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ICAR- NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT

Annual Report 2024

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Indian Council of Agricultural Research

NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT

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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 SDGs, ICAR-NIASM spearheaded research innovations, academics and community reach through extension programmes in 2024 are reflection of the efforts taken by its human resource in planning and execution of its year the round activities.

During 2024, ICAR-NIASM made significant research advancements in climate resilience, stress mitigation, and sustainable agriculture include geospatial stress mapping, heat-tolerant livestock strategies, CRISPR-edited crops, and technology-driven outreach, collectively addressing abiotic challenges in India's agroecosystems. Also enhancing crop resilience and sustainability under abiotic stresses innovations spanning microbial interventions, irrigation-PGR synergies, CAM pathway exploitation, genetic resource selection and utilization, sustainable livestock practices and integrated farming systems have shown improved water/nutrient efficiency, stress-tolerant genotypes, and scalable practices for semi-arid agroecosystems. NIASM also collectively advanced resilience, by empowering vulnerable communities through its DAPSC and TSP activities, and strengthen agricultural framework through research, policy support, and grassroots engagement are highlighted in this Annual report. It also provides a detailed compilation of institute publications (76 research papers, 10 review papers, 4 books, 27 book chapters, 6 technical bulletins, 26 popular articles and 10 extension folders), teaching, extension, linkages and other collaboration activities.

I sincerely thank Dr Himanshu Pathak, Secretary (DARE) & Director General (ICAR); Shri Sanjay Garg, Additional Secretary (DARE) & Secretary (ICAR); Ms. Alka Nangia Arora, Additional Secretary (DARE) & Financial Advisor (ICAR); Dr Suresh Kumar Chaudhari, Deputy Director General (Natural Resource Management); 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 Research Advisory Committee (RAC); members of 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.

ksreddy

Date: 31-12-2024 (K Sammi Reddy)
Baramati Director

प्रस्तावना

जलवायु परिवर्तन लगातार तीव्र होता जा रहा है। बढ़ते तापमान और अनियमित मौसम स्वरूप के कारण भारत की कृषि प्रणालियों पर जोखिम में निरंतर वृद्धि हो रही है। जलवायु-अनुकूल प्रथाओं और सतत विकास लक्ष्यों के प्रति भारत की प्रतिबद्धता के अनुरूप, राष्ट्रीय अजैविक स्ट्रेस प्रबंधन संस्थान ने वर्ष 2024 में विस्तार कार्यक्रमों के माध्यम से अनुसंधान नवाचारों, शिक्षाविदों और सामुदायिक पहुंच को आगे बढ़ाया है। यह संस्थान के मानव संसाधनों द्वारा वर्ष भर की गतिविधियों की योजना और क्रियान्वयन में किए गए प्रयासों का प्रतिबिंब है।

वर्ष 2024 के दौरान, भा.कृ.अनु.प. – रा.अ.स्ट्रै.अनु.सं. ने जलवायु लचीलापन, तनाव शमन और टिकाऊ कृषि के क्षेत्र में उल्लेखनीय अनुसंधान प्रगति की है। इसमें भू-स्थानिक तनाव मानचित्रण, गर्मी-सहिष्णु पशुधन रणनीतियाँ, CRISPR-संपादित फसलें और प्रौद्योगिकी-संचालित समाधान शामिल हैं, जो सामूहिक रूप से भारत के कृषि-पारिस्थितिकी तंत्र में उभरती अजैविक चुनौतियों से निपटने में सहायक हैं। अजैविक तनावों के तहत फसलों के लचीलेपन और स्थिरता को बढ़ाने के लिए, सूक्ष्मजीव हस्तक्षेप, सिंचाई और PGR (पादप वृद्धि नियंत्रक) के समन्वय, CAM पथ का दोहन, आनुवंशिक संसाधनों का चयन एवं उपयोग, टिकाऊ पशुपालन प्रथाओं और एकीकृत कृषि प्रणालियों में नवाचारों के माध्यम से बेहतर जल/पोषक तत्व दक्षता, तनाव-सहिष्णु जीनोटाइप और अर्ध-शुष्क कृषि पारिस्थितिकी प्रणालियों के लिए मापनीय प्रथाओं को विकसित किया गया है।

भा.कृ.अनु.प. – रा.अ.स्ट्रै.अनु.सं. ने अपने DAPSC और TSP कार्यक्रमों के माध्यम से कमजोर समुदायों को सशक्त बनाते हुए सामूहिक रूप से लचीलेपन को बढ़ावा दिया है। साथ ही, अनुसंधान, नीति समर्थन और जमीनी स्तर पर सहभागिता के माध्यम से कृषि ढांचे को मजबूत किया है, जिसे इस वार्षिक रिपोर्ट में रेखांकित किया गया है। यह रिपोर्ट संस्थान की प्रकाशनों (७६ शोध पत्र, १० समीक्षा लेख, ४ पुस्तकें, २७ पुस्तक अध्याय, ६ तकनीकी बुलेटिन, २६ लोकप्रिय लेख और १० विस्तार फ़ोल्डर), शिक्षण, विस्तार, सहयोग तथा अन्य गतिविधियों का भी विस्तृत संकलन प्रस्तुत करती है।

मैं डॉ. हिमांशु पाठक, सचिव (DARE) एवं महानिदेशक (ICAR); श्री संजय गर्ग, अतिरिक्त सचिव (DARE) एवं सचिव (ICAR); सुश्री अलका नांगिया अरोड़ा, अतिरिक्त सचिव (DARE) एवं वित्तीय सलाहकार (ICAR); डॉ. सुरेश कुमार चौधरी, उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन); तथा डॉ. ए. वेलमुरुगन, सहायक महानिदेशक (मृदा एवं जल प्रबंधन) को उनके निरंतर समर्थन एवं मार्गदर्शन के लिए हृदय से धन्यवाद देता हूँ। मैं अनुसंधान सलाहकार समिति (RAC) के अध्यक्ष डॉ. वी प्रवीण राव एवं अन्य सम्मानित सदस्यों, संस्थान प्रबंधन समिति (IMC) तथा संस्थान अनुसंधान परिषद (IRC) के सदस्यों से प्राप्त मार्गदर्शन एवं सहयोग के लिए भी आभार व्यक्त करता हूँ।

साथ ही, मैं राज्य कृषि विभागों, किसानों, केवीके तथा वित्त पोषण एजेंसियों के निरंतर सहयोग के लिए भी आभार प्रकट करता हूँ। मैं विद्यालय प्रमुखों, वैज्ञानिकों तथा संस्थान के तकनीकी, प्रशासनिक एवं वित्तीय कर्मचारियों को संस्थान की गतिविधियों के संचालन में उनके समर्पण एवं कठिन परिश्रम के लिए हार्दिक धन्यवाद देता हूँ। अंत में, मैं इस वार्षिक दस्तावेज़ के संकलन में लगे प्रकाशन समिति के सदस्यों के प्रयासों की भी विशेष सराहना करता हूँ।

KS Reddy

दिनांक : ३१-१२-२०२४ (के सम्मी रेड्डी)
बारामती निदेशक

EXECUTIVE SUMMARY

During the year 2024, 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 the above activities and others are briefly highlighted below under broader theme titles:

वर्ष 2024 के दौरान संस्थान द्वारा अम्ब्रेला एवं फ्लैगशिप परियोजनाओं तथा बाह्य वित्तपोषित परियोजनाओं के अंतर्गत विभिन्न प्रयोग किए गए। अनुसूचित जाति (DAPSC) और जनजातीय उपयोजना (TSP) के अंतर्गत विकास कार्य योजनाओं के माध्यम से भी आउटरीच कार्यक्रम संचालित किए गए। उपर्युक्त सभी गतिविधियों एवं अन्य प्रयासों की उपलब्धियों को व्यापक विषयगत शीर्षकों के अंतर्गत संक्षेप में नीचे प्रस्तुत किया गया है।

- **Geospatial Stress Mapping:** Geospatial analysis using AHP revealed 94% of western Maharashtra faces high abiotic stress due to soil depth, drought, and heatwaves. An Integrated Drought Index for drought-prone districts of Western Maharashtra (Pune, Satara, Solapur, Ahmednagar) was developed combining indices for agricultural (VHI, SNDVI), meteorological (SPI, SPEI), and hydrological (SGWI) droughts. Long-term temperature trends (1951–2022) showed rising monthly temperature maxima/ minima in southern/western India, while Indo-Gangetic Plains saw declines in winter maxima. Teleconnections linked ENSO/IOD indices to monsoon variability, aiding predictive models for agricultural planning.
- **Livestock Stress Management:** Heat stress studies on indigenous goats (Osmanabadi, Sangamneri, Konkan Kanyal) revealed severe afternoon THI levels (up to 71%). Physiological parameters (respiration rate, heart rate) correlated strongly with THI, varying by breed. A herbal formulation (HF) of 10

- **भू-स्थानिक तनाव मानचित्रण:** AHP (Analytical Hierarchy Process) पद्धति के उपयोग से किए गए भू-स्थानिक विश्लेषण से यह निष्कर्ष प्राप्त हुआ कि पश्चिमी महाराष्ट्र का लगभग 94% क्षेत्र मिट्टी की गहराई, सूखा तथा हीटवेव के कारण उच्च अजैविक (अबायोटिक) तनाव का सामना कर रहा है। पुणे, सतारा, सोलापुर एवं अहमदनगर जैसे सूखाग्रस्त जिलों के लिए एक समेकित सूखा सूचकांक विकसित किया गया, जिसमें कृषि (VHI, SNDVI), मौसम विज्ञान (SPI, SPEI) एवं जलविज्ञान (SGWI) से संबंधित विभिन्न सूखा सूचकांकों को एकीकृत किया गया। 1951 से 2022 की दीर्घकालिक तापमान प्रवृत्तियों के विश्लेषण से यह स्पष्ट हुआ कि दक्षिणी एवं पश्चिमी भारत में मासिक अधिकतम एवं न्यूनतम तापमान में वृद्धि हुई है, जबकि इंडो-गंगा मैदानी क्षेत्रों में शीत ऋतु के अधिकतम तापमान में गिरावट देखी गई है। टेलीकनेक्शन विश्लेषण के माध्यम से ENSO तथा IOD सूचकांकों को मानसून की परिवर्तनशीलता से जोड़ा गया, जिससे कृषि योजना हेतु पूर्वानुमान मॉडल को और अधिक सशक्त बनाने में सहायता मिली।
- **पशुधन तनाव प्रबंधन:** देशी बकरी नस्लों (उस्मानाबादी, संगमनेरी, कोंकण कन्याल) पर किए गए तापीय तनाव संबंधी अध्ययनों से यह पाया गया कि दोपहर के समय THI (थर्मल ह्यूमिडिटी इंडेक्स) का स्तर 71 तक पहुँच जाता है। श्वसन दर एवं हृदय गति जैसे शारीरिक मापदंड THI के साथ दृढ़ता से सहसंबद्ध पाए गए, हालांकि विभिन्न नस्लों में इनकी प्रतिक्रिया अलग-अलग रही। एक हर्बल फॉर्मूलेशन

micronutrient-rich plants improved hematological indices (e.g., MCHC, RDW) and body weight gain (57.86 g day^{-1} at 50% HF). *Goat Feed*: Sugarcane trash-based diets (50% trash + concentrate) maintained growth and hematological parameters comparable to conventional feeds. *Distillery spent wash optimization trials*: identified 4% concentration as optimal for duckweed biomass production (30 g $tray^{-1}$ in 14 days), offering sustainable fodder solutions.

(HF), जिसमें 10 प्रकार के सूक्ष्म पोषक तत्वों से भरपूर पौधे सम्मिलित थे, के उपयोग से हेमेटोलॉजिकल संकेतकों (जैसे MCHC, RDW) में सुधार तथा शरीर के वजन में वृद्धि देखी गई (50% HF आहार पर 57.86 ग्राम प्रतिदिन)। *बकरी आहार:* गन्ने की पराली पर आधारित आहार (50% गन्ना पराली + सांद्र मिश्रण) के उपयोग से पारंपरिक चारे के तुल्य वृद्धि दर एवं हेमेटोलॉजिकल मापदंड बनाए रखे गए। *डिस्टिलरी स्पेंट वॉश अनुकूलन परीक्षण:* डकवीड (जलकुंभी) जैवमास उत्पादन के लिए 4% सांद्रता को इष्टतम पाया गया, जिसमें 14 दिनों में प्रति ट्रे 30 ग्राम जैवमास प्राप्त हुआ। यह एक सतत चारा समाधान के रूप में संभावित है।

- **Fish Stress Mitigation:** Fe-NPs (15 mg kg^{-1} diet) reduced cortisol (34%) and HSP70 expression, improving thermal tolerance (CTmax: 47.59°C). *Copper Toxicity*: Cu-NPs (LC50: 3.60 mg L^{-1}) induced oxidative stress and genotoxicity in fish, surpassing ionic Cu toxicity (LC50: 7.56 mg L^{-1}).

- **मत्स्य तनाव शमन:** Fe-NPs (15 मिग्रा $किग्रा^{-1}$ आहार) के उपयोग से कोर्टिसोल स्तर में 34% की कमी तथा HSP70 जीन की अभिव्यक्ति में गिरावट देखी गई, जिससे मछलियों की तापीय सहनशीलता (CTmax: 47.59°C) में सुधार हुआ। *तांबा विषाक्तता:* Cu-NPs (LC50: 3.60 मिग्रा $लीटर^{-1}$) ने मछलियों में ऑक्सीडेटिव तनाव और जीनोटॉक्सिसिटी उत्पन्न की, जो आयनिक तांबे (LC50: 7.56 मिग्रा $लीटर^{-1}$) की तुलना में अधिक विषाक्त सिद्ध हुई।

- **Soil Health and Nutrient Management:** Low/Medium Nutrient Index Maps, derived from 160 million soil samples (2015–2020), highlighted deficiencies: 319 districts lacked nitrogen/organic carbon, while 12 districts faced multi-nutrient deficits (NPKSZnB). Thresholds for soil parameters were standardized to guide targeted fertilization strategies.

- **मृदा स्वास्थ्य और पोषक तत्व प्रबंधन:** वर्ष 2015 से 2020 के बीच एकत्रित किए गए 160 मिलियन मृदा नमूनों के विश्लेषण से प्राप्त निम्न/मध्यम पोषक तत्व सूचकांक मानचित्रों ने विभिन्न पोषक तत्वों की कमियों को उजागर किया। इस अध्ययन में पाया गया कि 319 जिलों में नाइट्रोजन एवं कार्बनिक कार्बन की कमी है, जबकि 12 जिलों में बहु-पोषक तत्वों (N, P, K, S, Zn, B) की गंभीर कमी दर्ज की गई। लक्षित उर्वरक प्रबंधन रणनीतियों के निर्माण हेतु मृदा मापदंडों के लिए सीमा-रेखा स्तरों का मानकीकरण किया गया।

- **Microbial Solutions for Stress Mitigation:** *Groundnut:* Of 126 endophytes and 21 rhizobia isolated from drought-prone areas to alleviate drought and salinity stress in groundnut, 36 produced indole acetic acid (15.3 µg mL^{-1}). Twenty-three endophytes and seven rhizobia tolerated -1.5 MPa moisture deficit, while 27 endophytes

- **तनाव कम करने के लिए माइक्रोबियल समाधान:** *मूंगफली:* सूखा प्रभावित क्षेत्रों से मूंगफली की जड़ों से अलग किए गए 126 एंडोफाइट्स और 21 राइजोबिया में से 36 सूक्ष्मजीवों ने इंडोल एसिटिक एसिड (15.3 µg mL-1) का उत्पादन किया। इनमें से 23 एंडोफाइट्स और 7 राइजोबिया -1.5 MPa तक की नमी की कमी को सहन करने में सक्षम पाए गए, जबकि 27 एंडोफाइट्स और 9 राइजोबिया 2.5 M NaCl की लवणता परिस्थितियों में जीवित रहे।

and nine rhizobia survived 2.5 M NaCl. Selected compatible pairs (20 endophytes + 10 rhizobia) showed promise in greenhouse and field trials (cv. TG37A and Phule Unnati), improving soil moisture retention and plant resilience in shallow basaltic murrum soils. *Rhizosphere Microbes:* 150 isolates from sugarcane/ soybean included 83 phosphate-solubilizing and 85 Zn-solubilizing strains, enhancing nutrient availability.

- **CAM Photosynthesis Transition in Legumes:** A shift from C3 to CAM photosynthesis under drought was identified in chickpea (genotypes ICC4958, BDG75, JG16), with night time carboxylation rates of ~9.71 µmol cm^{-2} s^{-1}. Key genes for carboxylation and decarboxylation modules were expressed. Similar evaluations in pigeon pea (23 accessions) and soybean (80 genotypes) aim to identify CAM-transition candidates for drought resilience.
- **Deficit Irrigation and PGR studies:** In mango orchards, 75% ET irrigation with salicylic acid (SA) and naphthalene acetic acid (NAA) achieved yields comparable to full irrigation (49.89 kg $plant^{-1}$), while 50% ET + PGRs maximized water use efficiency (12.33 kg m^{-3}). For garlic, PGRs (e.g., irradiated chitosan, nanourea) boosted bulb yield by 7–22% under 50–75% ET, saving 38% water. Potato trials revealed cultivar Kufri Kiran as drought-tolerant, yielding 20.4 t ha^{-1} under full irrigation. *Tomato Cultivation:* Mulching systems yielded 23.99 t ha^{-1} (100% ET) and minimized

चयनित संगत संयोजन (20 एंडोफाइट्स + 10 राइजोबिया) ने ग्रीनहाउस और खेत परीक्षणों (प्रजातियाँ: TG37A और फुले उन्नति) में आशाजनक परिणाम दर्शाए। इन संयोजनों ने उथली बेसाल्टिक मुरुम मिट्टी में नमी संरक्षण और पौधों की लचीलापन क्षमता में उल्लेखनीय सुधार किया। *राइज़ोस्फीयर सूक्ष्मजीव:* गन्ना और सोयाबीन की फसलों से अलग किए गए 150 राइज़ोस्फीयर सूक्ष्मजीवों में से 83 फॉस्फेट-घुलनशील और 85 ज़िंक-घुलनशील स्ट्रेन्स पाए गए। इन सूक्ष्मजीवों ने मृदा में पोषक तत्वों की उपलब्धता बढ़ाने में महत्वपूर्ण योगदान दिया, जिससे पौधों की वृद्धि और उत्पादन क्षमता में वृद्धि हुई।

- **फलियों में CAM प्रकाश संश्लेषण संक्रमण:** सूखा तनाव की स्थिति में चने (जीनोटाइप: ICC4958, BDG75, JG16) में C3 से CAM प्रकार की प्रकाश संश्लेषण पथ में संक्रमण की पहचान की गई है, जिसमें रात्रि के समय कार्बोक्सिलेशन दर लगभग 9.71 µmol cm^{-2} s^{-1} पाई गई। इस प्रक्रिया के दौरान कार्बोक्सिलेशन एवं डीकार्बोक्सिलेशन माड्यूल से संबंधित प्रमुख जीनों की अभिव्यक्ति दर्ज की गई। अरहर (23 अभिगम) एवं सोयाबीन (80 जीनोटाइप) में भी इसी प्रकार का मूल्यांकन CAM संक्रमण से संबंधित संभावित जीनों की पहचान के लिए किया जा रहा है, जिसका उद्देश्य सूखा सहनशीलता को बढ़ाना है।
- **कम सिंचाई एवं PGR अध्ययन:** आम के बागानों में 75% ET सिंचाई के साथ सैलिसिलिक एसिड (SA) और नेफ्थलीन एसिटिक एसिड (NAA) के प्रयोग से पूर्ण सिंचाई (49.89 किलोग्राम प्रति पौधा) के समतुल्य उपज प्राप्त हुई। वहीं, 50% ET सिंचाई + PGRs के संयोजन से जल उपयोग दक्षता अधिकतम (12.33 किलोग्राम प्रति घन मीटर) प्राप्त हुई। लहसुन की फसल में विकिरणित चिटोसन और नैनो-यूरिया जैसे PGRs के उपयोग से 50–75% ET सिंचाई स्तरों पर बल्ब की उपज में 7–22% तक वृद्धि दर्ज की गई, जिससे लगभग 38% जल की बचत संभव हुई। 'कुफरी किरण' किस्म को सूखा-सहिष्णु पाया गया, जिसने पूर्ण सिंचाई की स्थिति में 20.4 टन प्रति हेक्टेयर की उपज दी। *टमाटर की खेती:* मल्चिंग सिस्टम ने 23.99 टन प्रति हेक्टेयर (100% ET) की उपज दी और खरपतवार की वृद्धि

weed growth, while pot cultivation excelled under deficit irrigation.

- **Conservation Agriculture in Sugarcane:** Reduced tillage, surface trash retention, and split fertigation (55% via drip) increased sugarcane ratoon yields by 10.1–16.2%. Mulching improved yields by 9.4–36.4% under varying irrigation levels, while PGRs (e.g., irradiated chitosan) enhanced yields by 5–35%, closing yield gaps between plant and ratoon crops by 7.6%.
- **Crop Biotechnology and Genetic Research:** *Soybean Transformation:* An optimized *Agrobacterium*-mediated protocol using cotyledon explants accelerated shoot organogenesis in cultivar JS335. CRISPR/ Cas9 targeted knockout of stress-negative regulators enhanced drought tolerance, validated through VIGS silencing and stomatal function analysis. *Halophyte Genomics:* Salt-tolerant genes were identified in halophytes like *Avicennia marina* and *Ipomoea pes-caprae*, providing genetic resources for saline agriculture.
- **Genetic Resource Collection, Evaluation and Development:** *Germplasm Collection:* Over 2,500 accessions (e.g., quinoa, chickpea, soybean) were screened for drought, salinity, and waterlogging tolerance. *Cowpea:* GWAS identified 392 marker-trait associations for heat tolerance; 25 photo-thermo-insensitive accessions (e.g., EC240703) were validated. Mungbean*:* Drought-tolerant genotypes (e.g., V1001556BG) with high pod counts (>25/plant) and photosynthetic efficiency were identified. *Pigeonpea:* Genotypes ICP 14840 and ICP 16161 demonstrated waterlogging tolerance

को कम किया, जबकि पॉट की खेती ने कम सिंचाई के तहत उत्कृष्ट प्रदर्शन किया।

- **गन्ने में संरक्षण कृषि:** गन्ने की खेती में कम जुताई, सतही कचरा आवरण (मल्चिंग), और ड्रिप सिंचाई के माध्यम से विभाजित उर्वरीकरण (55%) के संयोजन से उपज में 10.1–16.2% तक वृद्धि दर्ज की गई। विभिन्न सिंचाई स्तरों पर मल्चिंग के उपयोग से उपज में 9.4–36.4% तक सुधार देखा गया, जबकि विकिरणित चिटोसन जैसे PGRs के प्रयोग से उपज में 5–35% तक वृद्धि हुई। इससे मुख्य फसल और पेड़ी फसल (ratoon crop) के बीच उपज का अंतर 7.6% तक कम हो गया।
- **फसल जैव प्रौद्योगिकी और आनुवंशिक अनुसंधान:** *सोयाबीन रूपांतरण:* बीजपत्र प्रत्यारोपण का उपयोग करते हुए एक अनुकूलित एग्रोबैक्टीरियम-मध्यस्थ प्रोटोकॉल के माध्यम से JS335 किस्म में प्ररोह अंगजनन को त्वरित किया गया। तनाव-नकारात्मक विनियामकों (जैसे EIN2, PARP1) के CRISPR/Cas9 आधारित लक्षित नॉकआउट ने सूखा सहनशीलता में वृद्धि दिखाई, जिसे VIGS साइलेंसिंग और स्टोमेटल कार्य विश्लेषण के माध्यम से मान्य किया गया। *हेलोफाइट जीनोमिक्स: एविसेनिया मरीना* और *इपोमोआ पेस-कैप्रे* जैसे हेलोफाइट्स में नमक-सहिष्णु जीनों (NHX1, SOS, NAC) की पहचान की गई, जो खारे क्षेत्रों में कृषि के लिए संभावित आनुवंशिक संसाधन प्रदान करते हैं।
- **आनुवंशिक संसाधन संग्रह, मूल्यांकन और विकास:** *जर्मप्लाज्म संग्रह:* 2,500 से अधिक परिग्रहण (जैसे, क्विनोआ, चना, सोयाबीन) का सूखा, लवणता तथा जलभराव सहनशीलता के लिए परीक्षण किया गया। *लोबिया:* GWAS विश्लेषण द्वारा ताप सहनशीलता से संबंधित 392 मार्कर-लक्षण संघों की पहचान की गई; 25 फोटो-थर्मो-असंवेदनशील परिग्रहण (जैसे, EC240703) को मान्य किया गया। *मूंग:* उच्च फली संख्या (>25 प्रति पौधा) और उच्च प्रकाश संश्लेषण दक्षता वाले सूखा-सहिष्णु जीनोटाइप (जैसे, V1001556BG) की पहचान की गई। *अरहर:* जीनोटाइप ICP 14840 और ICP 16161 ने विभिन्न विकास चरणों में जलभराव सहनशीलता दर्शाई। *कंगनी:* Ise 1805 जैसे परिग्रहण ने कम नाइट्रोजन स्थितियों में उच्च नाइट्रोजन उपयोग दक्षता प्रदर्शित की, जिससे जांच किस्म की तुलना में 38% अधिक

across growth stages. *Foxtail Millet*: Accessions like Ise 1805 (38% yield increase over checks) exhibited nitrogen use efficiency under low-N conditions. *Mutation Breeding:* Gamma-irradiated chia mutants showed stable traits (e.g., dwarfism, early flowering), while groundnut mutants displayed variability in pod morphology. Dragon fruit irradiation induced branched cladodes but faced seedling mortality challenges.

- **Novel Stress Mitigation Strategies**: *Potato:* Melatonin (0.3 mM) + proline (2.6 mM) synergistically enhanced tuber yield by 23% under water deficit, improving physiological stability and antioxidant activity. *Quinoa Intercropping*: Chickpea + quinoa systems doubled productivity (2,167 kg ha^{-1}) and reduced water/carbon footprints by 2–5× compared to mono-cropping. *Nutrient Management:* Phosphate-solubilizing bacteria (e.g. *Enterobacter cloacae*) reduced fertilizer needs by 20 kg P_2O_5 ha^{-1} in quinoa, maintaining yield parity.
- **Crop Stress Tolerance and Adaptation:** *Mango:* Genotypes L11M9 and L5M5 exhibited salinity tolerance by regulating Na+/Cl⁻ accumulation, while Kesar and NT were sensitive. *Dragon Fruit:* Red-fleshed genotypes (Regular Red, Andaman Red) excluded Na+/Cl⁻ efficiently, maintaining growth under salt stress (up to 100 mM). *Allium*: 36 wild *Allium* accessions (e.g., *A. tuberosum*, *A. chinensis*) showed 95–100% survival under 10-day waterlogging. *Fennel:* Genotypes FM2, FM43, and AF2 were identified as drought-tolerant using stress indices and PCA analysis. *Cowpea*: Waterlogging at 15 DAE reduced grain yield by 63%, while

उपज प्राप्त हुई। *उत्परिवर्तन प्रजनन:* गामा-विकिरणित चिया म्यूटेंट्स ने स्थिर लक्षण दर्शाए (जैसे, बौनापन, शीघ्र पुष्पन), जबकि मूंगफली म्यूटेंट्स ने फली आकृति विज्ञान में विविधता प्रकट की। ड्रैगन फ्रूट में विकिरण के कारण शाखित क्लैडोड उत्पन्न हुए, हालांकि अंकुरण मृत्यु दर एक प्रमुख चुनौती रही।

- **तनाव कम करने की नई रणनीतियाँ:** *आलू:* मेलाटोनिन (0.3 mM) और प्रोलाइन (2.6 mM) के संयोजन ने जल-आभाव स्थितियों में कंद की उपज में 23% तक वृद्धि की, जिससे शारीरिक स्थिरता और एंटीऑक्सिडेंट गतिविधियों में भी सुधार हुआ। *क्विनोआ इंटरक्रॉपिंग:* चना + क्विनोआ प्रणाली ने कुल उत्पादकता को दोगुना (2,167 किग्रा प्रति हैक्टेयर) कर दिया और एकल फसल प्रणाली की तुलना में जल एवं कार्बन फूटप्रिंट को 2 से 5 गुना तक घटा दिया। *पोषक तत्व प्रबंधन:* फॉस्फेट-घुलनशील बैक्टीरिया (जैसे एंटरोबैक्टर क्लोके) के प्रयोग से क्विनोआ में उर्वरक की आवश्यकता 20 किग्रा P_2O_5 प्रति हैक्टेयर तक घटाई जा सकी, जबकि उपज में कोई गिरावट नहीं आई।
- **फसल तनाव सहिष्णुता और अनुकूलन:** *आम:* जीनोटाइप L11M9 और L5M5 ने Na+/Cl⁻ संचय को नियंत्रित करके लवणता सहिष्णुता का प्रदर्शन किया, जबकि केसर और NT जीनोटाइप संवेदनशील थे। *ड्रैगन फ्रूट:* लाल-मांस वाले जीनोटाइप (जैसे, रेगुलर रेड, अंदमान रेड) ने 100 mM तक के नमक तनाव के तहत विकास बनाए रखते हुए Na+/Cl⁻ को कुशलतापूर्वक बाहर किया। एलियम: 36 जंगली एलियम परिग्रहण (जैसे, ए. ट्यूबरोसम, ए. चिनेंसिस) ने 10-दिवसीय जलभराव के तहत 95-100% जीवित रहने का प्रदर्शन किया। *सौंफ़:* जीनोटाइप FM2, FM43 और AF2 को तनाव सूचकांक और PCA विश्लेषण के माध्यम से सूखा-सहिष्णु के रूप में पहचाना गया। *लोबिया:* 15 DAE (दिनों का बाद) पर जलभराव से अनाज की उपज में 63% की कमी आई, जबकि 25 DAE पर एक-दिवसीय तनाव से न्यूनतम नुकसान (0.36%) हुआ। *लघु मिलेट:* पूर्ण सिंचाई के

one-day stress at 25 DAE caused minimal loss (0.36%). *Small Millets:* Finger millet achieved the highest yield (3,103 kg ha^{-1}) and water productivity (1.13 kg m^{-3}) under full irrigation.

तहत रागी ने सबसे अधिक उपज (3,103 किग्रा प्रति हैक्टेयर) और जल उत्पादकता (1.13 किग्रा प्रति मी³) प्राप्त की।

- **Integrated and Climate-Resilient Farming Systems**: *CIFS:* Generated ₹129,400 net income ha^{-1}, with goat rearing (BCR 1.94) and hybrid Napier + Drumstick (BCR 1.93) as top performers. Water productivity for sorghum reached 9.30 kg m^{-3}. *Mahogany Agroforestry*: Sequestered 13.13 Mg C ha^{-1} yr^{-1} (5×2.5 m spacing) and achieved 66% IRR with a Land Equivalent Value of ₹589,975 ha^{-1}. *CHARA Bank:* Three fodder models (Leucaena, Desmanthus) across 21 farms were established with objective to enhance year-round fodder availability in drought-prone regions. *Multilayer IFS*: improved soil organic carbon (1.42% with vermicompost) and system water productivity (19.73 ₹ m^{-3}).

- **एकीकृत और जलवायु-अनुकूल कृषि प्रणालियाँ:** *CIFS:* बकरी पालन (BCR 1.94) और संकर नेपियर + सहजन (BCR 1.93) के संयोजन ने ₹129,400 शुद्ध आय प्रति हेक्टेयर उत्पन्न की। ज्वार के लिए जल उत्पादकता 9.30 किलोग्राम प्रति मी³ तक पहुँच गई। *महोगनी कृषिवानिकी:* 13.13 टन कार्बन प्रति हेक्टेयर प्रति वर्ष (5×2.5 मीटर की दूरी पर) संग्रहित किया गया और ₹589,975 प्रति हेक्टेयर के भूमि समतुल्य मूल्य के साथ 66% IRR प्राप्त किया। *CHARA बैंक:* 21 किसानोंके खेतों में तीन चारा मॉडल स्थापित किए गए, जिससे सूखाग्रस्त क्षेत्रों में साल भर चारे की उपलब्धता में वृद्धि हुई। *बहुस्तरीय आईएफएस:* उन्नत मृदा कार्बनिक कार्बन (वर्मीकम्पोस्ट के साथ 1.42%) और प्रणाली जल उत्पादकता (19.73 ₹ मी⁻³) प्राप्त की गई।

- **Host-Plant Synergy and Agroforestry:** *Sandalwood*: Paired with *Leucaena leucocephala*, achieved 4.27 m height and 75.71% RWC under moisture stress, categorized as "very favorable" (PHI: 0.86).

- **मेजबान-पौधे का तालमेल और कृषिवानिकी:** *चंदन:* ल्यूकेना ल्यूकोसेफाला के साथ जोड़ा गया, नमी के तनाव के तहत 4.27 मीटर ऊंचाई और 75.71% आरडब्ल्यूसी (Relative Water Content) प्राप्त किया गया, जिसे "बहुत अनुकूल" (PHI: 0.86) के रूप में वर्गीकृत किया गया।

- **Agricultural Economics:** A study on dragon fruit marketing in Western Maharashtra revealed a rising farm-gate price (₹78.23 kg^{-1} in 2019 to ₹108.53 kg^{-1} in 2022), driven by growing demand. Farmers graded produce by weight, with producers receiving 40–60% of consumer prices. The analysis highlighted a demand-supply gap, emphasizing the need for value chain optimization.

- **कृषि अर्थशास्त्र** :पश्चिमी महाराष्ट्र में ड्रैगन फ्रूट मार्केटिंग पर एक अध्ययन ने बढ़ती मांग के कारण बढ़ते फार्म गेट मूल्य- (2019 में ₹78.23 प्रति किग्रा से 2022 में ₹108.53 प्रति किग्रा) का खुलासा किया। किसानों ने वजन के हिसाब से उपज को वर्गीकृत किया, जिसमें उत्पादकों को उपभोक्ता मूल्य का 40-60% प्राप्त हुआ। विश्लेषण ने मांग आपूर्ति-के अंतर को उजागर किया और मूल्य श्रृंखला

- **Livestock and Poultry Sector Dynamics:** Analysis of quinquennial

- **पशुधन और पोल्ट्री क्षेत्र की गतिशीलता**: पंचवर्षीय जनगणना डेटा के विश्लेषण से यह (2019-1961)

census data (1961–2019) showed Maharashtra's buffalo population grew at 5.09% CAGR (vs. 6.53% nationally), while poultry surged at 17.63% (nearly matching India's 18.23%). The Cuddy-Della Valle Instability Index revealed higher variability in Maharashtra's livestock (9.88%) compared to national levels (3.77%), linked to climatic shocks. Districts like Ahmednagar and Solapur demonstrated consistent livestock growth, underscoring the need for region-specific policies.

- **Technology Outreach and Sustainable Practices:** *Energy Budgeting Tool:* A spreadsheet tool for CIFS systems automated energy efficiency calculations (MJ year^{-1}), enabling farmers to optimize inputs/outputs for crops, livestock, and agroforestry. *Drone Demonstrations:* Over 50,000 farmers were trained via 112 onsite demos and a dedicated Marathi-language webpage, promoting drone adoption for precision agriculture funded under SMAM scheme of GOI.
- **Extension and Community Empowerment:** Under DAPSC and TSP initiatives, 1,091 SC farmers and 1,306 tribal farmers received critical inputs (seeds, dairy kits, machinery) and training. Key interventions included sanitary pad machines for women's SHGs, soil health campaigns, and silage preparation workshops. Outreach programs engaged 65+ institutions through 66 visits, fostering knowledge exchange with farmers, students, and officials.

स्पष्ट हुआ है किमहाराष्ट्र में भैंसों की आबादी में 5.09% की वार्षिक चक्रवृद्धि दर CAGR से वृद्धि हुई है, जबकि राष्ट्रीय स्तर पर यह वृद्धि 6.53% रही। वहीं, पोल्ट्री की आबादी में महाराष्ट्र में 17.63% की वृद्धि दर्ज की गई है, जो भारत की औसत वृद्धि दर 18.23% के लगभग समान है। कुड्डी डेला वैले-अस्थिरता सूचकांक के अनुसार, महाराष्ट्र में पशुधन में 9.88% की उच्च परिवर्तनशीलता देखी गई, जो राष्ट्रीय औसत 3.77% से कहीं अधिक है और यह जलवायु से जुड़ी अस्थिरताओं का संकेत देती है। अहमदनगर और सोलापुर जैसे जिलों में पशुधन की निरंतर वृद्धि देखी गई है, जो यह दर्शाता है कि क्षेत्रविशिष्ट नीतियों की आवश्यकता है।

- **प्रौद्योगिकी आउटरीच और संधारणीय प्रथाएँ:** *ऊर्जा बजटिंग टूल:* CIFS प्रणाली के लिए विकसित एक स्प्रेडशीट टूल ने ऊर्जा दक्षता (MJ वर्ष$^{-1}$) की गणनाओं को स्वचालित कर दिया है, जिससे किसान फसल, पशुपालन और कृषि वानिकी में इनपुट एवं आउटपुट का अनुकूलन कर सकते हैं। *ड्रोन प्रदर्शन:* भारत सरकार की SMAM योजना के तहत वित्तपोषित इस पहल में, 112 ऑनसाइट प्रदर्शन और एक समर्पित मराठी भाषा की वेबपेज के माध्यम से 50,000 से अधिक किसानों को प्रशिक्षित किया गया। यह पहल सटीक कृषि में ड्रोन तकनीक को अपनाने को बढ़ावा दे रही है।
- **विस्तार एवं सामुदायिक सशक्तिकरण:** DAPSC एवं TSP योजनाओं के अंतर्गत, 1,091 अनुसूचित जाति (SC) किसानों और 1,306 आदिवासी किसानों को आवश्यक इनपुट (बीज, डेयरी किट, मशीनरी) तथा प्रशिक्षण प्रदान किया गया। प्रमुख हस्तक्षेपों में महिला स्वयं सहायता समूहों (SHGs) के लिए सैनिटरी पैड निर्माण मशीनें, मृदा स्वास्थ्य अभियान तथा साइलिज़ (सुरक्षित चारा) निर्माण कार्यशालाएँ शामिल थीं। आउटरीच गतिविधियों के अंतर्गत 66 भ्रमणों के माध्यम से 65 से अधिक संस्थानों को जोड़ा गया, जिससे किसानों, छात्रों और अधिकारियों के साथ प्रभावी ज्ञान आदान-प्रदान संभव हुआ।

ABBREVIATIONS

ACZ	:	Agro-Climatic Zone
AHP	:	Analytic Hierarchy Process
BSS	:	Bright Sunshine Hours
CDVI	:	Cuddy-Della Valle Instability Index
CIFS	:	Climate Resilient Integrated Farming System
DI	:	Deficit Irrigation
DTR	:	Diurnal Temperature Range
ENSO	:	El Niño–Southern Oscillation
GBS	:	Genotyping by Sequencing
HCT	:	Haematocrit
HF	:	Herbal Formulation
HGB	:	Haemoglobin
IOD	:	Indian Ocean Dipole
IPTA	:	Innovative Polygonal Trend Analysis
ITA	:	Innovative Trend Analysis
LMT	:	Local Mean Time
LPA	:	Long Period Average
MCH	:	Mean Corpuscular Haemoglobin
MCHC	:	Mean Corpuscular Haemoglobin Concentration
MCV	:	Mean Corpuscular Volume
MJ	:	Megajoule
MK	:	Mann–Kendall
ML	:	Machine Learning
m-MK	:	modified Mann–Kendall
PCA	:	Principal Component Analysis
PE	:	Pan Evaporation
PGR	:	Plant Growth Regulator
PHI	:	Plant Health Index
RBC	:	Red Blood Cell
RDF	:	Recommended Dose of Fertilizer
RDW	:	Red Cell Distribution Width
RH	:	Relative Humidity
ROC	:	Receiver Operating Characteristic
SOI	:	Southern Oscillation Index
SW	:	Spent Wash
THI	:	Temperature Humidity Index
TPE	:	Total Pan Evaporation
TR	:	Total Rainfall
WBC	:	White Blood Cell
WS	:	Wind Speed

Contents

Introduction

The Intergovernmental Panel on Climate Change (IPCC) has consistently emphasized the urgency of addressing climate change. In Sixth Assessment Report (AR6), the IPCC stated, "Climate change is a long-term challenge, but the need for urgent action now is clear,". This underscores that immediate and ambitious actions are essential to mitigate climate change. The detrimental effects of climate change, in particular the increased frequency and severity of extreme weather events, negatively influence the security of food, nutrition, and water, which hinders efforts to attain sustainable development goals. Climate change has reduced agricultural output growth worldwide over the past fifty years, even though overall agricultural productivity has increased. Our country has been witnessing losses in agricultural productivity due to episodic and frequent droughts, floods, land degradation, temperature extremes, and pest and disease outbreaks. These stresses are anticipated to make climate change much more severe, which poses a significant risk to the nation's ability to provide enough food supplies in the coming century. Given the present estimates of population, national economy, and climate change, it would be challenging to raise agricultural output with minimal inputs without compromising agro-ecosystems' sustainability. This would be a challenge because it would be difficult to improve agricultural production. Therefore, the most important task that lies ahead is to ensure that the efficiency of the agroecosystem is preserved over the long term. This can be addressed by various methods, including those that aim to bridge the knowledge gaps in the systems that underlie tolerance to abiotic stresses in fishes, animals, and plants. In light of this, the Indian Council of Agricultural Research (ICAR) established the ICAR-National Institute of Abiotic Stress Management (ICAR-NIASM) on 21st February 2009. Its mission is to develop an understanding of the fundamental causes, strategies for mitigating the effects, opportunities for adaptation, and gaps in agricultural policies and education. The ultimate objective is to improve farmers' income and quality of life in abiotically stressed ecosystems. There is an urgent need for incremental scientific research to create insights and sustainable management solutions. This is because there is a renewed emphasis on limiting global warming to 1.5 degrees Celsius to develop a fair, equitable, and sustainable world. At the same time, as it was discovered that there are limitations to adaptation and that there is a requirement for focused and collaborative efforts in both adaptation and mitigation, it was also found that there are various realistic and successful adaptation solutions that can lower hazards to both people and nature. With any additional delay in this regard, we will miss a brief window of opportunity that is rapidly closing, which will allow us to ensure that everyone will have a livable and sustainable future.

