8. Among the crop combinations, Black gram–Groundnut recorded the highest gross income (₹18,280) and a substantial net income (₹7,282) with a favorable B:C ratio of 1.66, indicating good profitability. Pearl millet–Chickpea also showed strong economic performance with a gross income of ₹16,782, net income of ₹7,468, and a B:C ratio of 1.80. In contrast, Sorghum–Safflower generated relatively low returns, with a gross income of ₹7,825 and a marginal net income of ₹960, reflected in a low B:C ratio of 1.14. The Redgram + Sorghum–Cluster bean system was economically unviable, recording a negative net income (–₹365) and a B:C ratio below unity (0.96), indicating a loss under the given conditions. The Hybrid

Napier + Drumstick system emerged as the most profitable component, despite moderate gross income (₹7,560), due to very low cultivation cost (₹2,912), resulting in a high net income (₹4,647) and the highest B:C ratio (2.60). Overall, the CIFS generated a total gross income of ₹75,487 against a cultivation cost of ₹49,658, yielding a net income of ₹25,828 and an overall B:C ratio of 1.52, demonstrating the economic viability of the integrated system (Table 8).

Table 8. Economics of Livestock and Fisheries in CIFS

Livestock species	Gross Income (Rs)	Cost of rearing (Rs)	Net Income (Rs)	B:C Ratio
Gir cow	92952	72627	20324	1.28
Goat	126222	86775	39447	1.45
Poultry	21935	15625	6310	1.19
Total	241109	175027	66081	1.37

The economic performance of different livestock components under the Climate resilient Integrated Farming System (CIFS**)** in terms of gross income, cost of rearing, net income, and benefit cost (B:C) ratio is presented in Table 9. Among the livestock enterprises, goat rearing recorded the highest economic returns. It generated a gross income of ₹1,26,222 with a rearing cost of ₹86,775, resulting in the highest net income of ₹39,447 and the most favourable B:C ratio of 1.45, indicating better profitability compared to other enterprises. The Gir cow enterprise produced a gross income of ₹92,952 against a cost of ₹72,627, yielding a net income of ₹20,324 with a B:C ratio of 1.28, reflecting moderate profitability. Poultry farming generated a comparatively lower gross income of ₹21,935 with a cost of ₹15,625, resulting in a net income of ₹6,310 and a B:C ratio of 1.19, indicating relatively lower but still positive returns. Overall, the livestock component under CIFS generated a total gross income of ₹2,41,109 with a total cost of ₹1,75,027, resulting in a net income of ₹66,081 and an overall B:C ratio of 1.37. This indicates that livestock enterprises under CIFS are economically viable, with goat rearing being the most profitable component.

Table 9. Economics of fisheries in CIFS model

Fisheries	Gross Income (Rs)	Cost of rearing (Rs)	Net Income (Rs)	B:C Ratio
Fish	30000	10400	19600	2.88

The economics of the fisheries component in the CIFS model in presented in Table 10. Fish production generated a gross income of ₹30,000 with a relatively low cost of rearing of ₹10,400, resulting in a high net income of ₹19,600. The benefit cost (B:C) ratio of 2.88 indicates excellent economic efficiency and profitability of the fisheries enterprise. The high B:C ratio reflects efficient resource utilization and low operational costs compared to returns, highlighting fisheries as one of the most economically rewarding components of the CIFS model. Inclusion of fish culture therefore significantly contributes to enhancing overall farm income and economic sustainability of the integrated farming system.

Table 10. Economics of horticulture in CIFS model

Horticulture Component	Gross Income (Rs)	Cost of Cultivation (Rs)	Net Income (Rs)	B:C Ratio
Mango+Pomogranate+CA+ Sapota	23650	18127.06	5522.94	1.30

Table 11 summarizes the economic performance of the horticultural component in the CIFS model. The integrated horticulture system comprising Mango + Pomegranate + CA + Sapota generated a gross income of ₹23,650 with a cost of cultivation of ₹18,127.06, resulting in a net income of ₹5,522.94. The benefit–cost (B:C) ratio of 1.30 indicates moderate profitability of the horticulture component under the CIFS model. Although the cost of cultivation was relatively high, the positive net income and B:C ratio greater than unity demonstrate the economic feasibility of integrating diversified perennial and annual horticultural crops within the CIFS. This component contributes to income stability and diversification, complementing other crop, livestock, and fisheries enterprises in the overall system.

Table 11. Overall economics of CIFS

CIFS	Gross income (Rs)	Cost of cultivation (Rs)	Net Income (Rs)	B:C Ratio
Crop	75487	49659	25828	1.52
Livestock	241109	175027	66081	1.37
Horticulture	23650	18127	5523	1.30
Fishery	30000	10400	19600	2.88
Total	370246	253213	117032	1.46

The overall economic performance of different components of the Climate resilient Integrated Farming System (CIFS), including crops, livestock, horticulture, and fishery, in terms of gross income, cost of cultivation, net income, and benefit cost (B:C) ratio is presented in table 11. Among all components, livestock contributed the highest gross income (₹2,41,109) with a cost of ₹1,75,027, resulting in a net income of ₹66,081 and a B:C ratio of 1.37. This indicates that livestock plays a major role in total income generation under CIFS. The crop component generated a gross income of ₹75,487 with a cultivation cost of ₹49,659, yielding a net income of ₹25,828 and a B:C ratio of 1.52, reflecting good profitability and efficient resource utilization. Horticulture recorded a gross income of ₹23,650 against a cost of ₹18,127, resulting in a net income of ₹5,523 with a B:C ratio of 1.30, indicating moderate returns. Notably, the fishery component showed the highest economic efficiency with a gross income of ₹30,000 and a comparatively low cost of ₹10,400, generating a net income of ₹19,600 and the highest B:C ratio of 2.88. This demonstrates that fishery is the most profitable component within the CIFS model. Overall, the CIFS generated a total gross income of ₹3,70,246 with a total cost of ₹2,53,213, resulting in a net income of ₹1,17,032 and an overall B:C ratio of 1.46. The results clearly indicate that the integrated approach enhances overall farm profitability, with fishery and livestock significantly strengthening the economic sustainability of the system (Fig 9 & Table 12).

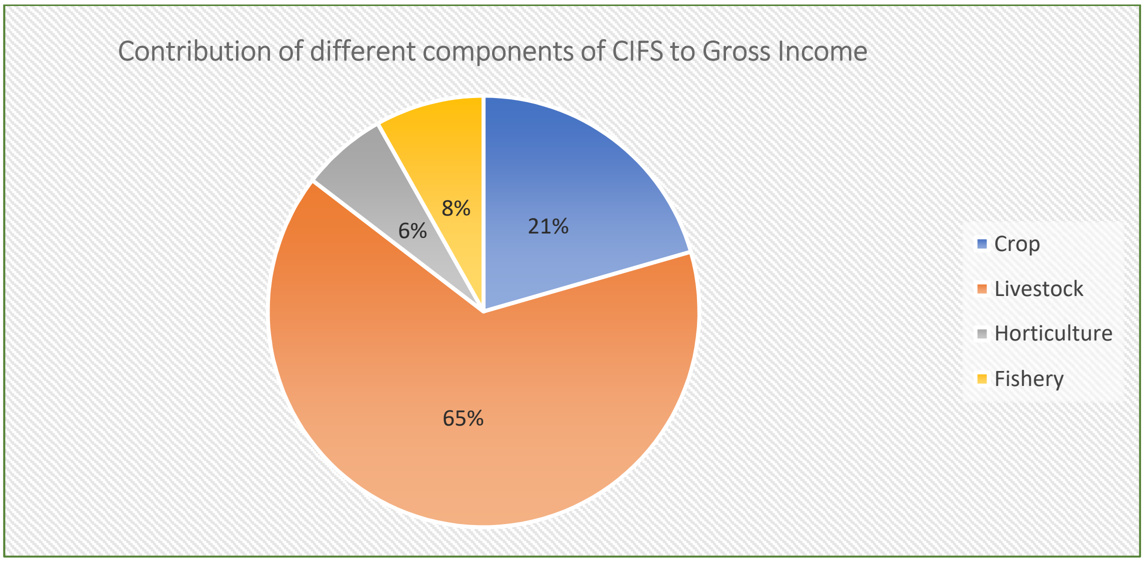


Fig 9. Contribution of different to CIFS gross income

The contribution of crop, livestock horticulture and fisheries to gross income of CIFS were 21%,65%, 6% and 8% respectively.

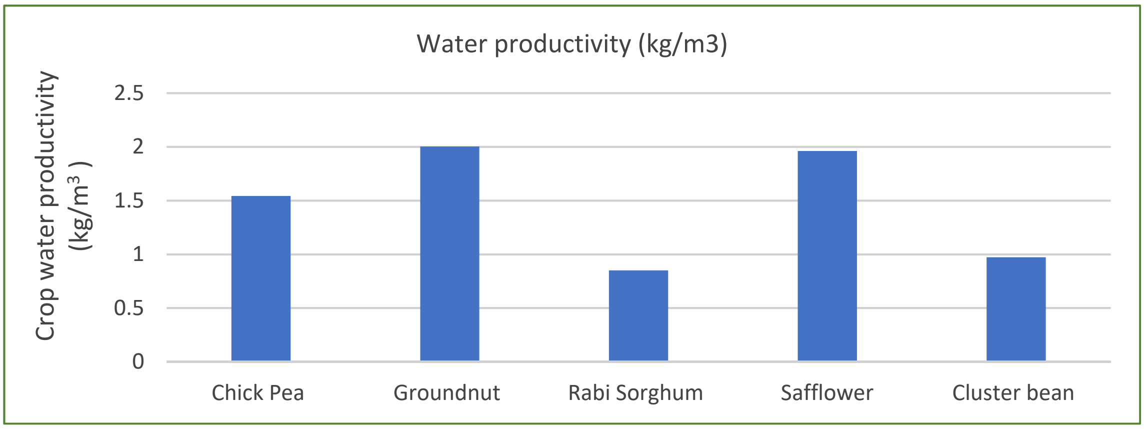


Fig 10. Water productivity in different crops

Table 12: Nutritional requirement of farm family and availability CIFS

Name of the food item	Qty.(kg)	Annual requirement of food items of four-member family (Kg)	Surplus production (Kg) for sale in market
Cereals	351	211	139
Oilseed	203	28	174
Pulses	262	52	209
Vegetables and fruits	1321	584	737

Milk (Lit.)	392	365	27
Eggs (No.)	1606	584	1022
Poultry meat (Kg)	0		
Goat meat (Live wt.) kg.	298		298
Fishery (Kg.)	200	14	185

The production of food items, annual household requirement, and surplus available for market sale of various food items for a four-member family in presented in Table 12. Cereal production amounts to 351 kg, against an annual household requirement of 211 kg, resulting in a surplus of 139 kg available for sale. Oilseeds show a substantial surplus, with 203 kg produced compared to a requirement of only 28 kg, leaving 174 kg for the market. Similarly, pulses record a production of 262 kg, household consumption of 52 kg, and a surplus of 209 kg. The production of vegetables and fruits is relatively high at 1,321 kg, of which 584 kg meets family needs, generating a sizeable surplus of 737 kg. Milk production is 392 litres, closely matching the annual family requirement of 365 litres, resulting in a modest surplus of 27 litres. Egg production totals 1,606 eggs, with 584 eggs required annually by the family, leaving a marketable surplus of 1,022 eggs. Goat meat (live weight) shows a production of 298 kg, with the entire quantity as surplus for sale. Fishery production amounts to 200 kg, far exceeding the household requirement of 14 kg, and providing a surplus of 185 kg. Overall, the table highlights that the integrated production system adequately meets household nutritional requirements while generating significant marketable surpluses, particularly in vegetables and fruits, eggs, pulses, oilseeds, and fish, thereby contributing to both food security and income generation.

Concept of Multilayer integrated farming system for multiple abiotic stress region

The concept involves cultivating and rearing different components of the Integrated Farming System (IFS) at multiple levels. These components were integrated to address various abiotic stresses such as shallow basaltic soils, small landholdings, and limited irrigation facilities, while ensuring sustainable agricultural income. In this model, seasonal vegetables and fruit crops are combined with backyard poultry production. Crops are irrigated using a micro-irrigation system, and poultry are allowed to scavenge, enabling the production of eggs and birds. This approach reduces the cost of poultry feed, improves soil properties over time, and supports the generation of sustainable income.

Table 13: Evaluation of Multilayer farming in CIFS (0.12 ha)

Components	Cost of cultivation	Gross income	Net income	B:C ratio
Vegetables and fruits (0.12 ha)	10087	28160	18072	2.79
Poultry (50 birds)	15625	21935	6310	1.19
Total	25712	50095	24382	1.94

The economic performance of multilayer farming components, detailing cost of cultivation, gross income, net income, and benefit cost (B:C) ratio in presented in Table 13. The vegetables and fruits component recorded a gross income of ₹28,160 against a cultivation cost of ₹10,087, resulting in a high net income of ₹18,072. This component achieved a B:C ratio of 2.79, indicating excellent profitability and efficient utilization of vertical and horizontal space under multilayer farming. The poultry component incurred a cultivation cost of ₹15,625 and generated a gross income of ₹21,935, yielding a net income of ₹6,310 with a relatively lower B:C ratio of 1.19, reflecting moderate economic returns. Overall, multilayer farming under the CIFS model generated a total gross income of ₹50,095 with a total cost of ₹25,712, resulting in a net income of ₹24,382 and an overall B:C ratio of 1.94. These results clearly demonstrate that multilayer farming, particularly through integration of vegetables and fruits, substantially improves farm profitability and contributes to efficient resource use and income enhancement in the CIFS.

Eco-Friendly Nano-Copper Synthesis: Gene and Enzyme Modulation for Combating Cadmium and Ammonia Toxicity in Fish

We conducted an experiment to investigate the role of copper nanoparticles (Cu-NPs) in mitigating cadmium and ammonia toxicity in fish. Cu-NPs were synthesized from fish waste and incorporated into fish feed at 0.8 and 1.2 mg kg^{-1} of diet. The study included four treatments: control, Cu-NPs diet at 0.8 and 1.2 mg kg^{-1} with Cd+NH_3 exposure, and concurrent exposure to cadmium and ammonia, fed with control diet. Stressors (Cd+NH_3) considerably increased the catalase (CAT) and superoxide dismutase (SOD), while diets containing Cu-NPs significantly decreased these levels. *TNFα, Ig,* and *GH* were markedly downregulated by Cd+NH_3 toxicity, while the gene expressions of *HSP 70, iNOS, Cas 3a, CYP 450,* and *MYST* were considerably increased. Furthermore, both under normal and stressful circumstances, the Cu-NPs diet regulated the expression of all these genes. Cu-NPs shielded the tissues from DNA damage, however the group subjected to Cd+NH_3 toxicity had the highest level of DNA damage. Cd+NH_3 toxicity was found to significantly increase the levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), malate dehydrogenase (MDH), and lactate dehydrogenase (LDH), in the liver and gill tissues. In contrast, the Cu-NPs diet controlled and shielded the tissues from the metabolism of proteins and carbohydrates. It's interesting to note that the Cu-NPs diet significantly increased the neurotransmitter enzyme acetylcholine-esterase in brain tissue. The outcomes also showed that Cu-NPs improve the cadmium detoxification process in fish tissues. The research findings indicate that dietary Cu-NPs, by their action on gene regulation and enzymatic systems, mitigate the effects of cadmium and ammonia toxicity in *Oreochromis niloticus* (GIFT strain). The results are presented in Fig 11-13. (For details please refer Biological Trace Element Research. 203, 5657–5675; https://doi.org/10.1007/s12011-025-04594-1).

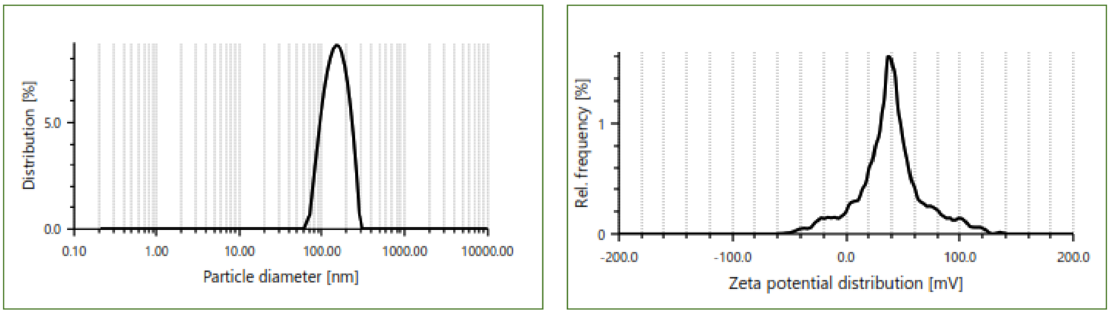


Fig 11. Green synthesis of Cu-NPs using fish waste (A) Size: 150.5 nm and (B) Zeta Potential: -36.8 mV

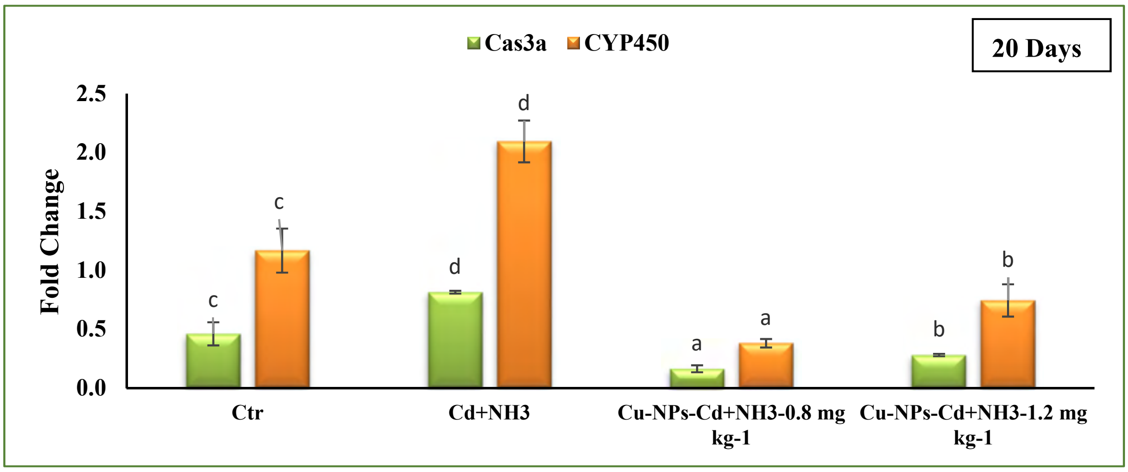


Fig 12. Defensive role of Cu-NPs on gene expression of *Cas 3a* and *CYP 450* on GIFT tilapia reared under cadmium and ammonia toxicity for 20 and 40 days.

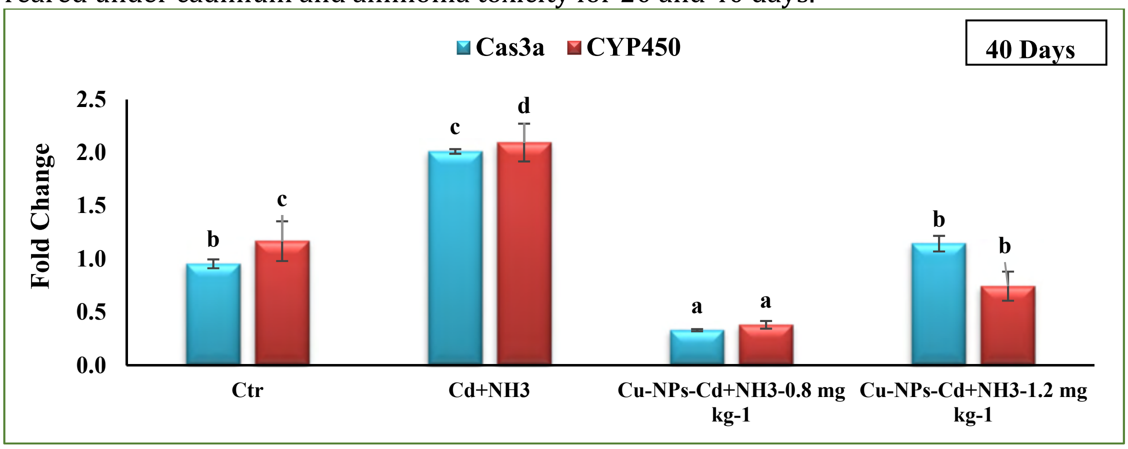


Fig 13. Within endpoints and groups, bars with different superscripts differ significantly (a–d). Data expressed as Mean ± SE (*n = 3*).

Combined effect of mercury and ammonia toxicity and its mitigation using selenium nanoparticles in fish

An experiment was conducted to mitigate mercury and ammonia toxicity (Hg + NH_3) in *Oreochromis niloticus* (GIFT strain) using selenium nanoparticles (Se-NPs). The Se-NPs were synthesized using green methods, employing fish waste as the substrate. Experimental diets were prepared by supplementing Se-NPs at concentrations of 0, 0.3, and 0.6 mg kg^{-1}. The oxidative stress enzymes, including catalase (CAT) and glutathione peroxidase (GPx), in the liver and kidney were significantly reduced by Se-NPs at 0.3 and 0.6 mg kg^{-1} under Hg + NH_3 stress compared to the control and stressor in 20 and 40-day periods. Additionally, superoxide dismutase (SOD) activity in the kidney at 20 days and in the liver at 40 days was significantly reduced by Se-NPs supplementation under similar conditions. The activity of acetylcholine esterase (AChE), which was significantly inhibited by Hg + NH_3 toxicity, was enhanced by Se-NPs supplementation at 0.3 and 0.6 mg kg^{-1} during 20 and 40-day intervals. The gene expression of *HSP70, iNOS, CYP450, Caspase-3a,* and *TNFα* in liver tissue, and *MYST* in muscle tissue was upregulated by Hg+NH_3 toxicity. However, this upregulation was significantly downregulated by Se-NPs supplementation at 0.3 and 0.6 mg kg^{-1} under Hg + NH_3 stress. Moreover, immunoglobulin (*Ig*) and growth hormone (*GH)* levels were noticeably upregulated with Se-NPs supplementation compared to the control and stressor under Hg+NH_3 stress. The activities of alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), and malate dehydrogenase (MDH) in liver and gill tissues, which were significantly elevated by Hg+NH_3 toxicity, were reduced by Se-NPs diet. Conversely, digestive enzyme activities, including protease, amylase, and lipase, were significantly enhanced by Se-NPs supplementation under stress conditions. Dietary supplementation with Se-NPs at 0.3 and 0.6 mg kg^{-1} improved growth performance parameters such as final weight gain percentage, feed conversion ratio, protein conversion ratio, specific growth rate, daily growth index, and relative feed intake compared to the control and other groups. DNA damage, assessed in terms of tail DNA percentage, was significantly reduced with Se-NPs supplementation. Additionally, mercury detoxification was significantly enhanced in fish fed Se-NPs-supplemented diets. In conclusion, this study demonstrates that dietary Se-NPs effectively alleviate the adverse effects of mercury and ammonia toxicity by modulating antioxidant status, enhancing immunomodulation, and mitigating stress biomarker impacts through changes in gene expression in fish.) Results are presented in Fig 14-16. (For details, please refer Aquatic Toxicology, 107270. 10.1016/j.aquatox.2025.107270).

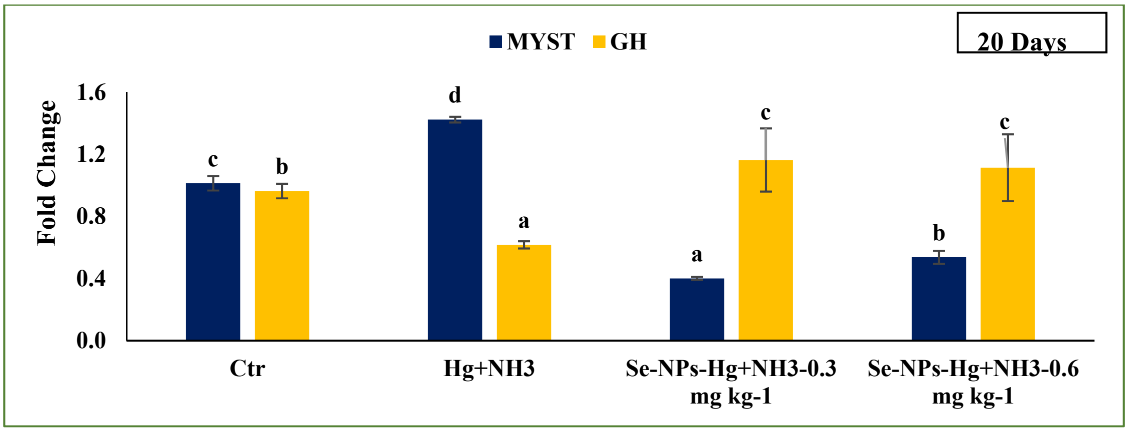


Fig 14. Mitigating role of Se-NPs on gene expression of *TNFα, Ig, MYST* and *GH* on GIFT tilapia reared under mercury and ammonia toxicity for 40 days.