Role of the Institute

The institute focuses on addressing challenges related to soil moisture stress, soil salinity, sodicity, acidity, waterlogging, declining water quality, heat stress, cold waves, floods, seawater inundation, and other similar stresses. It employs conventional and innovative methods for crop improvement, resource management, and policy development to tackle these issues. To achieve its mission, the institute has established four specialized research schools: Atmospheric Stress Management, Drought Stress Management, Edaphic Stress Management, and Social Sciences and Policy Support. These thematic programs drive significant research efforts aimed at reducing the impact of abiotic stressors. Through collaboration with national and international institutes, the institute aims to build strategic human resources to manage these stressors over the long term. Furthermore, the institute actively participates in ongoing research and development initiatives within the framework of the National Agricultural Research and Education System (NARES), maintaining a strong focus on the mitigation of abiotic stressors. In addition to its research activities, the institute produces essential intermediate materials, including gene constructs and stress-induced promoters, which are vital for developing crop varieties equipped with enhanced tolerance to abiotic stress. These resources will serve as significant inputs for other research institutions and agricultural developers, facilitating the creation of resilient crops, livestock, fisheries, and other agricultural products capable of withstanding the pressures of climate change and environmental degradation.

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

A) 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.

B) 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.

C) 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.

D) 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

The institute has adopted a six-point, hexagonally interlinked strategy to enhance the efficiency of research, extension, and academic activities (Fig. 1.1). This approach encompasses defining target environments, implementing adaptive techniques, developing mitigation strategies, supporting policy initiatives, and fostering synergies through networking. Institute's operational strategy emphasizes fundamental research on abiotic stresses affecting the country, strategic human resource development, robust databases establishment, and 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 agro-ecology-specific stress mitigation and adaptation technologies for the crops, horticulture, livestock, and fisheries. Achieving this goal requires sustained efforts to build world-class infrastructure and develop a highly skilled scientific workforce, positioning the institute as a center of excellence in abiotic stress management. Maximizing resource use efficiency in sustainable agriculture involves evaluating available inputs, optimizing 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 that 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.

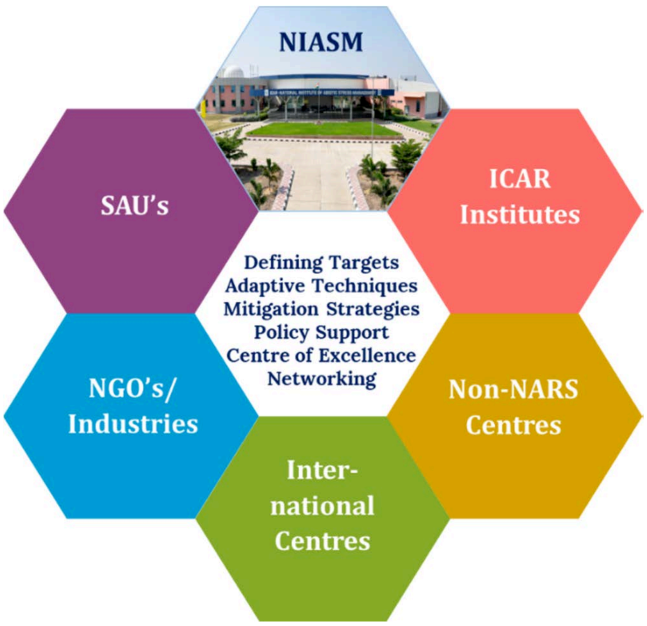


Fig. 1.1: Institute's strategy for achieving the mandate

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 36, 15, and 10, respectively.

Thus, the total filled-up cadre strength is 62 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

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	36	14 (28%)
Technical	35	15	20 (57%)
Administrative	32	10	22 (69%)
Grand Total	**118**	**62**	**56 (47%)**

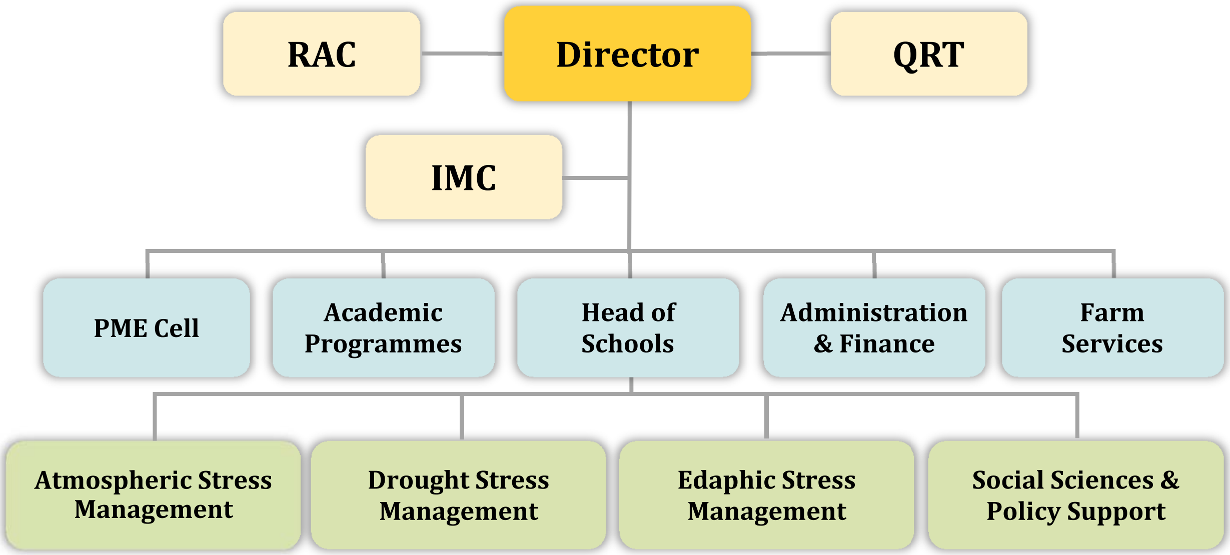


Fig. 1.2: Organogram of the Institute

Institure Infrastructure

Office-cum Administrative Building

Office-common administration building 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

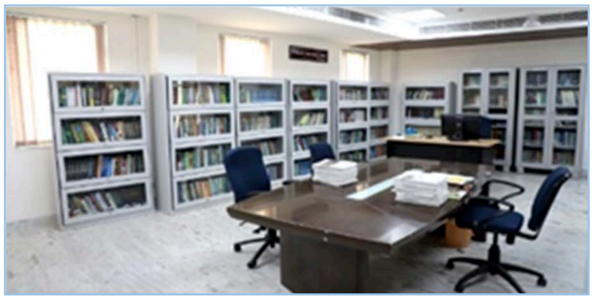
The Institute has four conference rooms equipped with audio-visual systems for conducting parallel sessions of conferences, trainings, meetings, etc.

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

Institute library has a good collection of books with areas related to 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. Library maintained its designated services and activities of acquisition of books, exchange of literature, circulation, reference services and documentation. Present library acquisitions have more than 2500 books in addition to other documents like newsletters of NAAS/ICAR institutes and other open-source articles and documents.



Guest House

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

Staff Quarters

The institute has well-constructed quarters, namely, Director Residence (Type VII quarter), and Type-IV quarters (6 nos.) built on the 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. The area is a peripheral plantation, garden, road, street lights and an electric substation.

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 National Innovations on Climate Resilient Agriculture (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 the plants within the facility 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 and light microscope, etc. Plant Genetic Engineering Laboratory has been developed to carry out basic and strategic research to address plants response to various abiotic stresses. Molecular Biology Laboratories have been developed to carry out basic and strategic research to address plant/animal/fish's response to various abiotic stresses. These laboratories have facilities for genomics and proteomics studies. The laboratory is well equipped with PCR cycler, Real-time PCR, Lyophilizer, Ultra-high-speed centrifuge, Bio-safety cabinets, Chemiluminescence imaging system, Multimode reader for DNA, RNA and protein quantification. The ROS generated due to various kinds of stresses can also be quantified and measured by multimode reader. Plant Tissue Culture (PTC) facility has been established and PTC facility having automated horizontal sterilizers, small growth chambers, 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 CO_2 incubator, biosafety cabinet and Inverted microscope.






Greenhouse Facility

There are four Hi-tech greenhouses with the total area spanning 240 m^2. Each Greenhouse is having three chambers of 10 m x 8 m of size. Greenhouses are equipped with cooling pad and 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

About 150 acres research farm is divided in to 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 like soybean, guar, green gram, etc. during kharif ason and with wheat, jowar, chickpea, sorghum and sugarcane in rabi season.Additionally, eight new plots have been developed and put under rainfed forages like marvel grass, stylo, anjan grass and irrigated Napier grass. The northeast side farm was terraced and put under various orchards to evaluate the impact of edaphic and drought stresses on horticultural crops. About four hectare of northwest side farm includes 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 liters has also been constructed for providing drip irrigation to the orchard crops.

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 (50m x 50 m size) has been built to facilitate field experiments at the site.

Model Herbal Garden

Institute has a model herbal medicinal garden named as 'Sanjeevani Garden' that was 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.

Nakshatra Udyan

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

Experimental Livestock Research Facility

Institute has an experimental livestock facility for conducting experiments related on abiotic stress management in livestock. The facility consists of cattle, goat and poultry sheds. The Committee for Control and Supervision of Experiments on Animals

(CCSEA) has approved the registration of the institute's animal house facility for the purpose of research & in-house Breeding of small animals and large animals.




Fisheries Research Farm

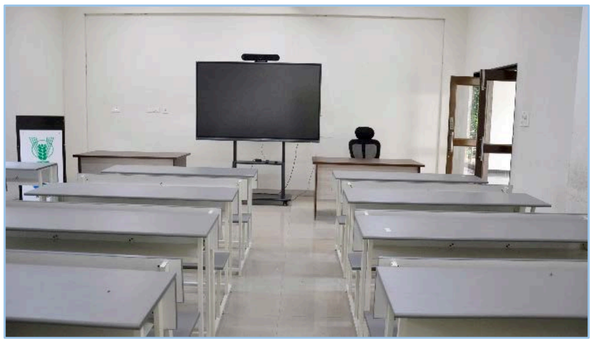
Institute has a modern fisheries facility consisting of glass aquarium, plastic rectangular tank, FRP tank and other facilities. The wet laboratories have facilities to conduct experiments in both ornamental and food fishes. There is a dissection unit for sample collection. Institute has three farm ponds for fish rearing fish brood stock.

Infrastructure for Academic Programmes

The institute has full-fledged facilities for conducting academic programmes namely Under Graduate programme for BSc (Hons.) Agriculture and MSc (Environmental Sciences). ICAR-NIASM has all the necessary infrastructural facilities for teaching such as, classrooms, laboratories, experimental fields, sport facilities and hostels with dinning facility.

Student Classrooms

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



Examination Hall

Examination hall for the conduct of academic examination of the UG and PG students is present in the Adminstrative block. The examination hall has individual seating arrangement and is equipped with CCTV surveliance system.

Hostels

Well maintained hostel facility comprising of two hostels (boys and girls) is available in the institute campus. Each hostel has 35 rooms and each room has attached toilet and bathroom with 24 hours water supply, provision of solar water heater and electricity backup. The hostel rooms are well furnished for students. There is also a common room for recreational activity in each hostel. The dining block of these hostels is equipped with 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 ITMU unit also conducted a Intellectual Property Right (IPR) Awareness week from June 20-26, 2024, under Dr K Sammy Reddy, Chairman ITMU. On the occasion, lectures were delivered namely by Dr Shweta Sharma, Registered Patent Agent & Senior Associate, Khurana and Khurana; Dr R Bagga, Founder and Managing Director, Aumirah, New Delhi; Dr A Siwal, Assistant Professor, Faculty of Law, University of Delhi; Dr DR Chaudhary, Joint Registrar and Dr P Malik, CEO AgriInnovate India Ltd. Dr Neeraj Kumar, Dr Aliza Pradhan, Dr RN Singh, Dr KK Pal, Dr AK Singh, DD Nangare and Dr GC Wakchaure were Convenor for this IPR Awareness week.

Technologies

Sr. No.	Title	Developer and Co-developers	Certificate No	Year
1	Multi-Functional Ratoon Drill (MRD) for Enhancing Productivity and Resource Conservation in Ratoon Sugarcane Cropping System	GC Wakchaure, RL Choudhary, AK Biswas, KS Reddy	ICAR-AE-NIASM-Technology-2024-022	2024
2	Trenching and Transforming Filled-in Soil Technology	GC Wakchaure, P Suresh Kumar, PS Minhas, Jagadish Rane, SK Bal, KS Reddy	ICAR-NRM-NIASM-Technology-2024-054	2024
3	Multipurpose Microbial-Biopolymer for Climate Smart Farming	KK Meena, GC Wakchaure, Ajay Sorty, CB Harisha, PS Minhas	ICAR-NRM-NIASM-Technology-2024-055	2024
4	Protocol for Identifying Drought-tolerant Tomato Rootstock through High-throughput Phenomics	PS Khapte, Pradeep Kumar, GC Wakchaure, Jagadish Rane, KS Reddy	ICAR-HS-NIASM-Protocol-2024-060	2024
5	Thiourea and Potassium Nitrate for Improving Storability and Alleviating Drought and Waterlogging Stress in Onion	GC Wakchaure, KK Meena, PS Minhas, PS Khapte, KS Reddy	ICAR-HS-NIASM-Technology-2024-061	2024

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Sr.	Title	Inventor	Date	Dairy No
1	Wastewater treatments, commercial floriculture, leafy vegetable cultivation, and fish rearing by NIASM-Designed constructed wetland and integrated aquaponics system	Paritosh Kumar, CB Harisha, Neeraj Kumar, NP Singh, Himanshu Pathak, KS Reddy	07/03/2024	6995/2024-CO/L

Budget Utilization

The institutes financial statement and revenue generated for the financial year 2023-24 are given in tables below:

Financial statement for financial year 2023–2024

Head /Sub-Head	Allocation (lakh ₹)	Expenditure (lakh ₹)
Grants in aid-Capital		
Office Building	327.27	51.78
Works		152.71
Equipment		75.43
Information Technology		15.15
Vehicles		20.69
Library Books		1.90
Furniture and Fixtures		9.61
Sub Total-1	**327.27**	**327.27**
Grants in aid-Salary		
a) Establishment Charges	985.00	985.00
Sub Total-2	**985.00**	**985.00**
Grants in aid-General		
Pension and other retirement Benefits	0.93	0.93
Travelling Allowance	12.00	12.00
Research and Operational Expenses	185.51	185.51
Administrative Expenses	465.16	465.16
Miscellaneous Expenses	10.33	10.33
Sub Total-3	**673.93**	**673.93**
Tribal Sub-Plan		
Grants in aid-Capital	5.99	5.99
Grants in aid-General	10.00	10.00
Sub Total-4	**15.99**	**15.99**
Scheduled Castes Sub-Plan		
Grants in aid-Capital	28.00	28.00
Grants in aid-General	44.00	44.00
Sub Total-5	**72.00**	**72.00**
Grand Total	**2074.19**	**2074.19**

Revenue generated during the financial year 2023–2024

Particulars	Amount (lakh ₹)
Sale of farm produce	13.82
License fee	21.62
Fees from the Candidate	6.43
Analytical & Testing Fees	0.06
Training Fees	2.87
Income generated from internal resource generation	36.75
Miscellaneous receipts	0.13
Grand Total	**81.68**

RESEARCH HIGHLIGHTS

SCHOOL OF ATMOSPHERIC STRESS MANAGEMENT

The performance of crops and livestock is influenced by their environment, and significantly by the anomalies caused by shifts in atmospheric conditions. Moreover, the interconnected population dynamics of biological factors such as pests and diseases indirectly affect yield and production efficiencies. The research initiatives by the School of Atmospheric Stress Management have predominantly directed their efforts toward understanding the implications of atmospheric stresses, factors causing it, and formulating assessment and management frameworks for crops and livestock through the spatio-temporal geospatial analysis and bio-molecular strategies. The principal research outcomes and the activities carried out over the past year at the School of Atmospheric Stress Management are presented below.

Weather at ICAR-NIASM, Research Farm Baramati

Information on weather is of paramount importance for agricultural production. The institute regularly records observations of weather parameters. Observations recorded from January to December 2024 are discussed below.

Temperature

The Long Period Average (LPA) of annual mean temperature of Baramati is 26.1 °C. The monthly mean temperature during different months recorded at ICAR-NIASM is presented in Fig. 2.1.1 During this year, annual mean temperature was 25.7 °C and the monthly mean temperatures varied between 21.8 °C (January) to 30.2°C (April and May). The monthly mean temperature increased linearly from February to May, reduced during June to September due to monsoon winds, further decreasing to 22.7°C in December. Monthly maximum temperature reached its peak in April (38.6°C) and dipped to 29.8°C in December. For minimum temperature, maximum (22.3°C) in May and minimum (13.8°C) in January was recorded (Table.2.1.1).

Relative humidity

Relative humidity measured, at standard hours in the morning (07:00 LMT) and afternoon (14:00 LMT), during the year 2024 is depicted as Monthly mean relative humidity in Fig. 2.1.1 It varied between 59% (April) and 93% (October) in morning while between 20% (March) to 71% (July) in the afternoon.

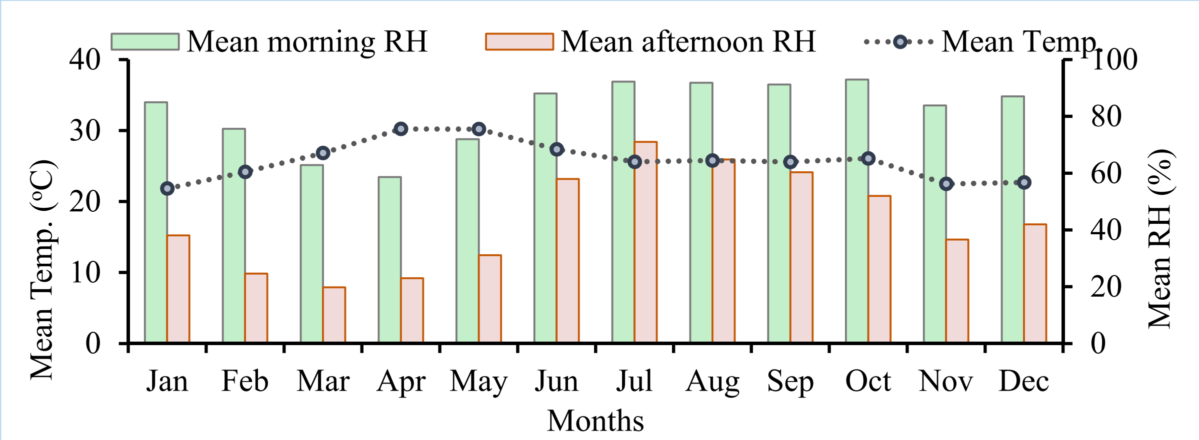


Fig. 2.1.1: Variations of monthly mean temperature, mean morning and afternoon relative humidity during 2024 at ICAR-NIASM Baramati.

The mean morning and afternoon relative humidity was found to be decreasing from January to April, which is due to the effect of increasing temperature, and then it reaches its highest value during the monsoon months, and then decreases again in the post-monsoon months. Annual mean relative humidity averaged over the entire year at 63% and ranged between 41% and 82%. Higher diurnal ranges (more than 45%) in RH were observed in November, December, January and February. The lowest diurnal range was observed in July (21%).

Rainfall

The Long Period Average (LPA) annual total rainfall of Baramati is 592.8 mm with an average of 34 rainy days per year. This year, Baramati received about 124% of its average annual rainfall, distributed among 47 meteorological rainy days, which yielded 737.0 mm of total rainfall in 2024. The monthly cumulative rainfall during different months recorded at ICAR-NIASM, Baramati has been given in Fig. 2.1.2. During the monsoon season the maximum rainfall was received in June (250.0 mm), followed by August (Table.2.1.1). In the monsoon season, there were 35 rainy days with total rainfall of 579.8 mm, which is 139% of normal rainfall of the region. Withdrawal of the monsoon resulted in incessant rains during October. In the post-monsoon season, highest rainfall occurred in October (82.8 mm) and during the summer season, 68.4 mm of rainfall was received (Fig. 2.1.2).

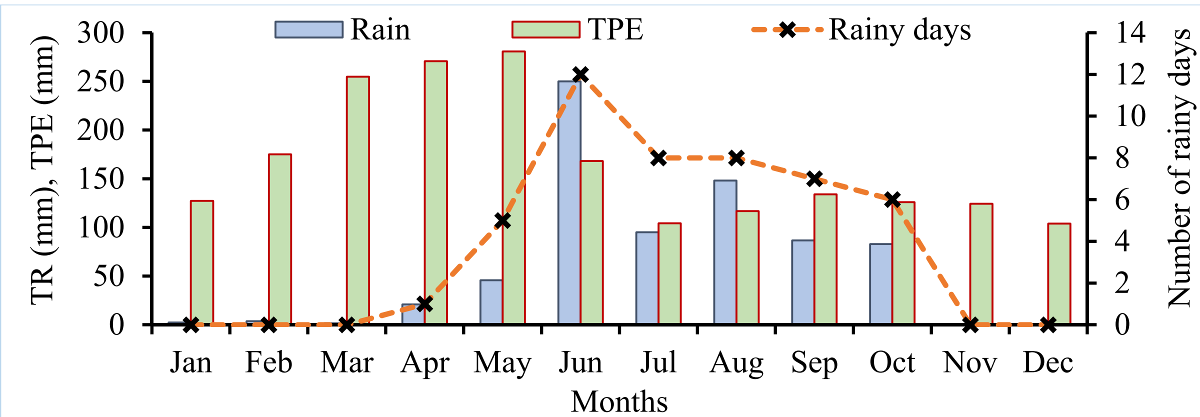


Fig. 2.1.2: Variations of monthly total rainfall (TR), total pan evaporation (TPE) and number of rainy days during 2024 at ICAR-NIASM Baramati.

Wind speed, Pan Evaporation and Sunshine duration

Monthly averages of the wind speed, pan evaporation and bright sunshine hours recorded at ICAR-NIASM are presented in Fig.2.1.3. Monthly average wind speed varied from 3.5 (November) to 9.5 kmph (July), and the annual average daily wind speed stood at 6.3 kmph. (Table.2.1.1). Annual total open pan evaporation (TPE) aggregated to 1986 mm, and is around 3 times of the total rainfall in 2024. The evaporative demand gradually increased from January and achieved its highest value in May (9.1 mm.day^{-1}). It declined thereafter to 5.6 mm.day^{-1} in June and from July to December average daily pan evaporation varied between 3.4 to 4.5 mm.day^{-1}.The lowest evaporation rate was recorded in July and December (3.4 mm.day^{-1}). The annual average of daily PE was 5.4 mm. During the year, the daily average of bright sunshine duration remained 6.4 hrs and monthly average varied from 1.6 hrs (July) to 8.8 hrs (February) (Fig. 2.1.3).

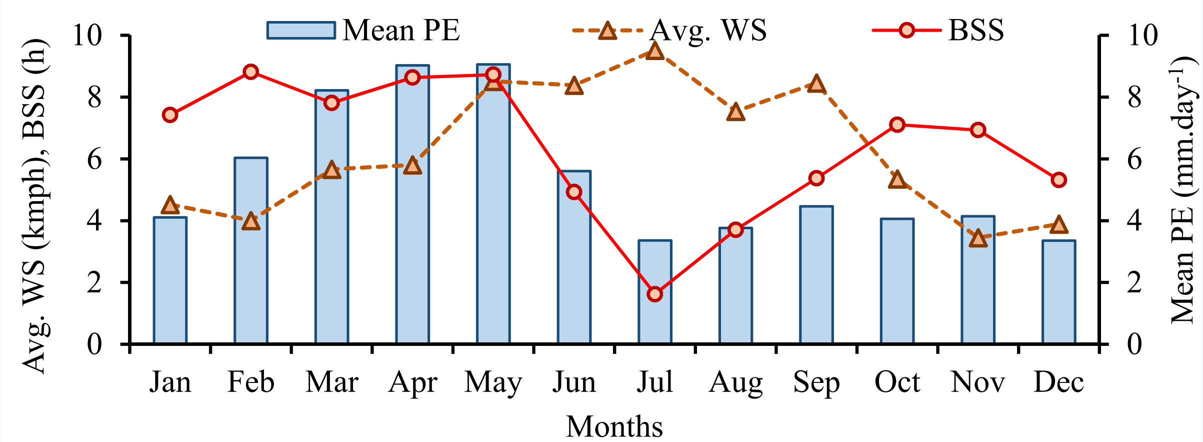


Fig. 2.1.3 : Variations of monthly mean pan evaporation (PE), average wind speed (WS) and mean bright sunshine hours (BSS) during 2024 at ICAR-NIASM Baramati.

Table 2.1.1: Mean monthly weather parameters recorded at ICAR-NIASM from Jan to Dec, 2024

Parameter	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmax (°C)	29.9	33.4	36.1	38.6	38.1	32.7	29.6	30.4	30.7	32.0	30.1	29.8
Tmin (°C)	13.8	15.0	17.5	21.9	22.3	22.0	21.7	21.1	20.4	20.1	14.9	15.6
RH I (%)	85	76	63	59	72	88	92	92	91	93	84	87
RH II (%)	38	25	20	23	31	58	71	65	60	52	37	42
Avg. WS (kmph)	4.5	4.0	5.7	5.8	8.5	8.4	9.5	7.5	8.5	5.4	3.5	3.9
BSS (h)	7.4	8.8	7.8	8.6	8.7	4.9	1.6	3.7	5.4	7.1	6.9	5.3
Total rain (mm)	2.4	3.6	1.6	21.0	45.8	250.0	95.0	148.2	86.6	82.8	0.0	0.0
Total rainy days	0	0	0	1	5	12	8	8	7	6	0	0
Mean PE (mm.day^{-1})	4.1	6.0	8.2	9.0	9.1	5.6	3.4	3.8	4.5	4.1	4.1	3.4

Extreme weather observation recorded in 2024

The warmest and coldest days based on daily mean temperature data, were 29th April (33.5°C) and 16th December (18.1°C), respectively (Table 2.1.1). Daily maximum temperature reached up to 41.6°C (6th May), while lowest daily minimum temperature dipped to 7.3 °C (16th Dec). The warmest and coldest months were calculated based on monthly mean maximum and minimum temperatures, respectively. April and May (30.2°C) was the warmest and Jan (21.8°C) was the coldest month during 2024 (Table.

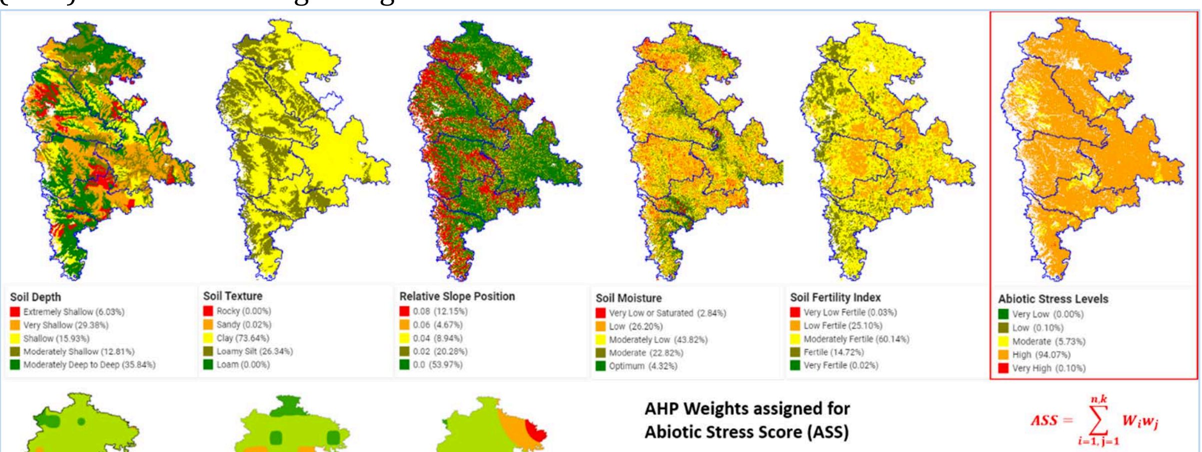
2.1.2). The cumulative monthly rainfall was highest in June (250.0 mm). The highest rainfall, pan evaporation and wind speed events were reported on 12th June (64.8 mm), 6th May (13.5 mm.day^{-1}) and 29th May (17.9 kmph), respectively.

Table 2.1.2: Important meteorological events of the year 2024.

Particular of weather parameter	Value	Date
Highest daily mean temperature	33.5 °C	29 Apr 2024
Lowest daily mean temperature	18.1 °C	16 Dec 2024
Highest daily maximum temperature	41.6 °C	6 May 2024
Lowest daily minimum temperature	7.3 °C	16 Dec 2024
Highest monthly mean temperature	30.2 °C	Apr & May 2024
Lowest monthly mean temperature	21.8 °C	Jan 2024
Highest daily rainfall	64.8 mm	12 Jun 2024
Highest monthly cumulative rainfall	250.0 mm	Jun 2024
Highest monthly cumulative PE	280.8 mm	May 2024
Highest rate of daily PE	13.5 mm	6 May 2024
Highest daily wind speed	17.9 kmph	29 May 2024

Abiotic stress level maps for western Maharashtra

Multiple factors contributing to geo-spatial assessment of abiotic stress levels viz. Soil Depth, Soil Texture, Relative Slope Position, Soil moisture, Soil fertility, Drought, Very heavy rainy days and Heatwave were combined into a single resampled Abiotic Stress Score map for western Maharashtra at 30m resolution. Analytic Hierarchy Process (AHP) was used to assign weights across five classes of each of these factors along with individual factor weight keeping consistency index below 10%. More than 94% area of western Maharashtra was estimated to have high abiotic stress levels by the methodology used. Ground-truthing is to be carried out to adjudge the suitability of this method for applicability to similar areas.



Abiotic Stress Indicators	Indicator Weights	Class Weights w1	w2	w3	w4	w5
Soil Depth	0.3	0.513	0.262	0.129	0.063	0.033
Soil Texture	0.214	0.503	0.256	0.155	0.056	0.03
Relative Slope Position	0.149	0.513	0.262	0.129	0.063	0.033
Drought NVI	0.135	0.513	0.262	0.129	0.063	0.033
Very heavy rainy days NVI	0.086	0.513	0.262	0.129	0.063	0.033
Soil Moisture	0.071	0.513	0.262	0.129	0.063	0.033
Heatwave NVI	0.03	0.513	0.262	0.129	0.063	0.033
Soil Fertility Index	0.015	0.514	0.258	0.122	0.053	0.053

Fig. 2.1.4: Maps and scores assigned for the abiotic stress indicator used in the study

Spatiotemporal analysis of maximum and minimum temperatures in agro-climatic zones of India

An in-depth analysis of long-term spatio-temporal trends of monthly maximum and minimum temperatures along with Diurnal Temperature Range (DTR) from 1951 to 2022 in various agro-climatic zones (ACZ) of India was performed using newly introduced Innovative Polygonal Trend Analysis (IPTA) and Innovative Trend Analysis (ITA) along with traditional Mann-Kendall (MK) or modified Mann-Kendall (m-MK) tests. The MK/m-MK and IPTA assessments detected significant trends in 44.6% and 86% of the time series data, respectively, while the ITA method detected significant trends in every time series data. The southern, western, and central parts of India are consistently experiencing rising monthly maximum and minimum temperatures. Western dry region, Central Plateau & Hills, East Coast Plains & Hills, Gujarat Plains & Hills, West Coast Plains & Hills, Southern Plateau & Hills, Western Plateau & Hills and Eastern Himalayan Region predominantly show increasing trends in both maximum and minimum temperatures in all months. The Indo-Gangetic Plains (Middle, Trans, Upper and Lower) exhibit decreasing trends in maximum temperatures during January, February, May, and June. The DTR showed increasing trends in the northern and western parts, while it has increasing trends in the central and southern parts of the country. The results of this study provide valuable information to assist in precise and informed decision-making in agricultural resource management.

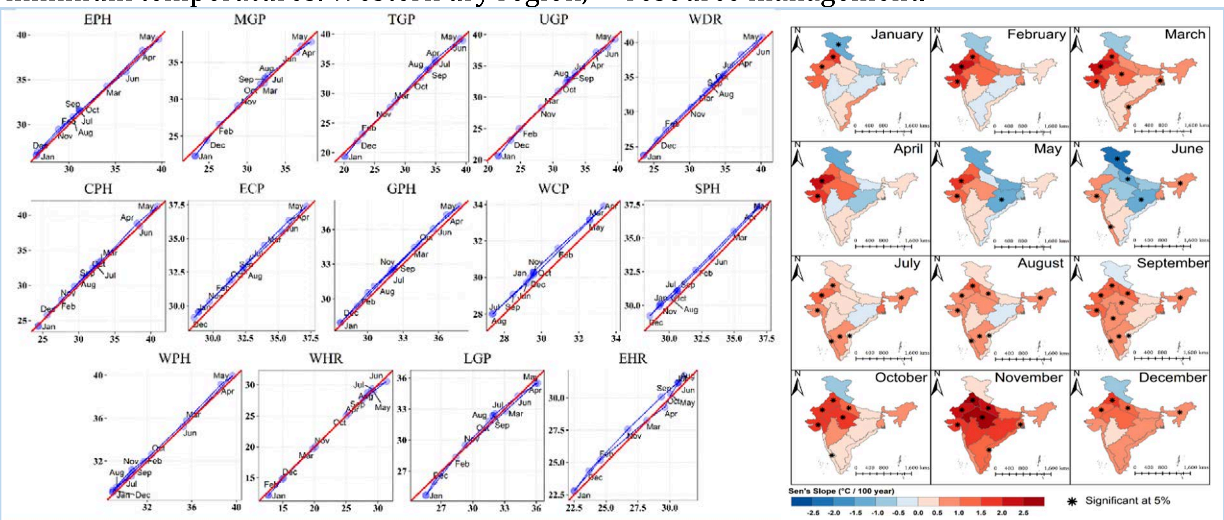


Fig. 2.1.5: Monthly trends of maximum temperature and its spatial variation for 1951-2022.

Teleconnections of rainfall with El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) in agro-climatic zones of India

To study teleconnections of rainfall in various ACZ's of India and understand the correlations, the rainfall data was processed along with derivation of ocean atmospheric indices including DMI, SOI, Niño 1+2, Niño 3, Niño 4 and Niño 3.4 at monthly, seasonal and annual time scales. Significant correlations were observed during 1901-2022 period in various ACZ's of India and best teleconnections indices were identified for ACZ's of India.

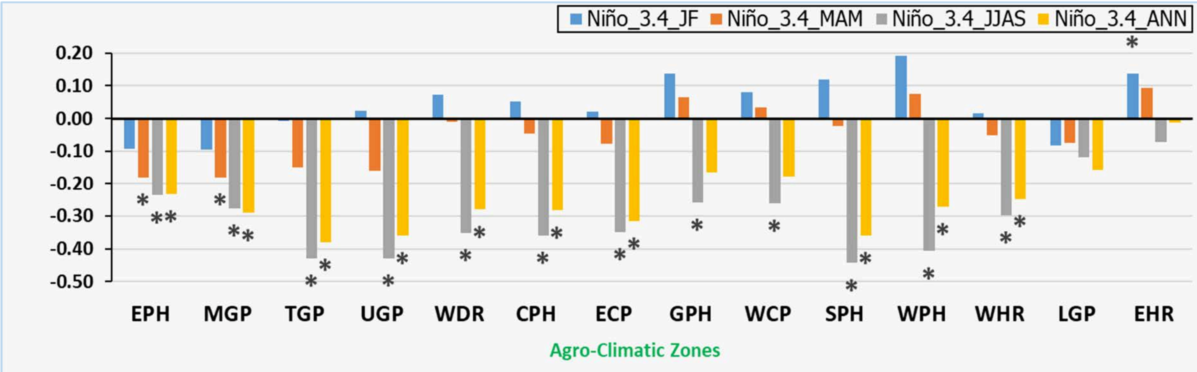


Fig. 2.1.6: Correlation of monsoon rainfall in ACZs of India with ENSO during 1901-2022 depicted using Niño 3.4.

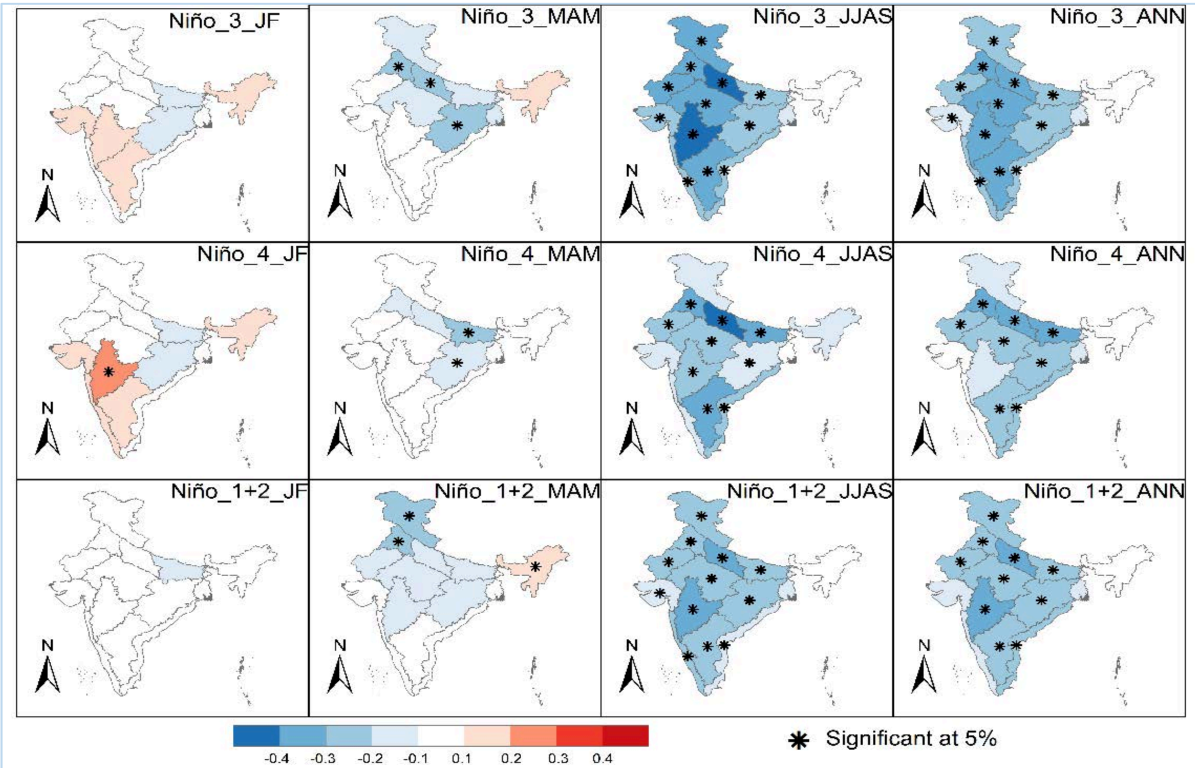


Fig. 2.1.7: Correlation of monsoon rainfall in ACZs of India with ENSO during 1901-2022 depicted using Niño 3, Niño 4 and Niño 1+2.

Assessment of effect of heat stress on physiological and hematological parameters in indigeneous goats.

The study was conducted to assess the effect of heat stress on physiological and hematological parameters in indigenous goats breeds namely, Osmanabadi, Sangamneri & Konkan Kanyal during the summer months. The temperature and relative humidity inside the shed was recorded at an hourly interval throughout the day. The degree of heat stress in goats was calculated using temperature humidity index (THI) as an indicator of heat stress (Fig. 2.1.8). It was observed that the goats were under variable degrees of heat stress throughout the experimental period. The THI levels in morning varied from 'normal to severe heat stress, whereas, in afternoon varied from 'heat stress to very severe heat stress'.

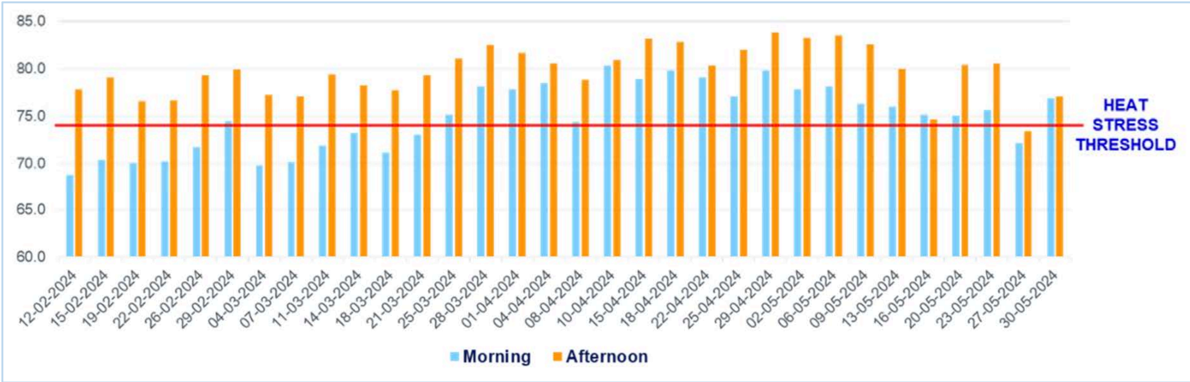


Fig. 2.1.8: The THI levels observed in morning and afternoon during the experimental period.

The physiological parameters, namely, rectal temperature, heart rate and respiratory rate, were recorded at the regular interval during the study period. Measurements of physiological parameters were done twice daily, in the morning and afternoon hours, with a gap of three days between recordings i.e., twice weekly. These measurements were taken with the utmost care to minimize disturbance to the animals. Significant changes were observed in the goats physiological parameters in response to THI, reflecting different breeds adaptive response to heat stress. Positive correlations were found between THI and each of the physiological parameters namely, respiration rate, body temperature and heart rate in all the three goat breeds studied (Fig. 2.1.9 a,b,c). However, the degree of correlation varied between the breeds, indicating breed wise difference in heat stress response.

a.

b.

c.

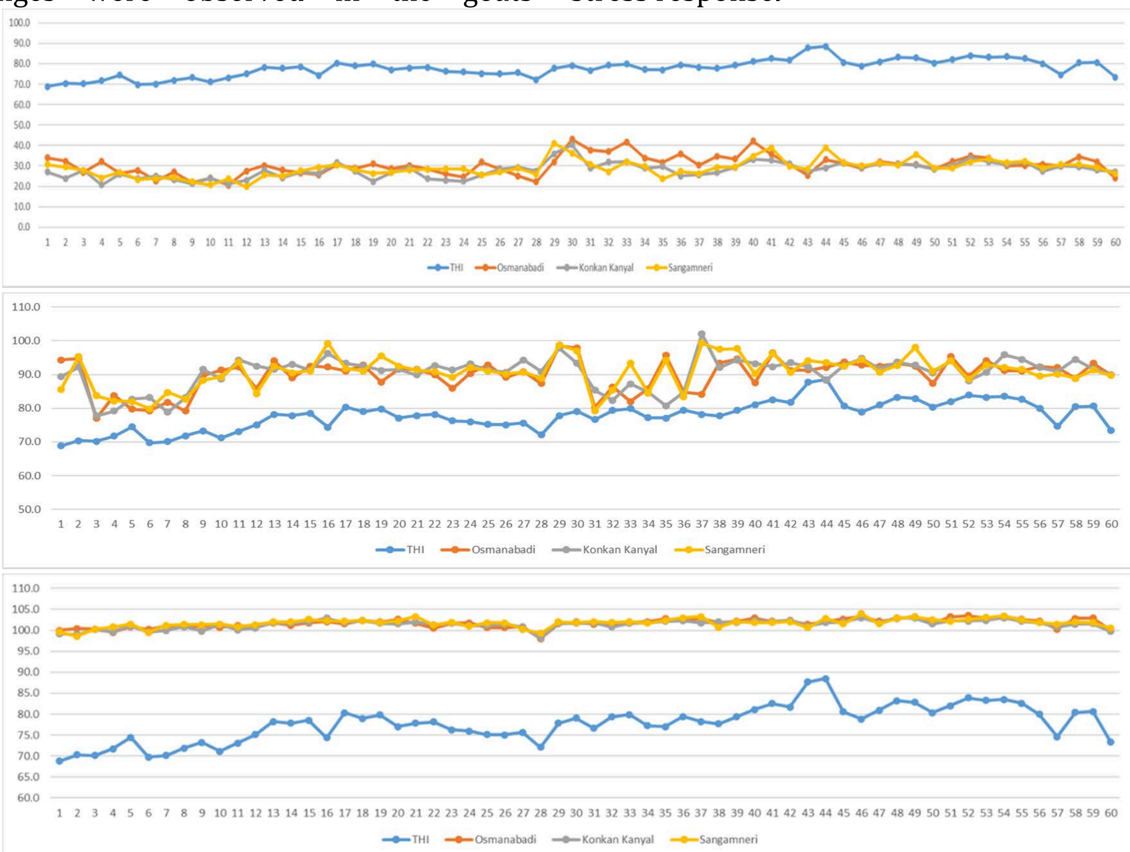


Fig. 2.1.9: Association of THI with different physiological parameters; a. Respiration rate, b. Heart rate, c. Body temperature (°F).

To assess the haematological parameters, blood samples were collected from the experimental goats once in a week for haematological analysis. The following parameters were evaluated from the collected blood; WBC: White blood cells; RBC: Red blood cells; HGB: Haemoglobin; HCT: Haematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular haemoglobin; MCHC: Mean corpuscular haemoglobin concentration and RDW: Red cell distribution width. In response to heat stress in goats, significant effect between breeds was observed for the parameters, namely, WBC, MCV and RDL; while there were no significant difference in-between breeds for other parameters (Fig. 2.1.10).

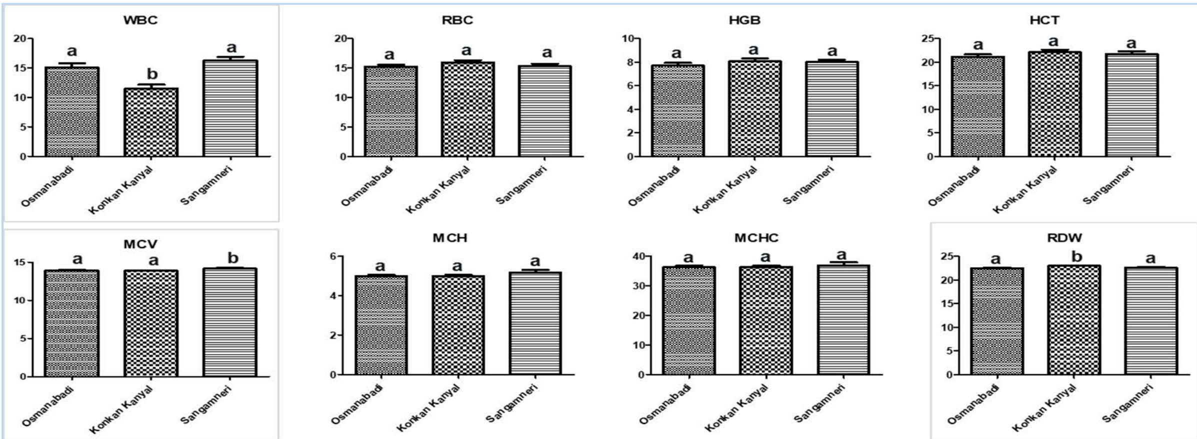


Fig. 2.1.10: Changes in haematological parameters in response to heat stress.

Herbal formulation feeding for alleviating multiple stress in goats:

In drought-prone areas, animals are frequently exposed to a scarcity of nutritional resources. The climate change situation has aggravated the problem, leading to loss of production and productivity of animals. The survey of goat farmers from the scarcity region of Maharashtra revealed exposure of goats to multiple abiotic stressors such as heat stress, nutritional stress, and walking stress during grazing. The haemato-biochemical study in the field goats revealed that anaemia indicates multiple abiotic stressors in goats, as 67% prevalence was observed in field goats. Herbal formulation (HF) (Pellets) using 10 plants with medicinal properties was prepared and evaluated for the treatment of anaemia in goats. The nutritional composition of each plant as per the available literature was used for the selection of plants. The selected 10 plants were available locally in the scarcity region, micro-nutrient rich, having anti-parasitic activity, protein-rich, and known for vitamins and polyphenol sources. The plants were shade-dried, powdered and mixed in equal quantities for preparation of the HF. Pellets were prepared by mixing HF at 25% and 50% proportions along with commercially available concentrate feed.

Nutrient evaluation of HF, prepared for goats, revealed higher total ash, crude fiber, and ether extract, whereas, slightly lower proportion of crude protein to that of concentrate feed. This HF was evaluated in 18 goats having low haemoglobin (<9 gm%). The goats were divided into three equal groups and fed with 25 and 50% HF replaced in concentrate feed. The control group received only the concentrate diet. HF feeding in goats improved MCHC and RDW values in haematological studies. Herbal formulation feeding in goats also revealed enhanced growth performance as indicated by dose-dependent average daily gains in body weight during 15 days of feeding.

Table 2.1.3: Nutritional composition of herbal formulation and concentrate feed

	Moisture	Crude Protein	Ether extract (Crude Fat)	Total Ash	Acid insoluble Ash	Crude Fibre
HF	5.63	19.53	9.06	10.23	2.83	12.08
25% HF	6.07	19.78	4.36	5.62	1.12	5.2
50% HF	6.72	18.89	4.18	6.23	1.13	6.32
Concentrate feed	7.08	22.05	4.21	5.23	1.01	5.22

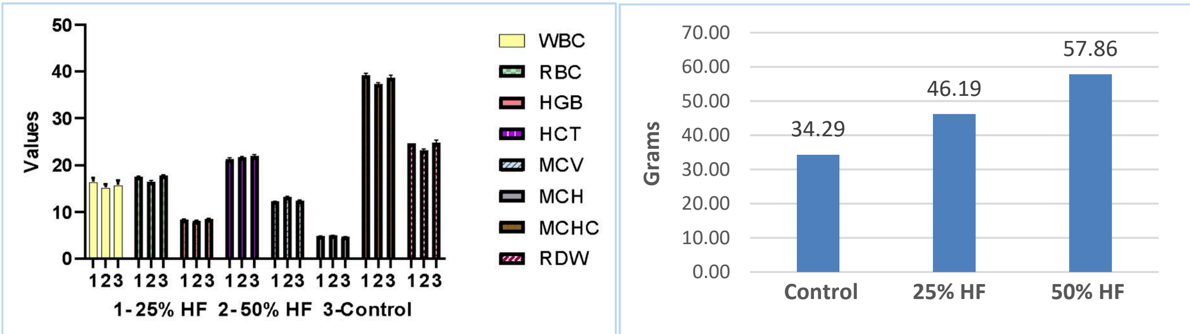


Fig. 2.1.11: (a) Haematological parameters (b) Average daily gain in body weight (g.day^{-1}.animal^{-1}) in different treatment groups of herbal formation feeding in goats

Experiment on optimizing the distillery spent wash concentration for maximum biomass productivity in duckweed

A shade house experiment was conducted to optimize the concentration of distillery spent wash for achieving maximum biomass in alternate fodder species, *Lemna minor* (lesser duckweed). CRD was adopted with 7 treatments and 3 replications; Control- 10L water + 5g duckweed, T1- 1% SW in 10L Water + 5g duckweed, T2 - 2% SW in 10L Water + 5g duckweed, T3 - 3% SW in 10L Water + 5g duckweed, T4- 4% SW in 10L Water + 5g duckweed, T5 - 5% SW in 10L Water + 5g duckweed, and T6 - 6% SW in 10L Water+ 5g duckweed. T1 and T2 showed the fastest growth rate, covering the trays in 7-8 days. T4 showed the maximum biomass accumulation followed by T3, though it took 13-14 days to cover the entire tray. T5 and T6 showed reduced biomass accumulation and took 16-17 days to cover the entire trays. From the above experiment, 4% spentwash concentration was observed to accumulate maximum biomass in a reasonable time of two weeks.

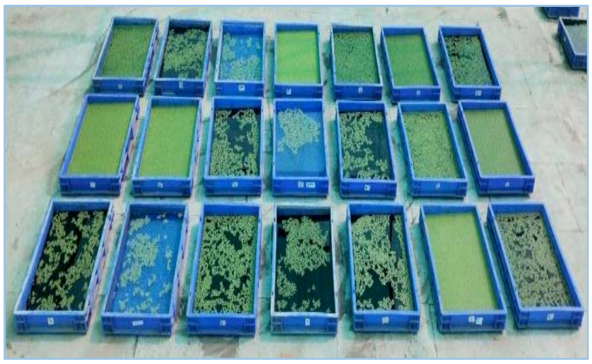


Fig. 2.1.12: Experimental setup with different concentrations of spentwash

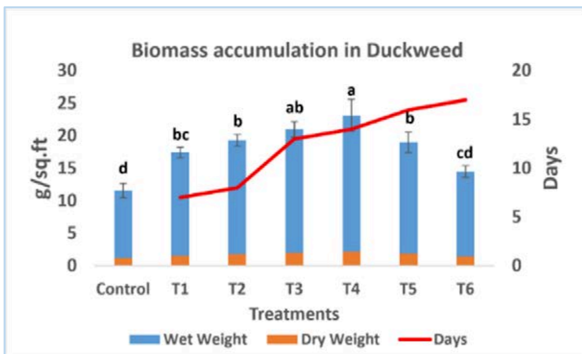


Fig. 2.1.13: Biomass accumulation in duckweed under different spentwash concentrations

Spreadsheet tool for Energy budgeting under CIFS

A spreadsheet tool was developed to perform energy budgeting of various components, *viz.*, crops, livestock, agroforestry, and fisheries, under the CIFS system. The tool has separate sheets for individual components of CIFS with the option to select inputs and outputs through the dropdown menu. Information on the type of crop, livestock, or tree species can be selected along with other inputs like water requirement, fertilizer, labour, machinery, electricity, etc. Outputs derived from individual components like grain yield, straw yield, fruits, biomass, milk, egg, dung, etc. have to be entered in the respective output tabs. After entering the input and output details, the amount of energy from both inputs and outputs will automatically be generated in MJ.year^{-1} based on conversion coefficients. In addition, it will also generate several energy indices like energy use efficiency, net energy gain, energy profitability, etc., for individual units of each component under CIFS.

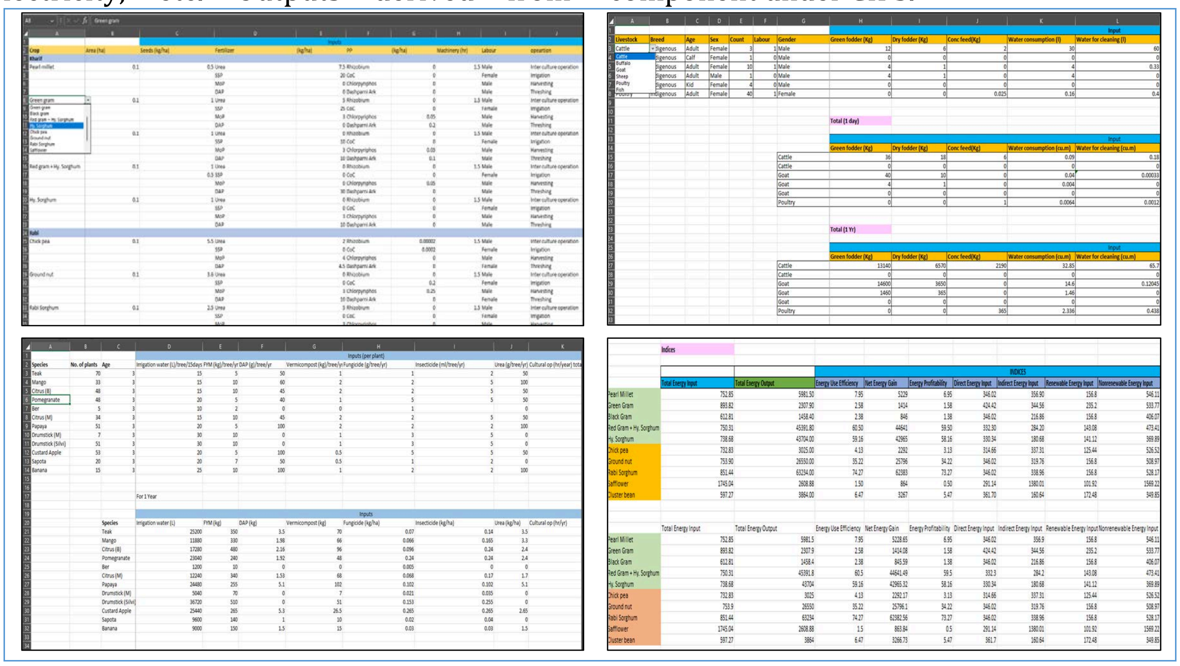


Fig. 2.1.14: Input sheets for various CIFS components and derived energy indices

Optimization of Agrobacterium mediated transformation protocol in Soybean using cotyledon as an explant

Despite the availability of various soybean transformation methods, a significant genotype dependency persists, necessitating the development of protocols tailored to different cultivars. In the present study, we optimized an *Agrobacterium*-mediated transformation protocol for the soybean cultivar JS335 using cotyledons derived from *in vitro* germinated seeds and pCAMBIA1301: GUS marker as control vector. The transformation protocol was refined by optimizing the concentrations of various hormones and reducing the time required compared to existing protocols. Notably, zeatin riboside was used in place of kinetin in the protocol. The concentrations of hormones such as BAP, GA, zeatin riboside, and IBA were adjusted for the different media types, including shoot initiation media, shoot elongation media, and rooting media. This optimized protocol resulted in rapid shoot organogenesis and elongation, enhancing the efficiency of transformation for soybean cultivar JS335.

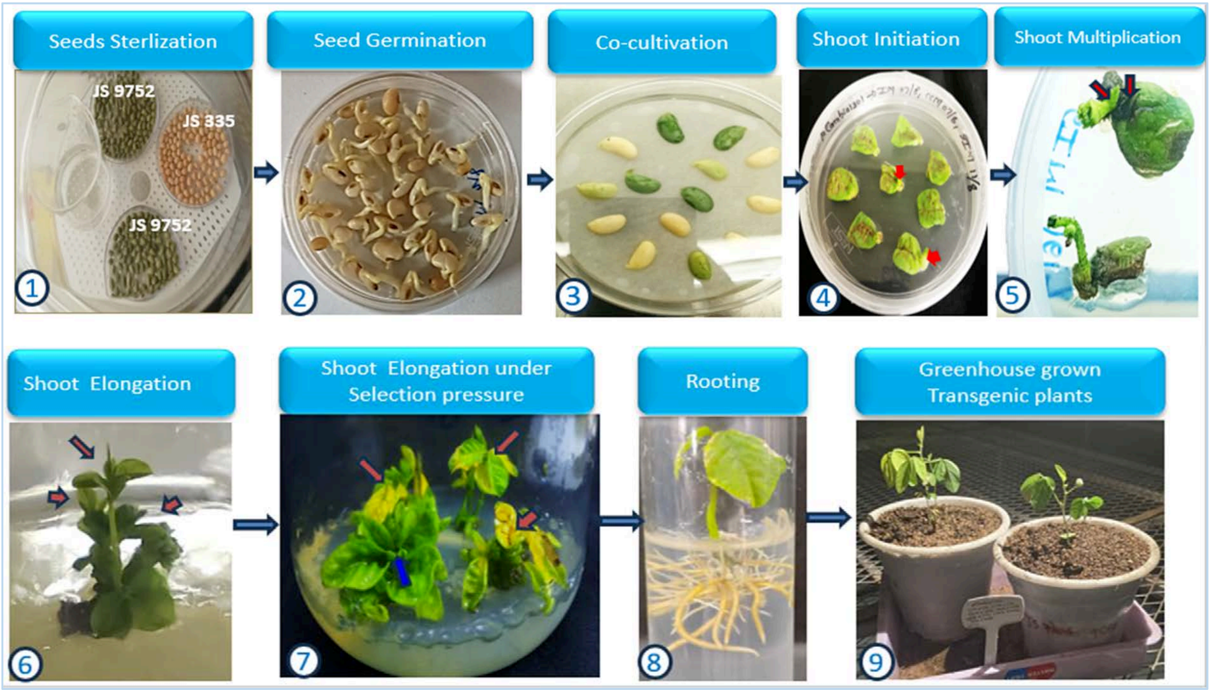


Fig. 2.1.15: Optimization of agrobacterium mediated genetic transformation of soybean cultivar JS 355

Targeted knockout of negative regulators

PCR amplification of target genes (negative regulators)

To enhance abiotic stress tolerance in soybean through the targeted knockout of negative regulators, the isoforms of target genes were identified in the genome database, and primers were designed for the PCR amplification and confirmation of full-length genes. The target genes included 1-Aminocyclopropane-1-Carboxylate Synthase (ACS), Poly (ADP-Ribose) Polymerase 1 (PARP1), Ethylene Insensitive 2 (EIN2), and Farnesyl Transferase (ERA1). PCR amplification was performed using genomic DNA isolated from leaf samples of the soybean cultivar JS355. Gene-specific primers were designed based on sequences retrieved from the NCBI database of the soybean cultivar Williams 82. Full-length genes were amplified using a high-fidelity proofreading enzyme, GXL DNA polymerase. The amplified sizes of the genes were as follows: ACS (2.2 Kb) and its isoform (2.2 Kb), PARP1 (8.4 Kb) and its isoform (8.0 Kb), ERA1A (5.4 Kb) and its isoform ERA1B (2.2 Kb), and EIN2 (7.2 Kb). The amplified gene products were sequenced using a nanopore sequencing machine, and the sequences were confirmed.

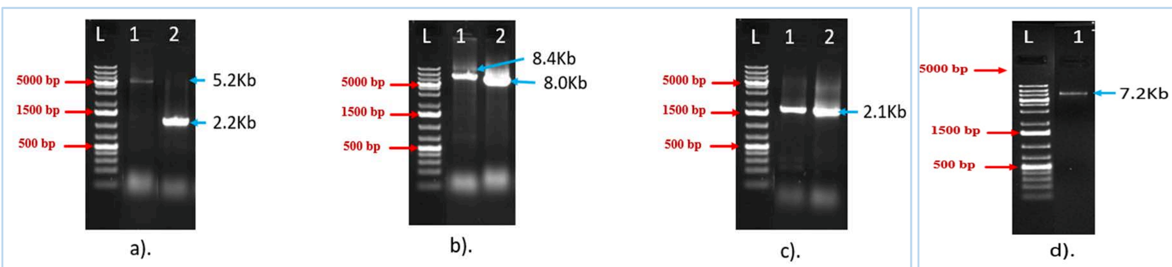


Fig. 2.1.16: PCR amplification of target genes. (Lane L-1Kb plus DNA ladder, a). Lane 1- ERA1A, 2-ERA1B; b). Lane 1- PARP1A, 2-PARP1B, c). Lane 1-ACS1A, 2-ACS1B and d). Lane 1-EIN2)

Table 2.1.4: Primer Sequences used for amplification of full-length genes

Gene Name	Primer Name	Oligos
Farnesyl Transferase (ERA1)	ERA1AFor1	TTTTCCTCCTAGAGGGATGTGTTC
	ERA1ARev4	TCAGGACTCAGTAAAGAAGAATACATGAG
	ERA1BFor1	GCTGTCGAGTATCACTAGAGTCAA
	ERA1BRev2	CTATTAATTGATGCCAGGGATTTCTC
1-Aminocyclopropane-1-Carboxylate Synthase (ACS)	ACS1For1	TCAAACCACACTCAAAAGGCTTC
	ACS.1Rev1	TAGATGAAGGTTGAAACTGCAAAG
	ACS2For1	CCCTCTCGGTGTTGTTGTTC
	ACS2Rev2	TCAAATTGTGGCTTTAACCAGAG
Ethylene Insensitive 2 (EIN2)	EIN2For1	GTCTCTCTGAGTATTGGTGCTTCC
	EIN2Rev6	CTACAAGTTGTATGGTGCTGATGT
Poly (ADP-Ribose) Polymerase 1 (PARP1)	PARP1.1For1	TAGGTACGCTCTTGCATTTCC
	PARP1.1Rev6	TCATCTCTTGTGATGAAACCTCA
	PARP1.2For1	TAGCTACGCTAATGCATTTCAC
	PARP1.2Rev6	TCATCTCTTGTGATGAAACCTCA

Construction of CRISPR/cas9: gRNA vectors

The confirmed gene sequences were subsequently used to design guide RNA (gRNA) sequences for the targeted knockout of various negative regulators. The designed gRNA sequences were synthesized and utilized for the construction of different vectors. Initially, the guide sequences were cloned into the intermediate vector, pBlu/gRNA, under the control of the AtU6 promoter, using the 2X BbsI restriction enzyme. The resultant clones were confirmed through sequencing. Subsequently, the gRNA sequences were cloned into the destination vector, G10 Cas9 MDC123, using the EcoRI restriction enzyme. The final clones were validated by restriction digestion with the EcoRI enzyme, and the construct for the Farnesyl Transferase gene was named G10Cas9MDC123-ERA1A.gRNA

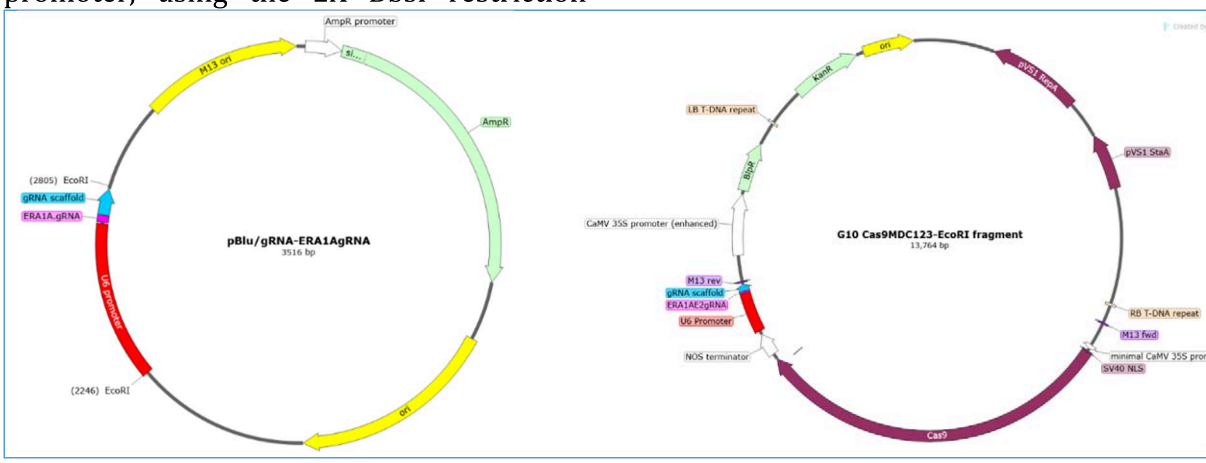


Fig. 2.1.17: Representative image of plasmid maps of (a) pBlu/gRNA (ERA1gRNA) and (b) G10-Cas9-MDC123 -gRNA Scaffold)

Genomics, genetic and molecular approaches to improve water stress tolerance in soybean and wheat (Shift to SDSM)

To improve water stress tolerance in soybean and wheat, various regulatory genes, including **EIN2, FNSL, WRKY**, and **ARF**, were functionally analyzed using a virus-induced gene silencing (VIGS) approach. For this purpose, the BPMV-based viral vectors **pHopRNA1** and **pG7RNA2** were utilized. Coding sequence (CDS) fragments of the targeted genes, ranging from 200–250 bp, were cloned into the **pG7RNA2 ve**ctor using **BamHI** and **MscI** restriction enzymes. The recombinant plasmids were transformed into the *E. coli* strain XL1-Blue, and the clones were confirmed by PCR using flanking primers (**pG7R2For** and **pG7R2Rev**) and by restriction digestion with **BamHI** and **MscI**. The confirmed plasmids were then used in *in vitro* experiments. The **pHopRI** plasmid was digested with **NotI** and **SalI**, while all **pG7R2** plasmids were digested with the **SalI** restriction enzyme. The digested plasmids were purified using the (Phenol: Chloroform: Isoamylalcohol) PCI method and used for the synthesis of *in vitro* transcripts.

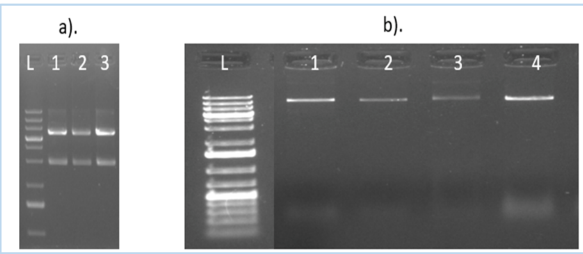


Fig. 2.1.18: Agarose gel electrophoresis of DNA digestion. Lane L: 1 Kb plus DNA ladder; (a). pHoRI digested with NotI and SalI; (b). Lanes 1–4: pG7R2 digested with SalI

In vitro transcripts from the native pHopR1-RNA1 and recombinant pG7R2-RNA2 are required together for gene silencing. Inoculation was performed at the VC stage using carborundum powder. For each construct, three replicates were used, along with the native pG7R2 (BPMV) transcript as a positive control and a mock control (phosphate buffer). Morphological, and biochemical analyses of EIN2, FNSL, ARF, and WRKY silenced soybean plants were conducted under both no-stress and drought-stress conditions. Additionally, the stomatal functions of EIN2, FNSL, ARF and WRKY silenced soybean plants were analyzed under both conditions.

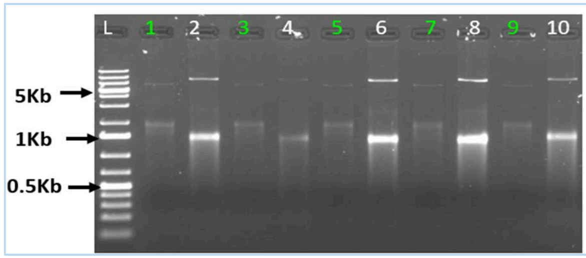


Fig. 2.1.19: Agarose gel electrophoresis of RNA1 & RNA2 transcript after 1hr incubation at 37°C (Lane L-1Kb plus DNA Ladder; 1, 3, 5, 7, 9-pHopR1 transcript and 2-EIN2 Transcript, 4-WRKY transcript, 6-FNSL transcript, 8-ACS transcript, 10-ARF transcript)

Fig. 2.1.20: Morphological phenotype of leaves from mock inoculated, empty vector infected, GmWRKY, GmEIN2, GmFnsl, GmARF-silenced soybean plants.

Exploitation of halophytic plant & associated microbiome for amelioration of saline agricultural land of arid & semiarid regions

Halophytes have demonstrated exceptional adaptability to extreme saline environments, positioning them as valuable resources for advancing saline agriculture. Investigating the molecular mechanisms underlying halotolerance and identifying key genes associated with high salt tolerance remain critical research priorities. Halophytes such as *Avicennia marina*, *Spartina alterniflora*, *Typha minima*, *Portulaca oleracea*, and *Ipomoea pes-caprae* are promising sources of salt-tolerant genes and regulatory elements, offering valuable opportunities for improving crop resilience and promoting sustainable saline agriculture. Several salt-responsive genes induced under saline conditions have been identified in these species. The salinity stress tolerance mechanism in these halophytes is highly complex, involving network of inter-connected pathways that collectively enable survival under harsh conditions. Despite progress in identifying salt-responsive genes, the search for novel, highly efficient candidates capable of regulating plant physiology under saline stress continues.

Table 2.1.5: Candidate genes identified for salt tolerance from halophytic plants

SN	Halophytes Species	Candidate genes for salt tolerance
1	*Avicennea marina*	Monodehydroascorbate Reductase (MDAR)
		NAC transcription factor (NAC1)
2	*Spartina alterniflora*	L-Myo-inositol 1-phosphate synthase (INO1)
3	*Ipomoea pes-caprae*	Receptor-like cytoplasmic kinase (RLK)
		Dehydrin (DHN1)
		Late Embryogenesis Abundant (LEA)
		Vacuolar Na+/H+ Antiporter (NHX1)
		Calcineurin B-like protein-interacting protein kinase (CBLs)
4	*Typha minima*	CIPK (CBL-interacting protein kinase)
5	*Portulaca oleracea*	NAC domain protein 6
		Vacuolar ATPase (V-ATPase)
		High-affinity Potassium Transporter (HKT)
		Salt Overly Sensitive (SOS)

Low and Medium Nutrient Index Maps of India

Soil health card data between 2015-2020 (160188425 sample points) cleansed by eliminating duplicate samples, nutrient-wise out-of-bound values, and sample geo-coordinates falling outside India, State, District and Tehsil boundaries were used to recreate nutrient-wise datasets based on low, medium and high categories given in Table 2.1.6. All the cleansed samples with and without geo-coordinates, except those falling entirely out of India, were only considered. These categories were used to create low and medium-nutrient index district-wise maps (Fig. 2.1.21) that depict the number of districts deficient simultaneously in two to six nutrients. While twelve districts were estimated to have low soil nutrients across six nutrients (NPKSZnB), 319 districts have low Nitrogen and Organic Carbon, indicating poor soil health across sampled locations.

Table 2.1.6: Threshold limits of low, medium and high categories for soil properties.

Parameter	Low (1)	Medium (2)	High (3)
Org C (%)	<0.5	0.5-0.75	>0.75
pH	<4.5, >9.0	4.5-6.0, 8.0-9.0	6.0-8.0
EC (dS.m^{-1})	>2.0	1.0-2.0	<1.0
Av N (kg.ha^{-1})	<280	280-560	>560
Av P (kg.ha^{-1})	<10	10-25	>25
Av K (kg.ha^{-1})	<110	110-280	>280
Av S (kg.ha^{-1})	<22	22-67	>67
Av Zn (ppm)	<0.5	0.5-1.0	>1.0
Av Fe (ppm)	<2.5	2.5-5.8	>5.8
Av Cu (ppm)	<0.2	0.2-0.5	>0.5
Av Mn (ppm)	<2.0	2.0-4.0	>4.0
Av B (ppm)	<0.5	0.5-1.0	>1.0

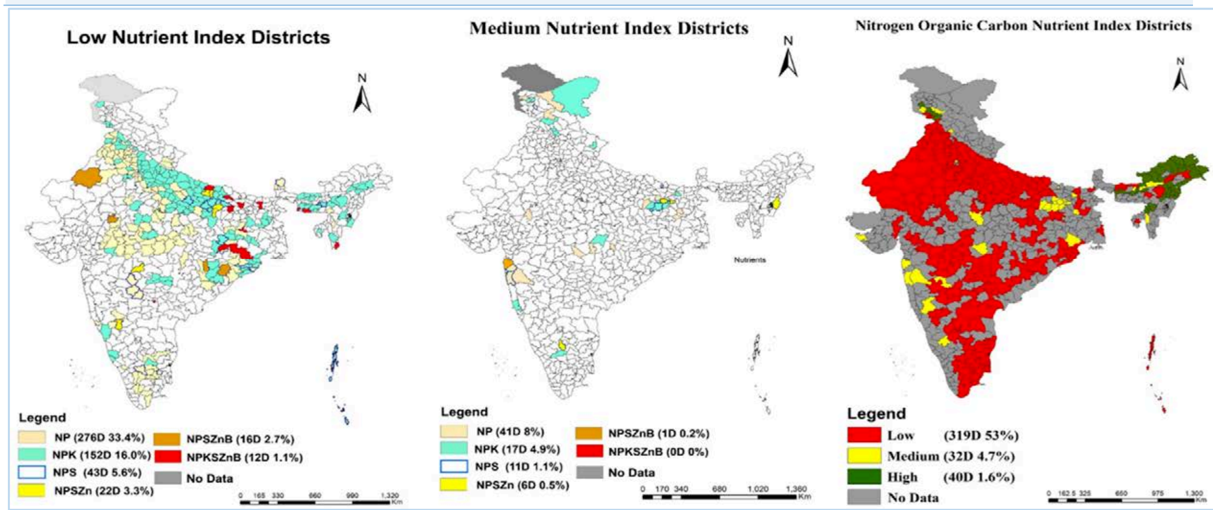


Fig. 2.1.21: Low and Medium Nutrient Index Maps of India

Agriculture Drone Demonstrations

More than 1900 beneficiaries (farmers and students from agriculture colleges visiting ICAR-NIASM and farmers from nearby villages) along with more than fifty thousand farmers during Krushik 2024 Farmers Mela (KVK, Baramati) were demonstrated and detailed about applications of agriculture drones across 112 onsite demonstrations during 2024 under the Agriculture Drone Project. The farmers were given a two-page extension folder on the Agriculture drone. The information was also passed on through a dedicated webpage (https://niasm.icar.gov.in/krushi-drone-2024) containing information in the local language (Marathi) about drone details, government schemes available, Do's and Don'ts on drone usage, along with a list of certified drones and drone pilot training centres available across India.

Fig. 2.1.22: Agriculture drone demonstrations to beneficiaries.

Image based Tree/Fruit/Livestock Counting

Drone captured image based counting of trees/fruits from several fruit orchards images of ICAR-NIASM and livestock counting from cattle fair images (Fig. 2.1.23) was tested using multi-modal models. It was found to work with good levels of accuracies.

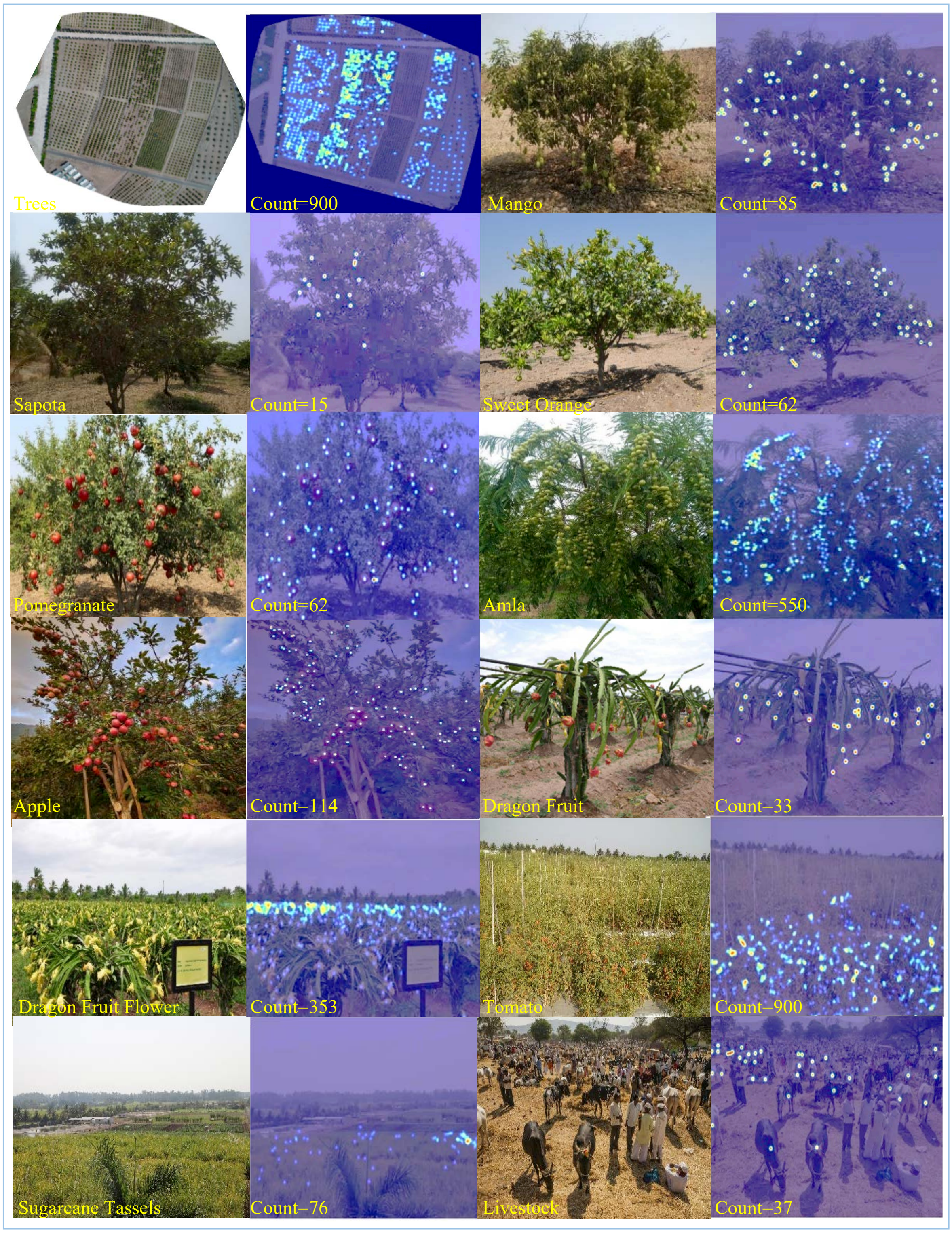


Fig. 2.1.23: Images before and after applying counting for selected use cases in agriculture

SCHOOL OF DROUGHT STRESS MANAGEMENT

Alleviation of drought- and salinity- stress in groundnut by habitat adapted endophytic bacteria

From the plant samples collected from drought-prone and salinity-affected groundnut-growing areas, 21 distinct morphotypes of rhizobia (*nif* $^{+}$*nod* $^{+}$) and 126 other endophytes were isolated (Fig. 2.2.1) and exposed to salinity and moisture deficit stress using PEG6000. Endophytes included *Heyndrickxia vini, Heyndrickxia sporothermodurans, Bacillus tropicus, Exiquobacterium acetylicum, Priestia endophytica, Pseudomonas fluorescens,* etc. Out of these isolates, 36 isolates were found to produce IAA (~15.3 ug ml^{-1}) (Fig. 2.2.2). Both rhizobia and endophytes were subjected to salinity- (~3.0 M NaCl) and moisture-deficit- stress (~ -2.0 MPa using PEG 6000 gradients) *in vitro*. While 23 endophytes and seven rhizobia could tolerate and grow at -1.5 MPa of moisture-deficit stress, 27 endophytes and nine rhizobia could tolerate salinity ~2.5 M concentration of NaCl. All the isolates were evaluated further for pair-wise compatibility to identify suitable compatible pairs for further studies. Based on compatibility, 20 out of 126 endophytes and 10 out of 21 rhizobia were selected, IAR patterns were determined, and 23 combinations are currently being evaluated in the greenhouse with TG37A (Fig. 2.2.3) and under field conditions with Phule Unnati (Fig. 2.2.4) to assess the role of these endophytes in alleviating moisture-deficit stress in shallow basaltic murrum soil. All the physiological and biochemical parameters responsible for alleviation are being studied along with regular monitoring of soil moisture and population dynamics of the introduced endophytes on the basis of IAR patterns.