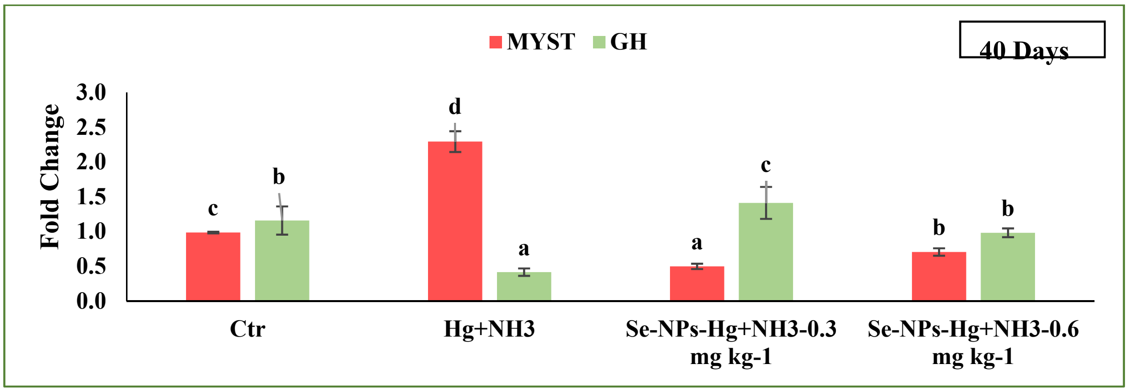


Fig 15. Within endpoints and groups, bars with different superscripts differ significantly (a–d). Data expressed as Mean ± SE (*n = 3*).

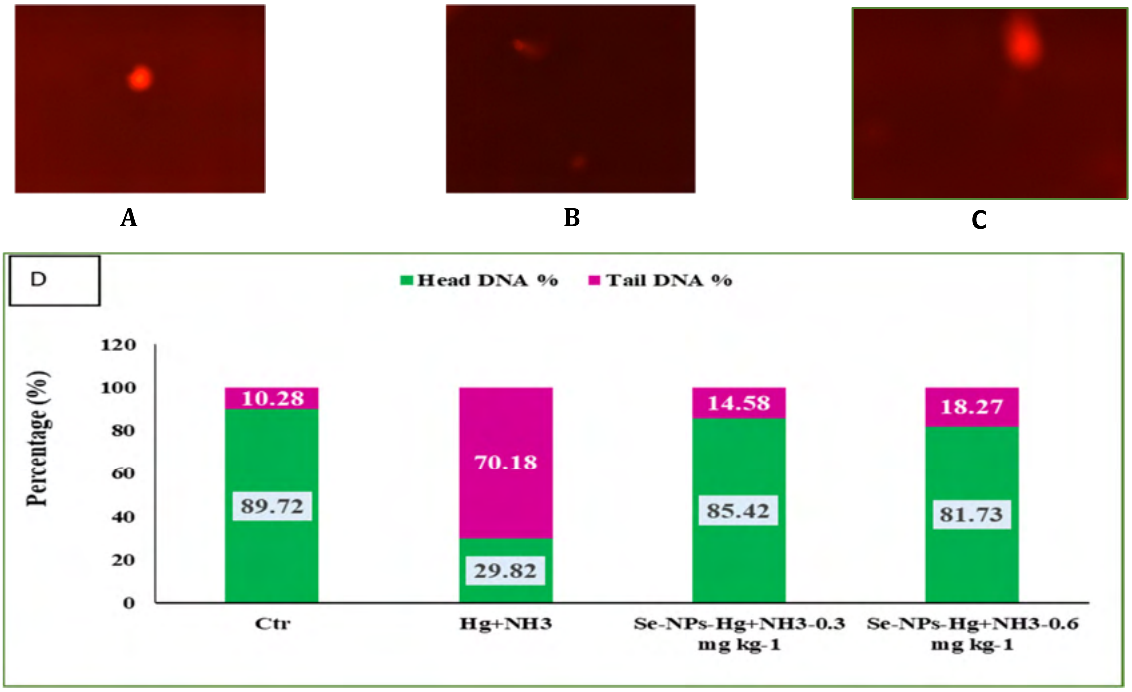


Fig 16. Effect of Selenium nanoparticles on DNA damage and comet score Head DNA % and tail DNA %) in gill tissue of GIFT tilapia reared under mercury and ammonia toxicity for 40 days

Integrative Biomonitoring in *Litopenaeus vannamei*: Metal Analysis and Biochemical Markers

Contaminants are a major cause of seafood export rejections in foreign markets and have significantly impacted consumer health. This investigation addresses the issues of metal contamination and biochemical markers in *Litopenaeus vannamei* from East Midnapore, West Bengal, India (Fig 17). The analyzed metals included vanadium (V), chromium (Cr), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), molybdenum (Mo), silver (Ag), gallium (Ga), germanium (Ge), arsenic (As), selenium (Se), strontium (Sr), tin (Sn), cadmium (Cd), mercury (Hg), and lead (Pb), determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Samples were collected from the muscle and hepatopancreas of *L. vannamei*, as well as from soil sediments and water at 19 sampling sites. The trace element levels detected were within the safety limits recommended by national and international regulatory agencies. A risk assessment, based on the Total Hazard Quotient (THQ) and cancer risk factors, indicated that *L. vannamei* cultured in this region is safe for human consumption. Additionally, oxidative enzymes such as catalase, superoxide dismutase, and glutathione s-transferase were measured as biomarkers. Other biochemical markers, including lipid peroxidation and acetylcholinesterase activity, were also assessed. Enzymes such as alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase, and malate dehydrogenase were identified as key biochemical indicators of pollution in this study. In conclusion, the findings suggest that the consumption of *L. vannamei* from East Midnapore is safe according to FAO/WHO guidelines. The study also highlights the utility of biochemical markers as reliable indicators of pollution in open water systems (For details, please refer Marine Pollution Bulletin. 10.1016/j.marpolbul.2025.117544).

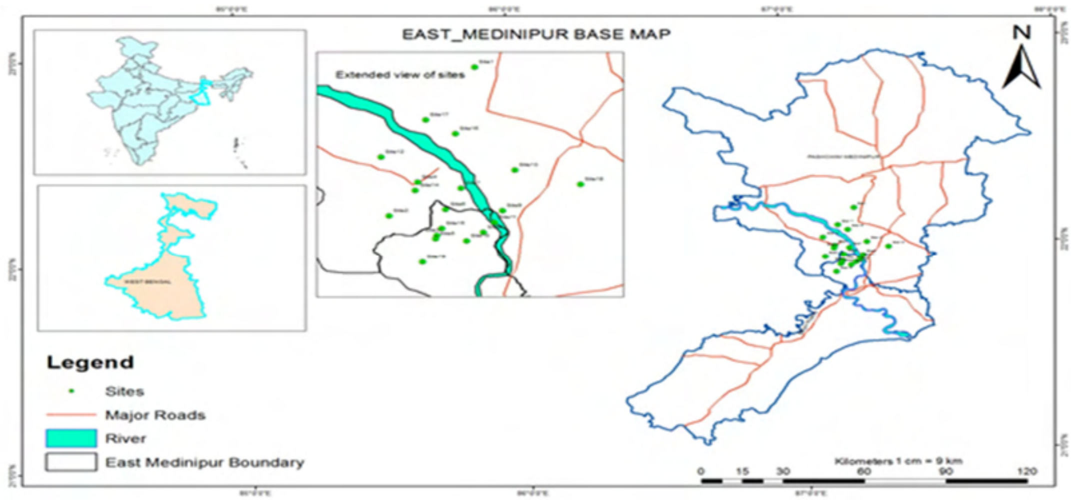


Fig 17. Sampling site map of east Midnapore, West Bengal

Development of Allometric Equations for Biomass Estimation in Mango (*Mangifera indica* L.) Across HDP and UHDP Orchards Using Destructive Sampling Approach

The study developed robust allometric equations for estimating biomass and carbon stocks in mango orchards using destructive sampling across major production regions of Maharashtra (India) and the Barind Tract (Bangladesh). A total of 60 mango trees (2–22 years old) were sampled to quantify component-wise fresh and dry biomass. Among dendrometric variables evaluated, diameter at 30 cm height (D30) emerged as the strongest predictor of total biomass (r = 0.94; R^2 = 0.89), outperforming tree height, age, and other diameter measurements (Table 14). Six allometric models were tested, of which the Power model consistently showed superior performance and validation accuracy (Adj. R^2 = 0.86; RMSE = 11.08; MAPE = 14.78%; AIC = 87.77). No significant difference was observed between measured and predicted biomass (p = 0.561), confirming the reliability of the selected model for operational biomass estimation. Nonlinear models also exhibited high explanatory power (>85%), while PCA-based regression performed relatively inferior.

Table 14. Parameter Estimates of different models fitted on training dataset (70% of entire data) for mango biomass (TB) estimation

Statistical Model	Model Expressions	Fitted Model	AIC	Adj. R^2	RMSE
Linear	$y = \alpha + \beta . x + \epsilon$	$y = 2.32 + 0.207x$	388.3	0.100	85.30
Power	$y = \alpha . x^{\beta} + \epsilon$	$y = 0.094x^{2.406}$	229.6	0.940	13.47
Exponential	$y = \alpha . exp(\beta x) + \varepsilon$	$y = 11.09exp(0.116x))$	257.2	0.887	18.57
Logistic	$y = \alpha / (1 + exp(-(x - \gamma) / \beta)) + \epsilon$	$y = 258.32/\big(1 + exp(-(x - 19.17)/4.03$	213.6	0.960	10.92
Gompertz	$y = \alpha * exp(-exp(-(x - p) / \beta)) + \epsilon$	$y = 375.18exp\big(-exp(-(x - 20)/9.74)\big)$	210.2	0.963	10.50
Chapman	$y = \alpha * (1 - exp(-\beta * x))^{\gamma} + \epsilon$	$y = 468.7\big(1 - exp(-0.071x)\big)^{4.48}$	210.9	0.962	10.58
PCA_linear	$y = \beta_0 + \beta_1 PC_1 + \beta_2 PC_2 + \varepsilon$	$y = 53.32 + 27.65PC_1 + (-3.48)PC_2$	264.2	0.870	19.68

Biomass partitioning varied significantly with tree age and orchard configuration (Fig 18). On average, biomass allocation followed the order: branches (43.29%) > roots (22.14%) > leaves (19.75%) > stem (14.83%). Aboveground and belowground biomass contributions ranged from 64.40–84.00% and 16.00–35.60%, respectively, with a mean AGB:BGB ratio of 77.86:22.14 and a root–shoot ratio of 0.29. The relatively lower stem biomass and higher branch proportion reflect the architectural characteristics of grafted trees in high-density and ultra-high-density orchards. Carbon concentration across mango tree components ranged from 40.43–45.38%, with the highest mean values recorded in the stem (45.38%) followed by branches (45.23%), roots (44.39%), and leaves (40.43%) (Fig 18). Carbon concentration showed no consistent age-related trend, indicating relative stability across growth stages. Strong positive correlations were observed between D30 and both total biomass and aboveground biomass (r = 0.91–0.94; $p < 0.05$), reaffirming the dominance of diameter-based predictors. High-density mango orchards demonstrated substantial carbon storage potential, with total biomass carbon stocks ranging from 3.27 to 90.90 Mg C

ha^{-1} across the age gradient, and mean annual sequestration rates of 1.63–6.25 Mg C ha^{-1} yr^{-1}, depending on age, planting density, and site conditions. The findings highlight that high-density and ultra-high-density mango orchards function as effective long-term carbon sinks, with biomass and carbon stocks comparable to or exceeding those reported for traditional orchard systems. The developed Power-based allometric equation, anchored on D30, offers a robust, biologically meaningful, and operationally simple tool for biomass estimation, carbon accounting, and MRV applications in tropical semi-arid agroecosystems.

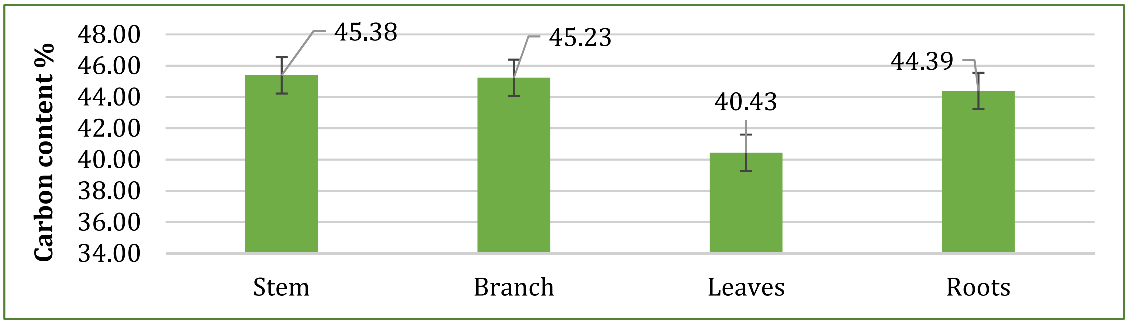


Fig 18. Average carbon content (%) in tree components in mango trees.

Assessing the host-sandalwood interactions under moisture deficit conditions in nursery

An experiment was conducted under nursery conditions to evaluate the influence of different host species on growth, physiological performance, and biochemical responses of *Santalum album* under moisture deficit stress, with the objective of identifying compatible hosts that enhance drought resilience during early establishment. The study was laid out in a factorial randomized block design with five replications, comprising eight host treatments (seven host species plus sandalwood without host) and two moisture regimes (well-watered and water stress). Sandalwood seedlings were co-cultivated with host plants at a distance of 10–15 cm and maintained for six months prior to stress imposition. Initial soil moisture was uniform across treatments (18.0–19.6%), ensuring comparable baseline conditions. The experiment was carried out during May 2025, a period characterized by high evaporative demand. Initial soil moisture was uniform across treatments (18.0–19.6%), ensuring comparable baseline conditions; however, after ten days of irrigation withholding, marked host-mediated differences were observed. The lowest soil moisture levels were recorded in sandalwood grown with *Emblica officinalis* (11.78%) and *Azadirachta indica* (12.14%), whereas comparatively higher moisture was maintained in association with *Terminalia arjuna* (15.94%) and in sandalwood without host (16.02%), indicating differential soil water extraction and retention influenced by host species. Fig 19 depicts the visual response of *Santalum album* grown with different host species under well-watered and water-stress conditions, illustrating distinct host-mediated differences in plant vigor, canopy development, and stress expression. Water stress significantly affected chlorophyll dynamics, with host effects being more pronounced than irrigation alone. Mean chlorophyll-a content across treatments ranged from 1.11 to 2.08 µg mg^{-1} FW, with the highest values observed in sandalwood associated with *Punica granatum* (2.08 µg mg^{-1} FW) and *Azadirachta indica* (1.76 µg mg^{-1} FW), while the lowest was recorded with *Emblica officinalis* (1.11 µg mg^{-1} FW). Under water stress, reductions in chlorophyll-a were evident across most host combinations; however, pigment decline was relatively smaller in *Punica granatum* (2.15 to 2.01 µg mg^{-1} FW) and *Psidium guajava* (1.24 to 1.49 µg mg^{-1} FW), indicating better pigment stability. Chlorophyll-b content exhibited wider host-dependent variation (0.90–2.96 µg mg^{-1} FW), with *Punica granatum* maintaining the highest levels under both well-watered (2.97 µg mg^{-1} FW) and stress (2.95 µg mg^{-1} FW) conditions, followed by *Azadirachta indica* (mean 2.07 µg mg^{-1} FW). Consequently, total chlorophyll content was highest in *Punica granatum* (5.04 µg mg^{-1} FW) and *Azadirachta indica* (3.83 µg mg^{-1} FW), while substantial reductions were observed under stress in sandalwood without host (3.05 to 1.91 µg mg^{-1} FW) and with *Emblica officinalis* (2.13 to 1.89 µg mg^{-1} FW). Gas exchange responses further highlighted host-mediated stress buffering. Mean net photosynthetic rate declined sharply under water stress from 7.67 to 3.28 µmol m^{-2} s^{-1}, representing a reduction of nearly 57%. Among host associations, Azadirachta indica recorded the highest mean photosynthetic rate (8.66 µmol m^{-2} s^{-1}), followed by Terminalia arjuna (7.09 µmol m^{-2} s^{-1}) and Casuarina equisetifolia (6.24 µmol m^{-2} s^{-1}). Under stress, Azadirachta indica sustained higher photosynthesis (4.51 µmol m^{-2} s^{-1}) compared to sandalwood without host (2.78 µmol m^{-2} s^{-1}) and associations with Psidium guajava (2.40 µmol m^{-2} s^{-1}) and Emblica officinalis (2.33 µmol m^{-2} s^{-1}). Stomatal conductance declined from 254.46 to 118.45 mmol m^{-2} s^{-1} under stress, with the highest mean values in Azadirachta indica (294.15 mmol m^{-2} s^{-1}) and Terminalia arjuna (288.01 mmol m^{-2} s^{-1}), and the lowest in sandalwood without host (66.14 mmol m^{-2} s^{-1}). Transpiration rate followed a similar trend, decreasing from 3.62 to 1.69 mmol m^{-2} s^{-1}, with higher mean values maintained in Azadirachta indica (3.59 mmol m^{-2} s^{-1}) and Terminalia arjuna (3.26 µmol m^{-2} s^{-1}).

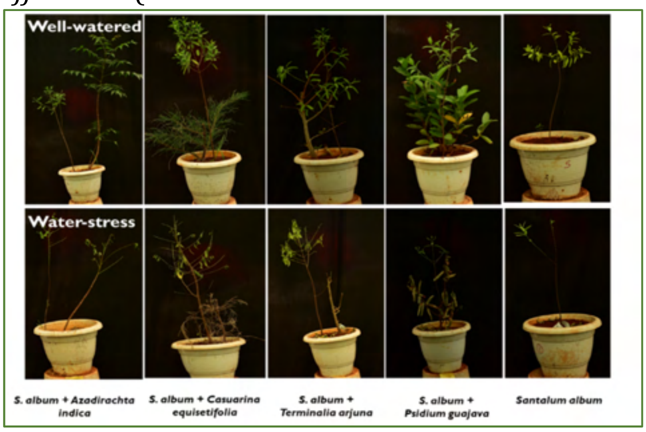


Fig 19. Visual response of *Santalum album* with different host species under well-watered and water-stress conditions

Correlation analysis (Fig 20) revealed strong positive associations among stomatal conductance, photosynthetic rate, transpiration, internal CO_2 concentration, and relative water content, indicating coordinated regulation of water relations and gas exchange under compatible host associations. Total free amino acids and proline showed a strong positive correlation, reflecting integrated biochemical stress responses, while vapor pressure deficit and leaf temperature were negatively correlated with key physiological traits. Proline exhibited a negative association with relative water content, indicating osmotic adjustment under reduced tissue water status. Overall, the results clearly demonstrate that host species such as *Azadirachta indica*, *Terminalia arjuna*, *Casuarina equisetifolia*, and *Punica granatum* enhanced drought resilience of sandalwood by sustaining photosynthetic pigment stability, gas exchange, and biochemical adjustment under moisture-limited conditions.

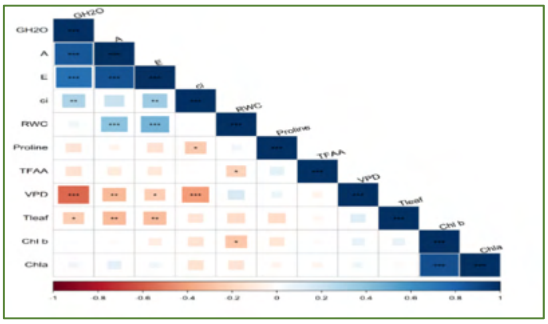


Fig 20. Correlation study between physio-biochemical parameters after imposing water stress in sandalwood with host species

Evaluation of Allium genotypes for anthracnose resistance

A total of 29 cultivated and wild Allium genotypes were screened for resistance to anthracnose, revealing substantial variation in disease (Table 15) metrics and biochemical responses. Disease screening showed severity from 2.6% to 100%, with most cultivated onions rated susceptible or highly susceptible. Wild genotypes like AF-1, AF-4, AF-7, AF-8, and AF-9 demonstrated moderate to high resistance with severity below 5%. Biochemical profiles in resistant wild types featured higher basal phenols and proteins that held steady after infection, unlike susceptible types. Resistant genotypes induced stronger SOD and GPX activities post-infection, aiding reactive oxygen species scavenging. CAT activity dropped across all, most sharply in cultivated varieties (Fig 21).

Table 15. Categories of *Allium* genotypes based on mean disease severity

Disease reaction	MDS (%)	Genotypes	
		Cultivated	Wild
Highly Resistant (HR)	<5	-	AF-1, AF-4, AF-7, AF-8, AF-9
Resistant (R)	5.1-10	-	-
Moderately Resistant (MR)	10.1-20	AC-1	AF-2, AF-3

Moderately Susceptible (MS_	20.1-40	AC-2, AC-4, AC-6, AC-10, AC-11, AC-12, AC-13	AF-5, AF-6
Susceptible (S)	40.1-60	AC-8, AC-9	-
Highly Susceptible (HS)	>60	AC-3, AC-5, AC-7, AC-14, AC-15, AC-16, AC-17, AA-1, AA-2, AA-3	-

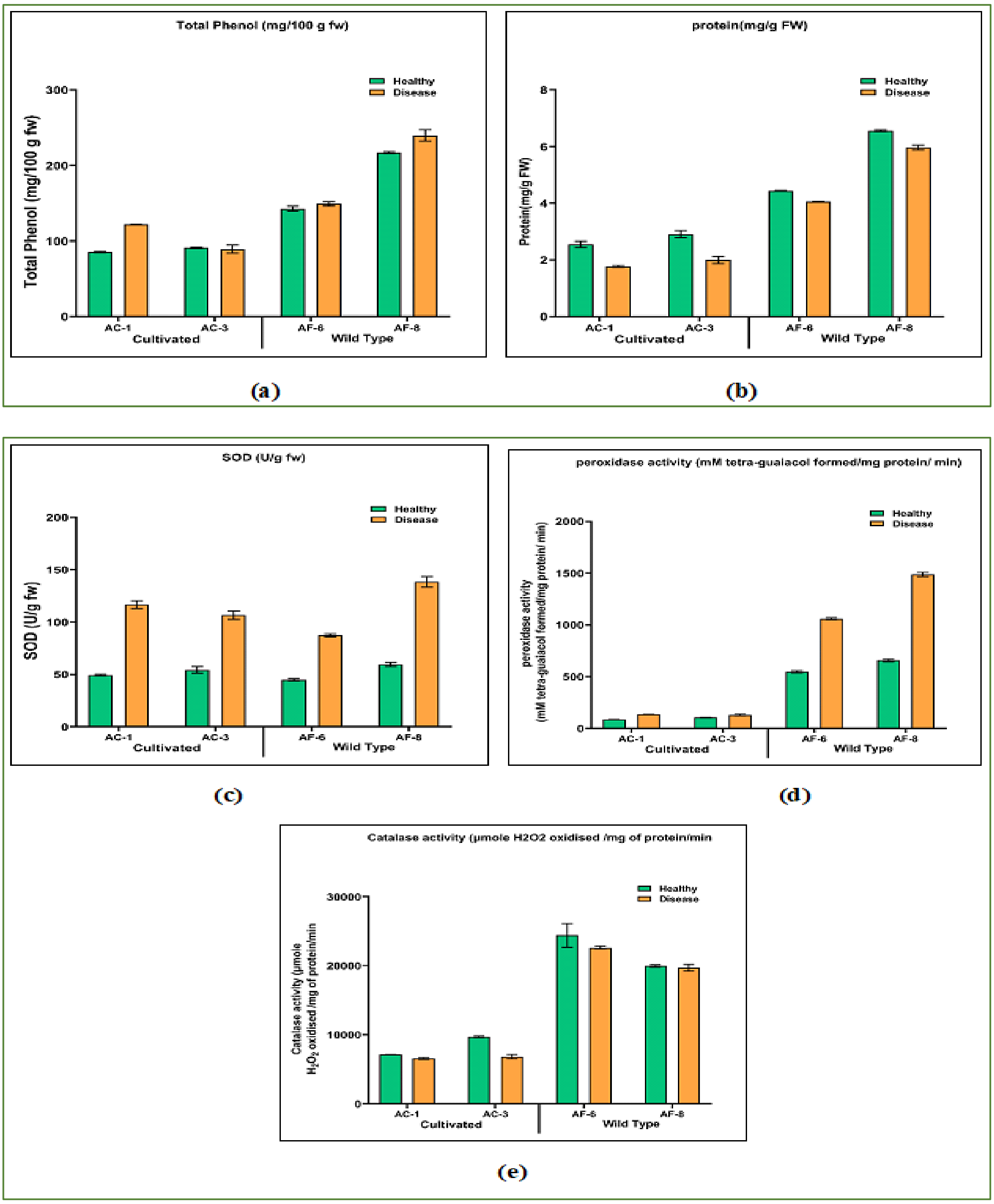


Fig 21. Secondary metabolites and oxidoreductase activity in onion genotypes against anthracnose-twister disease

Genotypic adaptations and mechanisms of salinity tolerance in dragon fruit (*Selenicereus* spp.)