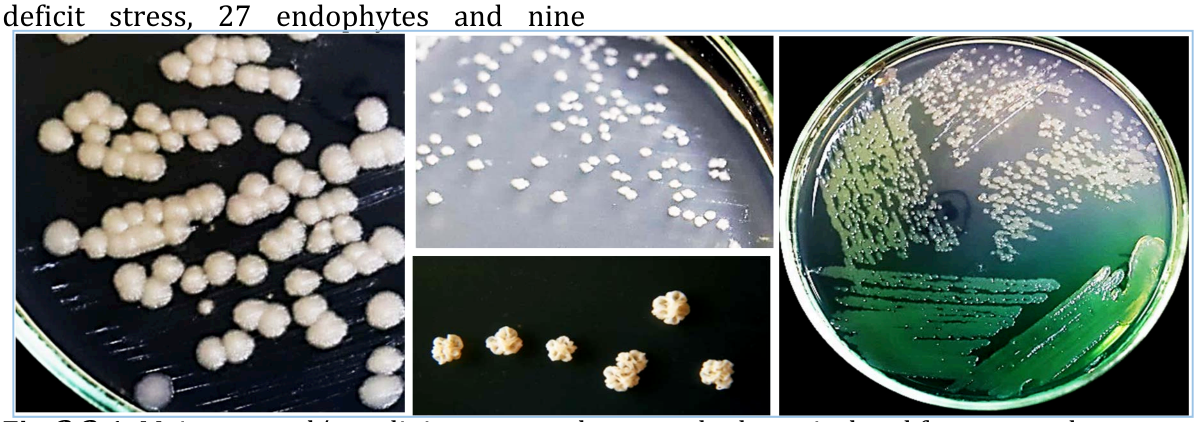


Fig. 2.2.1: Moisture- and/or salinity- stress tolerant endophytes isolated from groundnut

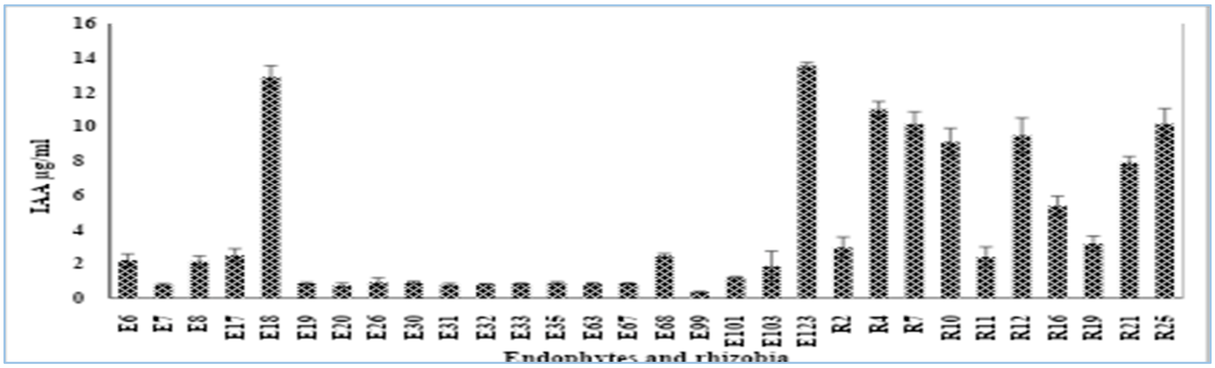


Fig. 2.2.2: IAA like substances produced by groundnut endophytes

Fig. 2.2.3: Evaluation of endophytes for alleviating moisture-deficit stress in potted conditions (Cv. TG37A) in green house

Fig. 2.2.4: Evaluation of endophytes for alleviating moisture-deficit stress in groundnut in shallow basaltic murrum soil (cv Phule Unnati)

Exploring possibility of finding CAM-photosynthetic transition in drought-stressed chickpea, pigeon pea and soybean

A functional C3 to CAM-photosynthetic transition was identified in chickpea genotype/accessions ICC4958, BDG75 and JG16 under drought stress. The expression of genes responsible for night-time carboxylation (carboxylation module: β-carbonic anhydrase, phosphoenolpyruvate carboxylase, phosphoenolpyruvate carboxylase kinase, malate dehydrogenase, aluminum activated malate transporter and V-type proton ATPase) and daytime decarboxylation (tonoplast dicarboxylate transporter, phosphoenolpyruvate carboxykinase, NADP-dependent malic enzyme and pyruvate phosphate dikinase) were found in ICC 4958 genotype. The rate of carboxylation was recorded as ~9.71 µmole m^{-2} s^{-1} in these genotypes in the night-time. All possible genes and their isoform(s), possibly involved in expression of CAM, was found in the genomes of chickpea. Further characterization of all the other modules and physiological parameters leading to transition of C3 chickpea to CAM mode of photosynthesis are in progress under field condition. Moreover, 189 chickpea accessions representing all gene pool and exotic collection were obtained on MTA from ICARISAT and are being evaluated for drought-tolerance and CAM transition, if any, under field condition. Similarly, 23 germplasm accessions, representing primary-, secondary- and tertiary- gene pools of pigeon pea have been obtained from ICARISAT, on MTA, for identification of CAM-photosynthetic transition in drought-stress and are being evaluated in field condition (Fig. 2.2.5). The work on CAM-photosynthetic transition has been extended to soybean and 80 selected genotypes/accessions/ released varieties, obtained from ICAR-IISR, Indore on MTA, are being evaluated in field condition to identify suitable genotypes in photo-insensitive background to study CAM-photosynthetic transition in drought stress, if any.

Plants under 90 days of drought stress

Plants under irrigated condition

Fig. 2.2.5: Performance of ICP11038 in shallow basaltic murram soil during *kharif* 2024

Deficit irrigation strategies combined with plant growth regulators for yield and water use efficiency (WUE) in a high-density mango orchard (Variety: Kesar)

Irrigation water applied to the mango orchard during the flowering to harvesting period (December 23 to May 24) varied according to the deficit irrigation strategies. The control treatment (T1, 100% ET) received 6,786 L $plant^{-1}$. Treatments irrigated at 75% ET (T2: DI 75; T4: PRD 75; T6: DI 75 + PGR; T8: PRD 75 + PGR) each received 5,088 L $plant^{-1}$. For treatments at 50% ET (T3: DI 50; T5: PRD 50; T7: DI 50 + PGR; T9: PRD 50 + PGR), 3,392 L of water was applied per plant during this period. The highest yield per plant of 49.89 kg was recorded in the treatment 75% ET + DI + SA + NAA, which was comparable to the 48.93 kg per plant yield in the treatment 75% ET + PRD + SA + NAA, demonstrating a significant improvement in productivity. These results suggest that combining deficit irrigation with salicylic acid (SA) and naphthalene acetic acid (NAA) enhances water use efficiency and boosts mango productivity. In contrast, the lowest yield of 39.67 kg per plant was recorded in the 50% ET + PRD treatment, highlighting the negative impact of severe water deficit without plant growth regulator

(PGR) supplementation. The highest irrigation water use efficiency (IWUE) was observed in the treatment DI 50% ET + SA + NAA, with a value of 12.33 kg m^{-3}, followed by PRD 50% ET + SA + NAA and DI 50% ET, with values of 11.96 kg m^{-3} and 11.92 kg m^{-3}, respectively. PRD at 50% ET recorded a WUE of 11.7 kg m^{-3}. The lowest WUE values were recorded in DI 75% ET and PRD 75% ET, at 8.57 kg m^{-3} and 8.38 kg m^{-3}, respectively, while the control treatment at 100% ET showed the lowest WUE at 6.84 kg m^{-3}. These findings highlight the effectiveness of combining deficit irrigation with PGRs in improving water use efficiency, particularly DI at 50% ET and PRD at 50% ET.

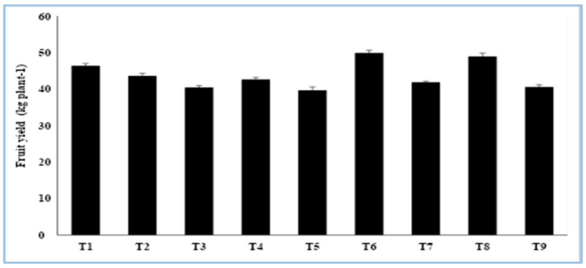


Fig. 2.2.6: Effect of treatments on mango yield per plant in a high-density mango orchard

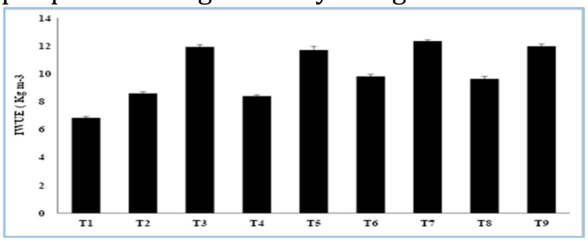


Fig. 2.2.7: Effect of treatments on water use efficiency in a high-density mango orchard

Mitigating water stress effects in vegetable and orchard crops

In 2024, two field and one laboratory experiments were conducted *viz.,* (i) to evaluate the interactive effects of deficit irrigation (DI) and plant growth regulators (PGRs) on garlic, (ii) to develop green peel candy from dragon fruit, and (iii) to establish water production functions for potato cultivars.

In 2024, a second-year reconfirmation trial was conducted during the *rabi* season to evaluate the interactive effects of five plant growth regulators (PGRs)—irradiated chitosan (IC, 5 mL L^{-1}), seaweed extract (SWE, 5 mL L^{-1}), thiourea (TU, 800 ppm), salicylic acid (SA, 30 μM), and nano-urea (NU, 2.5 mL L^{-1})—along with a control (no PGRs) under four deficit irrigation levels (100%, 75%, 50%, and 25% of ET) on garlic (Cv. Godavari). The experiment, replicated three times in a split-plot design with 24 treatment combinations, showed that the PGRs significantly increased bulb yield by 7%–22% through the regulation of photosynthesis, enzyme activity, plant-water relationships, and other physiological and biochemical processes. The maximum average water productivity achieved with various PGRs ranged from 3.9 to 4.6 kg m^{-3}, with water savings of up to 38% compared to the control without PGRs. Notably, PGRs such as IC, NU, and SWE, when combined with low to moderate water deficits (50%–75% ET), effectively enhanced bulb productivity, improved harvest quality, and increased water productivity of the garlic crop (Fig. 2.2.8).

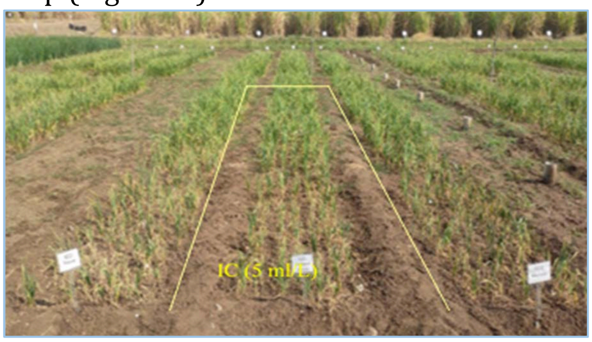


Fig. 2.2.8: Irritated chitosan response on garlic

Managing the green peel of unripe dragon fruit, especially after damage from heavy rain during the fruiting season, is a significant challenge. To address this, efforts have been made to develop value-added products, such as green peel candy (Fig. 2.2.9), from unripe dragon fruit at the PHT laboratory, NIASM, Baramati. The process involves several steps: washing the dragon fruit, peeling the skin, cutting it into small cubes, blanching, draining the hot water, dipping the cubes in sugar syrup (70° Brix), drying the candies, and finally packing them for storage. However, further efforts are needed to standardize the process and improve the texture of the green peel candy from dragon fruit

Fig. 2.2.9: Development of green peel candy

In another field experiment (2024), the responses of different potato cultivars (Cv. Kufri (K) Daksha, K. Ganga, K. Kiran, K. Thar-1, K. Thar-II, and K. Thar-III) were evaluated under varying deficit irrigation levels (100%, 80%, 60%, 40%, and 20% of ET) using a line source sprinkler (LSS) system. Compared to full irrigation, yield reduction in the different cultivars ranged from 56.0% to 75.3% with increasing water stress. The highest potato yield of 20.4 t ha^{-1} was obtained from Cv. K. Kiran under full irrigation (100% ET), while the lowest yield (7.83 t ha^{-1}) was recorded for Cv. Thar-II (Fig. 2.2.10). Interestingly, the performance of Cv. K. Kiran was sometimes better than that of K. Pukraj, which is commonly cultivated in this region. Cv. Ganga showed poor performance, requiring frequent gap-filling. Results also revealed that cultivation of Cv. K. Kiran could save up to 20% of irrigation water compared to other varieties. Overall, Cv. K. Kiran outperformed the other cultivars and showed potential as an alternative to K. Pukraj for cultivation in semi-arid Deccan Plateau regions, although further validation is needed.

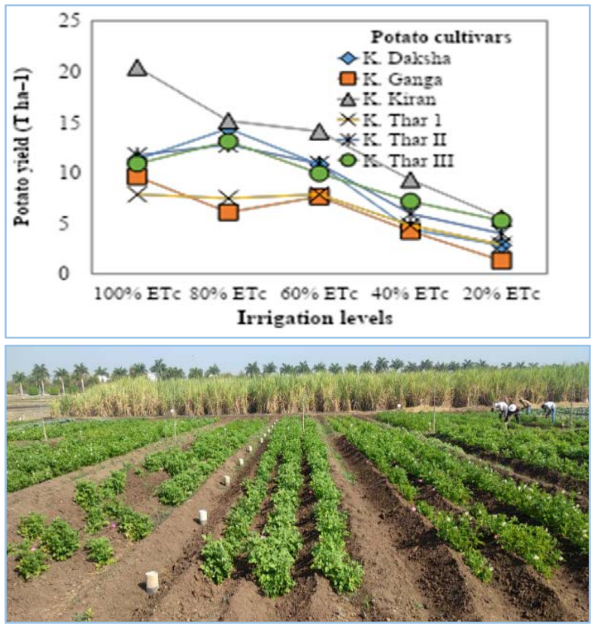


Fig. 2.2.10: Variation in potato yield under varied deficit irrigation levels

Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system

In 2024, four field trials were conducted to: (i) assess 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; (iii) examine the interactive effects of tillage, intercropping, and soil surface crop residue management in the sugarcane cropping system; and (iv) evaluate the performance of sugarcane-chickpea intercropping using MRD drill in farmers' fields. The third-year sugarcane ratoon trial was conducted to assess the long-term effects of tillage, residue, and nutrient management in laser-levelled plots under a drip-irrigated sugarcane (Cv. Co-86032) system. The results showed the highest yield increase (10.1–16.2%) with reduced tillage and SORF, achieved by applying 15% of the recommended dose of fertilizer (RDF) as basal, 30% of the RDF at 60 days after planting, and the remaining 55% through fertigation (Fig. 2.2.11). Additionally, a 7.2–11.7% yield increase was observed under mulching treatments compared to conventional tillage practices i.e. application of 10% of the RDF as basal + 90% through fertigation with trash burning.

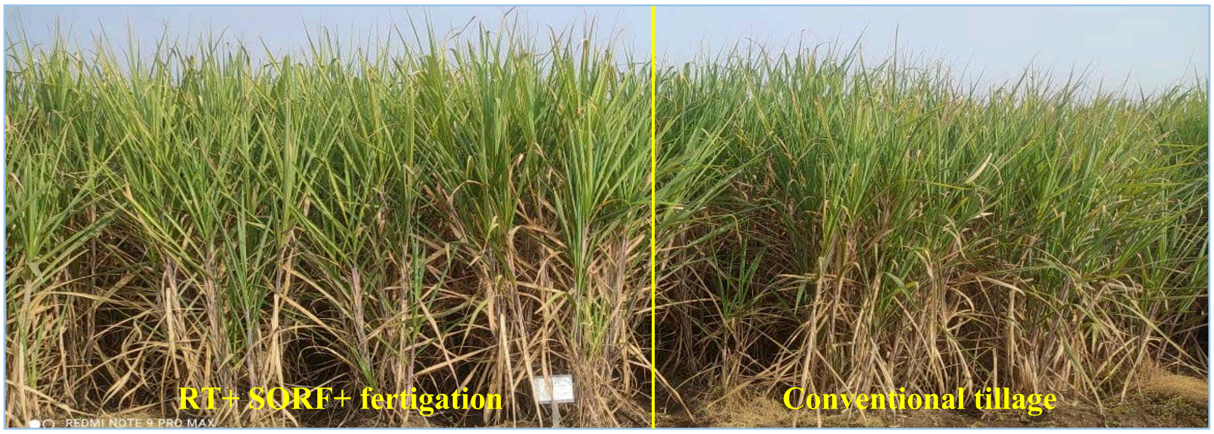


Fig. 2.2.11: Effect of reduced tillage, SORF, and fertigation on sugarcane ratoon crop in laser-leveled plots *Vs* conventional farmers' practice

In another experiment, following the harvest of the first plant crop, a field trial was conducted to evaluate the interactive effects of deficit irrigation (DI), plant growth regulators (PGRs), and surface trash retention in the ratoon crop (Cv. Co-86032) during 2024. The treatments included three deficit irrigation levels: 50% ET, 75% ET, and 100% ET, applied via a drip system in main plots; foliar application of four PGRs—800 ppm thiourea (TU), 10 mL L^{-1} irradiated chitosan (IC), 4 mL L^{-1} nano-urea, 25 µM salicylic acid (SA), and a control (no PGRs) in subplots; and two soil surface trash retention practices: S1 (mulching) and S2 (no mulching/burning) in sub-sub plots. As expected, similar to the first crop (157.1 t ha^{-1}), the highest ratoon cane yield of 140 t ha^{-1} was achieved when irrigated at 75% ET with irradiated chitosan (5 mL L^{-1}) in trash-retained plots under reduced tillage practices.

Fig. 2.2.12: Response of ratoon sugarcane to DI (75%ET), IC (10 ml L^{-1}), and trash mulching (S1)

Mulching (S1) increased ratoon cane yields by 9.4%, 21.0%, and 36.4% under full irrigation (100% ET), 75% ET, and 50% ET, respectively, compared to the non-mulching control (S2). Similarly, PGRs improved ratoon cane yields by 5.0–12.0%, 9.9–25.4%, and 15.9–35.4% under full irrigation (100% ET), 75% ET, and 50% ET water deficit levels, respectively. When compared with the results from the previous plant crop, the combined practice of 75% ET, IC (10 mL L^{-1}), and surface mulching reduced the yield gap between plant and ratoon crops by up to 7.6%, while also saving 21% of irrigation water compared to farmers' practices (Fig. 2.2.12).

Identification of promising foxtail millet accessions suitable to low soil nitrogen availability

Based on overall ranking of stress indices (2022 and 2023- Fig. 2.2.13A), six foxtail millet accessions *viz*., FXM 70 (Ise 1805), FXM 74 (Ise 1704), FXM 21 (Ise 1162), FXM 34 (Ise 1511), FXM 39 (Ise 1575), and FXM 38 (Ise 1593) performing well under both recommended dose of fertilizers (RDF) and low soil nitrogen (RDF-N) conditions were further validated along with non-performing, nitrogen-sensitive accessions (Ise 1419, Ise 289, Ise 254) and a check variety (SiA 3156) during *kharif* 2024 (Table 3 and Fig. 2.2.13B). The promising accessions except Ise 1575 showed significant yield improvements over the check under both RDF and low nitrogen conditions, making them ideal candidates for cultivation without compromising yield. Notably, Ise 1805 emerged as the top performer, exhibiting a 38.14% and 32.97% yield improvement over the check in RDF and low N conditions, respectively (Table 2.2.1). The evaluation of a large number of foxtail millet accessions over three years indicated that some of these accessions (Fig. 2.2.14) may be potential candidates for registration as genetic stocks with nitrogen use efficiency (NUE) traits and could be released as varieties for low nitrogen soils after multi-location trials under AICRP. Further, characterization of these accessions is essential to identify the specific traits and mechanisms associated with high nitrogen-use efficiency. The selected accessions (indicated with NIASM Code) performing well under both the conditions during 2024 (B)

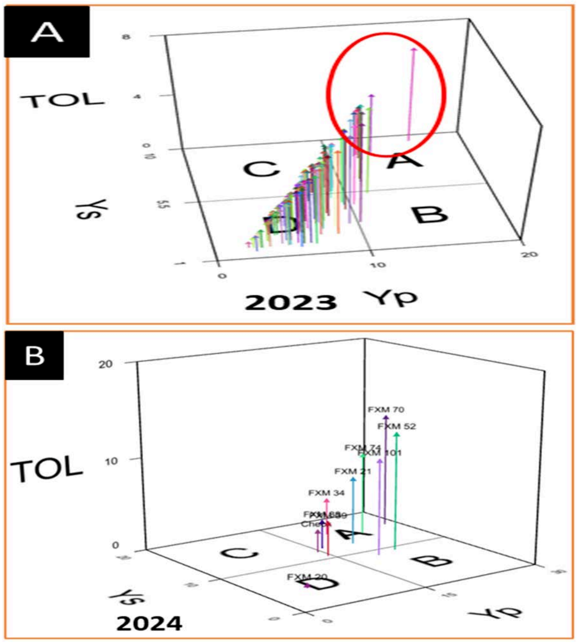


Fig. 2.2.13: Tolerance indices of 118 foxtail millet accessions showing differential performance under RDF and RDF-N conditions during 2023 (A), promising lines within red circle of 3D plots (iPASTIC: an online toolkit to calculate the plant abiotic stress index) indicating their better performance under both the conditions.

Table 2.2.1: Overall ranking of foxtail millet accessions based on average stress indices (the accessions which performed well during all the years were shown in bold letters)

Overall rank	2022*	2023*	2024**	Yield in RDF (g plant^{-1})	Yield in RDF-N (g plant^{-1})	Yield reduction (%)	Yield increase over check in RDF (%)	Yield increase over check in low N (%)
1	Ise 1805	Ise 1597	Ise 1511	20.03	15.89	20.67	38.14	32.97
2	Ise 1162	Ise 1162	Ise 1805	28.31	15.84	44.05	95.24	32.55
3	Ise 1593	Ise 1704	Ise 1704	23.67	14.64	38.17	63.24	22.47
4	Ise 1067	Ise 1575	Ise 1593	15.87	12.66	20.20	9.41	5.94
5	Ise 827	Ise 1511	Ise 1162	19.92	12.52	37.17	37.38	4.73
6	Ise 1511	Ise 132	Check	14.5	11.95	17.59	-	-
7	Ise 1575	Ise 1664	Ise 1419	5.165	4.58	11.33	-	-
8	Ise 1704	Ise 1059	Ise 1575	14.49	10.68	26.33	-	-
9	Ise 1851	Ise 1251	Ise 289	21.965	9.215	58.05	-	-
10	Ise 1286	Ise 1805	Ise 254	19.09	8.665	54.61	-	-

*Total of 118 accessions were evaluated along with check variety (SiA 3156).
** Common accessions performing well under both RDF-N and RDF during 2022 and 2023

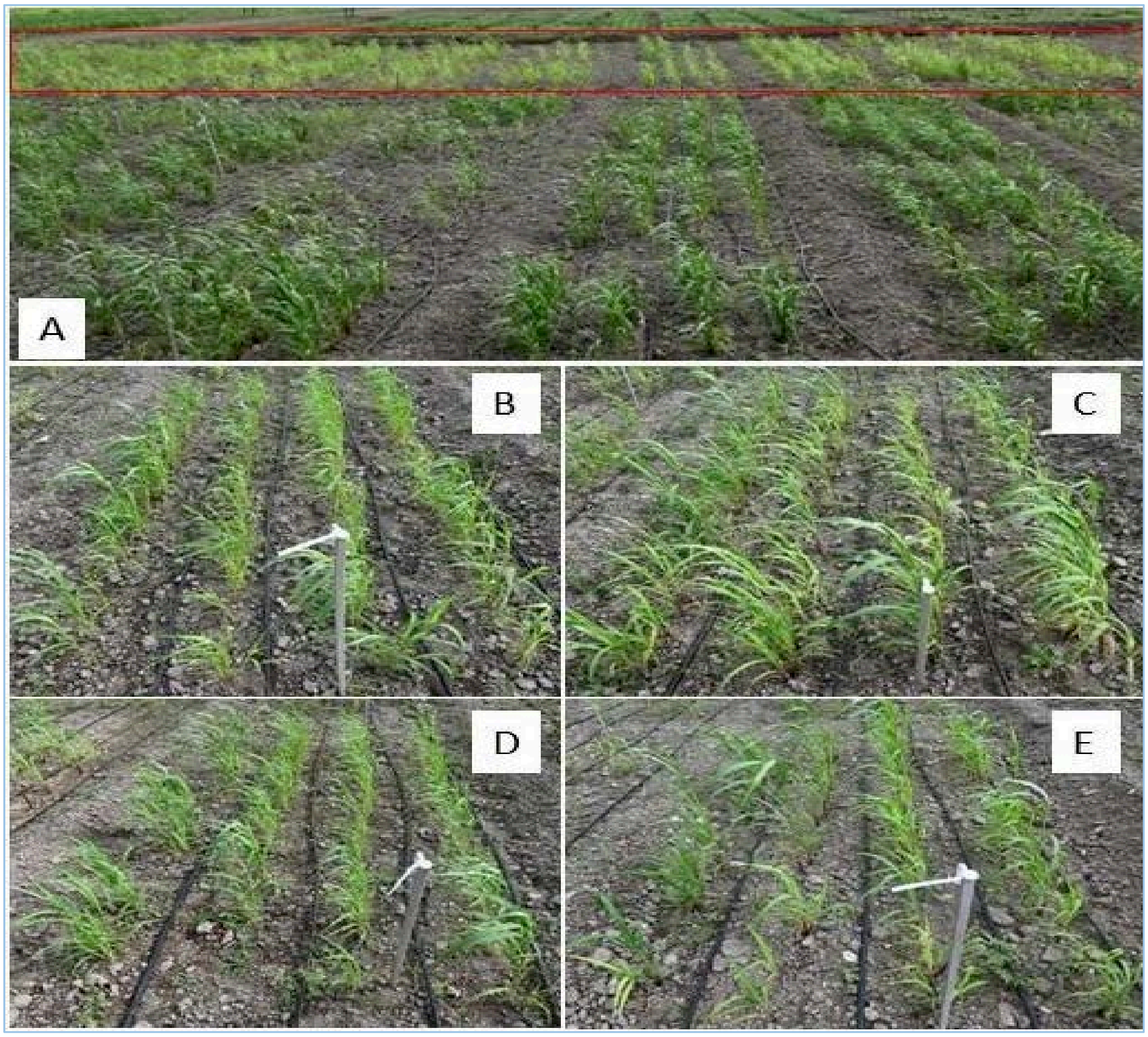


Fig. 2.2.14: Field view of validation study of foxtail millet accessions under both recommended dose of fertilizers (RDF) and low soil nitrogen (RDF-N). The phenotypic response of foxtail accessions under RDF and RDF-N (A) indicating the chlorotic symptoms (Red box) under RDF-N. Some of the best performing accessions viz. Ise 1805 (B), Ise 1704 (C) and Ise 1511 (D) under RDF-N compared to check variety SiA 3156 (E).

Generation advancing and on-station evaluation trials of chia mutants

In 2020, black and white chia varieties were irradiated with gamma rays at doses of 400, 500, and 600 Gy to induce genetic variability. More than 1,000 M1 plants were selected, and M2 plants were sown in 2021 using the plant-to-row method. These plants exhibited segregation for various morphological traits such as plant height, leaf shape and colour, flowering time, and seed colour and size. These variations, along with the expression of novel traits like purple pigmentation, bold seeds, and chlorosis, were observed in the M3 generation in 2022, indicating the expression of recessive genes. Macro and micro mutants were then selected and planted in double rows (of progeny) in late *kharif* 2023 to confirm the stable expression of traits, advancing to the M4 generation (Fig. 2.2.15). To accelerate the generation advancement (M_4 to M_6) of chia mutants, an effort was made to explore the possibility of obtaining two generations per year. Promising mutant lines were harvested immediately after maturity and sown in late *rabi* 2023-24. Materials obtained from segregating plants (M_4 from late Kharif 2023 and M_3 from *rabi* 2022-23) were sown using the plant-to-row method, and bulk-harvested plants (M_4 from late *kharif* 2023) were planted in plots. It was found that some mutant lines (selected from M_4 of late *kharif* 2023) exhibited poor germination, possibly due to short-term dormancy. Therefore, it is essential to standardize the harvesting time and investigate the existence of short-term dormancy or the optimum seed moisture content to ensure better germination. The M_5 generation mutant lines (Fig. 2.2.16A), which showed variability in phenological traits (flowering and maturity) and morphological traits such as spike size and shape (Fig. 2.2.16B and Table 2.2.3), confirm the penetrance and stability observed in the M_4 generation. However, M_4 mutant lines selected from M_3 during *rabi* 2022-23 exhibited segregation for the observed traits, with a few lines expressing novel traits such as dwarf and sturdy plant types (Table 2.2.3 and Fig. 2.2.17), indicating a polygenic and recessive inheritance pattern.

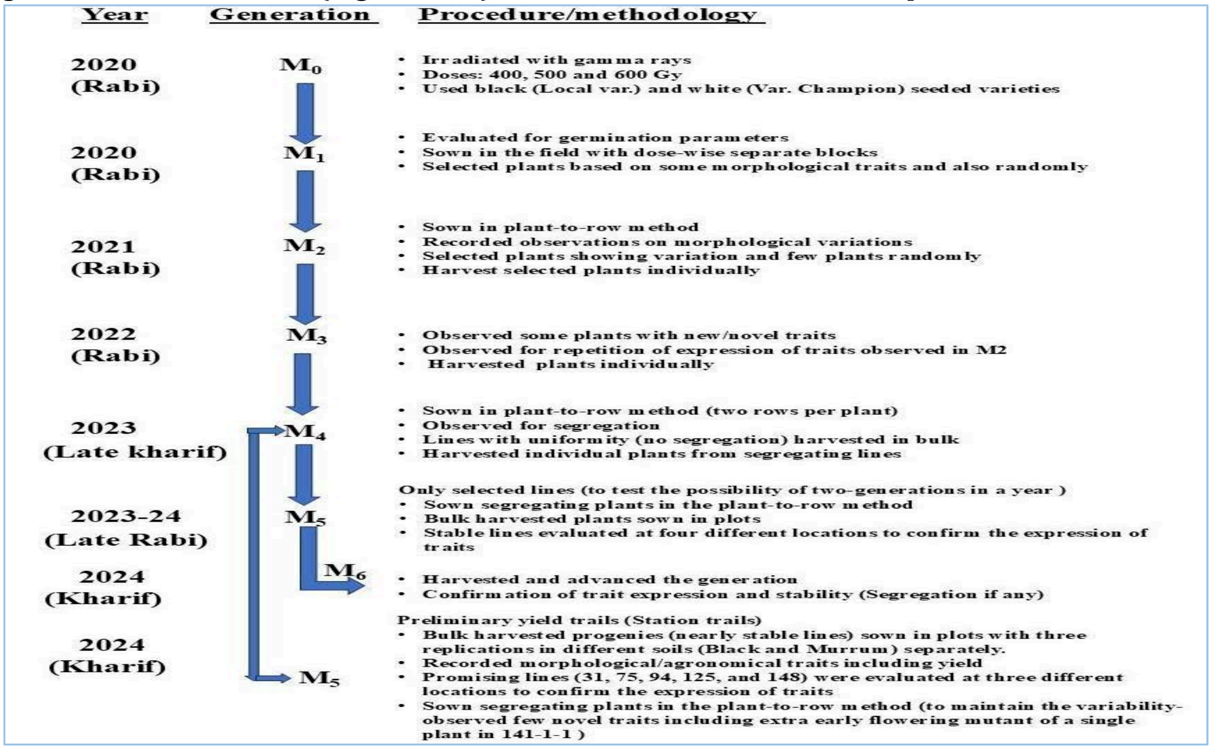


Fig. 2.2.15: Development and advancement of chia mutant lines

Fig. 2.2.16: Variability for maturity (94-1-1) and spike (size, shape, arrangement of florets, branching) during M_5 generations.

The selected bulk-harvested progenies (M_5) (Table 2.2.2), which were nearly stable (showing little or no segregation), were sown in plots (5m x 6m), accommodating approximately 10 rows of 6m length, with three replications in two different soils (black and murrum/native) separately. Morphological and agronomic traits, including yield per plot, were recorded. Additionally, promising lines (pedigree of plant no. 31, 75, 94, 125, and 148 originally selected from M_2) were evaluated at three different locations (NIASM, Baramati; ICAR-CRIDA, Hyderabad; and ICAR-IISS, Regional Station, Bengaluru) to confirm the expression of traits in different agro-climatic conditions during 2024. About 300 mutant lines (some still exhibiting segregation) were sown using the plant-to-row method to advance the generation and maintain the diverse variability observed across different generations (Fig. 2.2.16-18). Most of the lines showed very little or no segregation for the observed traits. The dwarf and sturdy plants (plant-to-row) exhibited segregation for height, as well as for flowering and maturity within the lines (Fig. 2.2.17A). The sturdy and dwarf mutants were also more resilient, as they showed delayed wilting symptoms (Fig. 2.2.17B) after uprooting, whereas the wild-type plants began wilting within 5-10 minutes after uprooting (Fig. 2.2.17C). Interestingly, some novel variations, including extra early flowering (Table 2.2.3 and Fig. 2.2.20A & B), were observed in the M5: M6 generation during *kharif* 2024. The variability and segregation observed in later generations highlight the importance of delayed selection for polygenic & recessive traits.

Table 2.2.2: Number of potential mutant lines considered for preliminary yield (station) trials at ICAR-NIASM, Baramati

Mutant lines (with pedigree of line)		**Phenological traits**			**Distinguishable traits**
Murram soils (D-4 plot)	**Black soils* (C-2 plot)**	**DFI**	**DFF**	**DM**	
94					Purple pigmentation on stem, petiole and spike (calyx). These lines were 8-12 days early as compared to wild type (Fig. 2A).
94-1-1	94-1-1	66	72	103	
94-1-3	94-1-5	80	83	104	
94-2-1	-	81	85	110	
94-2-2	94-2-2	81	86	109	
94-2-3	94-2-3	76	81	105	
94-2-4	94-2-4	80	86	109	
94-3-1	94-3-1	81	86	111	
94-3-3	-	77	81	110	
94-3-4	94-3-4	82	86	109	
94-3-5	94-3-5	82	87	112	
125					Purple pigmentation on stem, petiole and spike (calyx). Late flowering and maturity compared to wild type. Two seeded per floret (Fig. 4E) instead of four in the wild type but seed was bold (almost double the size of wild type).
-	125-1-1	92	98	151	
-	125-1-2	91	96	152	
125-1-3	125-1-3	92	96	124/151	
125-1-4	-	78	85	127	
125-1-5	-	82	88	130	
-	125-1-4	94	101	152	
-	125-2-1	91	97	155	
-	125-2-2	87	94	149	
125-2-6	125-2-6	92	96	129/148	
125-2-7	125-2-7	90	95	123/153	
	125-3-2	92	98	155	
125-3-7	125-3-7	94	101	130/154	
Local black variety (BSC-1)	78-80	83-86	115-119	-	Purple flower, black seed, and vigorous growth compared to white variety
White (Champion)	80-83	84-88	118-121	-	White flower, white seed

*Observed approx. 20 days delayed flowering/ maturity compared to murrum soil. DFI: days to flowering initiation; DFF: days to 50% flowering and DM: days to maturity

Fig. 2.2.17: Dwarf, sturdy and hardy mutant (52-3-2/5/6) progenies showing segregation (A), delayed wilting symptoms (B & C) upon uprooting, chimera (D) for spikes and uniform flowering (E)

Table 2.2.3: Number of promising mutant lines potential for registration as genetic stocks

Mutant lines (with pedigree)	DFI	DFF	DM	Uniformity/ stability	Special traits
52-3-2	70-89	76-94	115-122	Uniform flowering and very less segregation	Dwarf, sturdy, dark and crinkled elongated leaves. Potential for ornamental plant type (Fig. 3).
52-3-5	79-80	85	118-120	Sown in bulk	
52-3-6	76-88	80-92	116-122	Observed less segregation	
31-1-1	67-73	75-77	100-105	No segregation	Entire plant is chlorotic and has potential for ornamental plant type (Fig. 5B).
148-1-1	87-89	89-92	115-120	No segregation	Cup shaped cotyledon and crinkled dark green leaves with light green at the basal region (Fig. 5A).
148-1-3					
75-1-6	99	105	155-160	No segregation	Tall (lodging), late, long spike with phyllody type, intermittent flowers with pinnate type leaves in between (Fig. 5C).
75-1-14	100	107	155-160	Less segregation	
86-1-1	90	96	125-130	No segregation	Branching spike (Fig. 2B)
80-1-2	88	95	123-128	No segregation	Rounded spike (Fig. 2B)
138-3-8	81-84	85-90	120-125	No segregation	Branching spike (Fig. 2B)
138-2-6	85-86	88-90	122-126	No segregation	
65-2-1/2/3/4	84-90	91-96	120-122	No segregation	Spike with closed corolla (delayed dropping of corolla from floret (Fig. 2B)
11-1-1/2/3/4/5	61-64	66-70	95-100	No/very less segregation	Early flowering and maturity (Fig. 6C).
141-1-1-P$_2$	55	60	90	Single plant selected	Extra early flowering mutant line (Fig. 6A&B)
Local black selection-1(BSC-1)	78-80	83-86	115-119	-	Purple flower, balck seed, vigorous compared to white
White (Champion)	80-83	84-88	118-121	-	White flower, white seed

Fig. 2.2.18: Variability for spike traits in M_5 generation in chia. The branching (A), round (B) shaped spike, blue and purple colour florets, (C), phyllody (75) type spike (D), 2 seeded (125) mutant (E)

Fig. 2.2.19: Macro mutants exhibiting morphological variation for foliage (A & B) and spike shape (C)

Fig. 2.2.20: Extra early (141-1-1) flowering, maturity (A&B) & early (11-1) flowering mutants (C) in M_5

Evaluation of soybean germplasms for photo-thermo insensitivity and drought tolerance

Soybean, a short-day plant, is highly sensitive to photoperiod, restricting its cultivation mainly to the *Kharif* season in India. It is predominantly rainfed but highly susceptible to drought, which significantly impacts productivity. To facilitate year-round cultivation in rainfed or residual moisture areas with life-saving irrigation, drought-tolerant genotypes in a photo-thermo insensitive background are essential. Therefore, 240 GWAS-characterized germplasm accessions/genotypes/varieties were screened for blooming under a photoperiod regime of 11h 02min (December 14 to 29) to 13h 13min (June 16 to 26) and temperatures ranging from 9-42°C at ICAR-NIASM, Baramati. Accessions from IISR, Indore, and other sources were evaluated across seasons (*rabi*, *kharif*, and *summer*) to identify candidate genotypes. In *rabi* 2022-23, the germplasm was assessed for blooming, pod formation, fertilization efficiency (flower-to-pod ratio), and yield under shorter photoperiod conditions. The same germplasm was also screened under optimal conditions (*kharif* 2024) and the longest photoperiod (13h 13min, June 16 to 26, 2024). Short-lighted accessions/varieties were re-sown on November 18, 2024, for blooming between December 14 to 29, 2024. Of the 80 selected accessions/genotypes/varieties, 48 bloomed within the desired timeframe. Promising genotypes with consistent flowering and yield across all conditions will be selected and sown in *summer* 2025 for further confirmation and validation of photo-thermo insensitivity and drought tolerance.

Rabi 2023-24 (29.02.2024) Summer, 2024

Fig. 2.2.21: Evaluation of soybean germplasm across the *kharif, rabi*, and summer seasons during 2022-24 to identify photo-thermo insensitive genotypes

Creating genetic variability in dragon fruit by mutation breeding

Dragon fruit germplasm accessions/ varieties exhibit limited variation. To create variability, eliminate heterostyly, and induce traits that promote early pollination for improving fruit size and yield, mutation breeding was initiated in this heterostylous exotic horticultural crop. Dragon fruit seeds from different varietal types and cross combinations were subjected to gamma irradiation at doses ranging from 400-1200 Gy in early 2024.