Salinity stress significantly influenced sprouting, vegetative growth, biomass accumulation, physiological performance, and ion regulation in dragon fruit genotypes. Sprouting was delayed by 4 and 7 days at 50 and 100 mM NaCl, respectively, compared to the control (Fig 22). The LW genotype exhibited the earliest sprouting (20.53 days), whereas other genotypes required 24–26 days, with red-fleshed genotypes generally showing delayed sprouting. Salinity stress reduced the production of new sprouts from 5.31 per plant in the control to 3.93 and 2.81 sprouts at 75 and 100 mM NaCl, representing reductions of 25.98% and 47.08%, respectively. Among genotypes, AW produced the highest number of sprouts (5.40), followed by RR and LW, while AR produced the fewest (2.85). A similar trend was observed for cladode segments. Shoot length was unaffected at 25 mM NaCl but declined by 3.66–12.90% at higher salinity levels, with RR producing the longest shoots (110.81 cm), followed by AW, while LW and AR recorded the shortest shoots. Fresh biomass of new shoots declined sharply with increasing salinity, from 412.98 g in the control to 217.24 g at 100 mM NaCl, corresponding to a 47.39% reduction. Red-fleshed genotypes RR and AR recorded higher fresh biomass (335.48 and 300.45 g, respectively) than white-fleshed genotypes, which exhibited 19.47–27.17% lower biomass. Dry biomass followed a similar pattern, declining by 21.24% up to 75 mM and 30.41% at 100 mM NaCl, with RR showing the highest dry biomass (33.42 g). Above-ground fresh biomass declined from 549.40 g in the control to 297.34 g at 100 mM NaCl (45.89% reduction). Plant mortality increased to 15.00–16.66% at 75–100 mM NaCl, with white-fleshed genotypes (LW and AW) exhibiting 21.33–25.33% mortality, whereas red-fleshed genotypes (RR and AR) showed 100% survival.

Despite reductions in shoot biomass, root length increased under moderate salinity, reaching 34.81 cm at 75 mM NaCl, which was 13.05% higher than the control, although root fresh biomass declined by 28.95–36.35%. Physiologically, chlorophyll content remained stable up to 50 mM NaCl but declined at higher levels, with AR recording the highest chlorophyll 'a' (5.85 µg mL^{-1}) and LW the lowest (4.52 µg mL^{-1}). NDVI declined from 0.54 in the control to 0.32 at 100 mM NaCl, while WUE decreased by 18.29% and 27.07% at 75 and 100 mM NaCl, respectively. QYmax declined marginally from 0.78 to 0.74 under salinity stress. Soil pH increased from 7.50 (control) to 8.32 at 100 mM NaCl, and soil EC increased from 1.61 to 9.55 dS m^{-1}. White-fleshed genotypes accumulated substantially higher Na^{+} in stems (AW: 54.19 ppm; LW: 40.85 ppm) compared to RR (9.81 ppm), whereas RR accumulated the highest stem K^{+} (219.83 ppm). Overall, red-fleshed genotypes exhibited superior salinity tolerance through restricted Na^{+} and Cl^{-} accumulation, better ion homeostasis, and enhanced survival under saline irrigation.

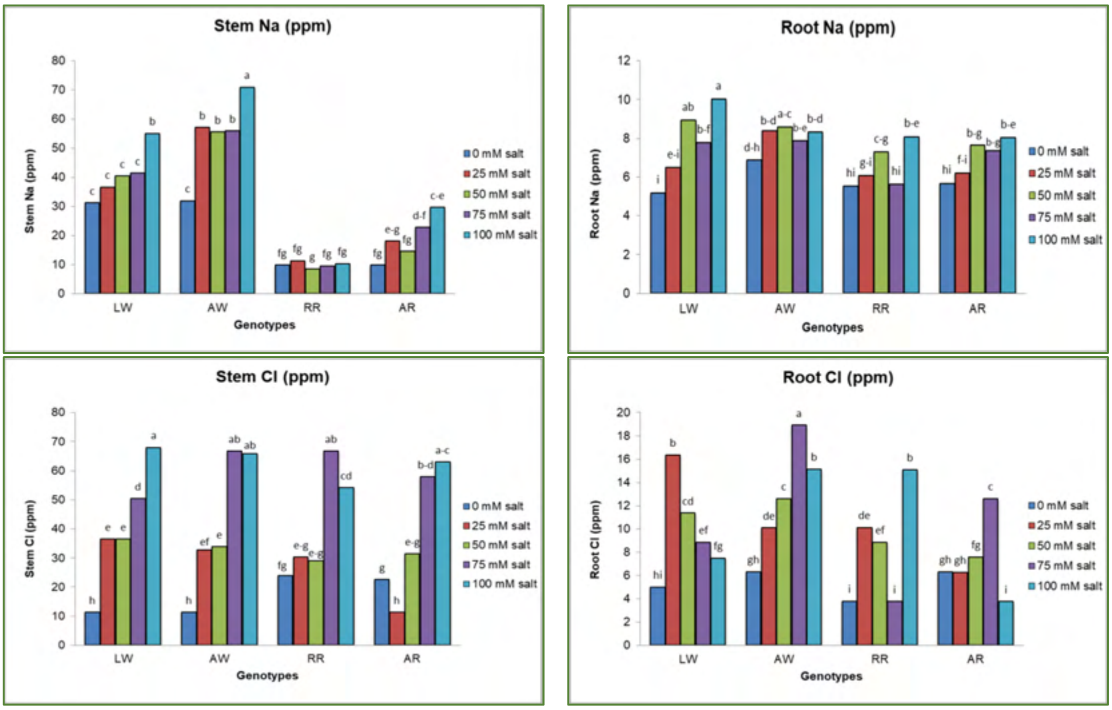


Fig 22. Effect of Saline Irrigation on Sodium and Chloride Accumulation in Stem and Root Tissues of Dragon Fruit Genotypes. Bars with same lowercase letters are not significantly different in LSD test at *p=0.05.* (LW: Local white fleshed; AW: Andaman white fleshed; RR: Regular red fleshed; AR: Andaman red fleshed)

Enhancing Soil Moisture Retention in Tomato Cultivation through Tradecorp Products

The field experiment conducted during December 2024–May 2025 at ICAR–NIASM, Baramati, evaluated the effectiveness of selected soil conditioners in improving growth, yield, and physiological resilience of tomato (*Solanum lycopersicum* L.) cv. 'TO 6242' under full and deficit irrigation regimes (Table 16). Treatments included ORO RZ and ORO TF applied at 2.5 and 5.0 L ha^{-1}, Kamasol Aqua at 2.5 L ha^{-1}, and Zeba at 12.5 kg ha^{-1}, tested under 100% ETc and 75% ETc irrigation, along with recommended dose of fertilizers (RDF) and an untreated control. All treatments received full irrigation during the initial establishment phase, after which deficit irrigation was imposed. Growth parameters were significantly influenced by both soil conditioners and irrigation regimes. Under full irrigation, ORO RZ 2.5 and ORO TF 2.5 recorded the tallest plants at 50 DAT (57.8 and 56.7 cm, respectively), compared to RDF (53.8 cm) and the control (52.4 cm), and this superiority was maintained at 100 DAT, with plant heights of 78.0 cm and 76.1 cm, respectively. Under deficit irrigation, although overall growth was reduced, ORO TF 2.5 and ORO RZ 2.5 maintained higher plant height (54.3 and 52.6 cm) compared to RDF and the control. Stem diameter and number of primary branches were consistently higher under ORO TF 2.5 across irrigation regimes, indicating improved structural growth and assimilate transport. Root growth was markedly enhanced by ORO formulations, with ORO TF 2.5 and ORO RZ 5.0 recording the longest roots under full irrigation (41.83 and 39.63 cm, respectively), while under deficit irrigation, ORO RZ 5.0 maintained superior root length (37.93 cm), reflecting improved soil moisture exploration under water-limited conditions. Biomass accumulation was significantly higher under ORO treatments; ORO RZ 5.0 and ORO TF 2.5 recorded the highest shoot fresh and dry weights under full irrigation, while under deficit irrigation, ORO TF 2.5 sustained maximum shoot biomass and ORO RZ 5.0 recorded the highest root biomass. Reproductive performance was substantially improved by soil conditioner application, with flowering exceeding 98% under ORO treatments across irrigation regimes. ORO TF 2.5 produced the highest number of flower clusters, fruits per panicle, and fruits per plant. Under deficit irrigation, ORO RZ 2.5 and ORO TF 2.5 achieved yields of 21.35 and 20.95 t ha^{-1}, respectively, representing more than a 120% increase over the control and approximately 47–50% improvement over RDF. Under full irrigation, ORO TF 2.5 recorded the highest yield (28.78 t ha^{-1}). Fruit quality attributes, including fruit size, weight, firmness, total soluble solids, and acidity, were consistently superior under ORO treatments, particularly under deficit irrigation. Antioxidant traits (phenols, flavonoids, FRAP, and DPPH activity) and physiological parameters such as membrane stability and leaf area further confirmed the enhanced stress resilience of tomato plants treated with ORO soil conditioners, highlighting their potential for sustaining productivity under water-scarce conditions in semi-arid regions.

Table 16. Effect of soil conditioners on fruit set and yield attributes of tomato

Treatments	Fruits/plant (nos.)	Fruit yield/plant (g)	Fruit yield (t/ha)	Fruit set (%)
Main plot				
100	18.98^{a}	881.26^{a}	18.36^{a}	56.31^{a}
75	16.77^{a}	783.60^{a}	16.32^{a}	51.25^{a}
Sub-plot				
C	9.35^{d}	439.55^{e}	9.16^{f}	43.06^{c}
KA	17.32^{bc}	925.30^{bc}	19.28^{bc}	51.36^{bc}
RDF	16.48^{bc}	766.03^{cd}	15.96^{de}	48.03^{c}
RZ2.5	19.57^{b}	874.46^{bc}	18.22^{bcd}	52.07^{bc}
RZ5	19.47^{b}	985.69^{b}	20.53^{b}	58.65^{ab}
TF2.5	27.75^{a}	1193.70^{a}	24.87^{a}	61.96^{a}
TF5	19.66^{b}	804.69^{cd}	16.76^{cde}	64.17^{a}
ZEBA	13.38^{cd}	670.01^{d}	13.96^{e}	50.97^{bc}
Interaction				
100:C	10.01^{hi}	486.57^{fg}	10.14^{ef}	46.39^{ef}
100:KA	20.63^{bcde}	980.27^{cd}	20.42^{b}	56.11^{bcde}
100:RDF	19.18^{bcdef}	848.43^{cde}	17.68^{bc}	48.14^{def}
100:RZ2.5	15.14^{efgh}	724.21^{e}	15.09^{cd}	51.51^{bcdef}
100:RZ5	22.42^{bcd}	1239.50^{ab}	25.82^{a}	62.43^{abc}
100:TF2.5	32.68^{a}	1381.64^{a}	28.78^{a}	63.43^{ab}
100:TF5	17.69^{cdefg}	753.37^{de}	15.70^{cd}	73.75^{a}

100:ZEBA	14.05^{fghi}	636.11^{ef}	13.25^{de}	48.75^{cdef}
75:C	8.69^{i}	392.53^{g}	8.18^{f}	39.72^{f}
75:KA	14.00^{fghi}	870.33^{cde}	18.13^{bc}	46.61^{ef}
75:RDF	13.78^{fghi}	683.63^{ef}	14.24^{cde}	47.92^{def}
75:RZ2.5	23.99^{b}	1024.72^{bc}	21.35^{b}	52.64^{bcdef}
75:RZ5	16.52^{defg}	731.88^{e}	15.25^{cd}	54.86^{bcde}
75:TF2.5	22.82^{bc}	1005.76^{bc}	20.95^{b}	60.49^{abcd}
75:TF5	21.62^{bcd}	856.02^{cde}	17.83^{bc}	54.58^{bcde}
75:ZEBA	12.72^{ghi}	703.92^{ef}	14.66^{cd}	53.19^{bcdef}

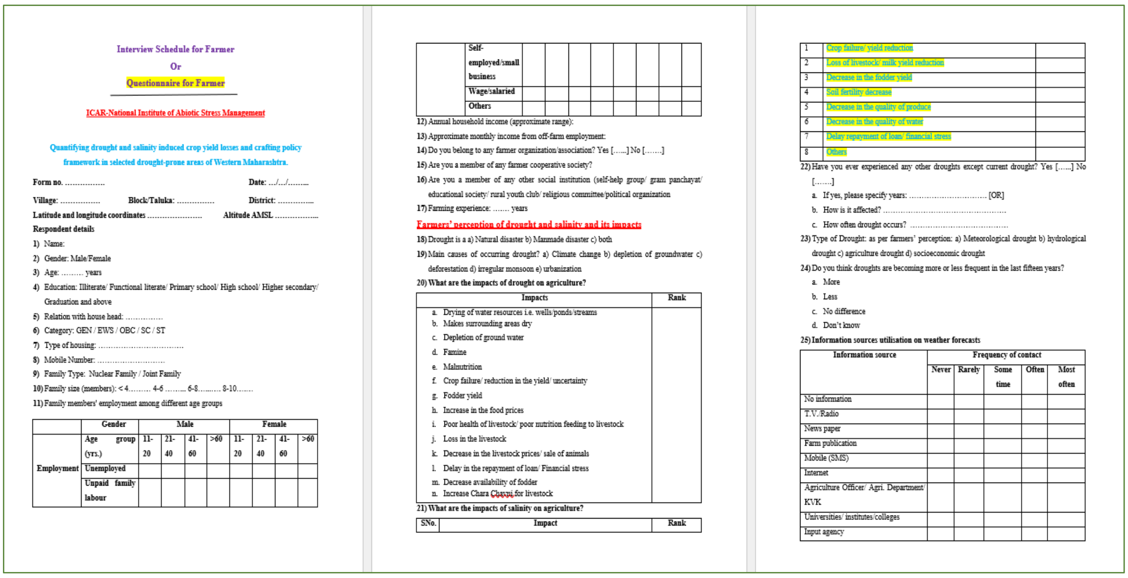
SCHOOL OF SOCIAL SCIENCE & POLICY SUPPORT

The school of social science and Policy support mandated to carry out research, extension and capacity building activities through various research projects, technology demonstrations, coordination of extension activities and capacity building of various stake holders thus playing key role in information sharing, technology dissemination and adoption to mitigate abiotic stress in agriculture. In addition to research and extension the school also involved in developmental programmes of DAPSC and TSP through distribution of need-based agriculture inputs and training programmes to enhance livelihood of farmers.

Assessment of Drought- and Salinity-Induced Crop Yield Losses in Baramati Tehsil

The study was conducted in 11 villages of Baramati Taluka, Pune district, Maharashtra, a semi-arid and drought-prone region characterized by low and erratic monsoon rainfall (550-600 mm annually), high temperature variability, and basaltic soils prone to poor drainage and salinity build-up. Agriculture in the region is predominantly irrigated, relying on groundwater and canal systems, with sugarcane as the dominant crop cultivated under Adsali, Suru, and Ratoon systems. A total of 173 farmers were surveyed and categorized into marginal, small, medium, and large landholding groups. The area was purposively selected due to its recurring droughts, emerging soil salinity issues, and its importance as a major sugarcane belt of Western Maharashtra. Primary data were collected through structured questionnaires, personal interviews, and field observations, while secondary data were sourced from AICRP-Sugarcane, CSRS/CSRI Padegaon, Commissionerate of Agriculture, ICAR-NIASM reports, and relevant literature (Fig 1, 2).

The findings reveal that drought and salinity-induced yield losses are strongly influenced by varietal choice, farm size, and management practices. Larger farmers are better able to offset productivity losses through access to irrigation, inputs, and institutional support, whereas marginal and small farmers remain more vulnerable. Despite the availability of stress-tolerant Phule varieties, varietal dominance of Co-86032 reflects path dependency in farmers' choices, and limited adoption of ratoon cropping suggests perceived profitability risks under salinity stress. Although average farmer yields (88.52 t/ha) exceeded state (+1.02 t/ha) and national (+6.27 t/ha) averages during 2019-20 to 2023-24, they remain substantially below the potential yield (150-200 t/ha), indicating significant yield gaps. By identifying key biophysical and socio-economic drivers of yield loss using statistical and machine-learning approaches, the study provides evidence to inform targeted interventions and policy frameworks aimed at enhancing crop resilience and reducing drought- and salinity-induced productivity losses in Western Maharashtra.


Interview Schedule for Farmer
Or
Questionnaire for Farmer

ICAR-National Institute of Abiotic Stress Management

Quantifying drought and salinity induced crop yield losses and crafting policy framework in selected drought-prone areas of Western Maharashtra.

Form no. .... Date: .../.../........

Village: .... Block/Taluka: .... District: ....

Latitude and longitude coordinates .... Altitude AMSL ....

Respondent details

1) Name:
2) Gender: Male/Female
3) Age: .... years
4) Education: Illiterate/ Functional literate/ Primary school/ High school/ Higher secondary/ Graduation and above
5) Relation with house head: ....
6) Category: GEN / EWS / OBC / SC / ST
7) Type of housing: ....
8) Mobile Number: ....
9) Family Type: Nuclear Family / Joint Family
10) Family size (members): < 4......... 4-6 .... 6-8......... 8-10.......
11) Family members' employment among different age groups

	Gender	Male				Female			
Employment	Age group (yrs.)	11-20	21-40	41-60	>60	11-20	21-40	41-60	>60
	Unemployed								
	Unpaid family labour								
	Self-employed/small business								
	Wage/salaried								
	Others								

12) Annual household income (approximate range):
13) Approximate monthly income from off-farm employment:
14) Do you belong to any farmer organization/association? Yes [......] No [.......]
15) Are you a member of any farmer cooperative society?
16) Are you a member of any other social institution (self-help group/ gram panchayat/ educational society/ rural youth club/ religious committee/political organization
17) Farming experience: .... years

Farmers' perception of drought and salinity and its impacts

18) Drought is a a) Natural disaster b) Manmade disaster c) both
19) Main causes of occurring drought? a) Climate change b) depletion of groundwater c) deforestation d) irregular monsoon e) urbanization
20) What are the impacts of drought on agriculture?

Impacts	Rank
a. Drying of water resources i.e. wells/ponds/streams	
b. Makes surrounding areas dry	
c. Depletion of ground water	
d. Famine	
e. Malnutrition	
f. Crop failure/ reduction in the yield/ uncertainty	
g. Fodder yield	
h. Increase in the food prices	
i. Poor health of livestock/ poor nutrition feeding to livestock	
j. Loss in the livestock	
k. Decrease in the livestock prices/ sale of animals	
l. Delay in the repayment of loan/ Financial stress	
m. Decrease availability of fodder	
n. Increase Chara Chavni for livestock	

21) What are the impacts of salinity on agriculture?

SNo.	Impact	Rank
1	Crop failure/ yield reduction	
2	Loss of livestock/ milk yield reduction	
3	Decrease in the fodder yield	
4	Soil fertility decrease	
5	Decrease in the quality of produce	
6	Decrease in the quality of water	
7	Delay repayment of loan/ financial stress	
8	Others	

22) Have you ever experienced any other droughts except current drought? Yes [......] No [.......]
a. If yes, please specify years: .... [OR]
b. How is it affected? ....
c. How often drought occurs? ....
23) Type of Drought: as per farmers' perception: a) Meteorological drought b) hydrological drought c) agriculture drought d) socioeconomic drought
24) Do you think droughts are becoming more or less frequent in the last fifteen years?
a. More
b. Less
c. No difference
d. Don't know
25) Information sources utilisation on weather forecasts

Information source	Frequency of contact				
	Never	Rarely	Some time	Often	Most often
No information					
T.V./Radio					
News paper					
Farm publication					
Mobile (SMS)					
Internet					
Agriculture Officer/ Agri. Department/ KVK					
Universities/ institutes/colleges					
Input agency					

Fig 1. Abiotic Stress Questionnaire for Farmers.

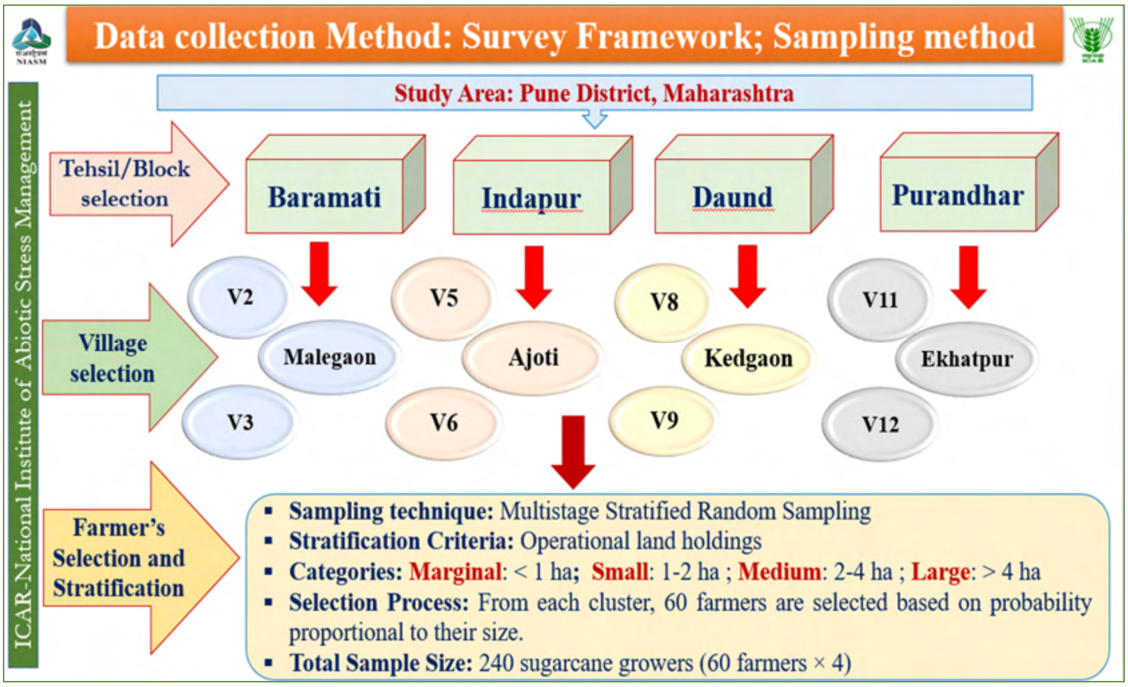


Fig 2. Survey Framework and Sampling Method.

Development and Multi-Scale Validation of an Integrated Drought Index using Hydro-Meteorological, Vegetation, and Productivity Indicators in Semi-Arid Western Maharashtra, India

This study presents a complete and structured framework for the development of an Integrated Drought Index (IDI) aimed at holistic drought monitoring in drought-prone regions. The framework integrates meteorological drought derived from standardized precipitation-evapotranspiration metrics, agricultural drought quantified through satellite-based vegetation condition and surface soil moisture indicators, and hydrological drought represented by combined streamflow and groundwater anomalies. Individual components were first processed and standardized within a common spatial and temporal framework, followed by objective integration using entropy-based methods at the sub-index level. Subsequently, principal component analysis (PCA) was employed to derive data-driven weights and synthesize meteorological, agricultural, and hydrological drought components into a single IDI (Fig 3). This integrated framework ensures physical consistency, reduces subjectivity in weighting, and effectively captures the complex propagation of drought across climate, land surface, and hydrological systems, making it suitable for regional-scale drought monitoring and climate risk management applications.