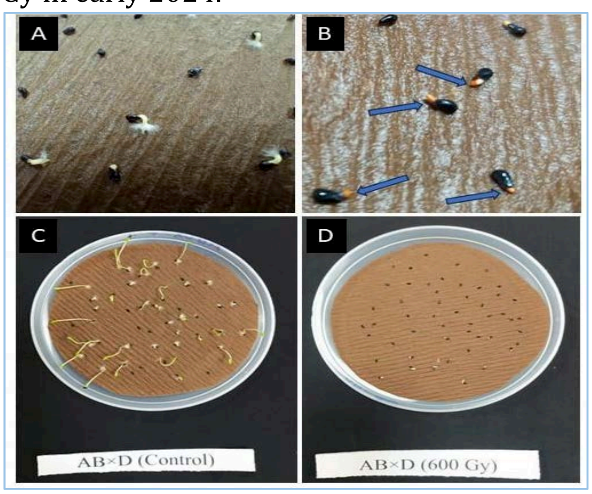


Fig. 2.2.22: Effect of gamma radiation on seed germination in dragon fruit showing red colour radicle (B) and delayed germination (D) compared to wild type (A & C)

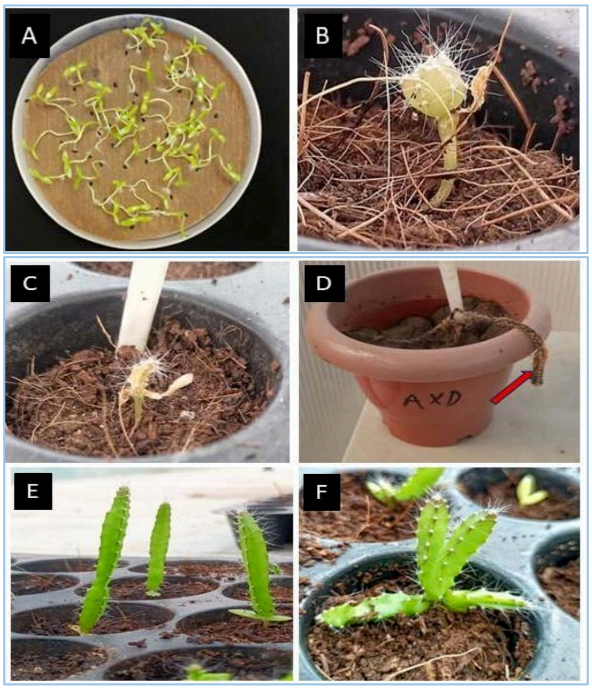


Fig. 2.2.23: Early germination and seedling growth of M_1 generation due to higher dose. Normal germination and growth at early stage, later seedlings starts yellowing (B), wilting (C) and mortality (D). Abnormalities seedling (F) due to lower dose of gamma irradiation and normal seedling (E) growth in wild types.

The white-fleshed variety seeds, obtained from manual self-pollination and cross-pollination (since natural pollination in

Selenicereus undatus results in poor germination), were irradiated. For crosses, pollen from red-fleshed varieties was used. The irradiated seeds displayed red coloration in emerging radicles (Fig 2.2.22B). While the irradiated seeds exhibited normal germination, they were delayed by 8-10 days (Fig 2.2.22D) compared to wild type seeds (Fig 2.2.22C). Despite normal germination (Fig 2.2.23A), the seedlings from irradiated seeds could not survive beyond 2-3 months, showing higher mortality at higher doses (Fig 2.2.23B, C & D). Therefore, the radiation doses were adjusted, and seeds from different crosses, along with self-pollinated seeds, were irradiated with reduced doses (50, 100, and 150 Gy). This adjustment did not affect seedling survival, but affected germination and caused some morphological abnormalities, such as branched cladodes (Fig 2.2.23F) in place of the usual single main cladode (Fig 2.2.23E). The seedlings are currently being hardened before transplanting into the field for further studies. Since dragon fruit is vegetatively propagated, these mutants will remain at the M_1 stage.

Creating genetic variability in groundnut by mutation breeding

A gamma radiation-based mutation breeding program was initiated in *summer* 2024 at ICAR-NIASM to create genetic variability in groundnut and dragon fruit. Groundnut seeds of the Kadri Lepakshi variety (a drought-tolerant and high-yielding cultivar) were subjected to gamma irradiation at three doses (150 Gy, 200 Gy, and 250 Gy) to address issues such as bitter kernel and haulm taste, seed viability, and kernel size. A significant reduction in germination was observed in the irradiated seeds (M_1), especially at the 250 Gy dose, compared to the un-irradiated Kadri Lepakshi seeds.

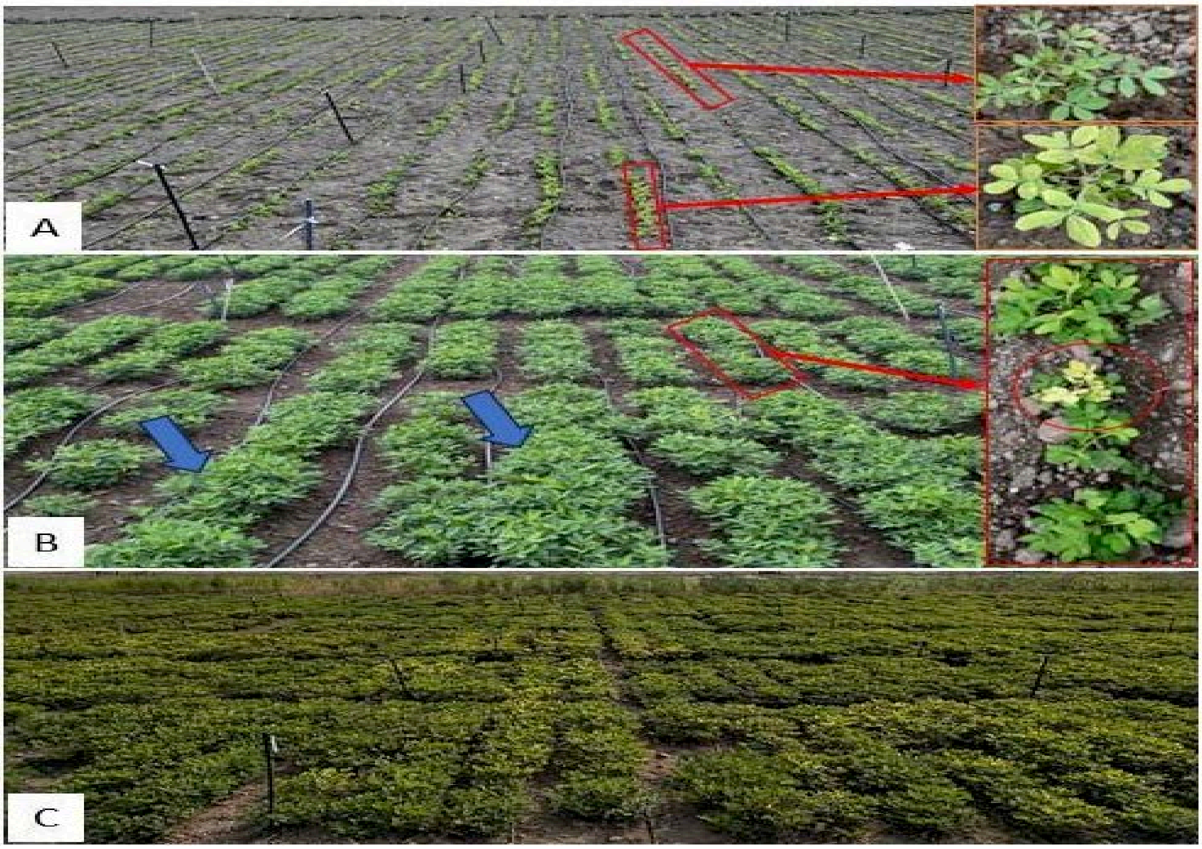


Fig. 2.2.24: Field view of M_2 generation of groundnut at vegetative (A & B) and reproductive stage (C) showing the variation vigorous (Arrows) and chlorosis (red circle in the set figure) plants in different mutant lines

No major morphological variations were observed in the M_1 generation, except for slight chlorosis and foliage colour. Approximately 1000 M_1 plants were randomly selected and sown using the plant-row method during the *Kharif* 2024. The M_2 generation exhibited considerable variability in both morphological and quantitative traits (Fig. 2.2.24-25) including plant height, branching (ranging from profuse branches to few or none), growth habit (spreading, erect, or semi-spreading), leaf size (narrow or broad), leaf shape (pinnate, oval, or lanceolate), pigmentation (light or dark green, and chlorosis), pod number, shape, and reticulation, as well as kernel number, shape, and colour. Mortality in the M_2 generation was minimal, although the plants displayed sterility and the absence of pods (Fig. 2.2.25). Selected plants from M_2 will be raised during *rabi-summer* 2025 using the single plant progeny method for further selection based on desired traits, stability, expression, and validation.

Fig. 2.2.25: Spectrum of variability observed in M_2 generation in groundnut

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" about 2518 germplasm/ genotypes/ accessions (as on February, 2024) of different crops (Table 2.2.4) have been collected during 2020-24 from different organizations. The seed/planting materials of collected germplasm maintained and being utilized for basic research and screening for different abiotic stress tolerance.

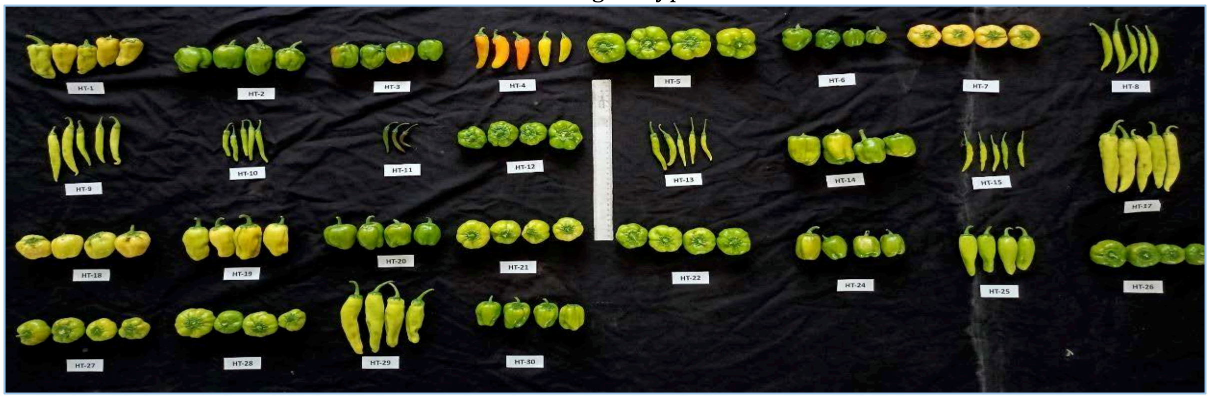
Table 2.2.4: Germplasm maintained under genetic garden at ICAR-NIASM, Baramati

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	Basavaraj PS
Soybean	6 genotypes	Drought	ICAR-IISR, Indore	AK Singh
	2 genotypes	Water logging		AK Singh
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, Ajmer	CB Harisha
Fennel	43 mutants		NRCSS, Ajmer	CB Harisha
Pigeon pea	193 accessions		ICAR-IIPR, Kanpur	Hanjagi PS
	500 advanced breeding lines			
	141 Accessions		ICRISAT, Hyderabad	Basavaraj PS Boraiah KM KK Pal
	23 wild species			
Groundnut	174 Accessions			
Foxtail millet	118 Accessions			
Finger millet	77 Accessions			
Cow pea	250 Accessions			
Mungbean	296 Accessions		WVC, Taiwan	Basavaraj PS
Tomato	122 Accessions		NBPGR, New Delhi & WVC, Taiwan	PS Khapte
Chilli	22 Accessions		IIHR, Bengaluru & WVC, Taiwan	PS Khapte
Ajwain	12 genotypes		NRCSS, Ajmer	CB Harisha
Chickpea	72 genotypes		IIPR, Kanpur	Boraiah KM
	10 Wild species		ICRISAT, Hyderabad	Basavaraj PS
	192 Minicore Accessions			KK Pal
Lentil	32 genotypes		IIPR, Kanpur	Gurumurthy S
Groundnut	8 varieties		UAS, (R) & (D)	Boraiah KM
Finger millet	35 wild Sp. & varieties			Boraiah KM
			ICAR-IISS, Mau	
Avocado	15		ICAR-IIHR, RS, Chettali	VD Kakade
Citrus	30 rootstocks		IARI, New Delhi	VD Kakade
Dragon fruit	20 collections		Maharashtra/ Hyderabad	Boraiah KM
Total	**2518**			

Collection, conservation and maintenance of vegetable germplasm

Tomato, eggplant, and capsicum germplasm were collected from both international and national institutes, as well as local areas, between 2020 and 2024 (Fig. 2.2.26). The germplasm was purified through self-pollination and is being maintained under field and greenhouse conditions. This collection includes wild species of fruiting solanaceous vegetable crops, which are currently being screened for resistance to various abiotic and biotic stresses.

Tomato genotypes



Capsicum genotypes

Fig. 2.2.26: Diversity in tomato and capsicum genotypes collection

Identification of promising brinjal genotypes from local collection

Twenty-six local brinjal genotypes collected from peninsular were evaluated in shallow basaltic murrum soil in *kharif* 2023. A wide range of variability was observed for both qualitative and quantitative characters in these brinjal local collection. Therefore, based on the mean performance of the genotypes Tembhurni Local, AM Kolhapur and RP Sangli were found superior for most of the characters (Fig 2.2.27 & Table 2.2.5).

Tembhurni local AM Kolhapur RP Sangli

Fig. 2.2.27: Local brinjal genotype collection

Table 2.2.5: Mean performance of local brinjal collection for yield attributing parameters

Genotypes	Average fruit weight (g)	No. of fruits per plant	Yield per plant (kg)	Genotypes	Average fruit weight (g)	No. of fruits per plant	Yield per plant (kg)
Mattu Gulla	131.66	32.33	2.74	RP Sangli	63.80	16.67	2.00
Erengire Local Purple	111.50	39.00	1.83	S. Sangli	82.97	15.00	1.65
Erengire Local Green	102.77	36.33	1.60	SP Sangola	51.50	23.00	1.93
S. Mohini	79.27	27.00	1.53	GM Pandharpur	67.77	19.00	1.57
Polur Local	82.47	20.00	1.58	AM Kolhapur	96.70	29.67	2.42
Devnur Local	57.77	20.67	0.95	Barshi Local	74.40	24.33	1.81
Bethapudi Local	29.16	42.00	2.00	Latur Local	88.54	17.33	1.23
Rampura Local	52.34	22.67	1.68	Dharashiv local	85.77	17.33	1.62
Mallapur Local	49.20	20.00	0.89	Tembhurni local	107.94	29.00	2.35
Rayadurga badane	77.44	30.67	1.80	SS Kolhapur	56.47	20.24	1.55
Indira Safed	101.67	40.29	1.87	VC Pandharpur	64.74	17.33	1.43
Manjari Gota (check)	77.30	19.00	1.68	Haritha	102.80	12.33	1.26
KM Sangli	83.94	20.00	1.92	Surya	89.47	23.10	1.64

Evaluation of the dragon fruit hybrids (F1) for fruit quality and consumer acceptability

The fruits of hybrids, created by crossing different varietal (flesh) types, were analyzed for quality and evaluated for taste and consumer acceptability through organoleptic testing. It was observed that the hybrids exhibited variation in quality traits, including variegated flesh colour, taste, and consumer acceptance, suggesting differential inheritance of these traits (Fig 2.2.28). These findings will need to be confirmed through genetic and inheritance studies in the future.

Fig. 2.2.28: The variation observed for flesh colour in different hybrids of dragon fruit and organoleptic (sensory evaluation) test (below) of dragon fruit hybrid.

Synergistic effect of melatonin and proline on growth, physio-biochemical and yield traits of potato under water deficit stress: a novel technique

Potato (*Solanum tuberosum*) is a key crop in northern India's Indo-Gangetic Plain, but its growth is limited by water-deficit stress (WDS) due to reduced rainfall from climate change. This study explores the synergistic effects of melatonin (0.3 mM) and proline (2.6 mM) on potato growth, physiological traits, and yield under WDS (Fig. 2.2.29). A pot experiment under controlled conditions was conducted including treatments of control, WDS, melatonin, proline, and their combination (melatonin+proline). The WDS was imposed by withholding water for five and ten days. Key physiological parameters viz. relative water content, membrane stability index, chlorophyll content, and water use efficiency were measured. Biochemical markers such as proline content, malondialdehyde (MDA), and antioxidant enzymes (SOD, CAT, POX) were also assessed. The combination of melatonin and proline significantly improved RWC (12%), MSI (6%), and chlorophyll stability index (20%) under WDS. Photosynthetic traits, including stomatal conductance and net photosynthetic rate, improved, boosting iWUE. Biochemical analysis showed reduced oxidative stress (MDA) and increased antioxidant activity. The synergistic treatment resulted in a 12% increase in shoot biomass and a 23% increase in tuber yield. The combined application of melatonin and proline effectively enhanced potato resilience to WDS, improving physiological stability, biochemical defences, and yield, offering a promising strategy for enhancing productivity in water-limited environments.

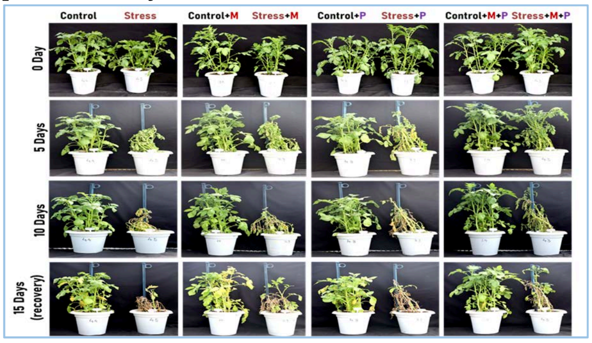


Fig. 2.2.29: Effect of melatonin and proline on potato under water-deficit stress
(M: melatonin, P: proline)

Inclusion of quinoa in cropping systems for ensuring food and nutrition security in drought prone semi-arid regions of India

Establishing a circular economy in agri-food systems involves minimizing water, and carbon inputs while enhancing efficiency in crop production. This approach is crucial for achieving sustainable development goals including sustainable production, consumption, and overall economic growth. In this context, a field experiment was conducted during 2022-23 and 2023-24 at ICAR-NIASM to assess the inclusion of quinoa (*Chenopodium quinoa* Willd.), a climate-resilient nutritious crop, in existing cropping systems to reduce environmental footprints while boosting system productivity and profitability. The experiment was laid out in a randomized complete block design with seven cropping systems (CS) and four replications. Different cropping systems comprised of mono-cropping of selected crops *viz.*, CS1: quinoa (Q); CS2: chickpea (*Cicer arietinum L.*) (CP); CS3: green gram (*Vigna radiate L.*) (GG); CS4: black gram (*Vigna mungo L.*) (BG); and intercropping of quinoa with these legumes viz., CS5: chickpea + quinoa (CP+Q); CS6: green gram + quinoa (GG+Q); CS7: black gram + quinoa (BG+Q). Quinoa as an intercrop were sown in the main crop (chickpea/ green gram/ black gram) at defined ratio (1:2). The study findings revealed that quinoa mono-cropping proved to be efficient in terms of water, and carbon use with higher net returns. Additionally, intercropping of chickpea and quinoa exhibited two to five times higher system productivity over conventional legume mono-cropping systems, with net-returns reaching US $1015.52 ha^{-1} (Table 2.2.6). Further, it significantly reduced water and carbon footprints, saving two to five times more water and one to three times more carbon compared to traditional legume systems. Despite being a relatively new addition to Indian agriculture with certain challenges, quinoa offers promising benefits for food, nutrition and environment security, making it an integral component of climate-smart cropping systems for drought-prone semi-arid regions.

Table 2.2.6 : Total system productivity and profitability of cropping systems (two year mean)

Cropping systems	Main crop productivity (kg ha^{-1})	Intercrop productivity (kg ha^{-1})	Total system productivity (kg ha^{-1})	Total cost of production (US$ ha^{-1})	Gross return (US$ ha^{-1})	Net Return (US$ ha^{-1})	Benefit: cost ratio
Q	1300.12	-	1300.12 ^{b}	283.41	1644.33	1360.92	5.80
CP	1178.23	-	1178.23 ^{c}	424.47	845.75	421.28	1.99
GG	463.31	-	463.31 ^{e}	290.72	449.50	158.78	1.55
BG	422.62	-	422.62 ^{e}	290.72	412.13	121.41	1.42
CP+Q	789.05	689.33	2167.66 ^{a}	437.23	1452.75	1015.52	3.32
GG+Q	362.21	595.11	1212.57 ^{c}	308.48	1098.60	790.12	3.56
BG+Q	328.67	518.87	1068.68 ^{d}	308.48	957.91	649.43	3.11
P value			<0.001				

Means followed by similar lowercase letter within a column are not significantly different at $p < 0.05$ according to LSD test. Q: quinoa; CP: chickpea, GG: green gram, BG: black gram, CP+Q: chickpea + quinoa, GG+Q: green gram + quinoa, BG+Q: black gram + quinoa.

Identification of novel cowpea genotypes for photo-thermo-insensitivity and high temperature stress tolerance through multi-location screening

A subset of 228 cowpea accessions, including national checks, from the National Genebank, NBPGR, New Delhi, was screened to identify photo-thermo-insensitive and high-temperature stress-tolerant genotypes. The germplasm was sown at three locations: ICAR-NIASM, ICAR-NBPGR, RS, Jodhpur, and ICAR-NBPGR, New Delhi. Two sowing dates were used: one in the first week of February (normal sowing) and another in the first fortnight of March to expose the germplasm to high-temperature stress. Based on morpho-physiological traits and heat susceptibility index, 25 accessions (EC240703, EC244059, IC331106, EC240917, EC244148, IC311929, EC241003, EC528691, IC326793, EC243943, IC342702, IC273989, EC243971, IC39875, IC590841, EC244021, IC39911, IC607151, EC244025, IC471926, IC91446, EC244046, IC472264, IC565522, and EC244057) were identified as photo-thermo-insensitive, exhibiting stable yields across locations and temperature regimes. Further validation will be conducted in the upcoming season.

Identification of marker-trait association for photo-thermo-insensitivity and high temperature stress tolerance in cowpea

A subset of 228 cowpea accessions and national checks from the National Genebank, NBPGR, New Delhi, was used to perform genome-wide association mapping (GWAS) to identify marker-trait associations for high-temperature tolerance traits. Phenotyping was conducted across three locations: ICAR-NIASM, ICAR-NBPGR, RS, Jodhpur, and ICAR-NBPGR, New Delhi. Two sowing dates were employed: one during the normal sowing period (first week of February) and the second in the first fortnight of March to expose the germplasm to high-temperature stress. Various morpho-physiological traits were assessed, including days to 50% flowering, plant height, number of primary and secondary branches, pods per plant, seeds per pod, test weight, and grain yield. Additionally, physiological traits such as canopy air temperature depression, leaf area, NDVI, and SPAD were recorded at different growth stages. Genotyping was performed using the Genotyping by Sequencing (GBS) approach. Marker-trait associations (MTAs) were analyzed using statistical models like BLINK, FarmCPU, GLM, MLM, CMLM, and MLMM. A total of 392 significant MTAs were identified under various environmental conditions, including 20 MTAs with ≥ 5% minor allele frequency.

Further validation will be conducted to pinpoint candidate genes responsible for high-temperature stress tolerance in cowpea.

Identification of mugbean genetic resources for drought tolerance

A total of 296 mungbean accessions (minicore collection) were screened for drought-stress tolerance under field and potted conditions. Based on various traits, specific germplasm accessions were identified for use in future mungbean breeding programs focused on enhancing drought tolerance (Table 2.2.7).

Table 2.2.7: Identification of drought tolerant mungbean germplasm accessions

Traits	Genotypes
Higher number of pods per plant under Stress (>25 pods /plant under stress)	VI001556BG, VI000188A-BLM, VI003337BG, VI001406BG, VI003560BG, VI003465BG, VI001535BG, VI000578AG
Higher pod length (>9 cm under stress)	VI000470AG, VI002063BG, VI000020AY, VI001244AG, VI002432AG, VI003235AG, VI001096AG, VI001066BG VI001126BG, VI003440AG
Higher quantum efficiency of PSII under Stress (>0.8)	VI000020AY, VI000164BG, VI000203B-BR, VI000554AG, VI000723AG, VI000766BG, VI000852AG, VI001023BG, VI001096AG, VI001126BG, VI001162AG, VI001191BG, VI001221AG, VI001268BG, VI001282AG, VI001385AG, VI001859BG, VI002051BG, VI002432AG, VI002469AG VI002487AG, VI002859BG, VI002934AG, VI002993BG, VI003019A-BLM, VI00322AG, VI003232AG, VI003329AG, VI003379BG, VI003407AG, VI003413BG, VI003440AG, VI003455AG
Higher net Photosynthetic rate under stress (>6 μmolm^{-2}s^{-1})	VI000020AY, VI000099AG, VI000316AG, VI000319AG, VI000380AG VI000554AG, VI000766BG, VI000938AG, VI000942AG, VI001126BG, VI001284AG, VI001400AG, VI001520A-BLM, VI001548AG, VI001820BG, VI003019A-BLM, VI003057BG, VI00322AG VI003337BG, VI003440AG, VI005030BY,
Test weight (>7.3 g/100 seed under stress)	VI001124 AG, VI002739AG, VI001244AG, VI001385AG, VI002523AG, VI000470AG, VI001096AG, VI002432 AG, VI002537AG, VI002063 BG
Grain yield (>8.5 g/plant under stress)	VI004096BG, VI004811BG, VI004006A-GM, VI003685AG VI003560BG, VI003455AG, VI003337BG, VI002195AG, VI002537AG, VI002051BG
Higher canopy greenness (High NDVI value under Stress)	VI000559AG, VI000942AG, VI001191BG, VI001385AG, VI001579BG, VI001612AG, VI001652BG, VI001728AG, VI001806AG, VI002051BG VI002487AG, VI002529B-BL, VI002537AG, VI002569BG, VI002739AG VI003187BG, VI003744AG, VI003957AG, VI004933AG, VI004968AG,
Cooler canopy than checks under stress conditions	VI000559AG, VI001411AG, VI001471AG, VI001490AG, VI001556BG VI001806BG, VI001820BG, VI002051BG, VI002173AG, VI003251A-BL VI003455AG, VI003560BG, VI003642AG, VI003685AG, VI003720BG VI004096AG, VI003685AG, VI003720BG, VI004096AG

Enhancing nutrient uptake and yield of quinoa by application of mineral solubilizers

To identify phosphate, potash, and Zn-solubilizing bacteria that enhance nutrient availability, uptake, and quinoa yield under drought stress, potential mineral solubilizers were isolated from the rhizosphere, rhizoplane, and endorhizosphere of quinoa. Accordingly, twenty-eight potential phosphate solubilizers were isolated, characterised, diversity of 16 isolates were studied using 16S rRNA sequence (Fig. 2.2.30). Similarly, diversity of 43 mineral solubilizers comprising phosphate, zinc, and potash solubilizers was also studied using 16S rRNA sequence (Fig. 2.2.31). All the phosphate solubilizers were evaluated to ascertain plant growth promoting traits *in vitro*. In germinating seedling bioassay (Table 2.2.8), the root length of treated seedlings varied from 35.9 mm seedling^{-1} to 54.4 mm seedling^{-1}, maximum root length was achieved with the inoculation of *Bacillus tropicus* QP9. Similarly, the maximum *in vitro* TCP solubilisation was obtained with *Enterobacter cloacae* QP3 (142.78 mg per 100 ml broth) (Table 2.2.8). All the 28 phosphate solubilizers, belonging to the genera *Pseudomonas*, *Pantoea*, *Enterobacter*, *Bacillus*, *Kosakonia*, *Klebsiella*, etc., were evaluated in pots and five selected isolates viz. *Enterobacter cloacae* subsp. *dissolvens* QPE7, *Bacillus tropicus* QP9, *Pseudomonas lalkuanensis* QZn-1, *Enterobacter sichuanensis* QZnPK, *Enterobacter hormaechei* subsp. *xiangfangensis* QP2, were evaluated in field condition with 40 and 60 kg P_2O_5 ha^{-1}. Application of *Enterobacter cloacae* subsp. *dissolvens* QPE7 with 40 kg P_2O_5 ha^{-1} gave at par yield with 60 kg P_2O_5 ha^{-1} and thus 20 kg P_2O_5 ha^{-1} can be saved with application of QP2, a phosphate solubilizing bacterium. Results will be validated in pots and field again. Characterisation of all the mineral solubilizers are underway for production of ACC deaminase, siderophore, IAA, giberrelic acid, etc. *in vitro*.

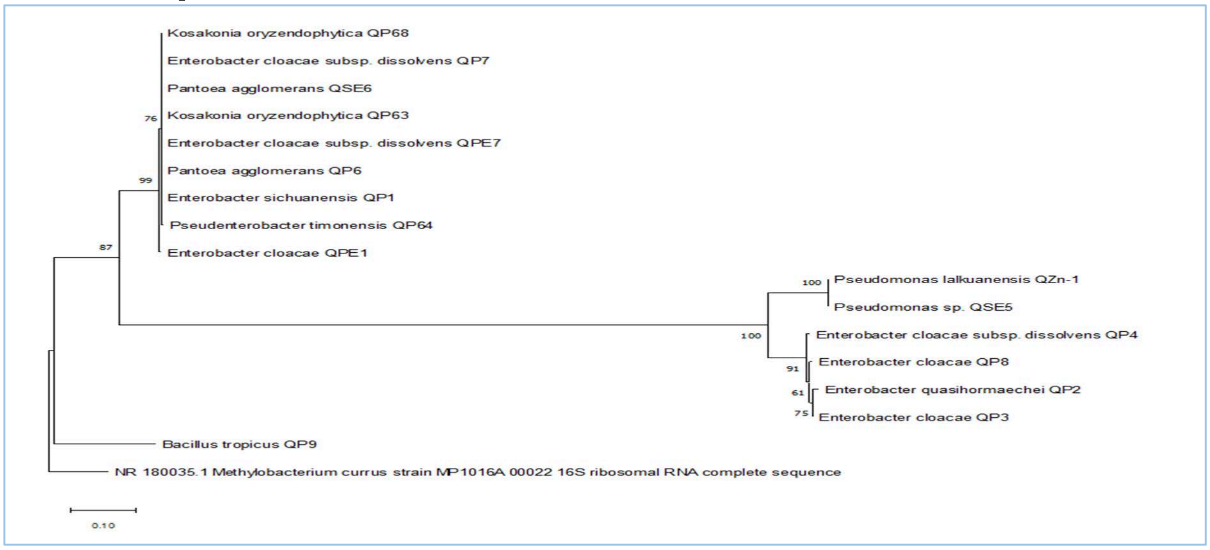


Fig. 2.2.30: Diversity of phosphate solubilizers of quinoa based on 16S rRNA sequences

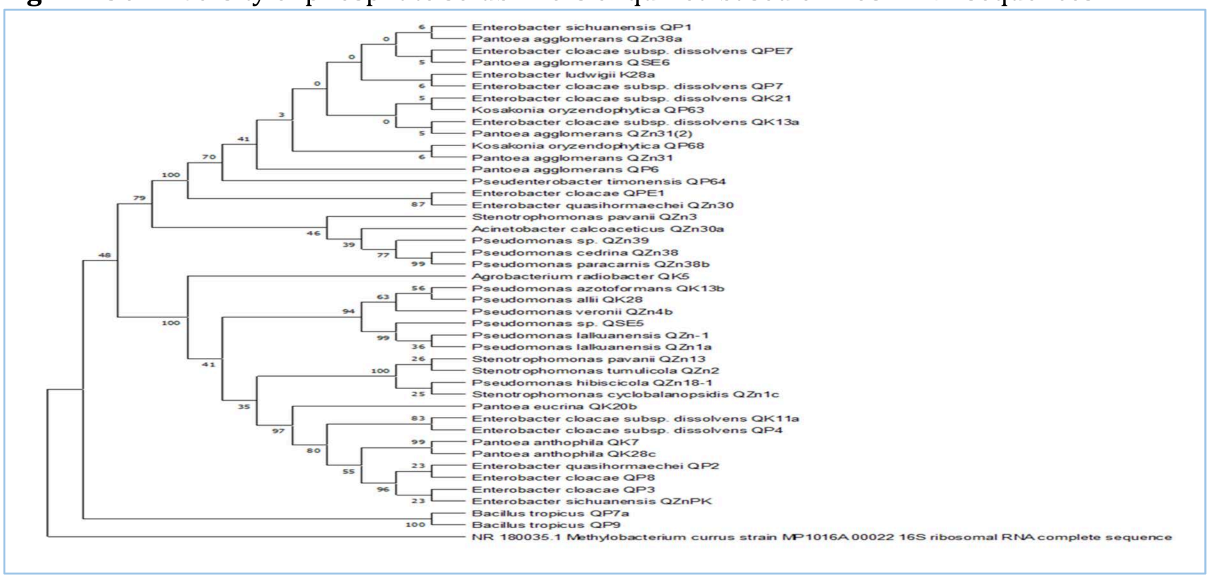


Fig. 2.2.31: Diversity of mineral solubilizers of quinoa on the basis of 16S rRNA sequence data

Table 2.2.8: *In vitro* solubilisation of tri-calcium phosphate (TCP) in liquid medium (observation after 7 days of inoculation) and germinating seedling bioassay

Treatment	Root length (mm. plant^{-1})	TCP solubilization (mg.100ml-1 broth)	Treatment	Root length (mm. plant^{-1})	TCP solubilization (mg.100ml^{-1} broth)
Control	36.1	NA	*Kosakonia oryzendophytica* QP63	44.8	47.59±4.49
Pantoea agglomerans QP1	43.6	3.98±0.32	*Pseudomonas* sp. QSE5	40.4	51.02±7.14
Enterobacter hormaechei subsp. *xiangfangensis* QP2	50.6	73.61±5.14	*Pantoea agglomerans* QSE6	47.3	48.15±3.26
Enterobacter cloacae QP3	43.1	142.78±8.33	*Pseudenterobacter timonensis* QP64	38.7	34.54±6.63
Enterobacter cloacae subsp. *dissolvens* QP4	44.5	39.98±7.93	*Kosakonia oryzendophytica* QP68	45.7	54.72±2.55
Pantoea agglomerans QP6	48.9	50.0±4.62	*Enterobacter sichuanensis* QZnPK	46.6	80.19±5.00
Enterobacter cloacae subsp. *dissolvens* QP7	38.6	92.50±12.33	*Pantoea agglomerans* QP66	42.9	75.65±6.67
Enterobacter cloacae QP8	44.0	45.00±2.42	*Enterobacter cloacae* subsp. *dissolvens* QP67	42.2	16.48±4.73
Bacillus tropicus QP9	54.4	63.06±7.95	*Pseudomonas* sp. QP12	37.4	47.04±2.23
Enterobacter cloacae QPE1	36.5	59.26±1.76	*Enterobacter* sp. QP16	44.5	39.98±7.93
Enterobacter cloacae subsp. *dissolvens* QP49	37.9	8.24±1.63	*Enterobacter* sp. QP20	40.2	27.87±2.80
Pseudomonas lalkuanensis QZn-1	47.4	90.56±4.11	*Pseudomonas* sp. QP17	38.1	45.37±4.89
Klebsiella pasteurii QP62	46.1	36.39±5.55	*Enterobacter cloacae* QP13	37.6	44.81±3.57
Enterobacter cloacae subsp. *dissolvens* QPE7	48.1	81.39±3.20	*Bacills* sp. QP25	35.9	35.00±4.33
Enterobacter sp. QP66	38.7	33.89±6.50	CV (%)	7.0	-
			CD (0.05)	4.9	

Identification of novel Pigeonpea genotypes for waterlogging tolerance at different crop growth stages

A total of 300 germplasm accessions, representing a subset of the core collection from ICRISAT, Hyderabad, were evaluated for waterlogging tolerance at different growth stages of pigeon pea. The screening was conducted at three critical stages: germination, early seedling stage (21 days after emergence; DAE), and mid-vegetative growth stage (70 DAE). Genotypic performance was assessed based on survival ability and key morpho-physiological traits, including plant height, number of branches per plant, pod number, and test weight. Additionally, physiological parameters such as higher canopy greenness, lower canopy temperature, delayed senescence, and superior photosynthetic efficiency were considered. Following the screening process, four genotypes—ICP 14840, ICP 14830, ICP 16234, and ICP 16161—were identified as tolerant to waterlogging across all assessed growth stages. These genotypes demonstrated superior growth and yield attributes compared to existing check varieties. Given their promising performance, these identified genotypes require further validation before being utilized as donor sources in pigeon pea breeding programmes aimed at enhancing waterlogging tolerance.

School of Edaphic Stress Management

Screening of local mango germplasm for salinity tolerance

The salinity tolerance in ten mango genotypes under controlled pot conditions was studied under three irrigation treatments with NaCl concentrations of 0 mM (control), 50 mM, and 100 mM during February to April 2024. Local mango genotypes exhibited differential morpho-physiological responses and nutrient uptake patterns under salinity stress. Salinity stress significantly increased leaf injury (Table 2.3.1) while negatively affecting key physiological traits, including leaf gas exchange parameters, relative water content (RWC), and membrane stability index (MSI). Biomass allocation to leaves, stems, and roots varied significantly among the tested genotypes, with reductions in both fresh and dry biomass under increased salinity levels.

Table 2.3.1: Influence of salinity levels on leaf injury index and number of leaves

Genotype	Leaf injury index			Number of leaves		
	0 mM	50 mM	100 mM	0 mM	50 mM	100 mM
MP	0.05 j	0.13 ij	0.44 d-g	16 e-h	11 h	17 d-h
NT	0.43 d-g	0.79 ab	0.92 a	18 d-h	15 f-h	19 c-h
L5M5	0.16 h-j	0.28 e-j	0.42 d-h	28 a-d	19 c-h	17 d-h
L6D1	0.24 g-j	0.29 e-j	0.75 a-c	25 a-f	27 a-d	33 a
L9M7	0.25 g-j	0.25 g-j	0.51 c-f	24 a-f	23 a-g	30 a-c
L12L1	0.41 d-h	0.53 b-e	0.75 a-c	20 c-h	20 c-h	16 e-h
L11M9	0.07 j	0.29 e-j	0.41 d-h	22 b-h	26 a-e	21 b-h
JK1	0.30 e-j	0.73 a-c	0.73 a-c	25 a-f	23 a-g	32 ab
JM1	0.26 f-j	0.66 a-d	0.90 a	19 c-h	23 a-g	19 c-h
Kesar	0.36 e-j	0.76 a-c	0.76 a-c	15 f-h	13 gh	11 h

Note: Interaction effects (GxT) with the same lower letters are not significantly different in LSD test ($p<0.05$).

Chlorophyll fluorescence measurements revealed that genotypes L5M5 and L11M9 maintained significantly higher values even at 50 mM salinity, indicating their better photosynthetic efficiency under stress. Salinity also reduced potassium uptake, with a marked potassium deficiency induced by chloride ions observed in the genotype 'Kesar' (Fig. 2.3.1). Based on combined morpho-physio-biochemical observations, L11M5, L5M5, and MP were identified as relatively tolerant to salinity stress. Notably, the tolerance of L11M9 was associated with its ability to accumulate sodium and chloride in roots while maintaining better potassium levels in leaves. In contrast, mango germplasm NT and Kesar were identified as sensitive to salinity stress. During the summer of 2024, fruits from 19 mango germplasm collected from the Baramati sub district were analysed in the laboratory for morphological and biochemical traits. An experiment to screen mango genotypes for salinity tolerance was initiated to further validate these findings and assess long-term adaptability under saline conditions

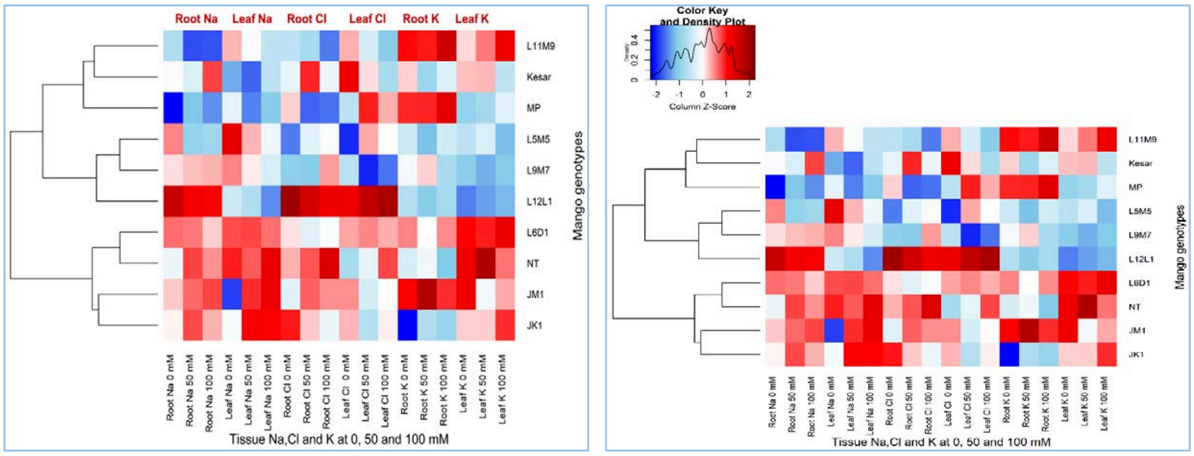


Fig. 2.3.1: Tissue Na, Cl and K influenced by salinity and mango genotypes

Comparative analysis of pot cultivation and mulching system for summer tomato cultivation under water deficit and heat stress

A comparative study of Ambronics pot, Tal-Ya tray, mulching and conventional cultivation (Control) for summer tomato cultivation under water deficit and heat stress revealed distinct advantages and limitations for each approach (Fig. 2.3.2). Pot cultivation was 2.36 times more expensive than mulching, making the latter more economical. Plant growth analysis showed that pots supported the highest shoot biomass, while the mulching system excelled in root biomass production, with pots significantly reducing root biomass (Fig. 2.3.3).