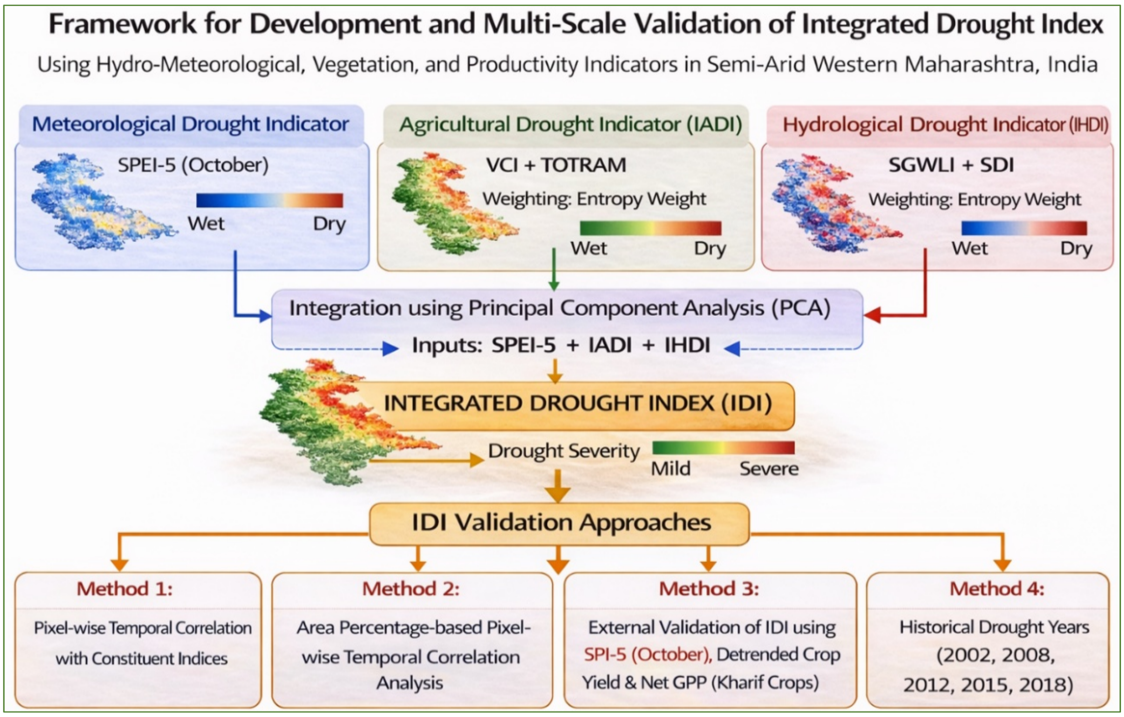


Fig 3. Complete framework of the integrated drought index for western Maharashtra.

Visits of Students, Farmers & Department Officials to ICAR-NIASM

Sl. No.	Visitors group	No. of groups	Total Visitors
1.	Students	48	2005
2.	Farmers	24	837
3.	Department Personnels	19	395
Total		**91**	**3237**

Students visit to ICAR-NIASM 2025

Farmers visit to ICAR-NIASM

Dragon fruit farmers survey

Drone demonstration to farmers at ICAR-NIASM

Women farmers visit to ICAR-NIASM

Tribal Sub Plan Activities 2025

Under the Tribal Sub Plan (TSP), three Farmers' Interaction Meetings (Kisan Gosthi) were conducted in different villages of Navapur Tehsil of Nandurbar District. The programme witnessed active participation from more than 900 farmers representing over 16 villages of Navapur Tehsil, Nandurbar district. During these meetings, TSP members emphasized the importance of Integrated Farming Systems (IFS), the adoption of improved animal husbandry practices, and improved crop management techniques. Special focus was given to waste utilization, vermicomposting, and the significance of recycling agricultural residues for enhancing soil fertility. Improved technologies in fish culture were also discussed in detail. Farmers were encouraged to use quality seeds, adopt improved agricultural implements, and participate in skill development programmes designed for both male and female farmers to enhance productivity and income. The participating TSP farmers expressed their need for agricultural implements, and exposure visits related to comprehensive fish farming, cattle feed preparation, poultry and goat farming, disease management, agricultural waste management, and vermicomposting. The team also interacted closely with the farmers to understand their challenges and collected valuable feedback for strengthening and refining future TSP activities.




Interaction with TSP farmers during Kishan Gosthi at Bedki, Nandurbar on 4th June 2025


Interaction with TSP farmers at Motekadwan (Navapur) Nandurbar on 10th June, 2025

Interaction with TSP farmers at Karanje (Navapur) Nandurbar on 11th June 2025

Table 1. Details of Kisan Gosthi/Farmers Interaction/Training in TSP project

Sl. No	Activities	Team of the Scientist	No. of Beneficiaries	Date of activities
1	Training on improved agricultural management practices, improved seeds and their varieties, Importance of Integrated Farming System	K. Ravi Kumar and S A Kochewad	110	03/06/2025
2	Training and demonstration on Backyard poultry practices Clean milk production, Improved Agricultural practices	S A Kochewad and K. Ravi Kumar	280	04/06/2025
3	Training on Kitchen Gardening and Waste Management for Manure production, Vermicompost, DAP, Biopesticide and etc	Paritosh Kumar and S A Kochewad	56	08/06/2025

Sl. No	Activities	Team of the Scientist	No. of Beneficiaries	Date of activities
4	Training on establishment and management of kitchen gardens for household nutritional security, Preparation of compost and vermicompost using locally available materials	Paritosh Kumar and S A Kochewad	45	09/06/2025
5	Training on Improved Livestock management and distribution of cattle feed, mineral mixture and Mini Rice mill	S A Kochewad and Paritosh Kumar	340	10/06/2025
6	Distribution and demonstration of farm implements	S A Kochewad, and Paritosh Kumar	74	11/06/2025

Table 2. Details of input distribution and no. of beneficiaries in TSP

Sr.no	Name of item	Quantity (kg/no.s)	No. of beneficiaries
1.	Mango saplings + Medicinal plants	1000 no.	100
2.	Paddy seed	2000 kg	160
3.	Cotton seed	192 packets	96
4.	Maize seed	1000 kg	200
5.	Cattle feed	285 bags	285
6.	Floating fish feed	6000 kg	50
7.	Tarpaulin sheet	200 no.	200
8.	Domestic flour mill	63 no.	126
9.	Plastic milk can	440 no.	220
10.	Groundnut seed	2000 kg	100
11.	NPK (19:19:19) fertilizer	9500 kg	380
12.	Vermicomposting bed	250 no.	125
13.	Micronutrient	1660 no.	207
14.	Mineral mixture	6500 kg	350
15.	Nano DAP	90 no.	45
16.	Spade	1000 no.	250
17.	Secateur	1000 no.	250
18.	Mineral bricks	775 kg	78
19.	Silage bags	150 no.	75
20.	Crowbar	230 no.	230
21.	Mini Rice mill	10 no.	40
Total number of Beneficiaries			3567

DAPSC interventions 2025

A multidisciplinary team of scientists and technical officer of ICAR-NIASM, as a part of the extension and developmental activities of the institute carried out DAPSC (Developmental Action Plan for scheduled caste) activities to enhance the livelihood and income of scheduled caste (SC) farmers. Under this scheme, various activities such as the distribution of critical agricultural inputs and capacity building programs were taken up.

Under the DAPSC program, various interventions were planned which included crops, and livestock, besides these some of the interventions were targeted for improving living standards, promoting health and nutrition, etc. Almost 1500 farmers and seven self-help group (SHG) from about 20 villages (from 5 tehsils viz Baramati, Daund, Indapur, Kadegaon, and Phaltan) were included based on a survey of their status and requirements for the upliftment of livelihood. Other inputs namely, utensil kits (200), sewing machines (14), Plastic utensil kit (200), dairy kits consisting of milk cans, SS buckets, milk measure, plastic baskets, mineral mixture, deworming tablets (200) and Farming (Water tank) kit (consisting of water tank-1000 Lit, power sprayer, tarpaulin sheet and water filter) were also provided to 200 beneficiaries. Five SC women self help groups (SHG) were provided with Dal Mill for employment generation. For promoting awareness about soil health, soil health cards were distributed to 50 SC beneficiaries, and 'World Soil Day' was celebrated in the Loni Bhapkar village. Out of the 1500 beneficiaries during the financial year 2024-25, 561 were women.


Dr K Sammi Reddy, Director, addressing the beneficiaries and handing over inputs


Awareness programme at Dhekalwadi village

During the year 2025, eight Training cum Technology Demonstrations on various aspects were organised under the Development Action Plan for Scheduled Castes (DAPSC) benefitting more than 1542 beneficiaries. Organized various

Training Programmes on "Upliftment of livelihood of SC Beneficiaries" during the period under the Development Action Plan for Scheduled Castes (DAPSC) at different villages, viz. Dhekalwadi from Baramati tehsil, Kapashi village of Satara District, Loni Bhapkar, Mudhale from Pune district Maharashtra and Vihapur from Sangli district. It was followed by the distribution of inputs like water tank kit, sewing machines, bicycles, utensil kits, plastic utensil kit and dairy kits to the identified SC beneficiaries of selected villages.

Distribution of Soil health cards & other inputs on World soil Day at Loni bhapkar village

Distribution of Utensil kits to SC beneficiaries

Distribution of Water tank, Bicycles with ice-box and Dairy kits to SC beneficiaries

Training & Capacity Building

ICAR-IARI BSc (Hons.) Students, IARI-NIASM Baramati Hub (2nd Year)

Sr. No	Name of the Student	Roll No
1	Sushain Padmaraj	IARIBAR20233001
2	Jonah Peter Manoj	IARIBAR20233002
3	T. Nandhana Shankar	IARIBAR20233003
4	Errala Aravind	IARIBAR20233004
5	Palak Thakur	IARIBAR20233005
6	Ahmed Ziyan T	IARIBAR20233006
7	Harshita Parihar	IARIBAR20233007
8	Eslavath Sravanthi	IARIBAR20233008
9	Ayaskanta Behera	IARIBAR20233009
10	Arnab Das	IARIBAR20233010
11	Karthik Ss	IARIBAR20233011
12	Sanjana Barman	IARIBAR20233012
13	Virbhadra Kumar	IARIBAR20233013
14	Mahima Kumari Shah	IARIBAR20233014
15	Shiv Kumar	IARIBAR20233015
16	Umashankar Kumar	IARIBAR20233016
17	Hrishikesh Vinod	IARIBAR20233018
18	Sujal Sahajpal	IARIBAR20233019
19	Neha S	IARIBAR20233020
20	Raser Panyang	IARIBAR20233021
21	Ajay Sharma	IARIBAR20233022
22	Jitendra Singh	IARIBAR20233023

ICAR-IARI BSc (Hons.) Students, IARI-NIASM Baramati Hub (3rd Year)

Sr. No	Name of the Student	Roll No
1	Naveen Panchar	IARIBAR20243024
2	Anushree Shivdas Adhau	IARIBAR20243025
3	Nayana Ajay	IARIBAR20243026
4	Amitanjali Kumari	IARIBAR20243027
5	Rahan A Basheer	IARIBAR20243028
6	Prince Kushwah	IARIBAR20243029
7	Dhanya D	IARIBAR20243030
8	Rudra Prasad Pradhan	IARIBAR20243031
9	Vyshnavi V S	IARIBAR20243032
10	Hamna Fathima S	IARIBAR20243033
11	Ameena N K	IARIBAR20243034
12	Sunil Meena	IARIBAR20243035
13	Gaurav Rathore	IARIBAR20243036
14	Arpita Dhanraj Zadke	IARIBAR20243037
15	Anjum Khatree	IARIBAR20243038
16	Deepak Kumar Bairwa	IARIBAR20243039
17	Bharti	IARIBAR20243040
18	Sujan NP	IARIBAR20243041
19	N. Sanjay Nagaraj	IARIBAR20243042
20	Karan Meena	IARIBAR20243043
21	Nasha N	IARIBAR20243044
22	Vishal Bairwa	IARIBAR20243045
23	Sahil	IARIBAR20243046
24	Yuvaraj Ramesh Badadal	IARIBAR20243047
25	Pankaj Thory	IARIBAR20243048
26	Ujjawal Vishwakarma	IARIBAR20243049

IARI-NIASM, Baramati Hub students who completed Master's Degree

Sr. No	Name of the Student	Roll No	Discipline	Degree	Name of Guide	Thesis Title
1	Navodhaya JV	IARIBAR 20232003	Plant Physiology	MSc	Gurumurthy S	Summer high temperature stress-induced drought tolerance during reproductive development in

						chickpea (*Cicer arietinum* L.)
2	Harimadhav C	IARIBAR 20232006	Plant Physiology	MSc	Gurumurthy S	Influence of melatonin on physio-biochemical responses in common bean (*Phaseolus vulgaris* L.) under combined heat and drought stress
3	Bhavani Vuggumoodi	IARIBAR 20232008	Environmental Science	MSc	AK Singh	Adaptive response of soybean (Glycine max) genotypes to combined stress of elevated temperature and limited soil moisture
4	Megha PP	IARIBAR 20232002	Soil & Water Conserve. Eng	MTech	DD Nangare	Study on partial root zone drying irrigation strategy and shifting frequency in high-density mango orchard grown in shallow basaltic soil
5	Swapnil Jain	IARIBAR 20232009	Processing and Food Engineering	MTech	GC Wakchaure	Assessing custard apple fruit storage quality under different coating materials and temperatures
6	Eram Fatma	IARIBAR 20232004	Processing and Food Engineering	MTech	GC Wakchaure	Drying kinetics and quality assessment of microwave vacuum-dried slices of dragon fruit pulp and peel

IARI-NIASM, Baramati Hub Students Pursuing Master's/PhD Degree

Sr. No	Name of the Student	Roll No	Discipline	Degree	Name of the guide
1	Diwakar Tiwari	IARIBAR20232010	Processing and Food Engineering	PhD	GC Wakchaure
2	Shrutarshee Kundu	IARIBAR20242011	Environmental Sciences	MSc	Neeraj Kumar
3	Milton Banerjee	IARIBAR20242012	Environmental Sciences	MSc	Aliza Pradhan
4	Seko-U-Thele	IARIBAR20242013	Environmental Sciences	MSc	AK Singh

5	Bhaskar Jha	IARIBAR20242014	Environmental Sciences	MSc	SB Chavan
6	Kashish Yadav	IARIBAR20252016	Environmental Sciences	MSc	-

MSc/PhD Students of ICAR/SAU's/Private Universities Joined ICAR-NIASM for research work (2025-26)

Sr. No	Name of Student	Degree	Guide/co-guide/ SAC member	University/college
1	Shruti Sarjerao Sarode	MSc	PS Khapte	Dr SPAC, Baramati
2	Priti Kakasaheb Mote	MSc	PS Khapte	Dr SPAC, Baramati
3	Priyanka Jadav	PhD	KM Boraiah	MPKV Rahuri
4	Karande Sagar Ashok	PhD	V Salunkhe	MPKV Rahuri
5	Omkar Sadakal,	MSc	A Morade	Dr SPAC, Baramati
6	Namrata Kailas Kote	MSc	A Morade	Dr SPAC, Baramati
7	Rutuja Pisal,	PhD	A Morade	MPKV, Rahuri
8	Sonal Dattatray Jadhav	PhD	DD Nangare	VNMKV, Parbhani
9	Sonal Nikam	PhD	GC Wakchaure	College of Engin, Malegaon
10	Kokani Nishigandha Kiran	MSc	VD Kakade	Dr SPAC, Baramati
11	Gayatri Sanjay Waghmare	MSc	VD Kakade	Dr SPAC, Baramati
12	Renuka Subhash Nagale	MSc	SB Chavan	Dr. BSKKV, Dapoli
13	Rupali Singh	PhD	SB Chavan	FRI, Dehradun
14	Vankalas Chaitanya Nihalkumar	MSc	PS Khapte	Dr SPAC, Baramati
15	Prakash	PhD	PS Khapte	ICAR-IIHR, Bengaluru
16	Solanke Amol Pralhadrao	PhD	S Gurumurthy	MPKV, Rahuri
17	Kalbhor Shashianand Uttam	MSc	R Rajkumar	Dr SPAC, Baramati
18	A Kalpana	PhD	N Kumar	ICAR-CIFE, Mumbai
19	Vinay M. Gangana Gowdra	PhD	HM Halli	UAS, GKVK, Bengaluru
20	Girish A Chopade	MSc	PS Basavaraj	MPKV, Rahuri
21	Suraj Gund	PhD	PS Hanjagi	MPKV, Rahuri
22	P.H. Puranik	PhD	BB Gaikwad	MPKV, Rahuri

Sr. No	Name of Student	Degree	Guide/co-guide/ SAC member	University/college
23	Yuktha D.U.	PhD	HM Halli	UAS, Dharwad
24	Payal Indrabhan Nirmal	MVSC	SS Pawar	KNPVC, Shirwal, MAFSU, Nagpur
25	A.B. Mali	PhD	SS Pawar	KNPVC, Shirwal, MAFSU, Nagpur
26	Nisha Guru	MSc	RN Singh	VNMKV, Parabhani
27	Sai Chavan	MSc	N Kumar	VPASCC, Baramati
28	Rutuja Rupanwar	MSc	N Kumar	VPASCC, Baramati
29	Deshmukh Krushna Ashokrao	MSc	R Rajkumar	VNMKV, Parabhani
30	Surve Saurabh Sanjay	MSc	JH Kadam	SPCOA, Baramati
31	G. Amruta Lakshmi	PhD	S Rathod	ANGRAU, Guntur
32	C.H. Vinod	MSc	S Rathod	PJTAU, Hyderabad
33	G. Sai Nikshiptha	MSc	S Rathod	PJTAU, Hyderabad
34	MPKumar Reddy	MSc	S Rathod	PJTAU, Hyderabad
35	Priyanka R Ingale	PhD	VD Kakade	VNMKV, Parabhani
36	Shubham Haribhau Kulkarni	PhD	VD Kakade	VNMKV, Parabhani
37	Abhishek	MSc	AS Morade	VNMKV, Parabhani
38	Rushikesh Prabhat	MVSc	M Gupta	NVC, Nagpur
39	Nakul Ghuge	MVSc	M Gupta	NVC, Nagpur
40	Yashi Singh	PhD	SK Mishra	PAU, Ludhina
41	Roshini Priya	MSc	S Rathod	PJTAU, Hyderabad
42	Nisha Rafiq	PhD	MP Bhendarkar	University of Kashmir, Hazratbal
43	Ghule Diksha Ashok	BTech	S Awaji	VPCAB, Baramati
44	Sadgir Keshav Machindra	BTech	AK Singh	VPCAB, Baramati
45	Bhagat Dheeraj Haridas	BTech	SK Changan	VPCAB, Baramati
46	Darisam Saroj Maharshi	MSc	SB Chavan	ANU, Guntur
47	Amudalaplli Sri Ganesh	MSc	VN Salunke	ANU, Guntur
48	Rajesh Kumar	MFSc	M Bhendarkar	ICAR-CIFE, Mumbai
49	Gauri Andhale	PhD	BB Gaikwad	MPKV, Rahuri
50	Debarjeet Rajkumar	PhD	BB Gaikwad	ICAR-CIFE, Mumbai

Trainings/Seminar/Workshop/Symposia/Conference Organized

Training	Beneficiary details & No.	Organized by
"Orientation Training Programme" from 12 Aug, 2024 to 31 Jul, 2025	T1 staff of ICAR-NIASM (5)	Rinku Dey (Coordinator)
15 days Internship training for S.Y.B. Voc. QCI students of Shardabai Pawar Mahila Arts, Commerce, and Science College Shardanagar, Malegaon (Bk.) from 19 Dec, 2024 to 09 Jan, 2025	Students (15)	Rinku Dey, Karthikeyan N, Rajagopal V, Hanamant M Halli
15 days Internship training for M.Sc. Microbiology students of Shardabai Pawar Mahila Arts, Commerce, and Science College Shardanagar, Malegaon (Bk.) 19 Dec, 2024 to 09 Jan, 2025	Students (8)	Rinku Dey, Karthikeyan N
PMFME on line training programme on "Turmeric processing and value addition" on 28 Apr, 2025	Farmers (71)	JH Kadam and State Nodal Agency PMFME and KVK, Baramati
Training program on "Ginger Cultivation" on 17 May, 2025	Farmers (125)	JH Kadam and Pani Foundation
PMFME on line training programme on "Jackfruit processing and value addition" on 24 May, 2025	Farmers (84)	JH Kadam and State Nodal Agency PMFME and KVK, Baramati
PMFME on line training programme on "Jamun processing and value addition" on 07 Jun, 2025	Farmers (76)	JH Kadam and State Nodal Agency PMFME and KVK, Baramati
Training program on "Turmeric Cultivation" 29 Jul, 2025	Farmers (125)	JH Kadam and Pani Foundation
PMFME on line training programme on "Turmeric processing and value addition" on 25 Nov, 2025	Farmers (65)	JH Kadam and State Nodal Agency PMFME and KVK, Baramati
NBSC, Lucknow (NABARD) sponsored "Write Shop Programme for Grade A, B and C Officers of NABARD" from 02 to 06 Jun, 2025 at ICAR-NIASM	Grade A, B and C Officers of NABARD (26)	SB Chavan (Course Director) JH Kadam, Nobin Paul, Navyashree P (Course Co-Directors)
BIRD-NABARD, Lucknow Sponsored Training Programme on "Climate Resilient Agriculture and	NGOs and FPOs (31)	SB Chavan, VD Kakade, AS Morade (Course Director)

Training	Beneficiary details & No.	Organized by
Livelihood Opportunities for NGOs and FPOs" from 24 to 28 Nov, 2025		VN Salunkhe, CB Harisha, Rafat Sultana, SS Changan (Course Co-Directors)
"Review and Monitoring of Foreign-Aided Projects" for the period Jan, 2025 to Jun, 2025 from 03 to 04 Nov, 2025	Scientists (40)	Rinku Dey, SB Chavan, V. Rajagopal (Coordinators)
21-day online National Training on "Advanced Statistical and Machine Learning Techniques for Data Analysis Using Open-Source Software for Abiotic Stress Management in Agriculture" from 16 Jul to 05 Aug, 2025	Scientist, Professors, and students (778)	Santosha Rathod, Nobin Chandra Paul, Navyashree P and K Ravi Kumar (Course Directors)
One-day workshop-cum-frontline demonstration on "Enhancing Sugarcane Productivity using Conservation Agricultural Practices and Engineering Interventions" on 27 Jan, 2025 at ICAR–NIASM, Baramati	Sugarcane farmers (50)	GC Wakchaure, Aliza Pradhan and Paritosh Kumar (Coordinators)
One day National Workshop on "Dragon fruit on 05 Apr, 2025 at Kadegoan, Sangali in association with Loknet Mohanrao Kadam College of Agriculture, MPKV; NIASM Baramati and Mahadragon Fruit Association.	Farmers (200)	GC Wakchaure and VD Kakade (Conveners)
"Vigilance Awareness Week" from 27 Oct to 2 Nov, 2025	ICAR-NIASM staff (100)	ICAR-NIASM, Baramati

Workshops/Seminar/Symposia/Conference/Training attended

Name of staff	Title	Venue	Organised by	Dates
AK Singh	International Conference on "Plant Physiology: Translational Genomics & Physiology for Sustainable Agriculture"	TNAU Coimbatore	TNAU Coimbatore and Indian Society of Plant Physiology, IARI, New Delhi	15 to 18 Dec
SK Mishra	"Working Group Meeting of AICRP on	PAU, Ludhiana	ICAR-CRIDA	27 to 30 Nov

Name of staff	Title	Venue	Organised by	Dates
	Agrometeorology" (AICRPAM)			
M Gupta	Vth Annual Conference of Animal Physiologists Association and National symposium on "Next Generation Physiological Approaches for Climate Adaptive Livestock Production"	Bidar Vet. College, Bidar	Bidar Veterinary College, Bidar	09 to 10 Oct
M Bhendarkar	"Matsy Sammelan – 2025: Nil Kranti Thi Artprapti"	Kamdhenu University, Gujarat	Kamdhenu University, Gujarat	21 Nov
SM Awaji	Training program on "Abiotic stress management in agriculture for enhancing the farmer's income with special reference to millets/ fodder crops cultivation in arid and semi-arid regions of India"	Online mode	ICAR-IIMR and MANAGE, Hyderabad	06 to 10 Jan
	Training program on "Decoding non-coding Genome: Insights into Gene Expression and Regulatory Interplay"	Online mode	ICAR-IASRI, New Delhi	25 Feb to 04 Mar
	iGOT training program on "Building climate resilience in agriculture systems"	Online mode	Rockefeller Foundation	27 May
	iGOT training program on "AI led digital transformation in agriculture"	Online mode	Wadhwani Foundation	28 May
	Participated in "Pre-Kharif Campaign on "Bharat Krishi-Jagran yatra: Anusandhan Kisan Ke Dwar"	Different villages of Baramati block	ICAR and DA&FW	29 May to 12 Jun

Name of staff	Title	Venue	Organised by	Dates
	ConSEPT 2025- International Dialogue on "Power of Plant Physiology in the multi-omics era" Connecting the dots	Online mode	Department of Crop Physiology, UAS, Bengaluru	27 Sep
	Webinar on "Leaf State Analyser Model LSA-2050 & PAM Chlorophyll Fluorometer with Porometer"	Online mode	M/s. Green Spectrum Technology Pvt. Ltd. New Delhi	17 Oct
	6th International Conference on Plant Physiology - 2025 on "Translational Genomics and Physiology for Sustainable Agriculture"	TNAU, Coimbatore	TNAU, Coimbatore and Indian Society for Plant Physiology, New Delhi	15 to 18 Dec
A Morade	National Seminar on "Digital Technologies for Transforming Horticulture Sector"	ICAR-IARI, New Delhi	IAHS, New Delhi and NASC, New Delhi	27 to 29 Jan
	Workshop on "IGGRAAL Research Projects: Review and Planning"	Hyderabad	RySS, Anantapur	17 to 18 Nov
	"National Citrus Symposium 2025: Meeting Challenges of Precision Production, Climate Change & Value Chain Management for Sustainability, Economic Viability, Fruit Quality and Safety"	Jain Hills, Jalgaon	CICR, Nagpur and Jain Irrigations, Jalgaon	21 to 23 Dec
H Halli	Training programme on "Requirements of quality management system for implementation of ISO/IEC 17025: 2017"	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	03 to 05 Mar
	Training programme on "Measurement of Uncertainty and Decision	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	27 Feb

Name of staff	Title	Venue	Organised by	Dates
	Rule" as per requirement of ISO/IEC 17025:2017			
	"Great Plains Water Conference: Securing Water Resources for Tomorrow"	University Of Nebraska, Lincoln, Omaha Campus, USA	Daugherty Water for Food Institute (DWFI), Lincoln, USA	01 to 19 Sep
	"CANVAS, International Agronomy Conference: Where Crop, Agronomic, Environmental, and Soil Sciences Connect"	Salt Lake City, Utah, USA	American Society of Agronomy, Crop Science Society of America, Soil Science Society of America	09 to 12 Nov
R Vadivel	Three days training programme on "Quality Management System for Implementation of ISO/IEC 17025:2017" (General Requirements for the competence of testing and calibration laboratories)	ICAR-NIASM, Baramati	ICAR-NIASM	03 to 05 Mar
	One day training programme on "Measurement of Uncertainty and Decision Rule as per requirement of ISO/IEC 17025:2017"	ICAR-NIASM, Baramati	ICAR-NIASM	27 Feb
R Dey	Training programme on "Measurement of Uncertainty and Decision Rule" as per requirement of ISO/IEC 17025:2017	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	27 Feb
	Training program on "Requirements of Quality Management System for implementation of ISO/IEC 17025:2017"	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	03 to 05 Mar
	Lecture of "Dr Kajal Chakrabarty on the occasion of World Intellectual Property Day"	Online mode	ICAR-NIASM, Baramati	30 Apr

Name of staff	Title	Venue	Organised by	Dates
	5 courses on the iGOT Karmayogi platform: 1. AI led digital transformation in Agriculture, 2. Building climate resilience in agriculture systems, 3. Overview of Viksit Bharat 2047, 4. Communication for Citizen Centricity, 5. Effective techniques to manage stress	Online mode	iGOT Karmayogi platform	May
CB Harisha	Global Conference on "Smart Horticulture for Prosperity and Nutritional Security"	UHS Bagalkot, Karnataka	UHS Bagalkot, Karnataka	12 to 14 Feb
	3rd International Online Conference on "Agriculture organized by Sciforum and Agriculture"	Online mode	MDPI, Agronomy	22 to 24 Oct
	The 5th International Electronic Conference on "Agronomy"	Online mode	MDPI, Agronomy	15 to 18 Dec
JH Kadam	11th Indian Horticulture Congress -2025 and International meet on "Horticulture for Inclusive, Equitable and Sustainable growth"	UAS, GKVK, Campus, Bengaluru , Karnataka	Indian Academy of Horticulture Sciences (IAHS), New Delhi	06 to 09 Nov
A Naveenkumar	One month "Orientation Training Programme" at ICAR-NIASM	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	
	The 115th "Foundation Course for Agricultural Research Service (FOCARS)"	ICAR-NAARM, Hyderabad	ICAR-NAARM, Hyderabad	11 Aug to 25 Nov
N Mandal	MCAER workshop on "Redefining Agriculture research Ecosystem in Maharashtra"	Maharashtra State Faculty Development Academy, Pune	MCAER	29 to 30 Oct

Name of staff	Title	Venue	Organised by	Dates
SB Chavan	"Review and Monitoring of Foreign-Aided Projects" for the period Jan 2025 to June 2025	ICAR-NIASM, Baramati	NRM Division, ICAR	03 to 04 Nov
VD Kakade	International conference on "WE-CARE-2025: Worldwide Efforts on Cutting-Edge Approaches for Restoring Saline Ecosystems" Oral presentation on 'Adaptation Strategies and Salinity Tolerance Mechanisms in Dragon Fruit (*Selenicereus* spp.) Genotypes'	ICAR-CCARI, Goa	ICAR-CSSRI, Karnal and ICAR-CCARI, Goa in collaboration with ISSSWQ, Karnal	29 Oct to 01 Nov
S Rathod	Eleventh International Conference on "Statistics for the Twenty-first Century-2025" (ICSTC-2025)	Department of Statistics, University of Kerala, Thiruvananthapuram, (Online mode)	International Statistical Fraternity (ISF) in association with the School of Physical and Mathematical Sciences and Department of Statistics, University of Kerala, Thiruvananthapuram	16 to 19 Dec
NC Paul	Eleventh International Conference on "Statistics for Twenty-first Century-2025" (ICSTC-2025)	Department of Statistics, University of Kerala, Thiruvananthapuram, (Online mode)	International Statistical Fraternity (ISF) in association with the School of Physical and Mathematical Sciences and Department of Statistics, University of Kerala, Thiruvananthapuram	16 to 19 Dec
NP Kurade	Brainstorming Workshop on "Biotic and Abiotic Stress Management and Policy Issues in Indian Agriculture"	ICAR-NIBSM, Raipur	ICAR-NIBSM, Raipur and ICAR-NIASM, Baramati	21 to 22 Jul

Name of staff	Title	Venue	Organised by	Dates
PS Basavaraj	National Conference on "Advances in Climate-Conscious Crop Science: Genetics, Genomics and Breeding"	UAS, GKVK, Bengaluru	Indian Society of Genetics and Plant Breeding and UAS, Bengaluru	31 Oct to 02 Nov
DD Nangare	59th Annual convention of Indian Society of Agricultural Engineers on "Engineering innovations for agriculture 5.0" and International symposium on "Mechatronics and Robotics in Pre and Post Production Agriculture"	ICAR-CIAE, Bhopal	Indian Society of Agricultural Engineering, New Delhi	10 to 12 Nov
	Workshop on "Redefining Agriculture research Ecosystem in Maharashtra"	Pune	MCAER, Pune and Department of Agriculture, Govt of Maharsahtra	29 to 30 Oct
A Pradhan	Training programme on "Measurement of Uncertainty and Decision Rule" as per requirement of ISO/IEC 17025:2017	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	27 Feb
	Training Programme on "Quality Management System for implementation of ISO/IEC 17025:2017"	ICAR-NIASM, Baramati	ICAR-NIASM, Baramati	03 to 05 Mar
	2nd International conference on "Rainfed Agriculture: Building pathways for resilience & sustainable livelihoods"	ICAR-CRIDA, Hyderabad	ISDA and ICAR-CRIDA, Hyderabad	29 to 31 Jan
	First International conference on "Transforming food, land and water system under global climate change"	ICAR-IIFSR, Modipuram	FSRDA and ICAR-IIFSR	07 to 09 Mar
	6th International Agronomy Congress on "Re-envisioning agronomy for smart agri-food systems	IARI, New Delhi	ISA, ICAR-IARI	24 to 26 Nov

Name of staff	Title	Venue	Organised by	Dates
	and environment stewardship"			
KM Boraiah	National Conference on "Challenges and New Frontiers in Agriculture and Sericulture and Allied Sectors (CHANAS)"	College of Sericulture, Chintamani, UAS, Bengaluru	College of Sericulture, Chintamani, UAS, Bengaluru	23 to 24, Dec
	National Conference on "Advances in Climate-Conscious Crop Science Genetics, Genomics and Breeding"	University of Agricultural Sciences, GKVK, Bengaluru.	Indian Society of Genetics and Plant Breeding	31 Oct to 02 Nov
	3rd International Online Conference on "Agriculture"	Online mode	MDPI, Agronomy	22 to 24 Oct
	Annual Group Meet of AICRN on "Potential Crops"	OUAT, Bhubaneswar	AICRN on Potential Crops & NBPGR, Delhi	24 Sep
	2nd International Conference on "Rainfed Agriculture: Building Pathways for Resilience & Sustainable Livelihoods (RAINBURS-2025)"	ICAR-CRIDA, Hyderabad	Indian Society of Dryland Agriculture	29 to 31 Jan
PS Hanjagi	Training program on "Abiotic stress management in agriculture for enhancing the farmer's income with special reference to millets/ fodder crops cultivation in arid and semi-arid regions of India"	Online mode	ICAR-IIMR and MANAGE, Hyderabad	06 to 10 Jan
	Participated in Pre-Kharif Campaign on "Bharat Krishi-Jagran yatra: Anusandhan Kisan Ke Dwar"	Different villages of Baramati block	ICAR and DA&FW	29 May to 12 Jun

Name of staff	Title	Venue	Organised by	Dates
PS Khapte	ConSEPT 2025-International Dialogue on "Power of Plant Physiology in the multi-omics era" Connecting the dots	Online mode	Department of Crop Physiology, UAS, Bengaluru	27 Sep
	Webinar on "Leaf State Analyser Model LSA-2050 & PAM Chlorophyll Fluorometer with Porometer"	Online mode	M/s. Green Spectrum Technology Pvt. Ltd. New Delhi	17 Oct
	National Conference on "Digital Technologies for Transforming the Horticulture Sector"	ICAR-IARI, New Delhi	Indian Academy of Horticultural Science, New Delhi	28 to 30 Jan
	Indian Horticulture Congress, 2025	UAS, Bangalore	Indian Academy of Horticultural Science, New Delhi	06 to 10 Nov
SS Changan	Workshop on "Anger Management and Effective Public Interaction under iGOT Karmayogi	Online mode	Indian Institute of Public Administration	13 May
	Workshop on "Yoga Break at Workplace" under iGOT Karmayogi	Online mode	Morarji Desai National Institute of Yoga	13 May
	Workshop on "Introduction to Emerging Technologies" under iGOT Karmayogi	Online mode	Capacity Building Commission	27 May


ICAR-National Institute of Abiotic Stress Management

Awards & Recognition

- Dr K Sammi Reddy, selected as Memebr, Executive Council (EC) of Mahatma Phule Krishi Vidyapeeth, Rahuri.
- Dr RN Singh joined Editorial Board of Food Security Journal as Senior Editor.
- Dr RN Singh received Best Oral Presentation award at International Conference on Environment and Sustainable Development, from 03-06 Feb, 2025, at Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi.

- Dr Mahesh Gupta received best oral presentation award for presentation of research work "Effect of Quantum dot butyrate supplementation on performance, egg quality, and intestinal health of layer chicken" in 5th Annual Conference of Animal Physiologists Association at Bidar Veterinary College, organised during 09 to 10 Oct, 2025.
- Dr Mukesh Bhendarkar awarded the Doctoral degree (PhD) for the thesis entitled "Advancing Environmental DNA Approaches for Optimizing Aquatic Ecosystem Monitoring and Ecological Assessment", conducted at the Plentzia Marine Station (PiE-UPV/EHU) in collaboration with AZTI, Spain.

- Dr Hanamant Halli awarded Water Advanced Research and Innovation (WARI) Fellowship (PDF) supported by the Department of Science and Technology, Govt. of India, the University of Nebraska-Lincoln (UNL), the Daugherty Water for Food Institute (DWFI) and the Indo-US Science and Technology Forum (IUSSTF) for the year 2025.
- Dr Hanamant Halli won Silver medal in the Badminton event on ICAR-Western Zone Sports Meet-2024 at ICAR- CICR Nagpur, Maharashtra on 1 to 4 Feb, 2025.

- Dr Amrut Morade received Best Oral Presentation Award at the National Seminar on Digital Technologies for Transforming Horticulture Sector for the presentation titled "Digitalizing Fruit Breeding : Imaging Tools to Decipher Abiotic Stress Tolerance" organized by the Indian Academy of Horticultural Sciences at ICAR-IARI, New Delhi, from 28 to 30 Jan, 2025.

- Dr Vadivel Rajagopal received Innovative Article Award for the article "Soil ecosystem services in arid and semi-arid regions of the Deccan Plateau region: Valuing the benefits of cropping systems and soil management practices." Agriculture & Food: e-Newsletter (Vol. 7, Issue 8). Agriculture & Food Magazine.
- Dr Sangram B Chavan received Fellowship from The Society for Science of Climate Change and Sustainable Environment for the year 2025 on 16 Oct, 2025.
- Dr Sangram B Chavan and Rupali Singh, Nobin Pal, Navyashree P developed Shniy application for calculation of Air pollution tolerance indices.
- Dr Sangram B Chavan recived "RAAST Young Associate Fellowsgip Award – 2025" from Western Ghat Researchers Association of Agricultural Sciences & Technologies, Tamil Nadu.
- Dr Sangram B Chavan and Uthappa AR, Manish rajan, and Perveen Kumar received Copyright of the development of "Wood Bazaar" android based application.
- Dr Sangram B Chavan selected as Editorial Board Member of Discover Forest (2025–2027), with expertise in carbon sequestration; journal link: https://link.springer.com/journal/44415/editorial-board.
- Dr Sangram B Chavan selected as Managing Editor of Indian Journal of Agroforestry, ISAF, Jhansi (UP), India.
- Dr Neeraj Kumar received Fellow of National Academy of Agricultural Sciences on 05 Jun, 2025.

- Dr Neeraj Kumar received Fellow, Bihar Agriculture Science Academy (BASA) on 24 Mar, 2025.
- Dr Neeraj Kumar received Best Indian Fisheries Scientist, Dr. M.S. Swaminathan Award on 12 Jul, 2025.

- Dr Rajagopal Vadivel served as Panellist to the section of "Re-envisioning Agronomy for Smart Agri-food Systems and Environmental Stewardship" in the Sixth International Agronomy Congress organized by IWMI, New Delhi from

24 to 26 Nov, 2025 at CSIR- National Physical Laboratory New Delhi.

- Dr Rajagopal Vadivel presented paper titled "Redesigning intercropping and residue management strategies to optimize nitrogen cycling in natural farming systems" in International conference on Natural Farming, Naturopathy, Yoga, Meditation and Arogya Fair – 2025 organised by Gujarat Natural Farming Science University & Surya Foundation International Naturopathy Organization (INO) in association with Ministry of Ayush, Govt. of India at Gujarat Natural Farming Science University Campus, Halol, Panchmahal, Gujarat, India from 20 to 21 Dec, 2025.
- Dr Rajagopal Vadivel invited as Keynote Speaker and Presented "Effect of pit and soil types on growth and development, nutrient content and fruit quality of pomegranate in the central Deccan plateau region, India" at "8th International virtual conference on food science & nutrition", held during virtual conference, UK London 08 to 09 Feb, 2025.
- Dr GC Wakchaure guided Ms. Eram Fatma, Roll No. IARIBAR20232004, Master of Technology in Agricultural Engineering (Processing and Food Engineering).
- Dr GC Wakchaure guided Swapnil Jain, Roll No: IARIBAR20232009, Master of Technology in Agricultural Engineering (Processing and Food Engineering).
- Dr GC Wakchaure, Aliza Pradhan, Paritosh Kumar, R. S. Choudhary, and K. S. Reddy were awarded the First Prize for Oral Presentation for the paper entitled 'Conservation agriculture strategies for managing the Food–Water–Energy–Environment Nexus in the sugarcane cropping system' during the 59th Annual Convention of the Indian Society of Agricultural Engineers and the International Symposium on 'Mechatronics and Robotics in Pre- and Post-Production Agriculture', held at ICAR-CIAE, Bhopal, from 10 to 12 Nov, 2025.

- Dr DD Nangare working as Vigilance Officer, CPIO and Nodal officer, RTI of NIASM.
- Dr DD Nangare acting as Member of IMC, Directorate of Floriculture, Pune.
- Dr DD Nangare acts as member of Internal screening committee of Periodical review of Technical cadre (Grade A).
- Dr DD Nangare acts as member of Internal review committee of Periodical review of administrative personnel (Group B).
- Dr Aliza Pradhan received FSRDA Young Scientist Award by Farming system research and development association (FSRDA), ICAR-IIFSR, Modipuram.

- Dr Aliza Pradhan received Best oral presentation in 2nd International conference on "Rainfed agriculture: building pathways for resilience and sustainable livelihoods", organized by ISDA and ICAR-CRIDA, from 29 to 31 Jan, 2025.
- Dr Aliza Pradhan received Best Oral presentation at International conference on "Transforming food, land and water system under global climate change", organized by FSRDA and ICAR-IIFSR from 07 to 09 Mar, 2025.
- Dr Aliza Pradhan nominated as member in the team constituted to brainstorm and come out with "Road Map for Viksit Bharat" by ICAR (NRM division).
- Dr Aliza Pradhan delivered Invited lecture on "DOE: Split plot and strip plot data analysis" in 21-day online training programme on "Advanced Statistical and Machine Learning Techniques for Data Analysis Using Open-Source Software for Abiotic Stress Management in Agriculture", 16 Jul to 5 Aug, 2025 at ICAR-NIASM.
- Dr Aliza Pradhan selected as rapporteur in the technical session on "Panel discussion 2: Carbon trading in Agriculture" during the 2nd International conference on "Rainfed agriculture: building pathways for resilience and sustainable livelihoods", organized by ISDA and ICAR-CRIDA, Hyderabad, during 29 to 31 Jan, 2025.
- Dr Aliza Pradhan selected as Rapporteur in the technical session on "Multifunctional landscapes for climate resilience" during sixth international agronomy congress on "Re-envisioning Agronomy for smart Agri-food systems and environmental stewardship", organized by Indian society of Agronomy, during 24 to 26 Nov, 2025.
- Dr Boraiah KM received best oral presentation during National Conference on Challenges and New Frontiers in Agriculture and Sericulture and Allied Sectors held during 23 to 24, December, 2025 at College of Sericulture, Chintamani.
- Dr Prashantkumar S Hanjagi served as reviewer of peer reviewed journals (Journal of Plant Growth Regulation, Scientific Reports, Plant Physiology Reports, Discover Plants, Discover Agriculture, Cereal Research Communications, Plant Methods).
- Dr Prashantkumar S Hanjagi selected as councilor (West zone), Association of Rice Research Workers (ARRW).
- Dr Rafat Sultana delivered lecture in the in-house Training on Design of Experiments and Biometrical Analysis in 21-day online training programme on "Advanced Statistical and Machine Learning Techniques for Data Analysis Using Open-Source Software for Abiotic Stress Management in Agriculture", 16 Jul to 5 Aug, 2025 at ICAR-NIASM.
- Dr Pratapsingh S Khapte received the Best Oral Presentation Award for the research work "Chlorophyll Fluorescence Imaging as a Digital Tool to Decipher Desiccation Tolerance in Eggplant Wild Relatives" at the National Conference on Digital Technologies for Transforming the Horticulture Sector, organized by the Indian Academy of Horticultural Sciences and ICAR at the NASC Complex, New Delhi, from 28 to 30 Jan, 2025.
- Dr Pratapsingh S Khapte received the Best Oral Presentation Award for the research work "Tomato Grafting for Mitigating Abiotic Stresses and

Enhancing Resource Use Efficiency" in Indian Horticulture Congress 2025, organized by the Indian Academy of Horticultural Sciences at UAS, Bangalore from 06 to10 Nov, 2025.

- Dr Sushil Changan has been elected as Councillor of the Indian Potato Association (IPA) Executive for the years 2025–2026, Region-VI.
- Dr Sushil S Changan was invited as Chief Guest at the Science Day Celebration organized by MES's English Medium School, Baramati, on 28 Feb, 2025.
- Dr Sushil S Changan participated as a member of the sports contingent of ICAR–NIASM, Baramati, in the ICAR West Zone Sports Tournament, held at ICAR–Central Institute for Cotton Research, Nagpur, from 01 to 04 Feb, 2025 competing in the Javelin Throw event.
- Dr Sushil S Changan delivered a radio talk titled "किसानवाणी - विकसित कृषी संकल्प अभियान - चर्चासत्र सहभा" which was recorded on 05 Jun, 2025 and broadcasted on 07 Jun, 2025, at 7:30 PM by Akashvani Ahilyanagar (All India Radio, Prasar Bharati).
- Dr Sushil S Changan guided three students named Mr. Atharav Nale, Mr. Shridhar Pawar, and Mr. Aniket Hirave to successfully conduct the activity entitled "In Vitro Estimation of Alpha-Amylase Enzyme Activity" at SDSM, ICAR-NIASM, Baramati, during 03 to 07 Jan, 2025 as part of their project work from College of Pharmacy, Baramati.
- Dr Sushil S Changan acted as a Member of the Research Advisory Board (RAB) of the Anekant Education Society, in alignment with its application for recognition as a Scientific and Industrial Research Organization (SIRO) under the Department of Scientific and Industrial Research (DSIR), Government of India.
- डॉ सुशिल सु चांगण को हिंदी पखवाड़ा में आयोजित प्रतियोगि "हिंदी निबंध लेखन"ता में तृतीय स्थान प्राप्त किया।
- डॉ सुशिल सु चांगण को हिंदी पखवाड़ा में आयोजित "हिंदी टिप्पण" प्रतियोगिता में प्रोत्साहन पर स्थान प्राप्त किया।
- डॉ सुशिल सु चांगण को हिंदी पखवाड़ा में आयोजित "हिंदी प्रश्नोत्तरी "प्रतियोगिता में द्वितीय स्थान प्राप्त किया।


ICAR-National Institute of
Abiotic Stress Management

Linkages & Collaborations

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

Maharashtra Animal & Fishery Sciences University, Nagpur

Kamdhenu University, Gandhinagar, Gujarat

University of Agricultural Sciences, GKVK, Bangalore

University of Agricultural Sciences, Dharwad

University of Agricultural Sciences, Raichur

Agharkar Research Institute, Pune

Shivnagar Vidya Prasarak Mandal, Malegaon, Baramati

University of Horticulture, Bagalkot

International Water Management Institute, New Delhi

Vasanth Dada Sugar Institute, Pune

Lovely Professional University, Punjab

BAIF Development Research Foundation, Pune

Agriculture Tourism Development Cooperation, Pune

MITCON Consultancy & Engineering Services Ltd., Pune

Yara Fertilisers India Pvt. Ltd.

iiCARE Foundation, Navi Mumbai

Ambronics Private Limited, Parbhani

Association for Innovation Development of Entrepreneurship in Agriculture (a-IDEA), Hyderabad

Alliance Bioversity & CIAT, New Delhi

Privi Life science, Pvt Ltd, Mumbai

Tradecorp Rovensa India Private Limited, Pune

Novem Solutions Private Limited, Hospet, Karnataka

Baramati Cattlefeeds Pvt Ltd (Hindustan Feeds), Baramati

Publications

Research Publications

1. Adhau A, Kadam J, Sanap P, Damodhar V, Dalavi P (2025) Storage stability and sensory quality assessment of value-added kokum mukhwas prepared from rind waste. European Journal of Nutrition and Food Safety. 17(11): 189–203.
2. Adhau AS, Kadam JK, Shirke GD, Swami SB (2025) Storage stability and sensory evaluation of value added kokum candy developed from rind waste. International Journal of Advanced Biochemistry. SP-9(10): 492–501.
3. Ali S, Vasudev L, Salma, Jhariya MK, Banerjee A, Singh L, Chavan SB, Singh JS (2025) Soil nutrient dynamics under horse gram intercropping in Melia dubia–based agroforestry in the Central Dry Zone of Karnataka. Indian Journal of Ecology. 52(5): 1212–1220. DOI: 10.55362/IJE/2025/4637.
4. Arambam K, Krishnani KK, Singh RD, Verma AK, Banerjee K, Chanu TI, Kumar N (2025) Medicinal plant-product encapsulated with herb-hydrogel for ammonia removal and stress alleviation in semi-biofloc system containing aquaponics water cultured with *Pangasianodon hypophthalmus*. Aquaculture. 601: 742285.
5. Arambam K, Krishnani KK, Singh RD, Verma AK, Banerjee K, Chanu TI, Neeraj Kumar (2025) Medicinal and aromatic plants assisted bioremediation of ammonical and bacterial contaminants in aquaponics water. Water Environment Research. 97(2): e70017.
6. Basavaraj PS, Babar R, Gangurde A, Lakshmi VG, Shinde S, Gund S, Boraiah KM, Harisha CB, Halli HM, Sreekanth D, Rane J, Nair RM, Reddy KS (2026) Unveiling drought-tolerant mungbean genotypes through integrated multi-trait selection. Scientific Reports. Article number: (2026). DOI: 10.1038/s41598-026-36830-6.
7. Basavaraj PS, Rane J, Ishwaryalakshmi VG, Kumar AC, Kumar M, Babar R, Gangurde A, Shinde S, Sreekanth D, Boraiah KM, Harisha CB, Halli H, Reddy KS, Prabhakar M (2025) Unravelling chickpea (*Cicer arietinum* L.) genotype stability through univariate and multivariate approaches under varying soil types and water regimes. Indian Journal of Genetics and Plant Breeding. 85(4): 578–592.
8. Basavaraj PS, Rane J, Jangid KK, Babar R, Kumar M, Gangurde A, Shinde S, Boraiah KM, Harisha CB, Halli HM, Reddy KS, Prabhakar M (2025) Index-based selection of chickpea (*Cicer arietinum* L.) genotypes for enhanced drought tolerance. Scientific Reports. 15: 8282. DOI: 10.1038/s41598-025-8282-x.
9. Basavaraj PS, Tripathi K, Sreekanth D, Boraiah KM, Harisha CB, Halli HM, Reddy KS (2025) Identification of heat

tolerant cowpea genotypes based on yield and stress tolerance indices. Journal of Crop Improvement. 39(6): 544–567. DOI: 10.1080/15427528.2025.2575914.