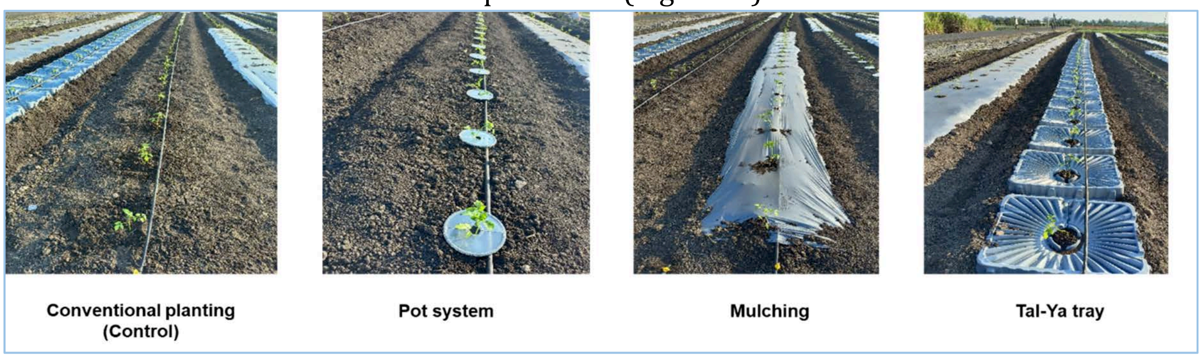


Fig. 2.3.2: Comparison of planting system under deficit irrigation in summer tomato

Yield parameters indicated the highest number of fruits and per-plant yield in the mulching system, though irrigation levels had no significant impact on it (Table 2.3.2). Average fruit weight was greater in pots, and yield estimates under both systems were statistically similar, irrespective of water deficit. Mulching achieved the highest yield under 100% ETc irrigation, but pots outperformed all other treatments under deficit irrigation. Fruit quality, assessed through total soluble solids (TSS), acidity, firmness, and volume, remained largely unaffected by irrigation or planting systems, though fruit volume was highest in pots and lowest in mulching. Weed growth was minimized in the mulching system, followed by tray system, with pots and control treatments showing no significant differences. The highest soil temperature was recorded in mulching system. Overall, pot cultivation proved suitable for summer tomato production under water deficit and heat stress, while mulching offered the cost-effective alternative under optimal conditions.

Table 2.3.2: Fruit yield estimate (t ha^{-1}) under different planting systems

Planting systems	Irrigation level			Mean
	1.00 ETc	**0.75 ETc**	**0.50 ETc**	
Mulching	23.99 a	16.32 b	12.70 c-e	17.67 A
Ambronics pot	15.98 b	15.29 bc	16.59 b	15.95 A
Tal-Ya tray	12.01 de	13.64 b-e	12.92 c-e	12.85 B
Control	15.02 b-d	12.82 c-e	11.77 e	13.20 B
Mean	15.94 A	14.52 A	14.31 A	
	I	P	I × P	
LSD (*p=0.05*)	NS	1.75*	3.04*	

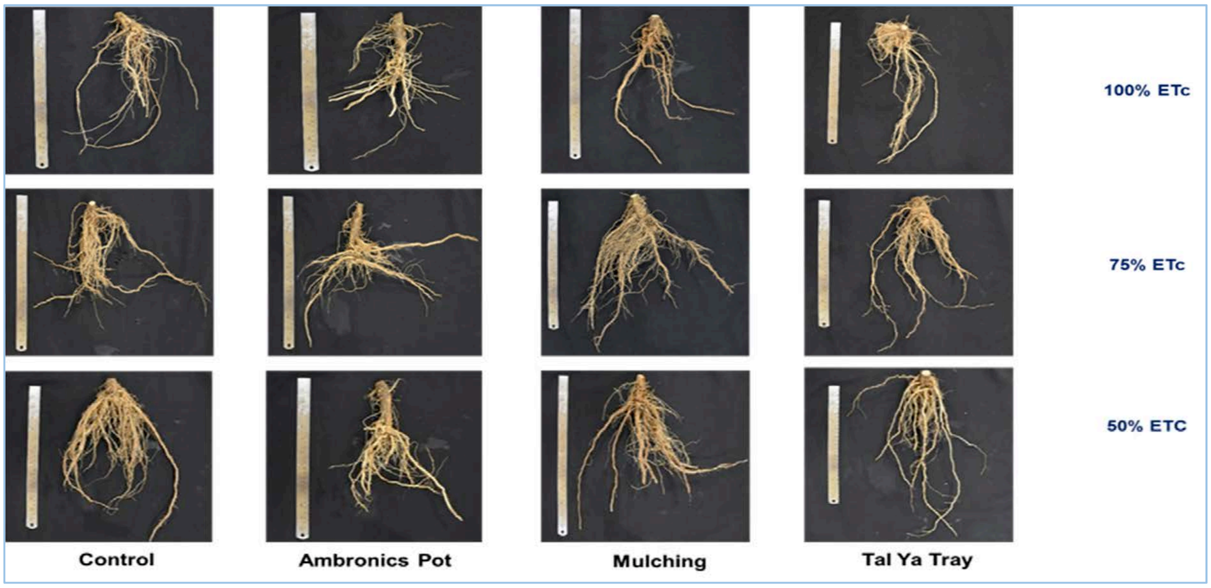


Fig. 2.3.3: Comparison of root growth under deficit irrigation in different planting systems

Climate resilient integrated farming system (CIFS) for semi-arid regions

Economics of various components of CIFS

A climate resilient integrated farming system is developed at ICAR-NIASM, Baramati. This system uses climate-smart technologies, optimizes the size of its components, and diversifies its farming system components both inside and between components, to reduce the risks and achieve sustainable production and income in the face of changing climate circumstances. The components of CIFS include 6250 m^2 of crops; 3000 m^2 of horticulture; indigenous livestock (two cows and five calves); goats; fifty native chicken birds; fisheries (400 m^2); and agroforestry (border plantings). In the crop component, the highest net return (₹5874) and B:C ratio (1.93) was obtained from Hybrid Napier+ Drumstick system from 0.12 hectare; while that in livestock component, was ₹66142. and 1.94 for Goat rearing, respectively. For Fisheries and horticulture the net return was ₹10900 and ₹15134 while the B:C ratio was 2.05 and 2.13, respectively. The overall cost of cultivation, gross income, net returns and B:C Ratio in CIFS model were ₹274564, ₹405753, ₹129400 and 1.48, respectively. The economics of CIFS components is presented in Table 2.3.3.

Table 2.3.3: Economics of Climate resilient Integrated Farming system

IFS Components	Gross income (₹)	Cost of Cultivation/ Rearing (₹)	Net Income (₹)	B:C Ratio
Cropping systems				
CS-1: Pearl millet-Chickpea	9320	8602	717	1.08
CS-2: Green gram-Sorghum	9435	8692	742	1.09
CS-3: Sorghum- Safflower	4121	5697	-1576	0.72
CS-4: Black gram-Groundnut	7328	9450	-2122	0.78
CS-5: Redgram+Sorghum-Cluster bean	2460	7304	-4844	0.34
CS-6: Hybrid Napier +Drumstick	12170	6295	5874	1.93
Sub-Total	44834	46043	-1209	0.97
Livestock Species				
Gir cow	155642	118435	37207	1.31
Goat	136857	70715	66142	1.94
Poultry	18640	15625	3015	1.19
Sub-Total	311139	204775	106364	1.48
Fisheries				
Fish	21300	10400	10900	2.05
Horticulture				
Mango+Pomegranate+Custard Apple+Sapota	28480	13345	15134	2.13
Total	405753	274564	129400	1.48

Water productivity in CIFS

The water footprints for different Rabi crops calculated as crop water productivity for chickpea, sorghum, groundnut, safflower and cluster bean were 6.35, 9.30, 3.39, 1.33 and 1.01 kg.m^{-3}, respectively. It was highest for rabi sorghum grains due to its higher yield. Water productivity of livestock included water required for different routine activities such as for drinking, cultivation of feed and fodder, and cleaning of animal shed and animals. The water utilized was divided by the gross income and net income to calculate the gross and net water productivity. The gross water productivity in cattle, goat and poultry was 8.10, 7.26 and 39.4 ₹.m^{-3}, respectively. The water productivity for milk, meat and eggs was 0.06, 0.02, 2.30 units.m^{-3}, respectively.

Carbon sequestration of perennial trees in CIFS project

The total Biomass (kg ha^{-1}) and total carbon stock from perennial tree components of CIFS was 5215.92 and 2503.64, respectively. Drumstick (28%) and Teak (23%) on boundary contributed highest biomass and carbon stocking (14%). Carbon stored in perennial tree components of the CIFS systems was 2.5 t ha^{-1}. Fodder production from boundary plantation of CIFS produced about 9.7 ton of green fodder.

Energy flow in CIFS (based on 2021-22 data)

The total energy input (MJ), total energy output (MJ), net energy gain (MJ), energy efficiency and energy profitability in crop component in 2021-22 was 10518.15, 136872.91, 126354.76, 13.01 and 12.01, respectively. The key findings from the Climate Resilient Integrated Farming System are tabulated below. Table 2.3.4, highlights the contribution of diverse farm components towards individual's balanced diet and nutritional security. Table 2.3.5 focuses on nutrient recycling, illustrating the efficiency of resource utilization and sustainability within the system. Table 2.3.6 presents data on soil chemical properties (2023-24) after the Rabi crop, showcasing the impact of integrated practices on soil health.

Table 2.3.4: Nutritional security provided by CIFS

Components	Nutritional Requirement			
	Qty. (kg)	Daily Per capita consumption (g)	Annual Family requirement (kg)	Surplus production (kg)
Oilseed	113	19.57	28	84
Pulses	129	35.68	52	76
Vegetables and fruits	745	400	584	161
Milk (L)	1252	250	365	887
Poultry meat (kg)	34	-	-	-
Goat meat - Live wt.(kg)	377	-	-	-
Fishery (kg)	142	9.76	14	127

Table 2.3.5: Nutrient recycling in CIFS

Nutrient Recycling	Qty. (kg)	Nutrient content (%)			Nutrient Supply (kg)		
Nutrients		N	P	K	N	P	K
FYM	10512	0.5	0.2	0.5	52	21	52
Goat Manure	11680	1.55	0.65	1.95	181	75	227
Poultry Manure	300	2.5	1.6	1.7	7.5	4.8	5.1
Vermicompost	1125	1.6	0.7	0.8	18	7.8	9

Table 2.3.6: Soil chemical properties 2023-24 (After *Rabi* Crop) in CIFS

Cropping System/crop	pH Reading	EC (dS m^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	OC (%)	K (kg ha^{-1})
Mungbean-Sorghum	8.07	0.187	164.32	11.02	0.67	211.01
Hybrid Sorghum-Safflower	8.14	0.173	158.05	10.57	0.66	127.79
Blackgram-Groundnut	8.17	0.152	144.25	10.12	0.83	162.29
Sorghum+Pigeonpea-Cluster bean	7.42	0.174	94.08	11.46	0.85	124.77
Pearl millet-Chickpea	8.19	0.197	170.59	10.57	0.65	203.95
Hybrid Napier +Drumstick	7.34	0.127	136.72	9.94	0.46	111.22
Multi-Layered	8.87	0.234	102.86	8.69	0.25	187.94
Pomegranate	8.13	0.138	126.69	8.69	0.43	117.04
Custard Apple	8.23	0.159	94.08	7.79	0.45	194.66
Sapota	7.63	0.143	95.33	10.48	0.65	158.59
Sugarcane	8.19	0.147	139.23	10.12	0.29	147.84
Vermi-Compost	7.61	0.176	189.41	11.37	1.42	140.00

Multilayer IFS for livelihood improvement in multiple abiotic stress regions

This system integrates various components of the Integrated Farming System (IFS) at different levels, strategically addressing challenges like shallow basaltic soils, limited land size, inadequate irrigation, and sustainable income generation on degraded lands. In this model (0.12 ha) integration of seasonal vegetables and fruit cultivation alongside the raising of backyard poultry was carried out. Micro-irrigation system was used for crop irrigation, and poultry birds were allowed to scavenge for food, which led to the production of both eggs and poultry. This approach aimed to reduce the cost of feeding poultry while simultaneously enhancing soil quality over time, ultimately resulting in a sustainable and steady income stream. The cost economics of the components of multilayer integrated farming system is presented in Table 2.3.7. The Crop Water productivity (26.14 ₹.m^{-3}), Water Productivity for eggs (1.61 No.m^{-3}) and System water productivity (19.73 ₹.m^{-3}) was also calculated.

Table 2.3.7: Economics of multilayer integrated farming system

Components	Gross income (₹)	Cost of Cultivation (₹)	Net income(₹)	B:C ratio
Vegetables/fruits	14290	8933	5356	1.59
Poultry	18640	15625	3015	1.19
System (MLIFS)	32930	24558	8371	1.34

Effect of feeding sugarcane trash-based complete feed on the growth performance of Osmanabadi goat kids

The study aimed to evaluate the effects of feeding sugarcane trash-based complete feed on the growth performance, haematological, biochemical parameters and growth, gene expression in Osmanabadi goat kids. Osmanabadi goat kids between 3-4 months of age, eighteen (18, 3×6) were selected from the Goat unit and divided in three groups in a Complete Randomized Design (3×6). The kids of uniform body weights were divided into three groups of six kids in each group. These six kids (three males and three females in each group) were allocated to each of the group Control (C), Sugarcane-trash 50% + concentrate 50% (T1), and Sugarcane-trash 50% + concentrate 50% + 2g cumin kg^{-1} (T2) to study the growth performance and associated parameters. All the animals were housed in an intensive housing system. The kids in all three groups were each provided with a covered area of one square meter per animal. The diets were formulated to meet the nutritional requirements of growing goat kids of approx. 10 kg body weight with estimated weight gain of 50g day^{-1} following the daily diet as per the recommendations of Ranjhan (1998). Proximate analysis of feed ingredients before start of experiment was carried out to formulate the diets. The ratio of roughage: concentrate in control group was 60%: 40%, but the complete feed prepared in (T1 and T2) consisted of Sugarcane-trash 50% + concentrate 50% (T1), and Sugarcane-trash 50% + concentrate 50% + 2g cumin kg^{-1} (T2). Results revealed that the body weights of goat kids (kg) in Control, T1 and T2 groups during fifth week were 11.51±1.37, 11.30±1.36 and 11.40±1.32, respectively. There was non- significant difference in body weight of kids due to treatments. However, the control and T2 group had higher body weights as compared to T1 group in all the weeks. Average daily gain (g) in Control, T1 and T2 groups in fifth week were 140.47±18.22, 135.71±22.96 and 142.85±7.37, respectively. There was non-significant difference in average daily gains of kids due to feeding of sugarcane trash based complete feed. The haemoglobin (g d^{-1} L^{-1}) in Osmanabadi goat kids in Control, T1 and T2 groups were 9.26±0.33, 8.68±0.30 and 8.95± 0.23, respectively. The RBC count (106 μl^{-1}) in Osmanabadi goat kids in Control, T1 and T2 groups were 19.53±1.03, 19.31±0.86 and 19.06±0.75 respectively. The WBC count (103 μl^{-1}) in Osmanabadi goat kids in Control, T1 and T2 groups were 12.71±0.74, 13.70±0.85 and 13.45±0.86 respectively. There was non-significant difference in haematological parameters of kids due to treatments. There was non-statistically significant difference in biochemical parameters in different groups. Upon comparing the gene expression levels across the three different feeding groups, significant differences were observed. Notably, T2 group, which received the combination of cumin seed, concentrate, and sugarcane trash, exhibited the most correct gene expression level for the GH gene. It is concluded from above findings that physical treatment and preparing complete feed comprising of sugarcane trash 50% + concentrate feed 50% (T1), sugarcane trash 50% + concentrate feed + cumin seed 2g kg^{-1} (T2) has exhibited similar growth performance as conventional feeding (control groups) in goat kids without having any adverse effect on haematological parameters, biochemical parameters and growth gene expression. Sugarcane trash based complete feeds can be fed to growing goat kids during scarcity of conventional fodders.

Host-sandalwood interactions under water stress environment

The experiment was conducted on degraded land with shallow basaltic bedrock, where sandalwood seedlings (8 month-old) were planted in November 2021. Sandalwood was planted with various host species, including *Cajanus cajan, Pongamia pinnata, Dalbergia sissoo, Cynodon dactylon, Acacia nilotica, Desmanthus virgatus, Leucaena leucocephala, Azadirachta indica, Tectona grandis, Stylosanthes hamata,* and sandalwood grown alone. After 2.5 years of establishment with weekly drip irrigation, moisture stress was induced by withholding irrigation for over two months during March–April 2024, exposing the plants to high temperatures and poor soil conditions.

Under moisture-stress conditions, *Leucaena leucocephala* supported the highest sandalwood height (4.27 m) and leaf area (15.48 cm^2), while *Acacia nilotica* achieved the maximum girth at breast height. *Dalbergia sissoo* and *Leucaena leucocephala* promoted superior photosynthetic performance with chlorophyll content reaching 9.69 µg mg^{-1} FW and 9.61 µg mg^{-1} FW, respectively. Proline and free amino acids, critical for osmotic adjustment, were highest in sandalwood paired with *Leucaena leucocephala* (89.02 µg mg^{-1} FW; 20.00 mg g^{-1} FW) and *Dalbergia sissoo* (84.77 µg mg^{-1} FW; 13.51 mg g^{-1} FW).

Wilting symptoms such as yellowing, leaf curling, and drop were severe in sandalwood grown with *Cynodon dactylon, Stylosanthes hamata, Tectona grandis*, and in isolation, whereas favorable host plants mitigated these effects, ensuring healthier foliage (Fig. 2.3.4). The highest NDVI values were observed in sandalwood paired with *Cajanus cajan* (0.79) and *Leucaena leucocephala* (0.78), indicating enhanced photosynthetic activity. PSII efficiency peaked with *Acacia nilotica* and *Pongamia pinnata* (0.80), while *Leucaena leucocephala* ensured the highest relative water content (75.71%), demonstrating its role in improving sandalwood resilience to moisture stress.

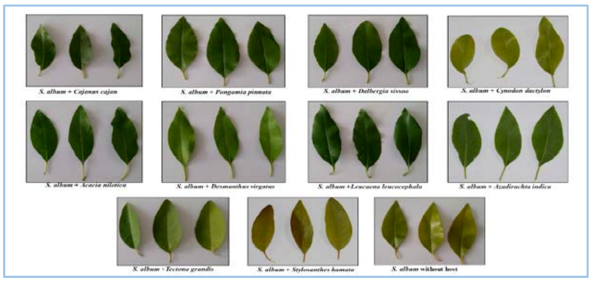


Fig. 2.3.4: Variation in leaf colour of sandalwood grown with different host species

The Plant Health Index (PHI) was developed to evaluate plant health based on physiological and biochemical parameters such as amino acids, PSII efficiency, photosynthetic rate, and water use efficiency. Principal Component Analysis (PCA) revealed that these variables explained 78.38% of total variance.

PHI values varied significantly among host species. *Cajanus cajan* (0.97), *Leucaena leucocephala* (0.86), and *Acacia nilotica* (0.86) were very favorable hosts, while sandalwood grown alone (0.32) and with *Cynodon dactylon* (0.34) had the lowest values (Fig. 2.3.5). Hosts were categorized into: Very Favourable (*Cajanus cajan, Leucaena leucocephala, Acacia nilotica, Dalbergia sissoo, Desmanthus virgatus*), Favourable (*Stylosanthes hamata, Tectona grandis, Pongamia pinnata, Azadirachta indica*), and Unfavourable (*Cynodon dactylon*, sandalwood alone). PHI helps optimize host-sandalwood combinations for better resilience and sustainable cultivation in semi-arid regions.

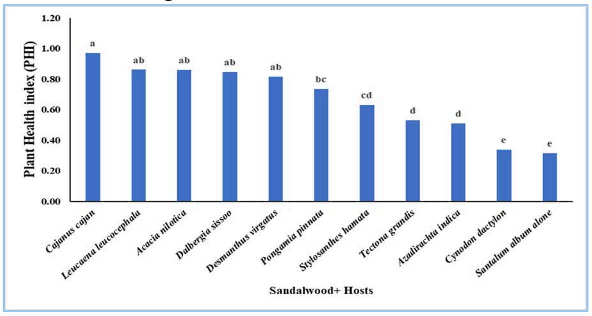


Fig. 2.3.5: Plant health Index (PHI) of sandalwood grown with different host plants.

Carbon sequestration and Economic analysis of Mahogany based agroforestry systems

In this project, comprehensive field visits and data collection were carried out from 41 farmers' fields of Mahogany-based agroforestry (Fig. 2.3.6). Biomass and carbon storage were estimated using non-destructive methods, measuring girth at breast height (GBH) and tree height. In block plantations with 5×2.5 meter spacing (800 trees ha^{-1}) and boundary plantations (180 trees ha^{-1}), the mean stem biomass was recorded at 248.74 and 286.97 kg $tree^{-1}$, respectively, at 18 years.

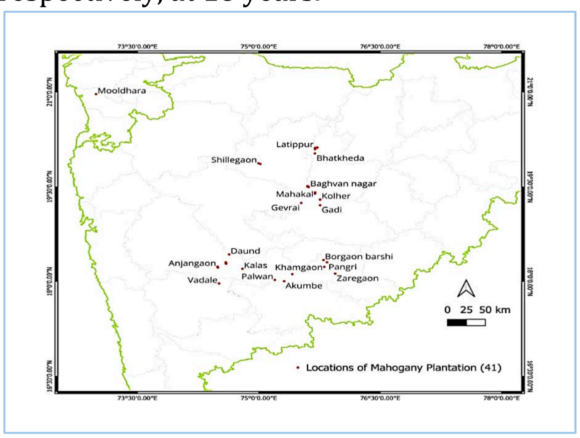


Fig. 2.3.6: Study area of Mahogany plantations in Maharashtra and Gujarat

In Maharashtra, plantations with 3×3 meter spacing (1,111 trees ha^{-1}) exhibited a notable increase in total carbon stock per tree, growing from 0.10±0.01 kg $tree^{-1}$ at one year to 13.83±0.76 kg $tree^{-1}$ at five years. At five years, total biomass was 32.70 Mg ha^{-1}, and at four years, it was 13.31 Mg ha^{-1}. The denser 5×2.5 meter spacing produced a higher total biomass of 502.95 Mg ha^{-1} at 18 years, emphasizing the significant carbon sequestration potential of Mahogany plantations, which contribute to environmental sustainability and economic viability. The carbon sequestration rate (CSR) in Mahogany plantations exhibited rapid growth during the first 1-5 years (1111 trees ha^{-1}), beginning at 0.12 Mg ha^{-1} yr^{-1} and increasing to 3.07 Mg ha^{-1} yr^{-1} by 5 year old . The rate continued to rise in the intermediate years (7-15 years, 130 trees ha^{-1}) from 1.04 to 3.39 Mg ha^{-1} yr^{-1}. At 18 years, the CSR varied depending on tree density, with 180 trees ha^{-1} yielding 2.37 Mg ha^{-1} yr^{-1} and 800 trees ha^{-1} yielding 13.13 Mg ha^{-1} yr^{-1} (Fig. 2.3.7). Volume and biomass equations were constructed for Mahogany plantations as follows: $V=0.00033×X^{0.460}$ and $Biomass=0.3462×X^{2.227}$ (X: DBH of tree in cm). These equations provide a framework for non-destructive sampling to quantify the volume and biomass of Mahogany trees. Economic analysis confirmed the financial viability of Mahogany-based agroforestry systems. The systems demonstrated strong economic performance, with a Benefit-Cost Ratio (BCR) of 1.31, a Net Present Value (NPV) of ₹1,51,432 ha^{-1}, and an Internal Rate of Return (IRR) of 66%. The Land Equivalent Value (LEV) of ₹5,89,975 per hectare highlighted the efficiency of Mahogany-based systems compared to conventional cropping methods (Table 2.3.8).

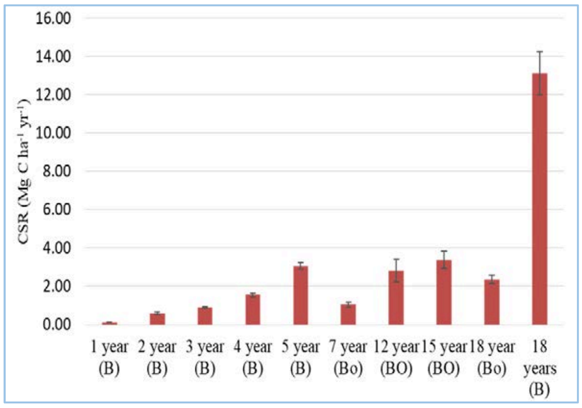


Fig. 2.3.7: Carbon sequestration rate of Mahogany plantation with respect to age, (B) block plantation & boundary plantation (Bo)

Table 2.3.8. Economic analysis of intercrop in Mahogany based agroforestry system

Particulars	Mahogany based agroforestry (3×3 m)				
	1 yr (n=2)	2 yrs (n=3)	3 yrs (n=12)	4 yrs (n=18)	5 yrs (n=4)
Cost of cultivation (Tree)	173704 (158379-164800)	10067 (8100-8500)	7760 (5974-6370)	6894 (5170-5370)	5596 (4170-4710)
Cost of cultivation (Intercrop)	137784 (93488-117276)	76946 (45409-52400)	70415 (36922-45682)	66334 (35700-45666)	59371 (33906-40113)
Total Cost of cultivation	311488	87013	78174	73228	64967
Returns from system					
Tree Mahogany	0	0	0	0	100000
Intercrops	210000	145000	153675.41	169011.77	108081
Total Return (₹ ha^{-1})	210000	145000	153675	169012	208081
Net Income	-101487.98	57986.78	75501.04	95784.056	143113.95
Net Present Value					151432
Benefit–cost ratio					1.31
Internal Rate of Return (%)					66%
Land Equivalent Value (₹ ha^{-1})					589975

Development of Climate Resilient CHARA Bank (Fodder system) in Drought-Prone Regions

The project titled *Development of Climate Resilient CHARA Bank for Round-the-Year Fodder Availability in Drought-Prone Regions*, sanctioned in 2024-25 by NABARD Regional Office, Pune, with a financial outlay of ₹25.18 lakhs, aims to enhance round-the-year availability of fodder through CHARA BANK under rainfed conditions in drought-prone regions, develop Standard Operating Procedures (SOPs) and bankable models of the proposed fodder systems for farmers, and study the impact of CHARA BANK on milk yield and the economics of dairy farmers To achieve these objectives, three fodder models were implemented on farmers' fields in seven villages of Baramati Tehsil, including Hedge Leucaena + Lucerne + Marvel (Rainfed conditions), Multi-tier model (Leucaena + Desmanthus + Cenchurus + Sesbania Boundary), and Boundary plantation of fodder species (Leucaena/Sesbania/Desmanthus).

Fig. 2.3.8: Pilot NABARD CHARA bank established at ICAR-NIASM, Baramati

Three pilot CHARA models were set up at ICAR-NIASM Baramati, each covering an area of 1,000 square meters (Fig. 2.3.8). A total of 21 demonstration plots were established, and a baseline survey was completed on 21 farmers' fields. The selection of 21 farmers and the recruitment of project staff were successfully carried out, and a brainstorming session for lead farmers was conducted on September 10, 2024 (Fig. 2.3.9). Inputs, including fodder seeds, drip lines, cutting instruments, and fertilizers, were distributed to the farmers.

Fig. 2.3.9: Visit of NABARD officials to pilot plot and farmers' field under Fodder Project

Genotypic responses to salt stress in dragon fruit

This research investigated the effects of salt stress on dragon fruit genotypes and their responses. Four genotypes were irrigated with saline water at concentrations of 0, 25, 50, 75, and 100 mM. Salt stress negatively impacted new sprout formation, growth, and biomass accumulation (both above- and below-ground), with the exception of root elongation, which showed varied responses among the genotypes. Sprouting was delayed by four and seven days at 50 mM and 100 mM salt concentrations, respectively, compared to the control. The highest plant mortality rates (15.00%–16.66%) occurred under 75 and 100 mM salt stress, with white-fleshed genotypes exhibiting the highest mortality (21.33%–25.33%). Salt stress also reduced chlorophyll pigments, normalized difference vegetation index (NDVI), photochemical quantum yield of PSII, and water-use efficiency (WUE). White-fleshed genotypes, specifically Andaman White and Local White, accumulated significantly higher levels of Na^+ in their stems (54.19 ppm and 40.85 ppm, respectively) compared to red-fleshed genotypes (Regular Red and Andaman Red, with 18.90 ppm and 9.81 ppm, respectively). Additionally, white-fleshed genotypes accumulated higher Cl^- levels in their roots (0.36% and 0.27%, respectively). In contrast, the Regular Red genotype accumulated the highest K^+ levels in its stem (219.83 ppm), followed by Andaman Red (206.32 ppm), while white-fleshed genotypes showed the lowest K^+ levels. These findings suggest that Regular Red and Andaman Red are efficient Na^+ excluders and moderately efficient Cl^- excluders, respectively, enabling them to maintain normal growth and physiological processes under salt stress conditions.

Conservation and evaluation of Allium species for waterlogging tolerance

A total of 46 wild *Allium* accessions, representing 10 species (*A. tuberosum, A. cepa var. aggregatum, A. fistulosum, A. chinensis, A. hookeri, A. fragrance, A. schoenoprasum, A. macranthum, A. angulosum, and A. ampeloprasum*), were obtained from ICAR-DOGR, Rajgurunagar, Pune, and maintained at the ICAR-NIASM field for further evaluation against waterlogging and anthracnose. In the initial screening, 42 wild *Allium* accessions and 7 cultivated (sensitive) checks were evaluated for waterlogging tolerance. Sixty-day-old potted plants were subjected to continuous waterlogging for 10 days, with the water level maintained at 5 cm above the soil surface. Among the tested genotypes, 36 exhibited tolerance, 3 showed relative tolerance, 7 were relatively sensitive, and 3 were classified as sensitive (Table 2.3.9).

Fig:2.3.10: Conserved Allium species

Table 2.3.9: Categorization based on percent survival & recovery after 10 days of waterlogging

Category	Survival & recovery (%)	No. of Geno-types	Entry Details
Tolerant	95-100% (36 genotypes)	17	*A. tuberosum* (2n=32): CGN-16373, EC-607483, All-1587, CGN-16418, MKG-83, MKG-84, MKG-85, NMK-3214, NMK-3228, NMK-3229, NMK-3231, Zimmu, NMK-3207, NMK-3219, CGN-16412, CGN-20779, NG-3183
		03	*chinensis (2n=32):* NMK-3236, NMK-3247, *A. chinensis* Chollang White (RAKYOO)
		03	*ledebourianum* (2n=16): EC-328491, AKO-17, AKO-50, AKO-3
		06	*A. fistulosum* (2n=16): *A. fistulosum L, A. fistulosum (OP), A. fistulosum L Georigien, A. fistulosum ladeborianum, A. fistulosum L. China All 646, A. fistulosum* Blue Green
		06	*A. macranthum* (2n=14): NMK-3238, NMK-3229, NMK-3232, NMK-3237, NMK-3233, NMK-3249
		01	*A. ampeloprasum* (2n=16): NMK-3211
Relatively tolerant	75-95% (03 genotypes)	01	*A. schoenoprasum* (2n=16): NR-6 NGB-5969
		01	*A. fragrance*: IC-383446
		01	*Allium angulosum* (2n=16): *A. angulosum*
Relatively sensitive	50-75% (07 genotypes)	03	*Allium cepa var. aggregatum*(2n=16): A. cepa var aggr-3, A. cepa var aggr-4, A. cepa var aggr-5
		04	*A. cepa* (2n=16): B. super, B. Raj, B. Shakti, B. shweta
Sensitive	<50% (03 genotypes)	03	B. Kiran, B. shubhra, B. safed

Moisture deficit tolerant fennel genotype identification using stress Indices

Fennel is an important major seed spice crop of India, but its sustainable production is affected by moisture deficit stress. The study was conducted with 43 fennel mutant genotypes to identify the moisture deficit stress tolerance along with two checks (AF-1 and AF-2). The moisture deficit stress was induced by withholding irrigation during flowering phase. The results of the combined analysis of variance revealed significant differences among main effects and their interactions for seed yield. The stress tolerant indices were employed to identify drought tolerant genotypes. The stress tolerance index, mean productivity index, geometric mean productivity, yield index and harmonic mean productivity, were found to be the best indicators for identifying high yielding genotypes under both conditions. The genotypes FM2, 43, 30, 31, 32 AF2 emerged as the most moisture deficit stress tolerant genotypes based on mean rank, standard deviation of ranks and rank sum. The cluster analysis grouped the genotypes into four distinct groups, highlighting FM2, 43, AF2, FM30, 31, 32, 39, 37, 29, 41 and 35 in group I as tolerant genotypes (Fig. 2.3.11a). The PCA (Fig.

2.3.11b) demonstrated that the first and second components accounted for 98.9% of the variations. Among all the genotypes, FM2, 43, AF2, FM30, 31, 32, 39, 37, 29, 41 and 35 were identified as the most drought tolerant. These genotypes exhibited cooler canopy and high photosystem II efficiency under stress condition compared to susceptible genotypes. These genotypes are recommended for breeding for drought tolerance in fennel.

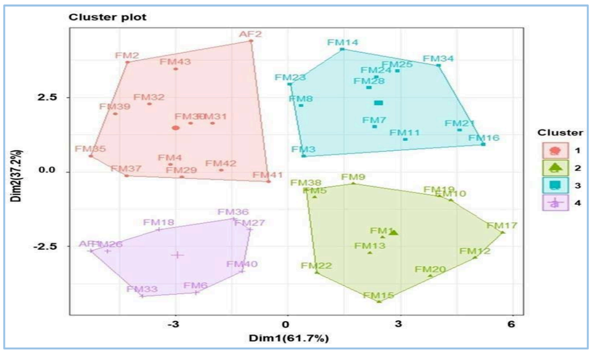


Fig. 2.3.11a: Cluster plot showing the grouping of genotypes according to the stress tolerance

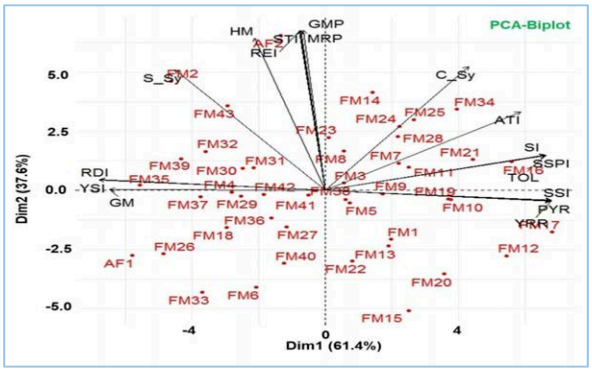


Fig. 2.3.11b : PCA Biplot showing the relation between the Stress Indices & fennel genotypes

Waterlogging effects on root morphology, yield, and stress tolerance in cowpea (Vigna unguiculata L. Walp) grown on semi-arid vertisols

Waterlogging, a major global stress, threatens food security with a $74 billion economic loss, projected to rise by 14–35% due to climate change. It severely affects leguminous crops by altering root morphology and yields. Studying root systems and yield loss is crucial for food security (SDG 2) and climate adaptation (SDG 13). Hence, studies were conducted during 2022 and 2023 to understand the effect of varied durations of waterlogging (1 to 25 days) at three growth stages (15 DAE; (days after emergence), 25 DAE, and at 50% flowering) of cowpea. Results revealed that the highest reduction in root length density (17.97%), surface density (17.31%), weight density (17.63%), and volume density (19.60%) were observed at early growth stages of cowpea (15 DAE) over control. As a result, the maximum reduction in crop growth and grain yield (62.90%) with the lowest yield stability index (YSI ~ 0.62) and stress tolerance index (STI ~ 0.78) was recorded (Table 2.3.10). Waterlogging for 17 to 25 days significantly reduced root morphological features and growth, resulting in highest reduction in grain yield (71.32–81.64%), and the lowest YSI and STI. Notably, plants at early growth stages produced a greater number of lengthier aerial roots with increasing waterlogging durations after 7 days. Whereas, the interaction of 1 day waterlogging at 25 DAE reported minimal yield reduction (~0.36%) with greater YSI (~0.99) and STI (~1.52).

Table 2.3.10. Grain yield of cowpea in response to waterlogging at different growth stages

Treatment	100 seed weight (g)	Grain yield (kg ha^{-1})	Percent yield reduction (PYR)
Growth stages (GS)			
15 DAE	8.39a	1066.9b	14.58a
25 DAE	8.49a	1152.3a	7.89b
50% flowering	8.68a	1131.0a	7.41b
p value	NS	0.0042	0.0031
Duration of waterlogging (D)			
1 day	8.63a	1199.8ab	3.26cd
2 days	8.45a	1116.1bc	9.98bc
3 days	8.45a	1063.5c	14.20b
5 days	8.41a	962.8d	22.36a
Control	8.66a	1241.3a	-
p-value	0.8559	<.0001	<.0001

Therefore, the sensitivity of cowpea roots to waterlogging explained the reduction in grain yield and stress tolerance. Cowpea was found highly sensitive at early growth stages (15 DAE) after three days of waterlogging stress on vertisols of semi-arid tropics.

Water productivity of small millets on poor soils of semi-arid vertisols

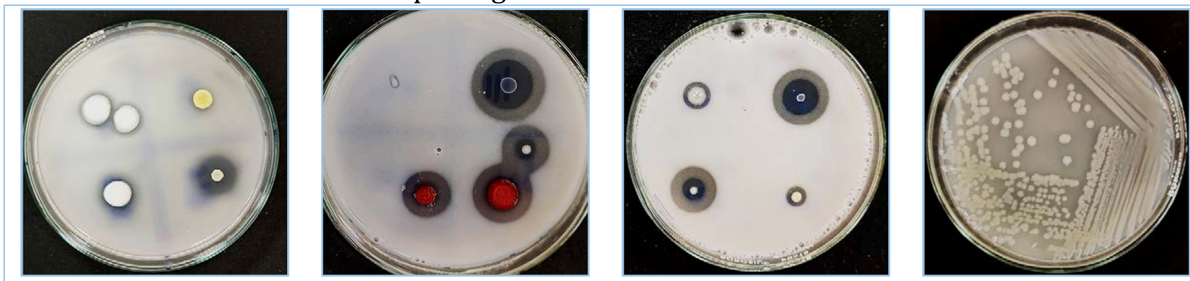
The experiment was laid out in split plot design with 28 treatment combinations in three replications on poor shallow soils of ICAR-NIASM Baramati. The main plot treatments includes, different levels of irrigation *viz.,* I_1- irrigation at 100% ET0, I_2- irrigation at 80% ET0, I_3- irrigation at 60% ET_0 and I_4- irrigation at 40% ET_0. Whereas subplots consist of seven small millets; C_1- finger millet, C_2- barnyard millet, C_3- foxtail millet, C_4- proso millet, C_5- little millet, C_6- kodo millet and C_7- brown top millet. The results revealed that the finger millet with irrigation at 100% ET0 recorded significantly higher leaf area (353 cm^2 $plant^{-1}$), dry matter accumulation (27.21 g $plant^{-1}$) and higher SPAD value (24.99). It further exhibited significantly higher PS-II activity (0.78) and lower proline accumulation at 60 days after sowing, which resulted in significantly higher test weight (3.90 g), grain yield per plant (10.47 g), grain yield (3103 kg ha^{-1}), stover yield (5677 kg ha^{-1}) and higher B-C ratio (2.72) compared to other treatments. The greater water productivity was observed in proso millet (1.13 kg m^{-3}), whereas it was significantly lower in kodo millet (0.18 kg m^{-3}) irrigated at 40% ET0. The yield reduction was 22.40, 36.68 and 57.24% in irrigation with 80, 60 and 40% ET0, respectively and it was least in finger millet (21.09%). Among small millets, significantly higher grain yield was recorded by finger millet (2422 kg ha^{-1}) while significantly lower grain yield was recorded by kodo millet (952 kg ha^{-1}).

Table 2.3.11. Yield of small millets on shallow poor soils as influenced by irrigation levels

Treatm -ents	Grain yield (kg ha^{-1})	Biomass (g $plant^{-1}$)
Irrigation level		
I_1	1898a	16.16a
I_2	1505b	12.70b
I_3	1193c	7.92c
I_4	819.2d	3.63d
p-value	<.0001	<.0001
Small millets		
Proso	1838b	11.56b
Foxtail	1350c	10.92bc
Browntop	1036e	9.49c
Barnyard	1037e	9.49c
Finger	2074a	16.45a
Little	1230d	7.61d
Kodo	910.4e	5.20e
P value	<.0001	<.0001

Isolation and characterization of microbes from Sugarcane and Soybean Rhizosphere and Endo-rhizosphere

Isolation of bacteria were carried out from sugarcane plant and soil samples on five different occasions and locations. A total of 150 bacterial isolates were obtained from sugarcane, including stem and root endophytes, rhizosphere and rhizoplane isolates. These bacterial isolates included endophytes (stem: 38; root: 22), rhizoplane isolates (26), rhizosphere isolates (20), putative *Acetobacter* like isolates (44), fluorescent pseudomonads (5), putative *Azospirillum* like isolates (2). These isolates were characterized for mineral solubilization (Fig. 2.3.12) (phosphate solubilization: 83 isolates with solubilization index ranging from 5.5 to 19.11; Zn solubilization: 85 isolates with solubilization index ranging from 4.5 to 15.28; K solubilization: 45 isolates with solubilization index ranging from 5.3 to 15.5), production of IAA-like substances, and ACC-deaminase activity. Seventy-one isolates showed ACC deaminase activity while 28 isolates produced IAA-like substances. Identification and characterization for other plant-growth promoting traits and quantification is underway.



P-solubilization | Zn-solubilization | Zn-solubilization | Pure colonies of a Zn-solubilizing bacterium

Fig. 2.3.12: Mineral solubilizing bacteria from rhizosphere of sugarcane

Copper and copper nanoparticles toxicity and multi-biomarker approach using integrated biomarker response in fish: a comparative study

The median lethal concentration of Copper (Cu) and copper nanoparticles (Cu-NPs) in the fish *Pangasianodon hypophthalmus* was determined as 7.56 and 3.60 mg L^{-1} respectively (Fig. 2.3.13 A-B). During the definitive test, concentrations of Cu and Cu-NPs were chosen to enclose these values and evaluate the toxic effects using a biomarker set involved in several biological processes such as oxidative stress, neurotransmission or cellular metabolism, and measure in the liver, kidney and gills. The Cu-NPs was synthesised using biological approaches with particle size 24 nm and zetapotential -54.7 mV (Fig. 2.3.14). Results highlighted that, exposures to different concentrations of Cu and Cu-NPs noticeably affected oxidative stress, neurotransmitter enzymes, stress biomarkers and cellular metabolic stress as compared to the unexposed group. Catalase, superoxide dismutase, glutathione-s-transferase, glutathione peroxidase and lipid peroxide in the liver, gill and kidney were remarkably enhanced ($p<0.01$) with Cu and Cu-NPs during acute test. Similarly, acetylcholinesterase activity was significantly inhibited ($p<0.01$) in the brain after exposure to Cu and Cu-NPs in comparison to the unexposed group. Cellular metabolic stress was highly affected by ($p<0.01$) Cu & Cu-NPs exposure. Cortisol, HSP 70 and blood glucose concentrations were significantly increased in exposed fish as compared to the unexposed group. Genotoxicity in gill and kidney tissues and histopathology in gill and liver were also investigated and revealed damage due to Cu & Cu-NPs exposure. The present investigation revealed that essential trace elements Cu and Cu-NPs (nano & inorganic form) at high concentrations led to toxicity & alteration of the cellular metabolic activities in fish.

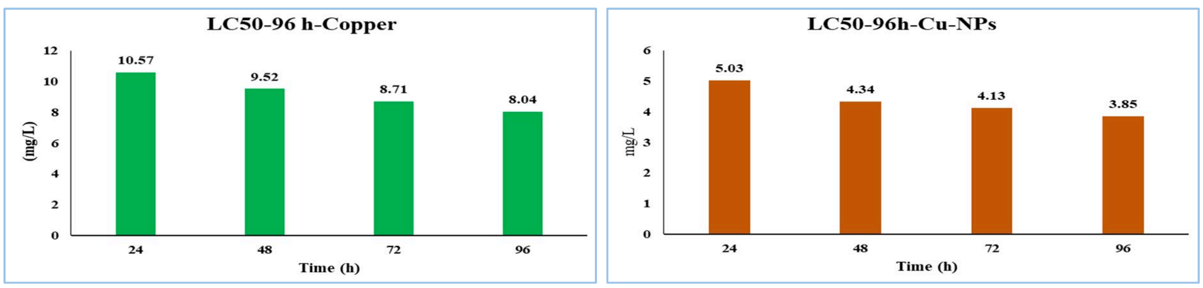


Fig. 2.3.13 (A-B): Determination of median lethal concentration (96-LC_{50}) of copper (Cu) and copper nanoparticles (Cu-NPs) to *Pangasianodon hypophthalmus* for a period of 96 h

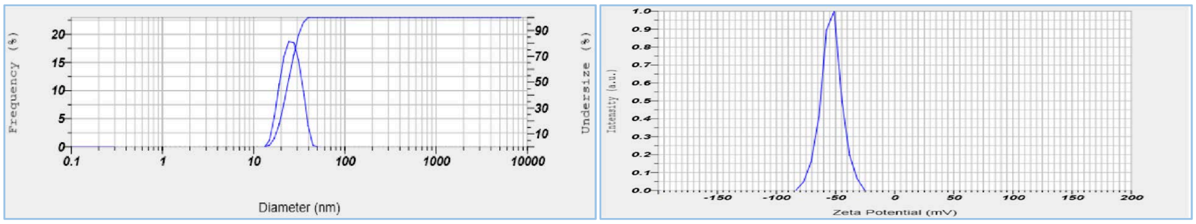


Fig. 2.3.14: Particle size (24 nm) & zeta potential (−54.7 mV) of copper nano-particles (Cu-NPs)

Eco-friendly synthesis of iron nano-particles for mitigation of abiotic and biotic stress in fish using gene regulation

An experiment was conducted on eco-friendly synthesis of iron nanoparticles (Fe-NPs) for mitigation of arsenic and ammonia toxicity as well as high temperature stress (As+NH_3+T) using gene regulation in fish. Fe-NPs was biologically synthesised using fish waste and incorporated for feed formulation at 10, 15 and 20 mg kg^{-1} diet. The twelve treatments were designed in triplicate following completely randomised design with five hundred forty fish. The dietary supplementation of Fe-NPs at 15 mg kg^{-1} diets with or without stressors followed by Fe-NPs at 10 mg kg^{-1} diet significantly lowered cortisol level in comparison to control and other groups (Fig. 2.3.15a). Similarly, the group fed with Fe-NPs at 10 and 20 mg kg^{-1} diet with or without stressors significantly lowered *HSP 70* gene expression compared to all the stressors groups (As, NH_3, As+NH_3 and As+NH_3+T) (Fig. 2.3.15b). *Cas 3a* gene expression was significantly upregulated (p=0.017) by exposure to As alone followed by As+NH_3+T and As+NH_3 and NH_3 alone group. Moreover, the Cas 3a and 3b was downregulated by Fe-NPs at 15 mg kg^{-1} diet with or without stressors compared to control and other groups (Fig. 2.3.15c). The *MT* gene expression was substantially upregulated (p=0.0031) by As+NH_3+T followed by As, NH_3 and As+NH_3 exposure in *P. hypophthalmus* compared to control and Fe-NPs supplemented groups (Fe-NPs 10 and 15 mg kg^{-1} diet). Whereas *CYP 450* gene expression was noticeably (p=0.016) highly upregulated by exposure to As alone followed by As+NH_3+T, NH_3 and As+NH_3 exposure compared to control and other groups. Interestingly, the *MT and CYP 450* gene expression were significantly downregulated by dietary Fe-NPs at 15 mg kg^{-1} diet compared to control and other groups (Fig. 2.3.15d). Further, gene expression of *TNFα* was significantly downregulated (p=0.0018) by As+NH_3+T followed by As+NH_3, NH_3 and As exposure compared to control and other groups. Whereas, *TNFα* was noticeably upregulated by dietary Fe-NPs at 15 mg kg^{-1} diet with or without stressors followed by Fe-NPs at 10 and 20 mg kg^{-1} diet compared to control and other groups (Fig. 2.3.15e). Similarly, *IL* (p=0.01) and Ig (p=0.016) gene expressions were substantially downregulated by concurrent exposure to arsenic, ammonia and high temperature followed by As+NH_3, NH_3 and As in comparison to control and diet supplemented groups. Whereas, IL and Ig gene expression were significantly upregulated by dietary Fe-NPs at 15 mg kg^{-1} diet with or without stressors compared to control, Fe-NPs fed group (10 and 20 mg kg^{-1} diet) and stressors groups (Fig. 2.3.15f). Further, the gene related with growth performance such as growth hormone regulator (*GHR1* and *GHRβ*), growth hormone (*GH*), Insulin like growth factor (*IGF 1X* and *IGF 2X*) were upregulated and enhanced the growth of the fish reared under stress whereas *SMT* and *MYST* were downregulated by Fe-NPs diet. Interestingly, the detoxification of arsenic was enhanced by Fe-NPs diet. Fe-NPs at 15 mg kg^{-1} of diet significantly reduced the critical thermal minimum (CTmin) to 14.44±0.21 °C and the lethal thermal minimum (LTmin) to 13.46±0.15 °C, compared to the control and other treatment groups. Conversely, when Fe-NPs at 15 mg kg^{-1} were administered with or without exposure to stressors (As+NH_3+T), the critical thermal maximum (CTmax) increased to 47.59±0.16°C, and the lethal thermal maximum (LTmax) increased to 48.60±0.37 °C, both significantly higher than the control and other groups. A strong correlation was observed between LTmin and CTmin (R^2 = 0.90) and between CTmax and LTmax (R^2 = 0.98) (Fig. 2.3.15g-h). The study concluded that, dietary Fe-NPs enhances the mitigation of arsenic and ammonia toxicity and high temperature stress using improved gene regulation in fish.

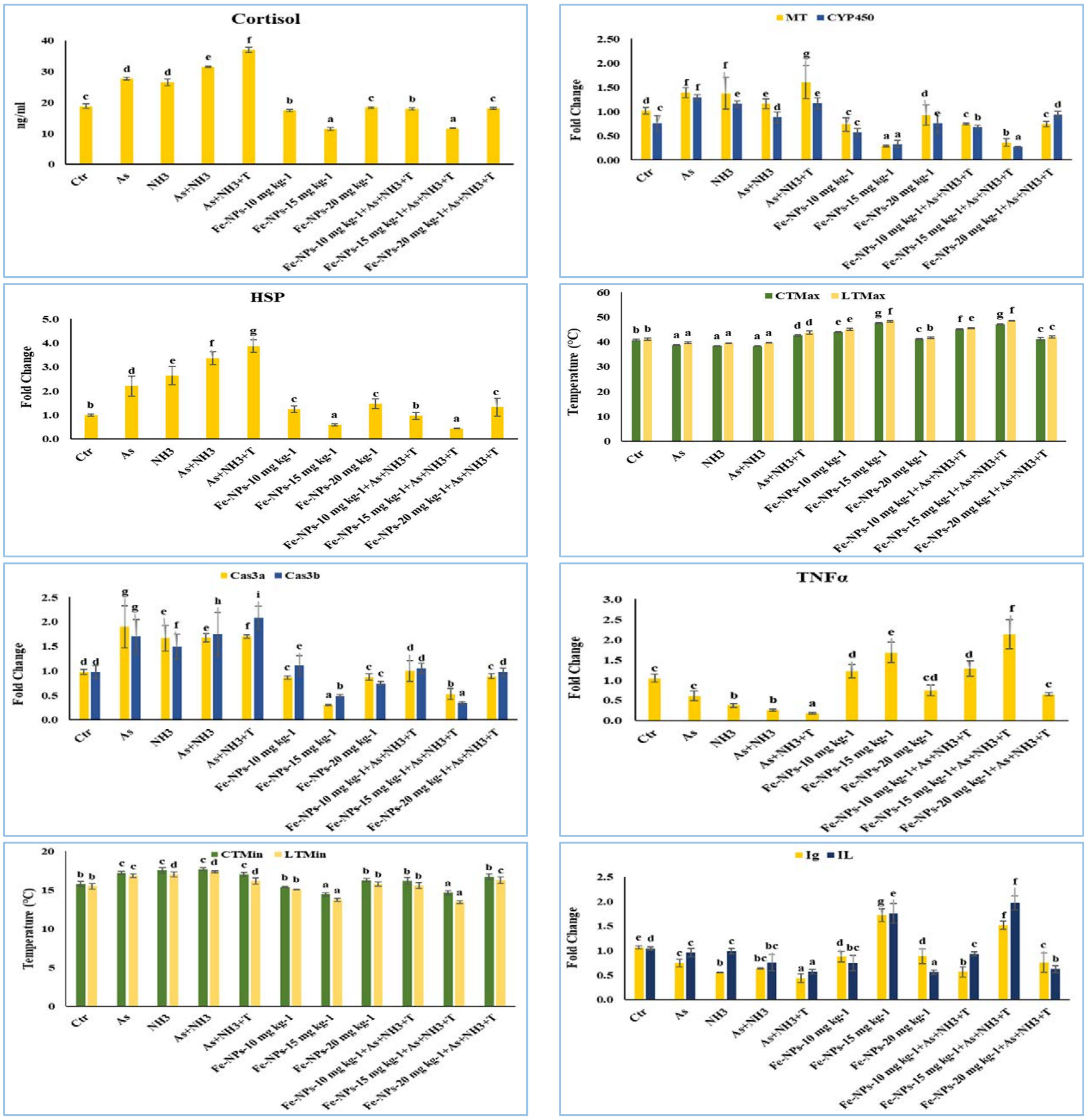


Fig. 2.3.15: Effect of dietary iron nanoparticles (Fe-NPs) on **(a)** cortisol against multiple stress in fish, **(b)** HSP 70 against multiple stress in fish, **(c)** Cas 3a & 3b against multiple stress in fish, **(d)** MT & CYP 450 against multiple stress in fish, **(e)** TNFα against multiple stress in fish, **(f)** Ig and IL against multiple stress in fish, **(g)** CT min and LTmin against multiple stress in fish, **(h)**CT max and LTmax against multiple stress in fish.

School of Social Sciences and Policy Support

The School of Social Sciences and Policy Support's research, education and extension activities are carried out through flagship research project, teaching social sciences courses and capacity-building programmes in line with the institute's mandate. The major activities of the school were farmer-oriented research focusing demonstration, capacity building, information sharing, and frontline extension activities along with developmental programmes of DAPSC and TSP as summarized below.

Research Highlights

Development of integrated drought index and stress mapping for selected drought-prone areas of Western Maharashtra

This research focuses on the development of an integrated drought index and stress mapping for drought-prone districts of Western Maharashtra *i.e.,* Pune, Satara, Solapur and Ahmednagar. A comprehensive meta-analysis of existing literature was conducted, focusing on different types of droughts, including agricultural, meteorological, and hydrological droughts. Key indices relevant to each drought type were identified, providing critical insights into their applicability and effectiveness. For agricultural drought monitoring, the indices considered include the Vegetation Health Index (VHI), Standardized Normalized Difference Vegetation Index (SNDVI), and Standardized Normalized Difference Water Index (SNWDI). For meteorological drought monitoring, the selected indices are the Standardized Precipitation Index (SPI), Standardized Precipitation Evapo-transpiration Index (SPEI), Rainfall Anomaly Index (RAI), and Precipitation Condition Index (PCI). For hydrological drought monitoring, the Standardized Groundwater Level Index (SGWL) was identified as the key metric. The table below provides a summary of the identified indices, categorized by drought type. A robust framework for the development of an integrated drought index is currently in progress.

Table 2.4.1: Identified indices/parameters for each drought type

Drought Type	Indices/parameters identified
Agricultural Drought	VHI, SNDVI, SNWDI
Meteorological Drought	SPI, SPEI, RAI, PCI, Soil Moisture Estimation using OPTRAM
Hydrological Drought	SGWI development using Geographically Weighted Regression (GWR) and Machine Learning (ML) Approach

Mapping and Assessment of Abiotic Stresses in Pune District, Maharashtra using Geospatial Techniques

Abiotic stress is the term used to describe non-living factors in the environment that negatively impact crop growth, development, and overall productivity. Accurately mapping abiotic stresses is crucial for agricultural planning and resource management. This study presents a novel approach for abiotic stress mapping by combining various terrain, climatic, pedological and vegetation parameters using the analytical hierarchy process (AHP) and AHP-integrated machine learning (ML) models for the Pune district located in the hot semi-arid ecosystem of western India. To quantify and map the abiotic stress, thematic layers and their sub-classes were given AHP-based weights and the final abiotic stress map was generated by integrating the selected reclassified thematic layers using the weighted sum approach. Furthermore, the result of AHP was used with other thematic layers to build AHP-integrated ML models. Using high-resolution Google Earth imagery, the generated map was validated at randomly selected locations to ensure robust validation. A receiver operating characteristic (ROC) curve has also been generated using these selected points to confirm the model's ability to effectively discriminate between different stress levels. The validation through Google Earth imagery indicates good agreement with the model output. The stress-prone areas were mainly noticed in the southern and south-eastern parts of the district, the majority of areas of the Purandar, Baramati, Indapur, and Daund tehsil come under very high and high-stress zones. These regions where drought, very shallow soil and very low rainfall (<550 mm) were noticeable. The study demonstrates the potential of the AHP and combined machine learning models in abiotic stress mapping and identification of hot spots with reasonable accuracy and the results of the study can be used in developing the combating strategies to minimize the impact of abiotic stress on agriculture systems.

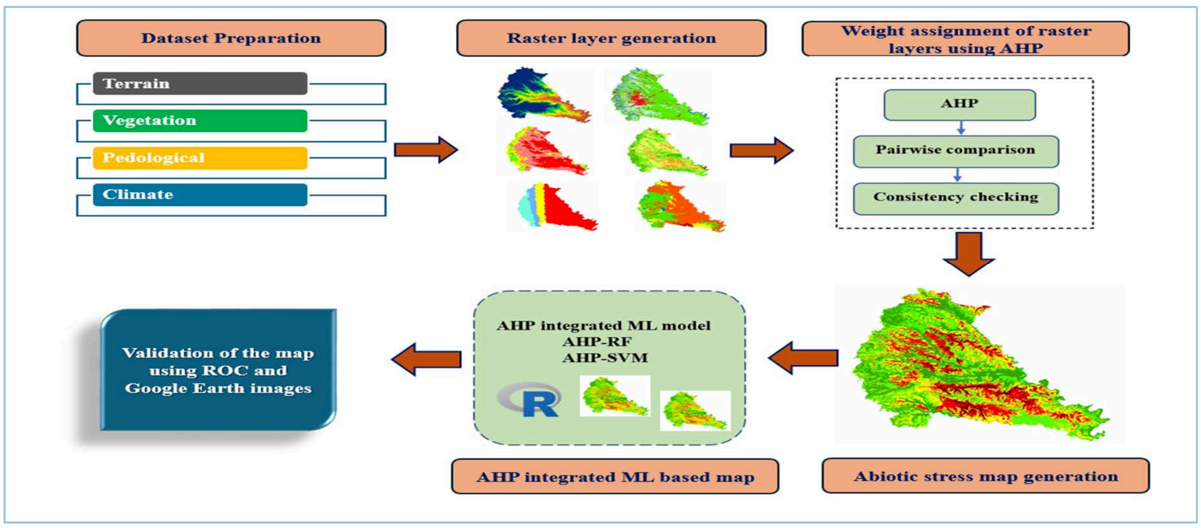


Fig. 2.4.1: Framework of the proposed methodology.

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

The present study was conducted to quantify crop yield losses induced by drought in the drought-prone districts of Western Maharashtra, namely Pune, Satara, Solapur, and Ahmednagar. A detailed meta-analysis of existing literature was carried out, focusing on drought stress and its effects on agricultural productivity. Drought years were identified as 2002, 2009, 2012, 2019, and 2023. A structured questionnaire has been meticulously prepared to collect ground-level data from farmers, agricultural experts, and other stakeholders. The questionnaire addresses multiple dimensions, including geo-location tagging, historical yield patterns, farmers' perceptions of drought and salinity impacts, economic costs and losses, adaptation strategies, feasibility and constraints in adopting stress mitigation technologies. A comprehensive framework is under development to accurately assess yield losses using advanced modeling tools and stress quantification techniques.

Targeting prospective technologies for abiotic stress resilience in rainfed & dryland regions

To assess the marketing aspects of dragon fruit, a survey was carried out in the Pune, Satara, Sangli and Solapur districts of western Maharashtra and data collected from farmers revealed that average selling price at farm gate by farmers or selling to whole sellers is at ₹78.23 kg^{-1}. (2019), ₹86.95 kg^{-1} (2020), ₹100.43 kg^{-1}. (2021) and ₹108.53 kg^{-1}. (2022). From this it is inferred that the farm gate price for dragon fruit is increasing at an increasing rate due to increase in consumption rate and still demand supply gap exists in the market. The farmers were generally grading the harvested produce into three standard grades on the basis of fruit weight, i.e., Grade-A (> 400 g), Grade-B (200-400 g) and Grade-C (< 200 g). The data also reveals that producer share in consumers rupees in dragon fruit is ranging from 40-60% depending on the type of market. Hence there is a need to study complete value chain analysis of dragon fruit in different growing regions and marketing channels.

Growth Dynamics and Sectoral Instability in Livestock and Poultry: A Policy-Centric Analysis with Focus on Maharashtra

The livestock and poultry sectors play a crucial role in the agricultural economy contributing significantly to rural livelihoods, nutrition, and food security. The study assessed the growth dynamics and instability of livestock and poultry populations using the quinquennial census data from 1961 to 2019 for India and Maharashtra. The findings indicate a Compound Annual Growth Rate of 5.09% for Buffalo in Maharashtra, slightly lower than the national average of 6.53%, highlighting regional disparities in growth dynamics. The poultry sector shows remarkable growth in both Maharashtra (17.63%) and India (18.23%), driven by rising demand for poultry products and government initiatives. The Cuddy-Della Valle Instability Index reveals significant variability in livestock species, with Maharashtra exhibiting a higher overall instability index (9.88%) compared to the national level (3.77%). The comparison of CDVI (%) values across livestock categories for Maharashtra and India as shown in the Figure 1 reveals distinct levels of variability, indicating differing stability in population growth trends. Maharashtra's buffalo sector shows a high CDVI (10.82%) compared to the national average (3.7%), reflecting moderate instability due to climatic shocks such as drought, water scarcity and fodder availability. The goat sector shows less variability in Maharashtra, with a CDVI of 6.07% compared to the national average of 14.03%, likely as goats are more resilient to the state's semi-arid conditions and promoted as a stable livelihood in drought-prone areas. The district-wise livestock population data for Maharashtra over three census periods-2007, 2012, and 2019-also reveals significant trends and variations across regions (Figure 2), with some districts experiencing consistent growth, while others show declines. Notably, districts like Ahmednagar and Solapur exhibit a steady increase in livestock numbers, reflecting their strong agricultural and pastoral base. These trends underscore the necessity for region-specific policy measures to promote sustainable practices.

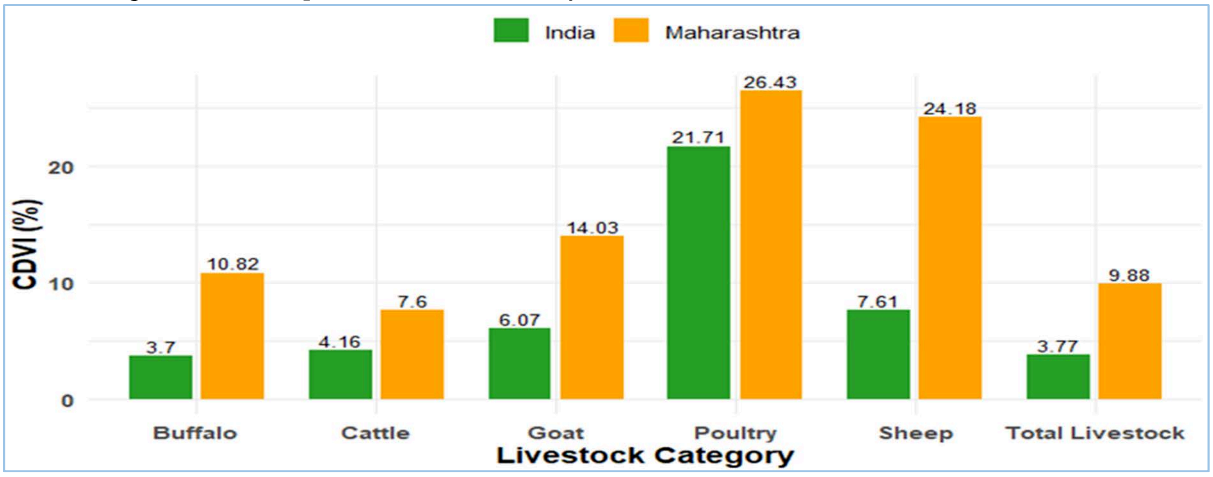


Fig. 2.4.2: Comparison of CDVI (%) for livestock species of India and Maharashtra.

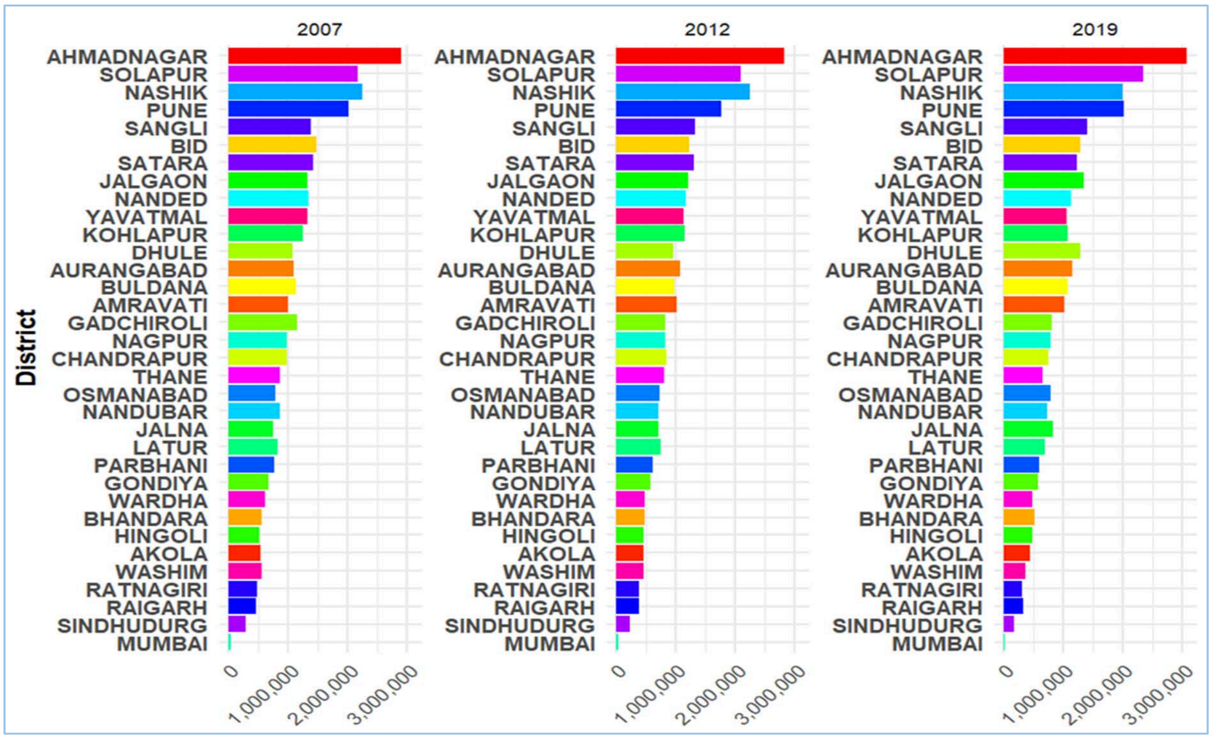


Fig. 2.4.3: Comparison of district-wise livestock populations for Maharashtra state over three census periods-2007, 2012, and 2019.

Extension Activities

- Monitoring of Feedback of Scientists visit to KVK, Baramati on 20.08.2024. (Dr. Sangram Chavan and K Ravi Kumar)
- Monitoring of Feedback of Scientists visit to KVK, Narayangaon on 07.10.2024. (Dr. Sangram Chavan and K Ravi Kumar)
- Monitoring of Feedback of Scientists visit to KVK, Dahigaon-ne on 08.10.2024. (Dr. Sangram Chavan and K Ravi Kumar)

Monitoring of Feedback of Scientists

ICAR- NIASM participated in Shinning Maharashtra Exhibition 19-21 February, 2024

ICAR-NIASM participated in Global Soils Conference 19-22 November, 2024

ICAR-NIASM participated Kisan Diwas exhibition at ATARI, Pune, 23rd December, 2024

KVK Staff, Dept. personnel, Farmers and Students visit to ICAR-NIASM during 2024

Visits of students, farmers and department officials to ICAR-NIASM (2024)

Sl. No	Name and Address of Organisation / College / Farmers group	Date of Visit	No. of visitors
1.	Shaswat Sheti Vikas Pratishtan, Pune	01-01-2024	25
2.	SVPMS college of Engineering, Malegaon	04-01-2024	60
3.	College of FPT & BE, AAU, Gujrat	04-01-2024	51
4.	College of Forestry, Dapoli	12-01-2024	22
5.	Balasaheb Desai college, Patan, Satara	17-01-2024	20
6.	Farmers from Junnar, Pune	17-01-2024	02
7.	DY Patil College of Agri Engineering & Technology, Talsande	18-01-2024	59
8.	Pratap singh Mohite patil Mahavidyalaya, Karmala, Solapur	18-01-2024	20
9.	Dadasaheb Mokashi College of Agriculture, Karad	19-01-2024	120
10.	Farmers from Musti, Solapur	20-01-2024	13
11.	Farmers from Bidar, Karnataka	22-01-2024	25
12.	KK Wagh College of Agri. Engineering & Tech., Nashik	05-02-2024	26
13.	Sharadabai Pawar Mahila college, Malegaon, Baramati	09-02-2024	16
14.	S.M. Joshi College, Hadapsar, Pune	12-02-2024	88
15.	Chandagarh F.P.O. Chandrapur	16-02-2024	05
16.	SVPMS C.O.E. Malegaon, Baramati	28-02-2024	43
17.	Ankur Seed Company, Nagpur	28-02-2024	12
18.	Scientist From Patanjali Uttarakhand	05-03-2024	04
19.	Nanasaheb Kadam College of Agri. Chatrapati Sambhajinagar	11-03-2024	45
20.	College of Horticulture SDAU, Gujrat	13-03-2024	56
21.	SCOA Mirajgaon	19-03-2024	07
22.	College of Agriculture, RAWEP Student, Pune	21-03-2024	05
23.	Officials from various State Agri. department	22-03-2024	08

Sl. No	Name and Address of Organisation / College / Farmers group	Date of Visit	No. of visitors
24.	Lokmangal College of Agriculture, Solapur	28-03-2024	07
25.	College of Agriculture, Latur	01-04-2024	58
26.	College of Agriculture, Naigaon, Nanded	03-04-2024	97
27.	National Water Academy, Pune	01-04-2024	26
28.	Jaywantrao Bhosale College of Agriculture, Karad	22-04-2024	58
29.	Jaywantrao Bhosale College of Agriculture, Karad	23-04-2024	57
30.	SAST NMIMS Shirpur, Dhule	16-05-2024	45
31.	Shriram college of Horticulture, Paniv	17-05-2024	32
32.	Vysakh AD NWA, CWC, Pune	17-05-2024	22
33.	College of Agriculture, Phaltan	12-06-2024	53
34.	College of Agriculture, Phaltan	13-06-2024	52
35.	College of Agriculture VNMKV, Parabhani	14-06-2024	83
36.	Shri Santa Shankar Maharaj college of Amrawati	27-06-2024	80
37.	Shahu Maharaj College of Agriculture, Kolhapur	03-07-2024	218
38.	Dr. Laxman Boekut college, Yavatmal	05-07-2024	05
39.	College of Agriculture, Dhule	16-07-2024	70
40.	Aaditya Agri Biotech, Beed	08-08-2024	27
41.	V.P. School of Agri. Biotech, Baramati	21-08-2024	28
42.	Baramati Cattlefields Pvt.Ltd	27-08-2024	45
43.	MGCABT Nanded	28-08-2024	43
44.	Lokmangal College of Agriculture, Solapur	29-08-2024	51
45.	SVPMS college of Pharmacy Malegaon	30.08.2024	30
46.	Jaywantrao Bhosale College of Agriculture, Karad	26-08-2024	07
47.	Institute of Technology Malegaon BK, Baramati	13-09-2024	61
48.	Institute of Technology Malegaon BK, Baramati	13-09-2024	41
49.	ACABC Training KVK, Baramati	17-09-2024	23
50.	Farmers From Gulbarga District, Karnataka	18-09-2024	02
51.	MGM College of Agri Biotech, Aurangabad	19-09-2024	53
52.	VP College of Agri Biotech. Baramati	24-09-2024	44
53.	SVPM College of Engineering. Malegaon	26-09-2024	44
54.	Vidya Pratishthan Polytechnic College, Indapur	26-09-2024	03
55.	Shrimant Shambhu Singh High school, Malegaon	04-10-2024	35
56.	Zeal College of Engineering, Pune	08-10-2024	90
57.	Savitribai Phule University Pune Dept of Biotech	15-10-2024	13
58.	SMM College, Akluj, Solapur	23-10-2024	30
59.	Farmers from Mohol, Solapur	27-11-2024	05
60.	School of Agri.Science and Tech shirpur, Dhule	04-12-2024	31
61.	DY Patil College of Agri Engineering & Technology Talsande	13-12-2024	57
62.	College of Agri Engineering and Technology PDKV, Akola	17-12-2024	39
63.	Shardabai Pawar Mahila College, Sharda Nagar	19-12-2024	15
64.	Mandeshi Foundation Mhaswad, Satara	21-12-2024	32
65.	Navsare Agriculture University Navsari, Gujrat	24-12-2024	125
66.	KVK, Bableshwar	30-12-2024	04
	Total		**2673**

DAPSC interventions 2024

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 & capacity building programs were taken up. Under the DAPSC programme, 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. Total of 1091 farmers and five self-help groups (SHG) from 57 villages (from 11 tehsils viz Baramati, Khandala, Phaltan, Daund, Maan, Kadegaon, Malshiras, Khatav, Haveli, Purandar and Indapur) were included based on a survey of their status and requirements for the upliftment of livelihood. Other inputs namely, utensil kits (100), sewing machines (100), flour mills (125), dairy kits consisting of milk cans, SS buckets, milk measure, plastic baskets, mineral mixture, deworming tablets (100) and Farming kit (consisting of water tank of 1000 L, power sprayer, tarpaulin sheet and water filter) were also provided to 100 beneficiaries. One SC women self-help group (SHG) was provided with Sanitary pad machine 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 Sangavi village. A total of 4 training programmes carried out benefitted more than 375 SC beneficiaries. World Environment Day on 5th June 2024 and various activities for SC beneficiaries, students and staff were carried out to create awareness about importance of environment as per guidelines issued by council. Out of the 1000 beneficiaries during the financial year 2023-24, 226 were women.

Dr K Sammi Reddy, Director, inaugurated the Sanitary pad machine to SC Self-help group

Dr Rinku Dey, Head SESM handing over the Sanitary pad machine to SC women's Self-help group

During the year 2024, three Training cum Technology Demonstrations on the "Preparation of Mixed Silage of Sugarcane Tops" were organised on 11th January, 9th September and 19th November under DAPSC benefitting more than 305 beneficiaries.

Various Training Programmes on “Upliftment of livelihood of SC Beneficiaries” were organized during the period under DAPSC at different villages Pulkoti, jambhulni, Devapur, Mahabaleshwarwadi village of Satara District, Katphal and Malad from Pune district Maharashtra. It was followed by the distribution of inputs like sewing machines, domestic flour mills, bicycles, utensil kits, and dairy kits to the identified beneficiaries of selected villages.

Distribution of Sewing machines at Sangavi

Distribution of Farming kits to SC beneficiaries

Distribution of Bicycles to SC beneficiaries

Distribution of Dairy kits to SC beneficiaries

Tribal Sub Plan (TSP) activities 2024

The TSP activities of ICAR-NIASM are implemented in ten villages in the Nandurbar district of Maharashtra. Farmers are provided with training, field demonstrations, and awareness programs on improved agricultural technologies. The selected farmers receive improved inputs related to agriculture production, livestock production, fish production, horticulture crops, etc. A total of 1306 tribal farmers were provided with inputs for improved agricultural practices. TSP team conducted two farmer interaction meetings (Kisan Gosti) in which farmers from more than 20 villages in the Navapur Tehsil of the Nandurbar district participated. The villages include Bedki, Dapur, Pati, Piprana, Borpadha, Kamod, Khokasa, Kotkhab, Nagchari, Nangipadha, Motekadwan, Keli, Vadphali, Vadsatra, Vadhda, and Nagare.


Distribution of agriculture input among the farmers and interaction with TSP Farmers




Activities during field demonstration and data collection

Training and live demonstration conducted to TSP farmers

S. No	Training/demonstration	Beneficiaries	Team	Date
1	Training on Livestock and Poultry farming management	85	SA Kochewad, Paritosh Kumar, Ravi Kumar and Neeraj Kumar	18.03.2024
2	Field demonstration and training on Fish culture including feeding	48	Neeraj Kumar, SA Kochewad, Paritosh Kumar, and Ravi Kumar	18.03.2024

Table 2.4.2: List of items distributed in TSP during 2023-2024

Sr. No.	Name of the items	Quantity (kg/nos.)	No. of beneficiaries
1.	Paddy seed	1000 kg	100
2.	Soyabean seed	500 kg	25
3.	Maize seed	600 kg	120
4.	Onion seed	84 kg	84
5.	Mung-bean seed	100	25
6.	Fish-Feed	2205 kg	40
7.	Mineral Bricks for Livestock	135	135
8.	Nano Urea and Nano DAP	250 + 250	250
9.	Moringa Harvester	10 nos.	10
10.	Brush cutter	20 nos.	80 (1 brush cutter for group of 4 farmers)
11.	Power sprayer (Petrol operated)	16 nos	64 (1 Power sprayer for group of 4 farmers)
12.	Self-propelled seed drill	20 nos.	40 (1 Seed drill for group of 4 farmers)
13.	Secateur	50 nos.	50
14.	Pick axe	40 nos.	40
15.	Spade	50 nos.	50
16.	Crowbar	18 nos.	18
17.	Plastic tubs for Agriculture use	50 nos.	50
18.	Mineral mixture	125 kg	125
	Total no of farmers		**1306**

Distinguished Visitors:

Unveiling of Selfie Point at ICAR-NIASM

The Selfie Point at ICAR-NIASM was unveiled by Dr B Venkateswarlu, Former Vice-Chancellor, VNMKV, Parbhani & Chairman QRT on 16th Feb. 2024 during the QRT review meeting of ICAR-NIASM, Baramati.

Foundation Stone laying of Type-V Quarters & Inauguration of institute facilities

Dr SK Chaudhari, DDG (NRM), ICAR, New Delhi, laid down the foundation stone of Chandrabhaga Residency (Type-V quarters) at ICAR-NIASM on September 27, 2024. He also inaugurated the newly constructed Experimental Poultry Shed having 14 experimental compartments with capacity of housing 1200 birds. DDG also inaugurated Water Treatment Plant at the institute. During the occasion, DDG (NRM) distributed ICAR technology certificates to the scientists, felicitated housekeeping staff, and released the institute's publications.

Training & Capacity Building

ICAR-IARI BSc (Hons) Agri. Students, IARI-NIASM Baramati Hub (2024-25)

Sr. No	Name of the Student	Roll number
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.	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

ICAR-IARI MSc/MTech/PhD students who joined IARI-NIASM Hub (2024-25)

Sr. No	Name of the Student	Roll number	Discipline	Degree
1.	Shrutarshee Kundu	IARIBAR20242011	Environmental Science	M.Sc.
2.	Milton Banerjee	IARIBAR20242012	Environmental Science	M.Sc.
3.	Seko- U Thele	IARIBAR20242013	Environmental Science	M.Sc.
4.	Bhaskar Jha	IARIBAR20242014	Environmental Science	M.Sc.