10. Bhendarkar M, Canals O, Jurado C, Mendibil I, Uriarte A, Borja A, Rodríguez Ezpeleta N (2025) Advancing ecological assessment: Towards the integration of eDNA metabarcoding into an estuarine fish index. Ecological Indicators. 181: 114464. DOI: 10.1016/j.ecolind.2025.114464.
11. Bhuvad VR, Ranveer RC, Patange SB, Pardeshi IL, Kadam JH (2025) Fortification of lemon ready-to-serve beverage with astaxanthin beads using spherification technology. European Journal of Nutrition and Food Safety. 17(9):222–231.
12. Bisht A, Maurya SK, Bhatt L, Singh D, Prasad B, Verma S, Kumar V, Khapte PS, Gruda NS, Kumar P (2025) Exploitation of heterosis for yield and quality enhancement in pumpkin (*Cucurbita moschata* Duch. ex Poir.). Horticulturae. 11(5): 473. DOI: 10.3390/horticulturae11050473.
13. Chaudhary VP, Sawant CP, Gupta A, Gautam R, Khadatkar A, Magar AP, Wakchaure GC, Kumar V, Chaudhary R (2025) Long-term zero tillage with residue retention boosts yield, enhances energy efficiency, and mitigates greenhouse gas emissions in the western Indo-Gangetic rice–wheat systems. Frontiers in Sustainable Food Systems. 9: 1672467. DOI: 10.3389/fsufs.2025.1672467.
14. Chavan N, Gupta M, Bahiram KB, Korde JP, Kadam M, Dhok A, Kumar S (2025) *Ligilactobacillus salivarius* and *Limosilactobacillus reuteri* improve growth and intestinal health in broilers via modulating gut microbiota and immune response. Research in Veterinary Science. 194: 105837. DOI: 10.1016/j.rvsc.2025.105837.
15. Chavan SB, Rawale GB, Pradhan A, Uthappa AR, Kakade VD, Morade AS, Paul N, Das B, Chichaghare AR, Changan S, Khapte PS, Basavaraj PS, Babar R, Salunkhe VS, Jinger D, Nangare DD, Reddy KS (2025) Optimizing tree shade gradients *in Emblica officinalis*-based agroforestry systems: impacts on soybean physio-biochemical traits and yield under degraded soils. Agroforestry Systems. 99: 21. DOI: 10.1007/s10457-024-01123-2.
16. Chavan SB, Rawale GB, Uthappa AR, Harisha CB, Kakade VD, Morade AS, Changan SS, Chichaghare AR, Das B, Jinger D, Basavaraj PS, Yadav DK, Ravi Kumar K, Babar RRS, Reddy KS (2025) Do different plant host species influence the response of *Santalum album* under moisture deficit stress? Agroforestry Systems. 99(7): 185.
17. Chichaghare AR, Chavan SB, Rawale GB, Uthappa AR, Kakade VD, Morade AS, et al. (2026) Tree shade mitigates stress and enhances chickpea productivity: insights from an Emblica officinalis-based agroforestry system in semi-arid shallow basaltic Deccan Plateau, India. Trees, Forests and People. Article number: 101164.
18. Chidambaranathan P, Nayak G, Jeughale KP, Selvaraj S, Balasubramania Sai C, Awaji S, Navadagi DB, Katara JL, Samantaray S (2025) *OsNCED2*, *OsNAM*, and *OsDEC* genes association with vegetative stage drought stress in rice validated through Mendelian randomization. The Nucleus. pp. 1–14.
19. Das B, Sah S, Reddy KV et al. (2025) Assessment of climate change vulnerability of agriculture in coastal districts of India using principal component analysis and entropy-based methods. Theoretical and Applied Climatology. 156: 409. DOI: 10.1007/s00704-025-05623-8.
20. Dharamsheela T, Sultana R, Singh R, Roy PK, Sinha S (2025) Assessment of genetic diversity in chickpea (*Cicer arietinum* L.) genotypes using SSR markers. Plant Archives. 25(1): 1926–1932.
21. Dhaygude VS, Mote CS, Bhong CD, Budhe MS, Swami SB, Pawar SS, Kamdi

BP, Kurkure NV (2025) Prevalence and clinico-pathological insights on *OvHV-2* infection in buffaloes reared in close contact with sheep from western part of India. Comparative Clinical Pathology. 34: 921–928. DOI: 10.1007/s00580-025-03701-x.
22. Dubey AK, Jha PK, Kumari S, Singh RN, Tamta M, Sah S, Kumar S, Kumar S, Kumar R, Saurabh K, Kumar R, Das A, Prasad PVV, Choudhary AK (2025) Predicting yellow mosaic disease severity in yardlong bean using visible imaging coupled with machine learning model. Scientific Reports. 15: 24886. DOI: 10.1038/s41598-025-09176-8.
23. Ganeshkar P, Sharma R, Kumar T, Kumar P, Reddy KS, Kumar N (2025) Eco-friendly nano-copper synthesis: gene and enzyme modulation for combating cadmium and ammonia toxicity in fish. Biological Trace Element Research. 203:5657–5675.
24. Gangana Gowdra VM, Lalitha BS, Halli HM, Senthamil E, Negi P, Jayadeva HM et al. (2025) Root growth, yield and stress tolerance of soybean to transient waterlogging under different climatic regimes. Scientific Reports. 15(1): 6968. DOI: 10.1038/s41598-025-91780-9.
25. Ghatak A, Kumar A, Mandal N, Das A, Gaber AO, Hossain A, Singh AK (2025) Copper and silver nanoparticle suppresses *Fusarium oxysporum* f. sp. ciceris causing root-borne disease pathogen in chickpea (*Cicer arietinum* L.). Journal of Plant Pathology. DOI: 10.1007/s42161-025-02041-7.
26. Gopalakrishnan B, Bhavani E, Kumari VV, Jain N, Paul NC, Deo A et al. (2026) Climate hazard linked adaptation options for soybean in South Asian region – a meta-analysis. Journal of Soil Science and Plant Nutrition. pp. 1–15.
27. Gupta SK, Gupta R, Nage S, Kumar N, Kumari R, Gupta A, Foysal MJ, Sarkar B, Krishnani KK (2025) Heavy metal accumulation and biomarker responses of Nile tilapia from a coal void reservoir cage aquaculture system. Journal of Hazardous Materials Advances. :100631.
28. Gurumurthy S, Solanke AP, Halli HM, Khapte PS, Prakasha TL, Singh JB, Hazra KK (2025) Harnessing potential of summer chickpea (*Cicer arietinum* L.) under drought-prone shallow basaltic soils of semi-arid tropics. Journal of Agronomy and Crop Science. 211(6): e70128. DOI: 10.1111/jac.70128.
29. Halli HM, Shivakumar BG, Wasnik VK, Govindasamy P, Yadav VK, Swami S et al. (2025) Co-implementation of deficit irrigation and nutrient management strategies to strengthen soil-plant-seed nexus, water use efficiency, and yield sustainability in fodder corn. European Journal of Agronomy. 168: 127609. DOI: 10.1016/j.eja.2025.127609.
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31. Hegde V, Sunoj VSJ, Pradhan A, Mohanty D, Rathod T, Rane J (2025) Chlorophyll fluorescence transients as indicators for rapid detection of desiccation in sugarcane (*Saccharum officinarum* L.). Plant Physiology Reports. DOI: 10.1007/s40502-025-00892-x.
32. Hegde V, Boraiah KM, Rane J (2025) Assessing the efficacy of orthosilicic acid in enhancing PS-II efficiency of minor millets to desiccation stress. National Academy Science Letters. https://doi.org/10.1007/s40009-025-01619-0
33. Imam Z, Sultana R, Rabiya P, Mankesh K, Nahakpam S, Reena K, Jyoti K, Kohli A, Singh AK, Choudhary AK, Bhadana VP, Saxena KB (2025) Assessment of heat tolerance indices and multivariate approaches for screening chickpea (*Cicer arietinum* L.) genotypes under field stress conditions. Plant Physiology

Reports. DOI: 10.1007/s40502-025-00918-4.

34. Jadhav P, Dhumal SS, Boraiah KM, Kate P, Kakade V, Basavaraj PS, Harisha CB, Halli HM, Kshirsagar DB, Patil BT, Pal KK, Ranpise SA, Reddy KS, Rane J, Pathak H (2025) Floral and pollination biology of dragon fruit reveals strategies for enhancing productivity through pollination management and reproductive window extension. Scientific Reports. 15: 37296. DOI: 10.1038/s41598-025-21168-2.
35. Jagtap DP, Kadam JH, Shirke GD, Ranveer RC, Swami SB, Kamat AS (2025) Encapsulation of curcumin through spherification: A novel nutraceutical approach. International Journal of Advanced Biochemistry Research. SP-9(10): 365–370.
36. Jagushte AS, Kadam JH, Shirke GD, Ranveer RC, Pardeshi IL (2025) Optimization of alkaline extraction method for natural dye extraction from arecanut husk. International Journal of Advanced Biochemistry Research. 9(10): 88–91.
37. Jena GG, Nangare DD, Kakade VD, Morade AS et al. (2025) Effects of deficit irrigation and growth regulators on physio-biochemical changes, yield, fruit quality and water productivity in pomegranate (*Punica granatum*) growing in shallow basaltic soils. Irrigation and Drainage. DOI: 10.1002/ird.70044.
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39. Kakade VD, Kumar R, Jinger D, Morade A, Dinesh D, Singh G, Chavan SB, Salunkhe V, Pradhan A, Reddy KS (2025) Soil- and moisture-saving techniques improve rain-fed sapota tree growth, productivity, and fruit quality in semi-arid degraded ravine lands. Applied Fruit Science. 67: 230. DOI: 10.1007/s10341-025-01445-0.
40. Kaur S, Gill K, Kaur N, Mishra SK, Sandhu S (2025) Response of wheat cultivars under varied irrigation regimes, temporal adjustments and locations in Punjab. Indian Journal of Agronomy. 70(3): 259–268. DOI: 10.59797/ija.v70.i3.5614.
41. Keerthika A, Parthiban KT, Chavan SB, Shukla AK, Gupta DK, Venkatesh V (2025) Leaf litter decomposition in different tree species of multifunctional agroforestry: decay constant and initial litter chemistry. Environment, Development and Sustainability. 27(7): 17005–17027.
42. Keerthika A, Parthiban KT, Chavan SB, Uthappa AR, Gupta DK, Verma A, Shukla AK, Mehta RS (2025) Integrating ecosystem services through sustainable land-use approaches in multifunctional agroforestry: the case of Tamil Nadu, southern India. Environmental and Sustainability Indicators. 28: 100998.
43. Khapte PS, Chavan LS, Changan SS, Wakchaure GC, Patil RA, Yadav LP, Singh TH, Reddy KS (2025) Synergistic potential of deficit irrigation and grafted eggplant on wild rootstocks for enhanced growth, yield, and water productivity. Applied Water Science. 15(10): 249.
44. Kochewad SA, Kumar N, Meena LR, Kumar KR, Chavan SB, Wakchaure GC, Pawar SS, Kurade NP, Nirmale AV, Kumar S, Reddy KS (2025) Self-sustaining goat farming model for abiotic stressed regions: a pathway to livelihood improvement for small and marginal farmers. International Journal of Environmental Sciences and Natural Resources. 35(4): 556419. DOI: 10.19080/IJESNR.2025.35.556419.

45. Kulkarni SS, Gadakh SR, Gaikwad RA, More SR, Boraiah KM (2025) Response of contrasting groundnut genotypes to water deficit during pre- and post-flowering stages. International Journal of Agriculture and Plant Science. 7(2): 69–74.
46. Kumar PS, Birundha MK, Pushpavalli S, Arthee R, Shuprajhaa T, Wakchaure GC (2025) Enhancing the dietary fibre in muffins with banana peel powder and evaluating its effect on physicochemical characteristics, textural quality and storage life. Discover Food. 5: 231. DOI: 10.1007/s44187-025-00544-x.
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1. Rathod S, Paul NC, Navyasree P, Kumar KR, Kumar P (Eds) (2025) Design of Experiments and Biometrical Analysis. ICAR-NIASM, Baramati. ISBN 978-81-985897-3-6
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1. Kadam JH, Morade AM, Kakade VD, Reddy KS and Dey R. 2025. Meta-analysis of critical threshold limits for abiotic stresses in fruit crops: Current research status and gaps. Paper presented at the 11th Indian Horticulture Congress 2025 and International Meet on Horticulture for Inclusive, Equitable and Sustainable Growth, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India.
2. Kadam JH, Reddy KS and Dey R. 2025. Present status and prospects of turmeric in India. In: Souvenir of the National Conference on Value Chain Management in Spices and Aromatic Plants for Profit Optimization and Resilience, pp. 12–13. Jain Irrigation Systems Limited, Jalgaon, Maharashtra, India.
3. Kochewad SA, Chavan S, Kumar N and Reddy KS. 2025. Self-sustaining goat farming model for livelihood improvement of small and marginal farmers. In: National Seminar on Agri-Diversification and Eco-Regional Farming, ICAR-Mahatma Gandhi Integrated Farming Research Institute, Piprakothi, Motihari, Bihar, India (March 4–5, 2025).
4. Kochewad SA, Pradhan A, Rajagopal V, Salunkhe V, Wakchaure GC, Chaudhary A, Chavan S, Rajkumar B, Kakade V, Halli HM, Gopalakrishnan B, Kumar N, Kumar KR, Meena LR, Subash N, Taware P, Chahande P and Reddy KS. 2024. Improving marginal land and generating sustainable farm income through a multilayer integrated farming system approach. In: Global Soils Conference 2024, Indian Society of Soil Science, NASC Complex, New Delhi, India (November 19–22, 2024).
5. Kochewad SA, Pradhan A, Rajagopal V, Salunkhe V, Wakchaure GC, Chavan S, Kumar N, Rajkumar B, Kakade V, Halli H, Gopalakrishnan A, Kumar KR, Meena LR, Subas N, Taware P, Chahande P and Reddy KS. 2024. Climate resilient integrated farming system model for improving farmer livelihoods in semi-arid regions. In: 8th National Youth Convention on New Perspectives for Sustainable Agriculture and Livelihood Security, Banaras Hindu University, Varanasi, Uttar Pradesh, India (August 22–23, 2024).


ICAR-National Institute of Abiotic Stress Management

Ongoing Projects

Umbrella Project I: Developing Abiotic Stress Information System

1. ***Abiotic Stress Information System (ASIS): Geo-spatial digital maps of multiple abiotic stresses, management options and future scenarios (IXX15697)***

   Investigators: BB Gaikwad, DD Nangare, NP Kurade, SS Pawar, Gopalakrishnan B, RN Singh

2. ***Climate variability, teleconnections and their impact on selected crops of India (4/CIN/IPP/IXX20119)***

   Investigators: RN Singh, Sonam, AK Singh, K Sammi Reddy, L Vishnoi

3. ***Quantifying the extent of water stressed soybean and cotton areas in relation to meteorological variables in Vidarbha region using remote sensing (24/CI/IPP/202401)***

   Investigators: Sonam, RN Singh, KK Pal, K Sammi Reddy, Bappa Das

4. ***Pilot study on multiple abiotic stress mapping for Western Maharashtra (24/CI/IPP/IXX20117)***

   Investigators: BB Gaikwad, Nobin Paul, RN Singh, V Rajagopal, K Sammi Reddy, G Obi Reddy, N Kumar, NG Patil

5. ***Development of Integrated Drought Index and Stress Mapping for Selected Drought-Prone Areas of Western Maharashtra***

   Investigators: N Ponnaganti, BB Gaikwad, RN Singh, DD Nangare

6. ***Atlas of Climate Adaptation in South Asian Agriculture (ACASA): Interconnections between climate risks, practices, technologies and policies (OXX7240) (Externally aided project: Funded by Bill and Melinda Gates Foundation)***

   Investigator Gopalkrishnan B/ BB Gaikwad

Umbrella Project II: Identifying Abiotic Stress Tolerant Genotypes for Climate Resilient Agriculture

1. ***Exploring morpho-physiological, biochemical, and molecular traits in onion and its wild relatives for tolerance to combined waterlogging and anthracnose (24/CI/IPP/IXX20122)***

Investigators: VN Salunkhe, PS Khapte, SS Changan, G Pranjali (DOGR)

2. ***Development of mitigation strategies for waterlogging in litchi orchards***

Investigators: VD Kakade, AS Morade, SB Chavan, K Ravi Kumar, Paritosh Kumar, K Sammi Reddy, B Vijayam, S Kumar (ICAR-NRC Litchi)

3. ***Germplasm conservation and Management (GCM): Genetic Garden and gene bank for abiotic stress tolerant plants, animals and fisheries for food security and sustainability (IXX15674)***

Investigators: Boraiah KM, AK Singh, Basavaraj PS, Rajkumar, Karthikeyan N (Study leave), Paritosh Kumar, SA Kochewad, MP Bhendarkar, Harisha CB, PS Khapte, VD Kakade, Gurumurthy S, Neeraj K, HM Halli, PB Taware, A More, R Gophane, L Aher.

4. ***Evaluation and identification of novel Pigeon pea genotypes for water and temperature stress tolerance and deciphering the underlying mechanism through omics approaches***

Investigators: PS Hanjagi, AK Singh, S Naik, SM Awaji, BB Gaikwad

5. ***Exploiting CAM-photosynthetic transition for imparting multiple abiotic stress tolerance in Pulses and Oilseeds***

Investigators: KKant Pal, RDey, Boraiah KM, PS Hanjagi, SS Changan, Basavaraj PS, K Sammi Reddy

6. ***Identification of potential rootstocks for tomato grafting to alleviate water stress***

Investigators: PS Khapte, SS Changan, Basavaraj PS, SM Awaji, VN Salunkhe, GC Wakchaure, KK Pal

7. ***Genomics, genetic and molecular approaches to improve water stress tolerance in soybean and wheat (IXX15660), Inhouse project***

Investigators: AK Singh, SA Kochewad, VN Salunkhe, Neeraj Kumar, Karthykeyan N (Study leave), Paritosh Kumar

8. ***Development of effective mass propagation technique for rapid multiplication and easy transportation of quality planting material in Bajra X Napier hybrid. (Externally aided project: Funded by Department of Animal Husbandry & Dairying under National Livestock Mission)***

Investigators: HM Halli, Basavaraj PS, SB Chavan, K Sammi Reddy

9. ***Phenotyping of pulses for enhanced tolerance to drought and heat. (OXX01737) (Externally aided project funded by NICRA, CRIDA, Hyderabad)***

Investigators: Basavaraj PS, Aliza Pradhan, Boraiah KM, RN Singh, K Sammi Reddy

10. ***Salinity and drought tolerance studies in Mango (Mangifera indica L.) (024/S/IPP/IXX20121)***

Investigators: AS Morade, VD Kakade, Boraiah KM, SS Changan, SB Chavan, Neeraj Kumar

Umbrella Project III: Genome Editing for Enhancing Abiotic Stress Tolerance in Major Crops

1. ***Genome Editing for improvement of abiotic stress tolerance in soybean through targeted knockout of negative regulators (24/S/IFX/202403) (externally aided project: ICAR, New Delhi)***

Investigators: AK Singh, SAwaji, Boraiah KM, Basavaraj, PS Khapte, SS Changan, Aliza Pradhan, GC Wakchaure, K Sammi Reddy

Umbrella Project IV: Evaluation of Alternate or New Crops for Building Resilience in Multiple Stressed Areas

1. ***Augmenting farm income in water scare regions with alternative crops (IXX15656)***

Investigators: Aliza Pradhan, AK Singh, DD Nangare, GC Wakchaure, Karthikeyan N (Study leave), Boraiah KM, SA Kochewad, RN Singh, Basavaraj PS, Harisha CB, H M Halli, Paritosh Kumar, Neeraj Kumar, R Dey, KK Pal, SS Changan, Santosh HB, K Bhojaraja Naik, PH Kuchanur

Umbrella Project V: Climate Smart Integrated Farming Systems for Risk Alleviation

1. ***Climate-smart IFS (CIFS): Climate resilient integrated farming system in semiarid region (IXX15697)***

Investigators: SA Kochewad, GC Wakchaure, VN Salunkhe, Rajkumar, Aliza Pradhan, SB Chavan, VD Kakade, V Rajagopal, HM Halli, Neeraj Kumar, Gopalakrishnan B, N Subash (IARI), Laxman Meena (ICAR-IIFSR), PB Taware, P Chahande.

Umbrella Project VI: Developing Nature Positive Solutions for Abiotic Stress Management (e.g. CA, Agroforestry, Microbial & Nano Formulations, INM, Biochar, NF, OF, Deficit Irrigation etc.)

1. ***Climate resilient agriculture practices for enhancing food grain production from low soil available water storage capacity areas of Deccan Plateau region (024/CI/IPP/IXX20120)***

Investigators: Rajagopal V, KS Reddy, BB Gaikwad, Aliza Pradhan, Nobin Paul, Nirmal Kumar

2. ***Development of bacterial consortia for alleviation of drought- and salinity-stress, and enhancing nutrient availability and uptake in Soybean and Sugarcane***

Investigators: R Dey, KK Pal, Karthikeyan N (Study leave), V Rajagopal

3. ***Model Green Farm (MGF): Environment friendly, economically viable, state-of the-art model farm for abiotic stressed regions (IXX15700)***

Investigators: DD Nangare, GC Wakchaure, BB Gaikwad, VN Salunkhe, Rajkumar, Paritosh Kumar, Aliza Pradhan, MP Bhendarkar, SB Chavan, VD Kakade, PS Khapte, HM Halli, V Rajagopal, AS Morade, SS Changan, R Dey, PB Taware, R Gophane, N Shaikh, S Pawar, AV Nirmale

4. ***Mitigating water stress effects in vegetable and orchard crops (IXX16553)***

Investigators: GC Wakchaure, DD Nangare, Aliza Pradhan, KM Boraiah, PS Khapte

5. ***Conversion of Sugarcane crop residue into Bio-engineered pellet/cake for alleviation of multiple edaphic stresses of semiarid tropics***

Investigators: Paritosh Kumar, R Dey, Neeraj Kumar, GC Wakchaure, SA Kochewad

6. ***Marginal quality water remediation by integrated constructed wetland and aquaponics (IXX19881)***

Investigators: Paritosh Kumar, Harisha CB, Neeraj Kumar

7. ***Assessing the host-sandalwood interactions under abiotic stressed environment for adaptability & income generation (24/S/IPP/IXX20123)***

Investigators: SB Chavan, Harisha CB, VD Kakade, AS Morade, SS Changan, K Ravi Kumar

8. ***Studies on synthesis of cerium nanoparticles and evaluation of its potential to alleviate water deficit stress in soybean***

Investigators: SS Changan, PS Khapte, Neeraj Kumar, KK Pal

9. ***Establishment of model herbal garden for medicinal and aromatic plants (OXX4927) (Externally aided project: NMPB, New Delhi)***

Investigators: Harisha CB, DD Nangare

10. ***Development of Agroforestry Business Models for long term sustainability (Contractual project, Funded by MITCON)***

Investigators: SB Chavan, K Sammi Reddy, VD Kakade, AS Morade, K Ravi Kumar, VN Salunkhe

11. ***Development of Climate Resilient CHARA Bank (Fodder system) for round-the-year fodder availability for livestock in drought-prone regions (Externally aided project: Funded by NABARD)***

Investigators: SB Chavan, BB Gaikwad, HM Halli, VD Kakade, AS Morade, K Ravi Kumar, NP Kurade, SS Pawar, SA Kochewad, K Sammi Reddy

12. ***Developing Allometric Equations for Biomass and Carbon Estimation in Ultra-High Density Mango Plantations (Contractual research project: Funded by Varaha Limateag Pvt Ltd, Haryana)***

Investigators: SB Chavan, N Paul, AS Morade; VD Kakade, K Sammi Reddy

13. ***Ensuring livelihood and environmental security through natural Farming practices in Abiotic-stressed regions of Maharashtra and Andhra Pradesh (Externally aided research project: Funded by RySS)***

Investigators: SB Chavan, Aliza Pradhan, VD Kakade, AS Morade, Rajagopal V, N Kartikeyan (Study leave), Harisha CB, VN Salunkhe, P Navyashree, A Velmurugan, K Sammi Reddy

14. ***Evaluation of Ambronics pot in alleviating drought stress in tomato (OXX20242) (Contractual project funded by Ambronics Pvt Ltd)***

Investigators: AS Morade, VD Kakade, PS Khapte, SS Chavan, DD Nangare, K Sammi Reddy

15. ***Appraisal of nutrient management systems influence on soil quality and resilience under rice cultivation at different landscape positions (Externally aided research project: Nature+ of Bioversity International, CIAT, Columbia)***

Investigators: Rajagopal V, SB Chavan, HM Halli, KK Pal, K Sammi Reddy

16. ***Enhancing Soil Moisture Retention in Tomato Cultivation through Rovensa Products: A Field Study (Externally aided project: Funded by Tradecorp Rovensa India Pvt Ltd, Pune)***

Investigators: VD Kakade, AS Morade, PS Khapte, Harisha CB, Aliza Pradhan, DD Nangare, SB Chavan, K Sammi Reddy

17. ***Conservation Agriculture for Enhancing Resource-use Efficiency, Environmental Quality and Productivity of Sugarcane Cropping System (OXX03355, Externally aided project: Funded by ICAR-CRP on CA, IISS, Bhopal)***

Investigators: GC Wakchaure, Aliza Pradhan, K Sammi Reddy, Paritosh Kumar

18. ***Alleviation of drought- and salinity- stress in groundnut by habitat adapted endophytic bacteria (OXX/202401, externally aided research project; funded by AMAAS)***

Investigators: KK Pal, R Dey

19. ***Bio-efficacy of micro-algae derived biostimulant vitaflora in alleviating abiotic stresses (Externally aided project: Funded by Sahyadri Farms Post Harvest Care Limited, Nashik)***

Investigators: PS Khapte, SS Changan, K Sammi Reddy

20. ***Effect of Nano Urea and DAP and popularisation of its use in crop production (Externally aided research project: funded by Dept. of Fertilizers, GoI, New Delhi)***

Investigators: Aliza Pradhan, K Sammi Reddy

Umbrella Project VII. Abiotic Stress Characterization and Management in Livestock

1. ***Adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability (IXX15676)***

Investigators: NP Kurade, SS Pawar, BB Gaikwad, SA Kochewad, Gopalkrishnan B, Rajkumar, MP Bhendarkar, RN Singh, DD Nangare, AV Nirmale, SV Potekar

2. ***Heat stress response studies in Indigenous Goats through functional genomics using transcriptomics approach***

Investigators: SS Pawar, NP Kurade, AK Singh, AV Nirmale

3. ***Assessing feed alternatives modulating enteric methane emission in cattle using metagenomics approach (24/CIN/CPJ/00158, Externally aided project: Funded by Baramati Cattle feeds Pvt. Ltd. Hindustan Feeds group)***

Investigators: SS Pawar, NP Kurade, SA Kochewad, AV Nirmale

Umbrella Project VIII. Ecological assessment and nanotechnology interventions for abiotic stress management in aquaculture and fisheries

1. ***Understanding the molecular basis of emergent contaminant in endocrine disruption in fish and its mitigation using nano-nutrients (25/S/IPP/202501)***

Investigators: Neeraj Kumar, Paritosh Kumar, SA Kochewad, P Kumar (CIFE)

2. ***Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressor (IXX15014)***

Investigators: Neeraj Kumar, AK Singh, Satish Kumar

3. ***Development of Nano-based delivery system to mitigate arsenic pollution, ammonia and temperature stress on growth and immune related gene expression in fish (OXX5181, Externally aided research project: Funded by LBSYSA)***

Principal Investigator Neeraj Kumar

4. ***Molecular characterization and identification of gene involved in the multiple stresses: Nanomaterial for mitigation (OXX5467, Externally aided research project: Funded by DST-SERB)***

Investigator Neeraj Kumar

Umbrella Project IX: Impact Analysis of Target Technologies on Farmers' Fields and Policy Development

1. ***Targeting prospective technologies for abiotic stress resilience in rainfed and dryland region (IXX15699)***

Investigators: K Ravi Kumar, DD Nangare, SS Pawar, SA Kochewad, BB Gaikwad, Rakjumar, Boraiah KM, Kartikeyan N (Study leave), NC Paul, P Navyasree

2. ***Application of Drone in Agriculture Research and Development (OXX5501) (Demonstration Project)***

Investigators: BB Gaikwad; NP Kurade, SS Pawar, Gopalakrishnan B, Rajkumar, S Potekar, Ravi Kumar K, PS Khapte, VN Salunkhe, V Rajagopal, HM Halli, VD Kakade, S B Chavan, Karthikeyan N (Study leave), PB Taware

3. ***Quantifying drought and salinity induced crop yield losses and crafting policy framework in selected drought-prone areas of Western Maharashtra***

Investigators: P Navyasree, NC Paul, K Ravi Kumar, DD Nangare, HM Halli, PS Khapte, BB Choudhary


ICAR-National Institute of
Abiotic Stress Management
Research Highlights
Agenda
• Research Progress
• Collaborations
• Capacity Building
• Outreach
• Future Plans
COLLABORATE
SHARE
INNOVATE
IMPACT
DISCUSS IDEAS
BUILD PARTNERSHIPS
REVIEW PROGRESS
PLAN STRATEGIES
ACHIEVE GOALS

Meetings

15th Institute Research Council meeting (IRC)

15th Institute Research Council (IRC) meeting was held on July 24-25 and July 28, 2025, under the chairmanship of Dr K Sammi Reddy, Director. In his address, the Chairman emphasized the importance of scaling up of NIASM technologies among stakeholders, especially farmers. He encouraged ICAR-NIASM scientists to undertake impactful research, and to focus on the development of technologies and high-quality publications in the area of abiotic stress management in crops, animals, and fish. During his address, Chairman also appraised the scientists about the proceedings of NRM Divisional Meeting held on 21st May 2025 under the chairmanship of Dr AK Nayak, Deputy Director General (NRM). As suggested by the DDG (NRM), with reference to proceedings of NRM Divisional Meeting held on 21st May 2025, and to have 8-10 major research projects at institute level.

13th Research Advisory Committee (RAC) Meeting

The 13th meeting of the RAC of ICAR-National Institute of Abiotic Stress Management, Baramati was held during 29-30 October, 2025 under the chairmanship of Dr. V. Praveen Rao, Former Vice-Chancellor of PJTSAU. The meeting was also attended by other members like Dr. A.K. Pal, Former Joint Director, ICAR-CIFE, Mumbai; Dr. Naveen P. Singh, Commission for Agricultural Costs & Prices, New Delhi; Dr. M. Maheshwari, Former Director (Actg.), ICAR- CRIDA, Hyderabad; Dr. A. Velmurugan, ADG (S&WM), NRM Division, New Delhi; Dr. K. Sammi Reddy, Director, ICAR-NIASM, Baramati and Member Secretary Dr. K.K. Pal, Head, SDSM, ICAR-NIASM, Baramati physically. Besides, Dr. S.M.K. Naqvi, Former Director, ICAR-CSWRI, Avikanagar and Dr. M.N. Jha,

Former Dean, BAU, Pusa participated in the deliberations online. Dr. K. Sammi Reddy, Director, ICAR-NIASM, Baramati welcomed all the members of the committee. In his introductory remark, the chairman emphasized the need for prioritizing the future research keeping in mind the national priority for Viksit Bharat 2047. The key focus areas of deliberations include stress characterization and threshold development, integration of AI, IoT, and digital technologies, impact assessment metrics and indicators, and meta-analysis of crops, livestock, and fisheries under abiotic stress, along with yield gap analysis of major crops across different agro-climatic zones of Maharashtra. The committee also visited experimental plots and laboratories, interacted with scientist and offered valuable suggestions for improvement.

15th Institute Management Committee (IMC) Meeting

The 15th IMC meeting was held on April 30, 2025, at ICAR-NIASM, Baramati. The meeting was chaired by Dr. K Sammi Reddy, Director, ICAR-NIASM, and Members, Dr. A Velmurgan, ADG (S&WM), NRM Division ICAR-Headquarter New Delhi, Dr. S.K. Behra, Head, Division of Soil Chemistry and Fertility, ICAR- IISS, Bhopal, Dr. K. Ramesh, Principal Scientist, ICAR-IIOR, Hyderabad, Dr JVNS Prasad, Principal Scientist, ICAR-CRIDA, Hyderabad, Dr. N.P. Kurade, Principal Scientist, ICAR-NIASM, Baramati, Shri. V.D. Shinde, F&AO ICAR-NRCP,Solapur, and Member Secretary, Shri. Junaidkhan Pathan, AO, ICAR-NIASM, Baramati, participated in the Meeting. The meeting was conducted in physical as well as in online mode. Dr. K. Sammi Reddy, Director, NIASM & Chairman of the Institute Management Committee extended a hearty welcome to the members. The Director gave a brief account of the scientific achievements and present activities of NIASM. Several agendas including the presentation of research highlights, Confirmation of proceedings of the previous 14th IMC meeting agenda item was discussed. Agenda Item for 15th IMC proceeding: Surrendering 01, equipment figured in EFC to accommodate escalated cost of urgently required 02 equipment's listed in EFC was discussed. Agenda item has been considered and approved by the IMC Members. Utilization of fund for the period ending 31st March 2025 and current financial year upto 30th September 2025, staff position as on 30.04.2025 and statement of pending advances with government departments and other bodies from 01.01.2025 to 31.03.2025 were discussed. Conformation of the proceedings has been received from council. The meeting concluded with vote of thanks.

राजभाषा अनुभाग

हिन्दी कार्यशाला का आयोजन

राजभाषा कार्यान्वयन समिति के अध्यक्ष एवं राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान के निदेशक डॉ कोथा सम्मि रेड्डी के मार्गदर्शन में संस्थान में हिन्दी भाषा के रुझान हेतु इस वर्ष कुल 4 हिन्दी कार्यशालाओंका आयोजन किया गया। दिनांक 20 जनवरी, 21 जून, 24 सितंबर और 19 नवंबर 2025 को एकदिवसीय कार्यशालाओंका आयोजन किया गया। इन कार्यशालाओंमें हिन्दी में सरकारी कामकाज करने हेतु टिप्पण प्रारुप लेखन, ई ऑफिस का उपयोग, और हिन्दी में शास्त्रीय लेखन करने हेतु संस्थान के कर्मचारियों को मार्गदर्शन किया गया।


हिन्दी कार्यशाला

संस्थागत राजभाषा कार्यान्वयन समिति की बैठक

कार्यालयिन कामकाज में हिन्दी का अनुप्रयोग बढ़ाने हेतु हर तिमाही में राजभाषा कार्यान्वयन समिति अध्यक्ष एवं निदेशक महोदय की अध्यक्षता में बैठक का आयोजन किया गया। इस शृंखला में दि. 26 फरवरी , 20 जून , 11 सितंबर और 14 नवंबर 2025 को बैठक का आयोजन किया गया। इसमें तिमाही रिपोर्ट के समीक्षण पर तथा उसमें सुधार हेतु चर्चा की गयी। नगर राजभाषा कार्यान्वयन समिति, पुणे (का 2) की सदस्यता प्राप्त होने के बाद संबन्धित बैठकों, कार्यशाला, प्रतियोगिता, आदि कार्यक्रमों में हमारे संस्थान की उपस्थिती अधोरेखित की गयी। नरकास स्तर पर 16 अप्रैल 2025 को आयोजित कार्यशाला में संस्थान के डॉ प्रवीण तावरे ने उपस्थिती जताई। 30 जून 2025 और 27 नवंबर 2025 को आयोजित छमाही बैठक में संस्थान की ओर से उपस्थिती जताई गयी और हिन्दी के रुझान हेतु मार्गदर्शन प्राप्त किया।

हिन्दी पखवाड़ा समारोह

हर साल, केंद्र सरकार के काम में राजभाषा हिंदी में काम करने को बढ़ावा देने के लिए हिंदी दिवस 14 सितंबर से अगले पंद्रह दिनों के लिए विशेष कार्यक्रम आयोजित किए जाते हैं। इस साल भी, हिंदी दिवस और संबंधित कार्यक्रमों का उद्घाटन 14 सितंबर 2025 को हुआ। अगले पंद्रह दिनों के दौरान, हिंदी संदर्भ में नोट लेखन, टाइपिंग, निबंध लेखन, स्वरचित कविता पाठ और प्रश्नोत्तरी प्रतियोगिताओं का आयोजन किया गया। साथ ही, संस्थान के वैज्ञानिक डॉ. परितोष कुमार, डॉ. सुधीर मिश्रा और डॉ. महेश गुप्ता ने छात्रों को हिंदी में शास्त्रीय लेख लिखने के बारे में मार्गदर्शन किया। पुरस्कार वितरण और अंतिम कार्यक्रम 30 सितंबर 2025 को हुआ। कार्यक्रम के मुख्य अतिथि, श्री इंद्रभूषण कुमार, मुख्य प्रशासनिक अधिकारी, CSWRI, अविकानगर ने हिंदी के प्रयोग को बढ़ाने पर विशेष प्रकाश डाला। संस्थान के निदेशक डॉ. कोठा सम्मी रेड्डी ने सभी सत्रों में विशेष मार्गदर्शन दिया और सरकारी कामकाज में हिंदी के प्रयोग को बढ़ाने के लिए अपनी अपेक्षाएं व्यक्त कीं।


हिन्दी पखवाड़ा समापन समारोह

Major Events

One-day workshop-cum-frontline demonstration under CRPCA (27th Jan)

76th Republic Day Celebration (26th Jan)

ICAR-NIASM participated in ICAR-west zone sports tournament at ICAR-CICR, Nagpur (1st-4th Feb)

Organization of Annual Sports Meet (12^{t} - 17th Feb)

ICAR-NIASM celebrated 17th Foundation Day (21st Feb)

One-day demonstration-cum-awareness program under CRPCA SCSP (27th Mar)

Farmers of Karanje Village appreciated ICAR-NIASM DAPSC Activities (14th Apr)

Field day cum farmers-scientist interaction meet under DAPSC (29th Apr)

International Day of YOGA (21st Jun)

Organization of Blood Donation Camp (26th Jun)

Farmer-Scientist Interaction Meeting (11th Jul)

21-day training programme (16th Jul-5th Aug)

Farmer's Training-cum-Awareness Programme under DAPSC (26th Aug)

PM Dhan Dhaanya Krishi Yojana Launch Programme (11th Oct)

Review and Monitoring Meeting of Foreign-Aided Projects under NRM (3rd-4th Nov)

Celebration of Vigilance Awareness Week at ICAR-NIASM (27th Oct-2nd Nov)

PM-KISAN Utsav Diwas' Celebration (19th Nov)

Celebration of Constitution Day (26th Nov)

World Soil Day 2025 Celebration (5th Dec)

Kisan Diwas Programme (23rd Dec)

QRT

RAC

IMC

IJSC

Major Committees

Quinquennial Review Team (QRT)

1. **Dr B Venkateswarlu, Chairman**
   Former Vice Chancellor, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani
2. **Dr. Raj Kumar Sairam, Member**
   Former Head, Division of Plant Physiology, ICAR-Indian Agricultural Research Institute, New Delhi
3. **Dr AL Pharande, Member**
   Former Director of Instruction & Dean, Mahathma Phule Krishi Vidyapeeth, Rahuri & Principal, Jaywantrao Bhosale Krishna College of Agriculture, Rethare, Karad
4. **Dr Asim Kumar Pal, Member**
   Former Joint Director, ICAR-Central Institute of Fisheries Education, Mumbai
5. **Dr NR Patel, Member**
   Head, Agriculture & Soils Department, Indian Institute of Remote Sensing, Dehradun
6. **Dr KK Pal, Member Secretary**
   Head, SDSM, ICAR-National Institute of Abiotic Stress Management, Baramati

Research Advisory Committee (RAC)

1. **Dr V Praveen Rao, Chairman**
   Former Vice-Chancellor, Professor Jayashankar Telangana State Agricultural University, Hyderabad
2. **Dr SMK Naqvi, Member**
   Former Director, Central Sheep and Wool Research Institute, Avikanagar
3. **Dr AK Pal, Member**
   Former Joint Director, ICAR-Central Institute of Fisheries Education, Versova, Mumbai
4. **Dr MN Jha, Member**
   Former Dean, Bihar Agricultural University, Pusa
5. **Dr Naveen P Singh, Member (Official)**
   Member (Official), Commission for Agricultural Costs & Prices, New Delhi
6. **Dr M Maheshwari, Member**
   Former Director (Actg.), ICAR-Central Research Institute for Dryland Agriculture, Hyderabad

7. **Dr A Velmurugan, Member**
   ADG (S&WM), NRM Division, KAB-II, Pusa, New Delhi
8. **Dr KK Pal, Member-Secretary**
   Head, SDSM, ICAR-National Institute of Abiotic Stress Management, Baramati

Institute Management Committee (IMC)

1. **Dr K Sammi Reddy, Chairman IMC & Director,**
   ICAR-National Institute of Abiotic Stress Management, Baramati
2. **Assistant Director General (Soil and Water Management)**,
   Natural Resource Management Division, ICAR Hqrs. New Delhi
3. **Dr KP Mote, Member**
   Director of Horticulture, Representative of Govt. of Maharashtra, Pune
4. **Dr SK Behera, Member**
   Principal Scientist, ICAR-Indian Institute of Soil Sciences, Bhopal
5. **Dr Nitin Kurade, Member**
   Principal Scientist, ICAR-National Institute of Abiotic Stress Management, Baramati
6. **Dr K Ramesh, Member**
   Principal Scientist, NICRA ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
7. **Dr JVNS Prasad, Member**
   Principal Scientist, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
8. **Shri Aniruddha Vasant Pujari, Member**
   Pujari Farm, Solapur
9. **Shri Charles Ekka, Member Secretary**
   Chief Administrative Officer, ICAR-National Institute of Abiotic Stress Management, Baramati
10. **Dr PG Patil, Member**
    Vice Chancellor, Mahatma Phule Krishi Vidyapeeth, Rahuri
11. **Shri Junaidkhan Pathan, Member Secretary**
    Administrative Officer, ICAR-National Institute of Abiotic Stress Management, Baramati

Institute Joint Staff Council (IJSC)

Dr K Sammi Reddy, Chairman IJSC & Director

Category	**Staff Side**		**Office Side**	
Administration	Sh Dayanand P Kharat	Member CJSC	All Heads of School	Members
	Sh Trilok Saini	Secretary IJSC	Administrative Officer	Member
Technical	Sh Pravin More	Member	Chief Finance & Accounts Officer	Member
	Sh Patwaru Chahande	Member	Smt Purnima Ghadge	Member Secretary
	Sh Pradnya Deshpande	Member		

Personnel

Staff of ICAR-NIASM

Director	
Dr K Sammi Reddy	
SCIENTIFIC STAFF	
School of Atmospheric Stress Management	
1.	Dr Ajay K Singh, Head & Principal Scientist (Agricultural Biotechnology)
2.	Dr Sachinkumar S Pawar, Principal Scientist (Animal Biotechnology)
3.	Dr Bhaskar B Gaikwad, Senior Scientist (Farm Machinery and Power)
4.	Dr Sudhir Kumar Mishra, Senior Scientist (Agricultural Meteorology)
5.	Dr Mahesh Gupta, Senior Scientist (Animal Physiology)
6.	Dr Sushma M Awaji, Scientist (Plant Physiology)
7.	Dr Gopalakrishnan B, Scientist (Environmental Science)
8.	Mr Rajkumar, Scientist (Agricultural Entomology)
9.	Mr Mukesh P Bhendarkar, Scientist (Fisheries Resource Mgmt.)
10.	Dr Ram Narayan Singh, Scientist (Agricultural Meteorology)
School of Drought Stress Management	
1.	Dr Kamal K Pal, Head & Principal Scientist (Microbiology)
2.	Dr Dhananjay D Nangare, Principal Scientist (Soil & Water Cons. Eng.)
3.	Dr Goraksha C Wakchaure, Principal Scientist (Agril. Structure & Process Eng.)
4.	Dr Rafat Sultana, Senior Scientist (Genetics and Plant Breeding)

5. Dr Boraiah KM, Senior Scientist (Genetics and Plant Breeding)
6. Dr Prashantkumar S Hanjagi, Senior Scientist (Plant Physiology)
7. Dr Pratapsingh S Khapte, Senior Scientist (Vegetable Science)
8. Dr Sushil Sudhakar Changan, Scientist (Plant Biochemistry)
9. Dr Aliza Pradhan, Scientist (Agronomy)
10. Dr Basavaraj PS, Scientist (Genetic & Plant Breeding)
11. Dr Sonam, Scientist (Agricultural Meteorology)
12. Dr Nilesh Joshi, Scientist (Genetic & Plant Breeding)

School of Edaphic Stress Management

1. Dr Rinku Dey, Head & Principal Scientist (Microbiology)
2. Dr Jitendrakumar H Kadam, Principal Scientist (Fruit Science)
3. Dr Sanjivkumar A Kochewad, Senior Scientist (LPM)
4. Dr Nintu Mandal, Senior Scientist (Soil Science)
5. Dr Vanita N Salunkhe, Senior Scientist (Plant Pathology)
6. Dr Rajagopal V, Scientist (Soil Chemistry/Fertility/Microbiology)
7. Dr Sangram B Chavan, Senior Scientist (Agroforestry)
8. Dr Harisha CB, Senior Scientist (Spices, plantation, medicinal & aromatic plants)
9. Dr Neeraj Kumar, Senior Scientist (Fish Nutrition)
10. Mr Amrut S Morade, Senior Scientist (Fruit Science)
11. Dr Vijaysinha D Kakade, Senior Scientist (Fruit Science)
12. Mr Karthikeyan N, Scientist (Agricultural Microbiology) (on study leave)
13. Dr Paritosh Kumar, Scientist (Environmental Science)
14. Dr Hanamant M Halli, Scientist (Agronomy)
15. Dr Naveenkumar, Scientist (Soil Science)

School of Social Science and Policy Support

1. Dr Nitin P Kurade, I/C Head & Principal Scientist (Veterinary Pathology)
2. Dr Santosha Rathod, Senior Scientist (Agricultural Statistics)
3. Mr Ravi Kumar, Scientist (Agricultural Extension)
4. Dr Nobin Chandra Paul, Scientist (Agricultural Statistics)
5. Ms Ponnaganti Navyasree, Scientist (Agri. Business Management) (on study leave)
6. Dr Prabhat Kumar, Scientist (Agricultural Statistics)
7. Dr Sayantani Karmakar, Scientist (Agricultural Statistics)

TECHNICAL STAFF	
1.	Dr Avinash V Nirmale, Chief Technical Officer (Animal Science)
2.	Dr Pavin B Taware, Assistant Chief Technical Officer (T 7/8) (Farm)
3.	Mrs Noshin Shaikh, Technical officer (T5) (Civil)
4.	Mr Santosh Pawar, Technical officer (T5) (Electrical)
5.	Mr Pravin More, Technical officer (T5) (Computer)
6.	Mr Rushikesh Gophane, Technical officer (T5) (Horticulture)
7.	Mr Lalitkumar Aher, Technical officer (T5) (Biotechnology)
8.	Mr Sunil Potekar, Technical officer (T5) (Agro-Meteorology)
9.	Mr Patwaru Chahande, Technical officer (T5) (Agriculture)
10.	Mr Aniket More, Technical Assistant (T3) (Field/Farm)
11.	Mr Ashutosh Chandra, Technician (T-1)
12.	Mr Abhaykumar Awasthi, Technician (T-1)
13.	Mr Durub Kumar, Technician (T-1)
14.	Ms Pradnya Deshpande, Technician (T-1)
15.	Ms Suman Kumari, Technician (T-1)
ADMINISTRATIVE & FINANCE STAFF	
1.	Mr Mahesh Khubdikar, Chief Administrative Officer
2.	Dr Sunil Kumar Das, Chief Finance & Accounts Officer
3.	Mr Junaid Pathan, Administrative Officer
4.	Mrs Purnima S Ghadge, Assistant Administrative Officer
5.	Mr Dayanand P Kharat, Assistant Administrative Officer
6.	Mr Girish V Kulkarni, Assistant Administrative Officer
7.	Mr Trilok Saini, Assistant Administrative Officer
8.	Mr Prakhar Tiwari, Assistant
9.	Mr Pratik Chandan, Assistant
10.	Mr Vikas Chaudhary, Assistant
11.	Mr Jayant Khaiwal, Assistant
12.	Mr Kuldeep Vaishya, Assistant

Joinings, Transfers and Promotions of Staff

Name of the staff	Date	Remarks
JOININGS		
Dr Santosha Rathod Senior Scientist (Agricultural Statistics)	15.04.2024	New Joining
Dr SK Mishra Senior Scientist (Agricultural Meteorology)	15.05.2025	New Joining
Dr Mahesh Gupta Senior Scientist (Animal Physiology)	23.05.2025	New Joining
Dr Rafat Sultana Senior Scientist (Genetics & Plant Breeding)	12.06.2025	New Joining
Dr Nintu Mandal Senior Scientist (Soil Science)	30.07.2025	New Joining
Dr Nilesh Joshi Scientist (Genetics and Plant Breeding)	07.07.2025	New Joining
Dr Naveenkumar Scientist (Soil Science)	07.07.2025	New Joining
Dr Prabhat Kumar Scientist (Agricultural Statistics)	07.07.2025	New Joining
Dr Sayantani Karmakar Scientist (Agricultural Statistics)		New Joining
Mr Kuldeep Vaishya Assistant	04.09.2025	Transfer from ICAR-NRCP
TRANSFERS		
Mr Pratik Chandan, Assistant	25.08.2025	Transfer to ICAR-CICR
Mr Vikas Chaudhary, Assistant	25.08.2025	Transfer to ICAR-CCRI
PROMOTIONS		
Dr Sachinkumar S Pawar, Senior Scientist (Biotechnology-AS), promoted to Principal Scientist (RGP 10000) w.e.f. 28.08.2023.		
Dr Goraksha C Wakchaure, Senior Scientist (Agri Structure & Process Engg), promoted to Principal Scientist (RGP 10000) w.e.f. 10.02.2024.		
Dr Bhaskar B Gaikwad, Senior Scientist (Farm Machinery Power), promoted to Senior Scientist (RGP 9000) w.e.f. 17.04.2022.		
Dr Sanjivkumar A Kochewad, Senior Scientist (LPM), promoted to Senior Scientist (RGP 9000) w.e.f. 23.06.2022.		
Dr Vanita N Salunkhe, Senior Scientist (Plant Pathology), promoted to Senior Scientist (RGP 9000) w.e.f. 27.04.2023.		
Dr Boraiah KM, Senior Scientist (Plant Breeding), promoted to Senior Scientist (RGP 9000) w.e.f. 15.09.2024.		
Dr Prashantkumar S Hanjagi, Scientist (Plant Physiology), promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.		

Dr Gurumurthy S, Scientist (Plant Physiology), promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.
Dr Harisha CB, Scientist (Spice Plantation Medicinal & Aromatic Plants), promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.
Dr Pratapsingh S Khapte, Scientist (Vegetable Science), promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.
Dr Amrut S Morade, Scientist (Fruit Science), promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.
Dr Vijaysinha D Kakade, Scientist (Fruit Science), promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.
Dr Gopalakrishnan B, Scientist (Environmental Science), promoted to Promoted to Senior Scientist (RGP 8000) w.e.f. 01.01.2024.
Dr Basavaraj PS, Scientist (Plant Breeding), promoted to Scientist (RGP 7000) w.e.f. 07.01.2024.
Dr Ram Narayan Singh, Scientist (Agricultural Meteorology), promoted to Scientist (RGP 7000) w.e.f. 30.05.2023.
Dr Amresh Chaudhary, Scientist (Soil Science), promoted to Scientist (RGP 7000) w.e.f. 02.07.2023.

Project Activities & Team

Sl.	Project activities	Team
1	Spatiotemporal analysis of rainfall in agro-climatic zones of India	RN Singh, Sonam , Lata Vishnoi, AK Singh, K Sammi Reddy
2	Teleconnections of rainfall with ENSO and IOD in in agro-climatic zones of India	
3	Spatiotemporal analysis of drought and its teleconnections in agro-climatic zones of India	
4	Targeted knockout of PARP and ERA1 genes using genome editing tool to enhance water stress tolerance in soybean	AK Singh
5	Silencing of negative regulator genes using VIGS approach for functional characterization of genes of soybean to enhance water and salinity stress tolerance	
6	Adaptive Responses of Indigenous Goat Breeds to Seasonal Thermal Stress in Semi-Arid Regions.	SS Pawar, NP Kurade, M Gupta, SA Kochewad, AV Nirmale
7	Development of an Efficient Protoplast Isolation Method from Immature Soybean Cotyledons for Plasmid-Free RNP-Based Genome Editing	AK Singh, SM Awaji, Boraiah KM, Basavaraj PS, PS Khapte, S Changan, A Pradhan, GC Wakchaure and K Sammi Reddy
8	Expression Profiling of Fermentative and Stress-Responsive Genes in Pigeon Pea Genotypes under Waterlogging Stress	PS Hanjagi, AK Singh, Gurumurthy S, SM Awaji
9	Application of endophytes for alleviation of moisture-deficit stress in groundnut	KK Pal, Rinku Dey
10	Exploring possibility of finding CAM-photosynthetic transition in drought stressed chickpea, pigeon pea and soybean	KK Pal, R Dey, KM Boraiah, PS Basavaraj, PS Hanjagi, SS Changan, K Sammi Reddy
11	Study on PRD irrigation strategies and shifting frequencies on high-density mango (Cv. Kesar) grown in shallow basaltic soils under semi-arid conditions	DD Nangare, VD Kakade, AS Morade

Sl.	Project activities	Team
12	Quality assessment of microwave vacuum-dried slices of dragon fruit pulp and peel	GC Wakchaure, DD Nangare, A Pradhan, KM Boraiah, PS Khapte
13	Effect of coating materials and temperatures on the storage quality of custard apple	
14	Plant growth regulators and potato cultivars' responses to alleviating drought stress	
15	Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system	GC Wakchaure, A Pradhan, Paritosh Kumar, K Sammi Reddy
16	Effect of tillage, trash, and nutrient management on water stable macro-aggregates, micro-aggregates and aggregate ratio in sugarcane cropping system	A Pradhan, GC Wakchaure
17	Validation and characterization of promising foxtail millet germplasm under low N soils	KM Boraiah, PS Basavaraj, CB Harisha, HM Halli
18	Adaptive Evaluation Trial of Advanced and Initial Varietal Entries of Quinoa at ICAR-NIASM Baramati	KM Boraiah, KK Pal, PS Basavaraj, Harisha CB
19	Selection and advancement of mutant generations (M3 and M4) in groundnut	
20	Preliminary characterization of germplasm collections and hybrids of dragon fruit for reproduction behaviour and fruit morphological traits	KM Boraiah, PS Basavaraj, CB Harisha, VD Kakade, KK Pal
21	Collection, multiplication and evaluation of the germplasm for different abiotic stresses	KM Boraiah, PS Basavaraj, PS Khapte, CB Harisha, VD Kakade, KK Pal, PS Hanjagi, R Sultana
22	Advancing (M6/M7) and evaluation (stable) of chia mutants	KM Boraiah, CB Harisha, PS Basavaraj, KK Pal,
23	Screening and identification of waterlogging and drought tolerant tomato germplasm	PS Khapte, SS Changan, VN Salunkhe, KK Pal
24	Screening and identification of waterlogging tolerant brinjal germplasm	
25	Collection, conservation and maintenance of vegetable germplasm (Tomato, eggplant and capsicum)	
26	Phenotyping pigeon pea genotypes for reproductive stage drought stress tolerance in field conditions	Basavaraj?
27	Identification of multiple abiotic stress tolerant pigeon pea genotypes	PS Hanjagi, AK Singh, Gurumurthy S, BB Gaikwad, SM Awaji, S Naik
28	High throughput screening of pigeon pea genotypes to stress tolerance at cellular level using temperature induction response technique	
29	Chlorophyll fluorescence-based signatures of desiccation tolerance in wild tomato species	PS Khapate?
30	Effect of tillage, trash, and nutrient management on water stable macro-aggregates, micro-aggregates and aggregate ratio in sugarcane cropping system	A Pradhan, GC Wakchaure
31	Identification of trait specific abiotic stress tolerant pulse genotypes	

Sl.	Project activities	Team
32	Identification of drought tolerant mungbean genotypes	PS Basavaraj, KM Boraiah, CB Harisha, K Sammi Reddy
33	Identification of high temperature stress tolerant cowpea genotypes	
34	Integrating High-Throughput Phenomics and Morpho-Physiological Traits for Selecting Drought-Tolerant Pigeonpea Genotypes	
35	Mapping of Water Status Proxies for Vidarbha Region using Sentinel-1 SAR data	RN Singh, B Das, KK Pal, K Sammi Reddy
36	Identification of salt-tolerant and salt-sensitive local mango genotypes based on plant morpho-physiological responses	AS Morade, VD Kakade, KM Boraiah, SS Changan, SB Chavan, Neeraj Kumar
37	Performance of Ambronics Pot under Deficit Irrigation in Tomato Cultivation	A. Morade, VD Kakade, PS Khapte, DD Nangare, SB Chavan, KS Reddy
38	Mitigating waterlogging stress in maize through foliar application of nitrogen sources and growth regulators	H. Halli, PS Basavaraj KM Boraiah, CB Harisha
39	Soil Quality status of rice growing areas at different landscape positions of the high rainfall region	Rajagopal V, K Sammi Reddy, SB Chavan, HM Halli, KK Pal
40	Chemical Characterization of Nutrient Inputs Used in the Nutrient Management System	Rajagopal V, K Sammi Reddy, SB Chavan, HM Halli, KK Pal
41	Long term effect of land use change on vertical distribution of soil carbon and nitrogen pools in the gravelly barren land	Rajagopal V, K Sammi Reddy, SB Chavan, HM Halli,KK Pal
42	Land use system impact on carbon pools at different soil depths after 10 years on the shallow and gravelly land	Rajagopal V, K Sammi Reddy, SB Chavan, HM Halli and KK Pal
43	Land use systems effect on soil N dynamics over the period of 10 years under the stony land situations	Rajagopal Vadivel, KS Reddy, SB Chavan, HM Halli and KK Pal
44	Characterization and Evaluation of microbes from Soybean Rhizosphere and Endo-rhizosphere	R Dey, KK Pal, Karthikeyan N, Rajagopal V
45	Response of geranium varieties to salinity stress and its alleviation by foliar application of KNO3	CB Harisha, HM Halli, SB Chavan SB, KM Boraiah, PS Basavaraj
46	Climate resilient integrated farming system for semi-arid regions	Kochewad?
47	Eco-Friendly Nano-Copper Synthesis: Gene and Enzyme Modulation for Combating Cadmium and Ammonia Toxicity in Fish	Neeraj Kumar
48	Combined effect of mercury and ammonia toxicity and its mitigation using selenium nanoparticles in fish	
49	Integrative Biomonitoring in Litopenaeus vannamei: Metal Analysis and Biochemical Markers	

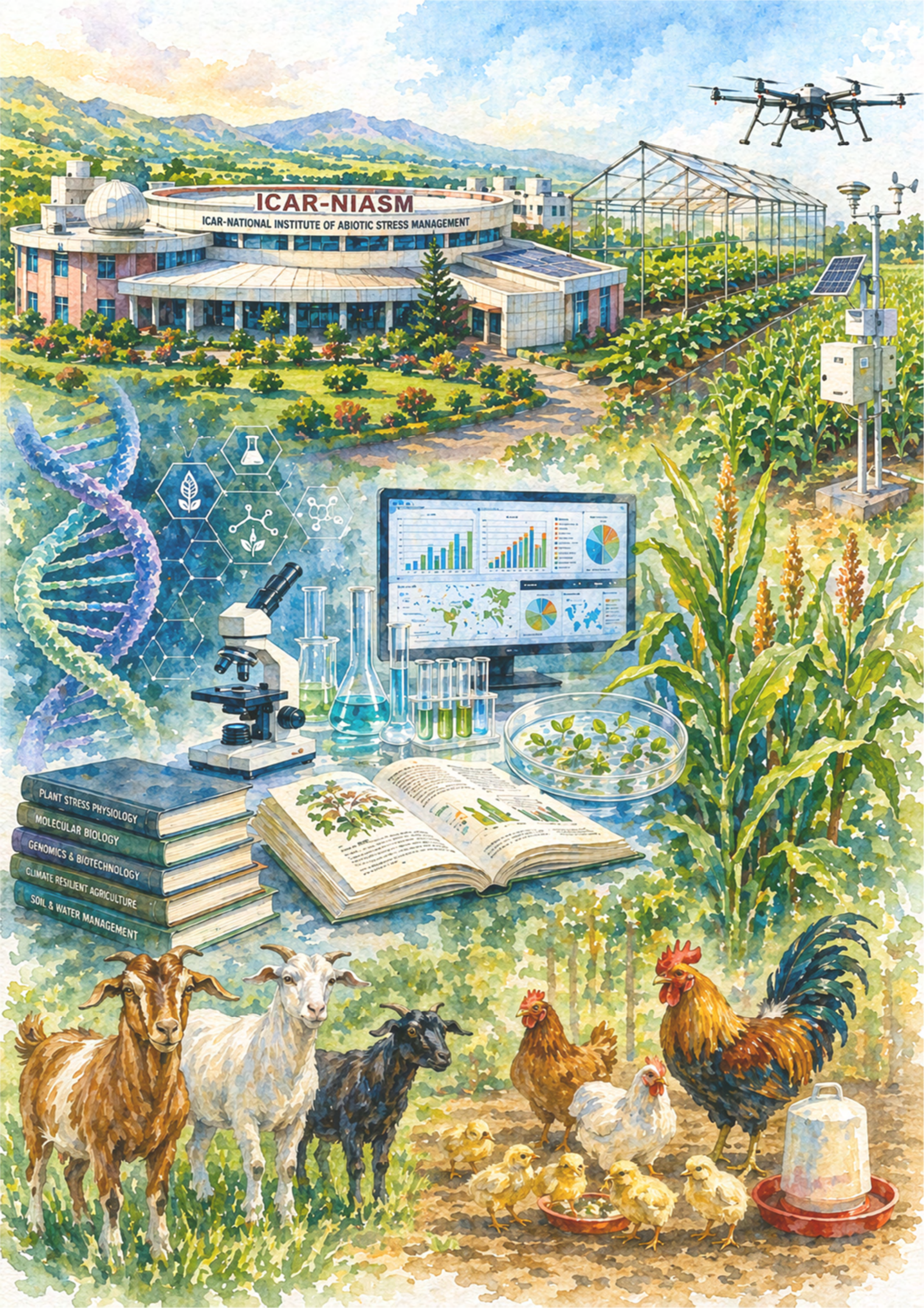
Sl.	Project activities	Team
50	Development of Allometric Equations for Biomass Estimation in Mango (Mangifera indica L.) Across HDP and UHDP Orchards Using Destructive Sampling Approach	SB Chavan, NC Paul, AS Morade, VD Kakade, K Sammi Reddy
51	Assessing the host-sandalwood interactions under moisture deficit conditions in nursery	SB Chavan; CB Harisha, AS Morade, VD Kakade, SS Changan, K Ravi Kumar, K. Sammi Reddy
52	Evaluation of Allium genotypes for anthracnose resistance	VN Salunkhe, PS Khapte and SS Changan
53	Genotypic adaptations and mechanisms of salinity tolerance in dragon fruit (*Selenicereus* spp.)	VD Kakade, AS Morade, SB Chavan, KM Boraiah
54	Enhancing Soil Moisture Retention in Tomato Cultivation through Tradecorp Products	VD Kakade, AS Morade, PS Khapte, CB Harisha, A Pradhan, DD Nangare, SB Chavan, KS Reddy
55	Assessment of Drought- and Salinity-Induced Crop Yield Losses in Baramati Tehsil	NC Paul?
56	Development and Multi-Scale Validation of an Integrated Drought Index using Hydro-Meteorological, Vegetation, and Productivity Indicators in Semi-Arid Western Maharashtra, India	NC Paul?

Technologies

SN.	Name of technology (Inventors)	Krishi Portal ID/ ICAR-Certificate No.	Year
1.	***Development of microbially derived polymeric product for gel formation, microbial colonization and metals binding*** KK Meena, AM Sorty, KK Krishnani, PS Minhas	201563524280563	2016
2.	***Regulated deficit irrigation strategy or short term interruption of irrigation at phenological stages of tomato crop for water saving and improving quality of tomato (Lycopersicon esculentum Mill.)*** DD Nangare, Y Singh, P Suresh Kumar, PS Minhas	201562663444775	2016
3.	***Dragon fruit: wonder crop for rocky barren lands and water scarce areas.*** DD Nangare, M Kumar, PB Taware, VD Kakade	201628672037221	2018
4.	***Deficit irrigation management in grape orchard in abiotic-stressed basaltic terrain.*** DD Nangare, PB Taware, Mahesh Kumar, Y Singh, PS Minhas, P Suresh Kumar, H Pathak	201628678020305	2018
5.	***Plant bio-regulators for enhancing productivity and quality of major crops under water scarce regions*** GC Wakchaure, PS Minhas, P Ratnakumar, RL Choudhary, KK Meena, NP Singh	201563532406642	2019
6.	***Deficit irrigation management with plastic mulch in pomegranate orchard in abiotic-stressed basaltic terrain.*** DD Nangare, PB, Mahesh Kumar, Y Singh, PS Minhas, VD Kakade, H Pathak	201628674653663	2019
7.	***Micro-blasting and soil-mix technique for sapota cultivation in abiotic-stressed basaltic terrain.*** DD Nangare, VD Kakade, PB Taware, P Suresh Kumar, Y Singh, PS Minhas, H Pathak	201628669987978	2020
8.	***Micro-blasting and soil-mix technique for pomegranate cultivation in abiotic-stressed basaltic terrain.*** PB Taware, DD Nangare, Mahesh Kumar, H Pathak	201628730570552	2021

SN.	Name of technology (Inventors)	Krishi Portal ID/ ICAR-Certificate No.	Year
9.	***High-density planting in mango for enhancing yield and resource use efficiency under abiotic stress conditions.*** VD Kakade, DD Nangare, PB Taware, SB Chavan, Rajkumar, H Pathak	201629534409748	2021
10.	***Micro-blasting and soil-mix technique for guava cultivation in abiotic-stressed basaltic terrain.*** VD Kakade, Y Singh, DD Nangare, PS Minhas, P Suresh Kumar, PB Taware, SB Chavan, H Pathak	201629536617536	2021
11.	***Cultivating medicinal and aromatic plants in shallow basaltic soil.*** CB Harisha, DD Nangare, PB Taware	201629540781386	2021
12.	***Rehabilitation of abiotic-stressed basaltic terrain with aonla (emblica officinalis).*** SB Chavan, DD Nangare, PB Taware, Aliza Pradhan, P Suresh Kumar, VD Kakade, RS Gophane, H Pathak	201633497056286	2021
13.	***Preparation of dragon fruit saplings.*** GC Wakchaure, Jadhav AR, DD Nangare, VD Kakade, J Rane, H Pathak	201633501439931	2021
14.	***Prevention of flower and immature fruit drop in Dragon Fruit through bagging, sheltering and supplementary pollination*** KM Boraiah, Basavaraj PS, VD Kakade, CB Harisha, GC Wakchaure, J Rane	201636529641652	2021
15.	***Enhancement of fruit size and quality in Dragon Fruit through supplementary pollination.*** KM Boraiah, PS Basavaraj, VD Kakade, CB Harisha, PA Kate, J Rane, H Pathak	201655802341202	2022
16.	***Cultivation of Kharif chickpea: A novel practice for rising farmers' income in Western Maharashtra.*** S Gurumurthy, KR Soren, Mahesh Kumar, KM Boraiah, J Rane, H Pathak	201664861284183	2022
17.	***Multi-Functional Ratoon Drill (MRD) for Enhancing Productivity and Resource Conservation in Ratoon Sugarcane Cropping System*** GC Wakchaure, RL Choudhary, AK Biswas, KS Reddy	201718299613383 (ICAR-AE-NIASM-Technology-2024-022)	2024
18.	***Trenching and Transforming Filled-in Soil Technology*** GC Wakchaure, P Suresh Kumar, PS Minhas, J Rane, SK Bal, KS Reddy	201718303612980 (ICAR-NRM-NIASM-Technology-2024-054)	2024
19.	***Multipurpose Microbial-Biopolymer for Climate Smart Farming*** KK Meena, GC Wakchaure, Ajay Sorty, CB Harisha, PS Minhas	ICAR-NRM-NIASM-Technology-2024-055	2024
20.	***Protocol for Identifying Drought-tolerant Tomato Rootstock through High-throughput Phenomics*** PS Khapte, Pradeep Kumar, GC Wakchaure, J Rane, KS Reddy	201718278727244 (ICAR-HS-NIASM-Protocol-2024-060)	2024

SN.	Name of technology (Inventors)	Krishi Portal ID/ ICAR-Certificate No.	Year
21.	***Thiourea and Potassium Nitrate for Improving Storability and Alleviating Drought and Water-logging Stress in Onion*** GC Wakchaure, KK Meena, PS Minhas, PS Khapte, KS Reddy	201718300894588 (ICAR-HS-NIASM-Technology-2024-061)	2024
22.	***Trash and nutrient management in ratoon sugarcane for enhancing cane yield, carbon sequestration and reducing GHG emissions*** Aliza Pradhan, GC Wakchaure, PS Minhas, AK Biswas, KS Reddy	ICAR-NRM-NIASM-Technology-2025-006	2025
23.	***Foliar Application of Thiourea, potassium nitrate and sodium benzoate for crop resilience under water stress conditions*** GC Wakchaure, PS Minhas, Satish Kumar, KK Meena, KS Reddy	ICAR-NRM-NIASM-Technology-2025-007	2025
24.	***Green Synthesis of selenium Nanoparticles from fisheries waste (First Report)*** Neeraj Kumar, Paritosh Kumar, SA Kochewad, Ajay Kumar Singh, KS Reddy	ICAR-NRM-NIASM-Technology-2025-008	2025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CLIMATE RESILIENT AGRICULTURE
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