MSc/MTech. students graduated from IARI-NIASM Baramati Hub (2024-25)

Sr No.	Name of student	Roll No.	Discipline	Guide/Co-guide name	Thesis title
1.	Renu Verma	70024	Environment Science	AK Singh	Soybean responsiveness to elevated temperature and CO_2
2.	Apoorva Ashu	70022	Plant Physiology	S. Gurumurthy	Physio-biochemical and molecular basis of photothermoinsensitivity in chickpea (*Cicer areitinum* L.)
3.	Kruthika S	70018	Plant Physiology	S. Gurumurthy	Physiological and biochemical characterization of common bean genotypes under water deficit stress at reproductive stage
4.	Sarnya A	70020	Soil & Water Conservation	GC Wakchaure	Alleviating Water Stress in Garlic Crop through Deficit Irrigation &Plant Growth Regulators in Deccan Plateau
5.	Subha Mondal	70021	Soil & Water Conservation	DD Nangare	Deficit drip irrigation (DDI) strategy and plant growth regulators (PGR) in High density mango orchard

MSc/PhD Students of ICAR/SAU's/Private Universities joined ICAR-NIASM for research work (2024-25)

Sr. No.	Name of the Student	Degree (Discipline)	Guide/co-guide/SAC member	University/college
1.	Gund Suraj Nivarutti	Ph.D. (Plant Physiology)	PS Hanjagi	MPKV, Rahuri
2.	Vidya Bharathi KS	Ph.D. (Plant Physiology)	Sushma M. Awaji.	MPKV, Rahuri
3.	Rajkumar Debarjeet Singh	Ph.D. (Aquaculture)	Bhaskar B. Gaikwad	ICAR-CIFE, Mumbai
4.	Yukta DU	Ph.D. (Agronomy)	Hanamant M. Halli	UAS, Dharwad
5.	Divakar V	M.Sc. (Fish nutrition & Biotechnology)	Neeraj Kumar	ICAR-CIFE, Mumbai
6.	Ranjit Singh Patel	M.Sc. (Fish Genetics and Biotechnology)	Neeraj Kumar	SKUAST Rangil, Ganderbal, J&K
7.	Nikita More	M.Sc. (Plant Biochemistry)	Sushil S Changan	Dr Sharadchandra Pawar College of Agriculture & Horticulture, Baramati
8.	Saee Chavan	M.Sc. (Biotechnology)	Neeraj Kumar	Vidya Pratishthan's Arts, Science and Commerce College, Baramati
9.	Rutuja Rupanwar	M.Sc. (Biotechnology)	Neeraj Kumar	Vidya Pratishthan's Arts, Science and Commerce College, Baramati
10.	Deshmukh Krushna Ashokrao	M.Sc. (Entomology)	Rajkumar	College of Agriculture, Latur
11.	Bhavana Ahiwale	M.Sc. (Biotechnology)	SS Pawar	Vidya Pratishthan's Arts, Science and Commerce College, Baramati
12.	Shreya Kamble	M.Sc. (Biotechnology)	SS Pawar	Vidya Pratishthan's Arts, Science and Commerce College, Baramati

Trainings/Seminar/Workshop/Symposia/Conference organized

Sl. No.	Training (Period)	Beneficiaries details (Nos.)	Organizers
1.	Blended Learning Programme - Writeshop Programme on Climate Change (27-31 August, 2024)	NABARD Officials (21)	SB Chavan, VD Kakade, AS Morade (Coordinators), BB Gaikwad, PS Basavaraj, Harisha CB (Co-coordinators)
2.	Climate-Smart Agriculture (2-7 September, 2024) funded by sponsored by the Directorate of Agriculture and Food Production, Government of Odisha	Group A & B Officials (17)	SB Chavan & Aliza Pradhan (Course Director) SA Kochewad, PS Khapte, K Ravi Kumar, & Nobin Paul (Co-course Directors)
3.	Climate-Smart Agriculture (14-19 October, 2024) funded by sponsored by the Directorate of Agriculture and Food Production, Government of Odisha	Group A & B Officials (20)	SB Chavan & Aliza Pradhan (Course Director) Gopalakrishnan B., AS Morade, VD Kakade, Shushama Awaji (Co-course Directors)
4.	Climate-Smart Agriculture funded by the Directorate of Agriculture and Food Production, Government of Odisha (11-16 November, 2024)	Group A & B Officials (23)	SB Chavan & Aliza Pradhan (Course Director) Prashant Kumar, SS Changan, RN Singh, Navyashree, P (Co-course Directors)
5.	On-location Training Programme on Adaptation Techniques in Climate Smart Agriculture (CSA) sponsored by BIRD NABARD, Lucknow (16-18 December, 2024)	Bankers and Training officers (24)	SB Chavan, VD Kakade, AS Morade (Coordinators) & Karthikeyan N, K Ravi Kumar, P Navyashree, and Nobin Paul (Co-coordinators)
6.	Nature Positive Solutions for Shifting Agrifood Systems onto Sustainable Pathways (21-22 October, 2024)	Farmers (50)	V Rajagopal, SB Chavan & HM Halli
7.	Environmental and Social Impact Assessment and Gender Mainstreaming in Developmental Projects funded by Bankers Institute of Rural Development, Lucknow (08-10 January, 2024)	NGOs, College, farmers, Researchers (30)	SB Chavan, VD Kakade, AS Morade
8.	Workshop on “Management of Mahogany Based Agroforestry Systems” (22 March, 2024)	MITCON officials and farmers (30)	SB Chavan, VD Kakade, AS Morade, VN Salunkhe, K Ravi Kumar
9.	One month Student Ready-Internship Training, ICAR-NIASM (5 April-4 May, 2024	Students (02)	SS Changan
10.	High-End workshop on “Advanced Instrumentation in Abiotic Stress Assessment, Monitoring & Management for Sustainable Agriculture” (11-20 March, 2024)	M.Sc. and Ph.D. Students (25)	Aliza Pradhan, Rinku Dey, GC Wakchaure, Neeraj Kumar, SB Chavan, VN Salunkhe, VD Kakade, AS Morade, Sonam, P Navyasree
11.	One month Student Ready-Internship Training on "Entrepreneurship skill development in molecular and biochemical analysis of Mangrove (Avicennia marina) for salt tolerance" (5 April - 4 May, 2024)	Student (01)	PS Hanjagi
12.	One month Student Ready-Internship Training on "Entrepreneurship skill development in molecular and biochemical analysis of Beach morning glory (Ipomoea pes-caprae) for salt tolerance" (5 April - 4 May, 2024)	Student (01)	PS Hanjagi

Sl. No.	Training (Period)	Beneficiaries details (Nos.)	Organizers
13.	Efficient Administrative and Financial Management for the Administrative Personnel of KVKs in India, (19 June- 5 July, 2024)	KVK Staff (175)	SK Das, HM Halli, Aliza Pradhan, Nobin Paul
14.	Pre Examination Training (for Limited Departmental Competitive Examination for the Post of Upper Division Clerks (in ICAR System (21 August - 6 September, 2024)	UDC aspirants across ICAR (50)	SK Das, HM Halli, Aliza Pradhan, DP Kharat, Trilok Saini
15.	Orientation Training Programme for T1 staff of ICAR-NIASM (12 August 2024 - 31 July 2025)	T1 staff of NIASM (5)	Rinku Dey
16.	Internship Training for S.Y.B. Voc. QCI students of Shardabai Pawar Mahila Arts, Commerce and Science College Shardanagar, Malegaon (Bk.) (19 December, 2024 - 9 January, 2025).	Students (15)	Rinku Dey, Karthikeyan N, Rajagopal V, HM Halli
17.	Internship Training for M.Sc. Microbiology students of Shardabai Pawar Mahila Arts, Commerce and Science College Shardanagar, Malegaon (Bk.) (19 December, 2024 -9 January, 2025).	Students (8)	Rinku Dey, Karthikeyan N

Workshops/Seminar/Symposia/ Conference/Training attended

Name of staff	Title of Seminar/Workshop/ Symposia/Conference/Training attended	Venue	Organized by	Dates
Nobin Chandra Paul	Training programme on "Geospatial Technologies & Applications"	NRSC, Hyderabad	NRSC, Hyderabad	01-05 July, 2024
Nobin Chandra Paul	Training programme on "Enhancing Pedagogical Competencies for Agricultural Education"	NASC, New Delhi	NASC, New Delhi	01-05 April, 2024
Nobin Chandra Paul	Training programme on "International Research Conference on Sustainable Financing for Food Security and Farm Income"	CAB, RBI, Pune	CAB, RBI, Pune	11-12 September, 2024
Nobin Chandra Paul	“Eleventh International Triennial Calcutta Symposium on Probability and Statistics” and presented paper for the “PACM Young Scientist Award”	University of Calcutta, Kolkata	University of Calcutta & Calcutta Statistical Association, Kolkata	27-30 December, 2024
Ponnaganti Navyasree	Training programme on “Multivariate Data Analysis Using R”	Online mode	ICAR-NAARM, Hyderabad	22- 26 July, 2024
SS Changan	IP Awareness Training program under National Intellectual Property Awareness Mission	Virtual	Intellectual Property Office, India	18 October, 2024
JH Kadam	Farmers Workshop on Turmeric	ZP, Satara	SDAO, Satara	13 December, 2024
PS Hanjagi, SM Awaji	One-day training program by the Technical Experts/Scientists of LI-COR INC., USA on use of LI-COR Products and equipment.	Hotel Ibis, Pune	DTPL Enviro Tech Solutions (OPC) Pvt. Ltd.	24 July, 2024

PS Hanjagi,	As Session Speaker, Delivered talk in the National Conference of Plant Physiology - 2024 on "Frontiers in cell to whole plant physiology: bridging science and sustainability"	ICAR-CPCRI Kasaragod, Kerala	Indian Society for Plant Physiology, New Delhi & ICAR-CPCRI	17-19 December, 2024
RN Singh	National Seminar on Smart Technologies for Sustainable Agriculture and Environment	ICAR-CRIDA, Hyderabad	ISAP, New Delhi & ICAR-CRIDA, Hyderabad	22-23 February, 2024
SS Pawar	Five days Online Training Programme on Bioinformatics Advances in Genomics Data Analysis	Online	ICAR-IASRI, New Delhi	24-28 June, 2024
KM Boraiah	National Youth Convention on "New Perspectives for Sustainable Agriculture and Livelihood Security	Online	Institute of Agricultural Sciences, BHU, Varanasi	22-23 August, 2024
KM Boraiah	International Conference on Current Innovations and Technological Advances in Agriculture &Allied Sciences	Online	GKU, Bathinda, Punjab	
KM Boraiah	International Conference on "Contemporary Perspectives in Strategies for Conservation of Biodiversity and Realizing Sustainable Development Goals	Online	Pithapur Rajah's Government College, Kakinada	04-05 July, 2024
KM Boraiah	International Conference "Environmental Sustainability, Green Technologies, Innovations and Start-up Ventures on and beyond Earth"	Online	Dr Harisingh Gour Vishwa - vidyalaya, MP	12-13 September, 2024
KM Boraiah	Organised and participated State Level Workshop (SLW) on "Commercial Dragon Fruit Farming"	SILLC, Pune	ICAR-NIASM, with SILLC, Agrowon, and Sakal Media Group	17 March, 2024
SS Changan	A short course training on "Advances in applications of nanotechnology"	ICAR-CIRCOT, Mumbai	ICAR-CIRCOT, Mumbai	29 January to 08 February, 2024
SS Changan	Hands-on Training on "Genome-Editing Technologies in Crops"	ICAR-IIRR, Hyderabad	ICAR-IIRR, Hyderabad	14-23 October, 2024
SS Changan	International Workshop-cum-Webinar on "CRISPR Genome Editing"	Virtual	Glostem, Chandigarh	22-26 July, 2024
SS Changan	राजभाषा हिंदी कार्यशाला	NCL, Pune	नरकास (का-२)	23 April, 2024
Aliza Pradhan	International conference on "Sustainability: challenges and opportunities in global sugar industry"	VSI, Pune	VSI, Pune	12-14 January, 2024
Aliza Pradhan	Training on "Current methodologies for water footprint estimation and techniques for water saving"	Online	ICAR-IIWM, Bhubaneshwar	18-20 March, 2024
Aliza Pradhan	5th Global Food Security Conference towards equitable, sustainable and resilient food systems	Leuven, Belgium	Elsevier, Ku Leuven and Wageningen University & Research	09-12 April, 2024
DD Nangare Ravi Kumar	Mega Exhibition 'Shining Maharashtra 2024'	Phaltan	SANSA Foundation, New Delhi	19-21 February, 2024
DD Nangare	52nd meeting of Joint AGRESCO	Dr PDKV, Akola	Dr PDKV, Akola	07-09 June, 2024

DD Nangare	One-day Seminar on 'Use of drip irrigation for increasing area and maximizing production of sugarcane in drought hit conditions with limited/ minimum water resources	DSTA, Pune	DSTA, Pune	20 April, 2024
DD Nangare BB Gaikwad	One day workshop on 'Soil and water management challenges in Western Ghats region	Agriculture College, Pune	Ohio State University & MPKV, Rahuri	24 October, 2024
DD Nangare, KK Pal, Paritosh Kumar, Nobin Chanra Paul, P Deshpande	Kisan Samman Diwas and exhibition	ATARI, Pune	ATARI, Pune	23 December, 2024
DD Nangare, GC Wakchaure	58th ISAE Annual Convention and International Symposium on 'Agricultural Engineering Education for Aspiring Youth in Transforming Agriculture	VNMKV, Parbhani,	ISAE New Delhi, and VNMKV Parbhani	12-14 November, 2024
HM Halli	National Seminar on "Integrating Biochar Production, Carbon Sequestration and Carbon Trading for Carbon Neutral Farming	UAS Dharwad, Karnataka	Dr SV Patil Foundation & UAS, Dharwad,	05-06 December, 2024
Harisha CB	3rd Indian Horticulture Summit-Cum International seminar	Regional Agriculture Research Institute Jaipur	Society for Horticulture Research and Development, Ghaziabad and RARI, Jaipur	01-03 February, 2024
KK Pal, R Dey VN Salunkhe Aliza Pradhan Basavaraj PS	National Conference on "Novel Strategies for Mitigating Biotic and Abiotic Stresses for Agricultural and Environmental Sustainability"	ICAR-NIBSM, Raipur	ICAR-NIBSM; ICAR-NIASM & Amity University, Raipur	28-29 February, 2024
KK Pal	National Conference on "Expanding the Horizons of Microbial Research in Agriculture"	NBAIM, Mau	ICAR-NBAIM and ACMA	10-11 June, 2024
R Dey	Training Programme on "Enhancing Pedagogical Competencies for Agricultural Education"	NAAS, New Delhi	NAAS, New Delhi	29 January to 02 February, 2024
R Dey, SM Awaji, KK Pal, VD Kakade, PS Hanjagi, SB Chavan	"IP Awareness Week Programme"	Online	Intellectual Property and Technology Management unit, ICAR	20-26 June, 2024
R Dey	iGoT Training Programme 'Yoga Break at Workplace'	Online	Morarji Desai National Institute of Yoga	23 December, 2024
Basavaraj PS	International Conference On " Modernized Technologies for Climate Change in Agriculture	Virtual	Mother Terasa College of Agriculture, Pudukkottai, TN	21 May, 2024
SB Chavan HM Halli AS Morade DD Nangare PS Khapte SS Changan NC Paul K. Ravi Kumar VD Kakade	Global Soils Conference 2024, Caring Soils Beyond Food Security: Climate Change Mitigation & Ecosystem Services	NASC, New Delhi	Indian Society of Soil Science, New Delhi; International Union of Soil Sciences, Italy; ICAR, New Delhi; NAAS, New Delhi	19-22 November, 2024

Awards & Recognition

- Dr Sangram B Chavan, Nominated as Member of Indian Standards on 'Sustainable Agriculture' under the Environment and Ecology Department (EED) of the Bureau of Indian Standards (BIS) on September 10, 2024.
- Dr. Sangram B. Chavan, Senior Scientist (Agroforestry) received Eminent Scientist Award-2022 from Society for Climate Change and Sustainable Environment, New Delhi on 03.01.2024 for significant work in field of Agricultural & Environment Management.
- Dr Nobin Chandra Paul, received Young Scientist Award (PACM YSA 2024) of Calcutta Statistical Association organized by University of Calcutta and CSA during December 27-30, 2024.
- Dr. Nobin Chandra Paul, received Best Oral Presentation Award for the paper entitled "Abiotic Stress Mapping using Spatially Integrated AHP-RF Approach Coupled with CLHS-based Validation" in the 74th Annual Conference of Indian Society of Agricultural Statistics on "Harnessing Statistics and Artificial Intelligence for Sustainable and Smart Agriculture" organized by Department of Agricultural Statistics, N.M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat on 02-04 February, 2024.
- Dr. Sushil S. Changan received Certificate of Excellence in Reviewing for an outstanding contribution to the quality of the Journal of Global Ecology and Environment on 29th November 2024.
- Dr. Sushil S. Changan recognized as Resource Person for National conference on "Current Advances and Opportunities in Agricultural Biotechnology" held on 4-5 October, 2024 at College of Agricultural Biotechnology, Loni, Ahmednagar (MH).
- Dr Sushil S Changan secured first position in Hindi Essay Competition during Hindi Pakhwada 2025 form 24 September to 2 October, 2024.
- Dr Sushil S Changan secured first position in Hindi Typewriting during Hindi Pakhwada 2025 form 24 September to 2 October, 2024.
- Dr Sushil S Changan secured first position in Hindi Extempore during Hindi Pakhwada 2025 form 24 September to 2 October, 2024.
- Dr. Prashantkumar. S. Hanjagi elected as Councillor (West zone) of Association of Rice Research Workers, ICAR-NRRI, Cuttack for the Triennial term (January 2025- December 2028).

- Dr. Harisha CB was awarded the Best poster award for an article entitled "Stress indices and photosystem II revealed the deficit moisture stress tolerant genotypes of fennel." In 3rd Indian Horticulture Summit-Cum International Conference-2024 held at RARI, Durgapura, Jaipur during 1-3 February 2024.
- Dr. Harisha CB was awarded the "Best popular articles award" during 16th Foundation of ICAR-NIASM, Baramati on 21st February 2024.
- Dr. Prashantkumar. S. Hanjagi recognised as distinguished resource person at the ICAR Sponsored Winter School on "Phenotyping Horticultural Crops for Abiotic Stress Tolerance to Enhance Resilience Under Climate Change", at ICAR-IIHR, Bengaluru during 1st to 21st February 2024, delivered a lecture on topic titled "Harvesting Insights: Advanced Phenotyping applications for Horticultural Crops with Innovative Sensor Technologies" on 15th February.
- Dr. RN Singh, received IARI Merit Medal for best PhD Thesis at 62nd Convocation of The Graduate School, ICAR - Indian Agricultural Research Institute, New Delhi .on 9th February, 2024.
- Dr. RN Singh, received KN Synghal Gold medal for best PhD Thesis in NRM division at 62nd Convocation of The Graduate School, ICAR - Indian Agricultural Research Institute, New Delhi on 9th February, 2024.
- Dr. RN Singh, received PD Mistry Award for Best PhD thesis in Agricultural Meteorology by Association of Agrometeorologists, Anand, Gujarat. on 10th February, 2024
- Dr. RN Singh, received SS Ray Best Doctoral Thesis award of Indian Society of Agrophysics (ISAP), New Delhi at National conference at ICAR-CRIDA, Hyderabad during 22–23 February 2024.
- Dr. Boraiah KM received best oral presentation for research work entitled "Advancing Chia Varieties: The Role of Mutation Breeding in Enhancing Genetic Variability" during International Conference on Current Innovations and Technological Advances in Agriculture and Allied Sciences (29-31 Aug, 2024) GKU, Bathinda, Punjab (Online).
- Dr. Basavaraj PS, received Best oral presentation at 2nd International Conference On "Modernized Technologies for Climate Change in Agriculture" organised by Mother Terasa College of Agriculture, Pudukkottai, Tamil Nadu on 26 April, 2024.
- Dr. Sushil S. Changan received High Rated Publication Award from the ICAR-NIASM on the occasion of 16th Foundation Day of ICAR-NIASM on 21st February 2024.
- Dr. Sushil S. Changan nominated as rapporteur in Technical Session I on Mitigating Abiotic Stress in Agriculture: Promising Technologies during ICAR-NIASM-KVK Interface Meeting held on 21st February 2024 at ICAR-NIASM, Baramati (MH).
- Dr. Sushil S. Changan recognized top performer trainee award during a ICAR short course training on "Advances in applications of nanotechnology" held during 29th Jan- 08 Feb, 2024 at ICAR-Central Institute for Research on Cotton Technology, Mumbai.
- Dr. Aliza Pradhan received SERB financial grant for conducting high-end Karyshala on "Advanced Instrumentation in abiotic stress assessment, monitoring and management for sustainable agriculture" from 11-20 March, 2024 at ICAR-NIASM.
- Dr. Aliza Pradhan received DST SERB ITS travel grant and Indian National Science

Academy (INSA) travel grant for attending 5th Global Food security Conference from 9-12 April, 2024 at Belgium.

- Dr. Aliza Pradhan secured first position in Hindi Extempore during Hindi Pakhwada 2025 form 24 September to 2 October, 2024.
- Dr. Aliza Pradhan secured first position in the Essay writing competition organised during Vigilance Awareness Week from October 28 to November 3, 2024 at ICAR-NIASM.
- ICAR-NIASM received Best Exhibition stall in Mega Exhibition 'Shining Maharashtra 2024' held at Phaltan 19.02.2024 -21.02.2024
- Dr. DD Nangare and Dr SA Kochewad were nominated for evaluation of four KVKs in Gujarat State (KVK, Mehsana, KVK, Patan, KVK Deesa, KVK Tharad) by ICAR-ATARI Pune during 29 September to 04 April, 2024.
- Dr. DD Nangare recognised as external expert as subject matter specialist for selection of Assistant Professor in Agricultural Engineering at Dr Sharadchandra Pawar College of Agriculture Baramati on 4.7.2024
- Dr Neeraj Kumar awarded as Member of National Academy of Sciences India (NASI) at NASI, Prayagraj, India during July 2024.
- Dr Neeraj Kumar awarded as Fellow, Bihar Agriculture Science Academy (BASA) at Central Agriculture University, Bihar during October 2024.
- Dr. Goraksha Wakchaure received certificate of technology titled "Trenching and Transforming Filled in Soil Technology" presented during the 96th Foundation Day of ICAR on July 16, 2024 by the Chief Guest, the Hon'ble Union Minister of Agriculture, Shri Shivraj Singh Chouhan, at the NASC Complex, New Delhi.
- Dr. Goraksha Wakchaure recognised as rapporteur of the oral session on 'Automation and Application of AI, IoT, and ML in land and water management (LWM)' during the 58th ISAE Annual Convention and International Symposium jointly organized by Indian Society of Agricultural Engineers, New Delhi and Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani held on 12–14th November 2024 at VNMKV, Parbhani, Maharashtra.
- Dr SA Kochewad, received best poster presentation award in 8th National Youth Convention on New Perspectives for Sustainable Agriculture and Livelihood Security' held at Banaras Hindu University, Varanasi during August 22-23, 2024. for research paper entitled "Climate resilient integrated farming system model for improving farmer livelihoods in semi-arid regions"
- Dr SA Kochewad, received best oral presentation award in IXth International Conference in Hybrid Mode on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2024) during December 10-12, 2024 for research paper entitled "Effect of Feeding Sugarcane Trash-Based Complete Feed on Growth Performance, Haematological, Biochemical Parameters and Growth Hormone Gene Expression in Osmanabadi Goat Kids".
- Dr. HM 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).

- Dr. HM Halli received highest rated publication award during 16th Foundation day of ICAR-NIASM Baramati on 21st February 2024.
- Dr. HM Halli recognised as Associate editor of the Natural Resources Management section for the Range Management and Agro-forestry Journal since 17 January, 2024.
- Dr. HM Halli participated in the Research Review Committee (RRC) meeting 2023-24 and Research Planning meeting 2024-25 of Department of Agronomy, MPKV Rahuri, Maharashtra as an expert member on 5-7th March 2024.
- Dr. HM Halli delivered a invited lead lecture on "Restoration of degraded lands with fruit-based systems to achieve carbon neutrality and land productivity in Semi-Arid conditions" during National Seminar on "Integrating Biochar Production, Carbon Sequestration and Carbon Trading for Carbon Neutral Farming at UAS Dharwad, Karnataka on 6th December, 2024.
- Dr. KK Pal received certificate of technology titled "SalGuard: A formulation of endophytes is a saviour of cultivation of groundnut in salt affected areas", presented during the 96th Foundation Day of ICAR on July 16, 2024 by the Chief Guest, the Hon'ble Union Minister of Agriculture, Shri Shivraj Singh Chouhan, at the NASC Complex, New Delhi.

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

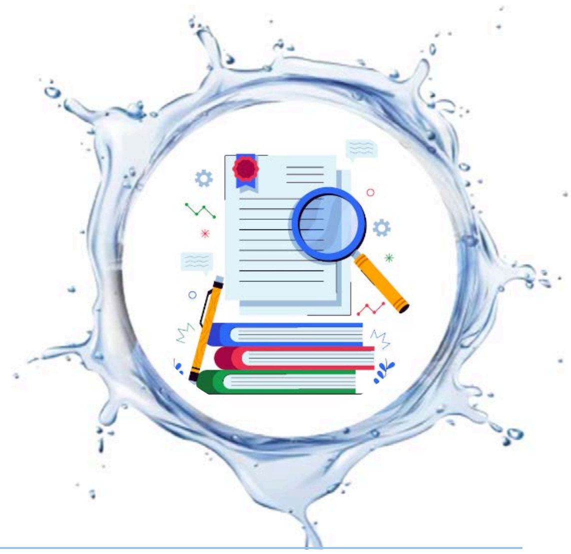
Alliance Bioversity & CIAT, New Delhi

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 Papers

1. Balusamy A, Ramesh T, Moirangthem P, Taland HD, Chanu LJ, Gopalakrishnan B, Islam M, Hazarika S, Kandpal BK, Choudhury BU (2024) Indigenous wisdom for sustainable mountain agriculture in the eastern Himalayas. Indian Journal of Soil Conservation. 52(1): 46-57. DOI:10.59797/ijsc.v52.i1. 149
2. Basavaraj PS, Jangid KK, Babar R, Gangana Gowdra VM, Gangurde A, Shinde S, Tripathi K, Patil D, Boraiah KM, Rane J, Harisha CB, Halli HM, Reddy KS, Prabhakar M (2024) Adventitious root formation confers waterlogging tolerance in cowpea (*Vigna unguiculata* (L.) Walp.). Frontiers in Sustainable Food Systems. 8: 1373183. DOI:10.3389/fsufs. 2024.1373183
3. Basavaraj PS, Jangid KK, Babar R, Rane J, Boraiah KM, Harisha CB, Halli HM, Pradhan A, Reddy KS (2024). Genetic variation in deficit moisture stress tolerance of Cicer accessions revealed by chlorophyll fluorescence. Genetic Resources and Crop Evolution. 71: 4723–4737. DOI:10.1007/s10722-024-01937-0
4. Basavaraj PS, Jangid KK, Babar R, Rane J, Boraiah KM, Harisha CB, Halli HM, Pradhan A, Tripathi K, Reddy KS, Prabhakar M (2024) Non-invasive measurements to identify mungbean genotypes for waterlogging tolerance. PeerJ. 12: e16872. DOI:10.7717/peerj. 16872
5. Bisht H, Shaloo, Kumar B, Rajput J, Singh DK, Vishnoi L, Singh RN, Tamta M, Gautam S (2024) Impacts of climate change on phenology, yield, and water productivity of wheat in a semi-arid region of India using the CERES-Wheat model. Journal of Water and Climate Change. 15(10): 5089–5106. DOI:10.216 6/wcc.2024.139
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Technical Bulletins

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Patent Granted

1. Indian Patent No. 514390, Singulation and pickup mechanism for bare root seedlings of onion, cuttings and the like. Inventors: Ajit Magar and Bhaskar Gaikwad

Software Packages

1. Kumar N and Paul NC (2024) SoilSaltIndex: Soil salinity indices generation using satellite data. R package version 0.1.0, https://cran.r-project.org/package=SoilSaltIndex
2. Kumar N, Paul NC, Reddy GPO (2024) CLimd: Generating Rainfall Rasters from IMD NetCDF Data. R package version 0.1.0, https://cran.r-project.org/package=CLimd
3. Singh G, Moharana PC, Kakade V, Jinger D, Singh AK, Raj Kumar, Kar SK, Bhatnagar PR, Kumar G, Rao BK, Madhu M, Tailor BL (2024) Ravine vulnerability index-based identification of potential reclamation zones for western India (ICAR-NRM-IISWC-Protocol-2024-103)
4. Uthappa, AR and Chavan SB developed android based application “Wood Baazar” provides information about various wood-based industries and market available in India. https://play.google.com/store/apps/details?id=icar.ccari.twood&hl=en_IN

Ongoing Projects

Umbrella Projects

Sr. No.	Project Name and Code	PI	Co-PI
1.	Abiotic Stress Information System (ASIS): Geo-spatial digital maps of multiple abiotic stresses, management options and future scenarios (IXX15659)	BB Gaikwad	DD Nangare, NP Kurade, SS Pawar, Gopalakrishnan B, RN Singh, NC Paul
2.	Germplasm Conservation and Management (GCM): Genetic Garden and gene bank for abiotic stress tolerant plants, animals and fisheries for food security and sustainability (IXX15674)	KM Boraiah	AK Singh, Basavaraj PS, Rajkumar, Karthikeyan N, Paritosh Kumar, SA Kochewad, MP Bhendarkar, Harisha CB, PS Khapte, VD Kakade, Neeraj K, H M Halli, Gurumurthy S, Bhojaraja Naik K, Santosh HB, PB Taware, Aniket More, Rushikesh Gophane, Lalitkumar Aher
3.	Model Green Farm (MGF): Environment-friendly, economically viable, state-of the-art model farm for abiotic stressed regions (IXX15700)	DD Nangare	Rinku Dey, GC Wakchaure, BB Gaikwad, Vanita Salunkhe, Rajkumar, Paritosh Kumar, Aliza Pradhan, SS Changan, MP Bhendarkar, AS Morade, SB Chavan, VD Kakade, PS Khapte, HM Halli, V Rajagopal, PB Taware, Rushikesh Gophane, Noshin Shaikh, Santosh Pawar, AV Nirmale
4.	Climate-smart IFS (CIFS): Climate resilient integrated farming system in semi-arid region (IXX15697)	SA Kochewad	GC Wakchaure, Vanita Salunkhe, Rajkumar, Aliza Pradhan, SB Chavan, VD Kakade, V Rajagopal, H M Halli, Neeraj Kumar, Gopalakrishnan B, Ravi Kumar, N Subash (IARI), Laxman Meena (ICAR-IIFSR), PB Taware, P Chahande

Flagship Projects

Sr. No.	Project Name and Code	PI	Co-PI
1.	Adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability (IXX15676)	NP Kurade	SS Pawar, BB Gaikwad, SA Kochewad, Gopalkrishnan B, Rajkumar, MP Bhendarkar, RN Singh, DD Nangare, AV Nirmale, SV Potekar

Sr. No.	Project Name and Code	PI	Co-PI
2.	New Crops: Exploiting under-utilized crops (ex. Quinoa) for augmenting income in water scarce regions (IXX15656)	Aliza Pradhan	AK Singh, KK Pal, Rinku Dey, DD Nangare, GC Wakchaure, Karthikeyan N, Boraiah KM, SA Kochewad, RN Singh, Basavaraj PS, Harisha CB, HM Halli, Paritosh Kumar, Neeraj Kumar, SS Changan, H B Santhosh, B Naik, PH Kuchanur
3.	Bio-saline Agriculture: Exploitation of halophytic plant and associated microbiome for amelioration of saline agricultural land of arid & semiarid regions (IXX15657)	AK Singh	Vanita Salunkhe, SA Kochewad, Paritosh Kumar, Neeraj Kumar, Amresh Chaudhary, Karthikeyan N, Ahmmad Shabeer
4.	Targeting prospective technologies for abiotic stress resilience in rainfed and dryland region (IXX15699)	Ravi Kumar	DD Nangare, SS Pawar, BB Gaikwad, SA Kochewad, Rajkumar, Boraiah KM, Karthikeyan N, MP Bhendarkar, NC Paul, Navyasree Ponnaganti

In-House Projects

Sr. No.	Project Name and Code	PI	Co-PI
1.	Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics (IXX14228)	Paritosh Kumar	Neeraj Kumar CB Harisha
2.	Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressors (IXX15014)	Neeraj Kumar	AK Singh
3.	Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)	Neeraj Kumar	Paritosh Kumar
4.	Mitigating water stress effects in vegetable and orchard crops (IXX16553)	GC Wakchaure	DD Nangare, Aliza Pradhan, KM Boraiah, PS Khapte
5.	Genomics, genetic and molecular approaches to improve water stress tolerance in soybean and wheat (IXX15660)	AK Singh	
6.	Climate resilient agriculture practices for enhancing food grain production from low soil available water storage capacity areas of Deccan Plateau region (IXX20120)	V Rajagopal	KS Reddy, BB Gaikwad, Aliza Pradhan and NC Paul
7.	Assessing the host-sandalwood interactions under abiotic stressed environment for adaptability & income generation	SB Chavan	VD Kakade, CB Harisha, SS Changan, AS Morade
8.	Marginal quality water remediation by integrated constructed wetland and aquaponics (IXX19881)	Paritosh Kumar	CB Harisha, Neeraj Kumar
9.	Exploring morpho-physiological, biochemical, and molecular traits in onion and its wild relatives for	Vanita Salunkhe	PS Khapte, SS Changan, Pranjali Gedam (ICAR-DOGR)

Sr. No.	Project Name and Code	PI	Co-PI
	tolerance to combined waterlogging and anthracnose (IXX20122)		
10.	Pilot study on multiple abiotic stress mapping for Western Maharashtra (IXX20117)	BB Gaikwad	KS Reddy, RN Singh, Sonam, V Rajagopal, and NC Paul
11.	Salinity and drought tolerance studies in Mango (*Mangifera indica* L.) (IXX20121)	AS Morade	VD Kakade, KM Boraiah, S Changan, SB Chavan and Neeraj Kumar
12.	Climate variability, teleconnections and their impact on selected crops of India (IXX20119)	RN Singh	Sonam, AK Singh, KS Reddy
13.	Quantifying the extent of water stressed soybean and cotton area in relation to meteorological variables in Vidarbha region using remote sensing	Sonam	RN Singh, KK Pal, KS Reddy, Bappa Das
14.	Conversion of Sugarcane crop residue into Bio-engineered pellet/cake for alleviation of multiple edaphic stresses of semiarid tropics	Paritosh Kumar	CB Harisha, Neeraj Kumar
15.	Studies on synthesis of cerium nanoparticles and evaluation of its potential to alleviate water deficit stress in soybean	SS Changan	PS Khapte, KK Pal, Neeraj Kumar
16.	Identification of potential rootstocks for tomato grafting to alleviate water stress	PS Khapte	SS Changan, PS Basvaraj, SM Awaji, Vanita Salunkhe, GC Wakchaure, KK Pal
17.	Development of bacterial consortia for alleviation of drought- and salinity- stress, and enhancing nutrient availability and uptake in Soybean and Sugarcane	Rinku Dey	KK Pal, N Karthikeyan, V Rajagopal
18.	Heat stress response studies in Indigenous Goats through functional genomics using transcriptomics approach	SS Pawar	NP Kurade, AK Singh, AV Nirmale
19.	Physio-biochemical, Molecular Studies and Generation Turnover in Chickpea, Common bean and Black gram under Combined Heat and Moisture Deficit Stress	S Gurumurthy	SM Awaji, SS Changan, PS Hanjagi, AK Singh,
20.	Evaluation and identification of novel Pigeon pea genotypes for water and temperature stress tolerance and deciphering the underlying mechanism through omics approaches	PS Hanjagi	AK Singh, SM Awaji, BB Gaikwad, S Gurumurthy
21.	Development of Integrated Drought Index and Stress Mapping for Selected Drought-Prone Areas of Western Maharashtra	NC Paul	P Navyashree, BB Gaikwad, RN Singh, DD Nangare
22.	Quantifying drought and salinity induced crop yield losses and crafting policy framework in	P Navyasree	NC Paul, K Ravi Kumar, DD Nangare, HM Halli, PS Khapte

Sr. No.	Project Name and Code	PI	Co-PI
	selected drought-prone areas of Western Maharashtra		
23.	Exploiting CAM-photosynthetic transition for imparting multiple abiotic stress tolerance in Pulses and Oilseeds	KK Pal	Rinku Dey, KM Boraiah, PS Basavaraj, PS Hanjagi, SS Changan, KS Reddy
24.	Standardization of irrigation and moisture conservation practices on higher productivity and quality of geranium in shallow basaltic soil	CB Harisha	HM Halli

Externally Aided Projects

Sr. No.	Project Name and Code	PI	Co-PI
1	Agri Drone Project (OXX5501: Central Sector Scheme, Ministry of Agriculture and Farmers Welfare, GOI)	BB Gaikwad	SN Potekar, SB Chavan, NP Kurade, SS Pawar, VD Kakade, PS Khapte, VN Salunkhe, HM Halli, V Rajagopal, N Karthikeyan, B Gopalakrishnan, Rajkumar, Ravi Kumar K
2	Atlas of Climate Adaptation in South Asian Agriculture (ACASA): Interconnections between climate risks, practices, technologies and policies (OXX7240)	B Gopalakrishnan	
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) (LBS)	Neeraj Kumar	
4	Molecular characterization and identification of gene involved in the multiple stresses: Nanomaterial for mitigation (OXX5467), Funded by DST-SERB	Neeraj Kumar	
5	Establishment of model herbal garden for medicinal and aromatic plants (OXX4927) (NMPB, New Delhi)	CB Harisha	Nangare DD
6	Development of effective mass propagation technique for rapid multiplication and easy transportation of quality planting material in Bajra X Napier hybrid. Funded by: Department of Animal Husbandry & Dairying under National Livestock Mission.	HM Halli	PS Basavaraj, SB Chavan, KS Reddy
7	Conservation Agriculture for Enhancing Resource-use Efficiency, Environmental Quality and Productivity of	GC Wakchaure	Aliza Pradhan, KS Reddy, Paritosh Kumar

Sr. No.	Project Name and Code	PI	Co-PI
	Sugarcane Cropping System (OXX03355): Funded by ICAR-Consortia Research on CA Platform (CRP-CA)		
8	Phenotyping of pulses for enhanced tolerance to drought and heat. (OXX01737) (NICRA)	PS Basavaraj	Aliza Pradhan, KM Boraiah, RN Singh, KS Reddy
9	Alleviation of drought- and salinity- stress in groundnut by habitat adapted endophytic bacteria (OXX202401)	KK Pal	Rinku Dey
10	Genome Editing for improvement of abiotic stress tolerance in soybean through targeted knockout of negative regulators (24/S/IFX/202403)	AK Singh	SM Awaji, KM Boraiah, PS Basavaraj, PS Khapte, SS Changan, Aliza Pradhan, GC Wakchaure, KS Reddy
11	Appraisal of nutrient management systems influence on soil quality and resilience under rice cultivation at different landscape positions	V Rajagopal	SB Chavan, HM Halli, KK Pal, KS Reddy
12	N-(n-butyl) Thiophosphoric Triamide (NBPT) as a Urease inhibitor for improving nitrogen use efficiency in sugarcane cropping systems in India (OXX4926)	Aliza Pradhan	PB Taware, K Sammi Reddy
13	Development of Climate Resilient CHARA Bank (Fodder system) for round-the-year fodder availability for livestock in drought-prone regions	SB Chavan	BB Gaikwad, HM Halli, Dr VD Kakade, AS Morade, K Ravi Kumar NP Kurade, SS Pawar, SA Kochewad, AV Nirmale, K Sammi Reddy

Consultancy/Contract Projects

Sr. No.	Project Name and Code	PI	Co-PI
1	Development of Agroforestry Business Models for long term sustainability	SB Chavan	KS Reddy, VD Kakade, AS Morade, K Ravi Kumar, Vanita Salunkhe
2	Enhancing Soil Moisture Retention in Tomato Cultivation through Rovensa Products: A Field Study	VD Kakade	AS Morade, PS Khapte, CB Harisha, Aliza Pradhan, DD Nangare, SB Chavan, KS Reddy
3	Evaluation of Ambronics pot in alleviating drought stress in tomato (OXX20242)	AS Morade	VD Kakade, PS Khapte, SB Chavan, DD Nangare, KS Reddy
4	Investigating the impact of varying nutrient composition on morphometric, physiological and yield traits in Potato. (24/S/CPJ/OXX6276)	PS Khapte	SS Changan, BB Gaikwad, K Sammi Reddy

Sr. No.	Project Name and Code	PI	Co-PI
5	Bio-efficacy studies of protein hydrolysate-based biostimulant on cotton, soybean, acid lime, chilli, maize and chickpea crops under drought stress condition (OXX5515: Funded by Ashwathy Green Enterprise Pvt. Ltd)	Gurumurthy S	N Karthikeyan, Mahesh Kumar, Pravin Taware, Aliza Pradhan, PS Khapte, VD Kakade, Jagadish Rane, Himanshu Pathak
6	Efficacy of bio-stimulants in alleviating drought stress in tomato (Solanum lycopersicum L.) (OXX5500: Funded by Yara Fertilizers India Pvt. Ltd.)	PS Khapte	Jagadish Rane
7	Assessing feed alternatives modulating enteric methane emission in cattle using metagenomics approach (24/CIN/CPJ/00158: Funded by Baramati Cattlefeeds Pvt. Ltd.)	SS Pawar	NP Kurade, SA Kochewad, AV Nirmale

Meetings

14th Institute Research Council meeting (IRC)

The 14th IRC meeting of ICAR-NIASM was held on June 6–8 and 19–20, 2024, chaired by the Director. He highlighted the institute's achievements in managing abiotic stress in crops, animals, and fish, and stressed the need to tackle multiple stresses due to climate change. Director urged scientists to seek external funding from agencies like the ICAR corpus fund, DST, and DBT. School heads and project investigators presented their research, followed by in-depth discussions. The Director emphasized the importance of quality research, technology development, and impactful publications. Meeting recommendations were recorded in the proceedings..

12th Research Advisory Committee (RAC) Meeting

The 12th RAC Meeting was held on 24–25 September 2024 and commenced with the introduction of the Chairman and members by Dr. K. Sammi Reddy, Director, ICAR-NIASM. The meeting was chaired by Dr. V. Praveen Rao, Former Vice-Chancellor, PJTSAU, Hyderabad, and attended by members Dr. S.M.K. Naqvi, Former Director, ICAR-CSWRI, Avikanagar; Dr. A.K. Pal, Former Joint Director, ICAR-CIFE, Mumbai; Dr. M.N. Jha, Former Dean, BAU, Pusa; 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; and Member Secretary Dr. K.K. Pal, Head, SDSM, ICAR-NIASM, Baramati. Key discussions focused on mechanisms of abiotic stress tolerance, development of nature-positive and natural farming solutions, use of emerging technologies (AI, ML, IoT, drones) for stress management, adaptation studies in livestock and poultry through local resources, and endocrine disruption in fish related to water pollution, temperature variations, and inland saline aquaculture. The committee also visited experimental plots and offered valuable suggestions for improvement.

13th Institute Management Committee (IMC) Meeting

The 13th IMC meeting was held on May 22, 2024, at ICAR-NIASM, Baramati, chaired by Dr. K. Sammi Reddy, Director, ICAR-NIASM. Members present included Dr. P.R. Yadav (ICAR HQ, New Delhi), Dr. K.P. Mote (Govt. of Maharashtra, Pune), Dr. S.K. Behra (ICAR-IISS, Bhopal), Dr. N.P. Kurade (ICAR-NIASM), Dr. K. Ramesh (ICAR-IIOR, Hyderabad), Dr. J.V.N.S. Prasad (ICAR-CRIDA, Hyderabad), Shri Aniruddha Vasant Pujari (Progressive Farmer, Solapur), and Member Secretary Shri Charles Ekka (CAO, ICAR-NIASM). The meeting was conducted in hybrid mode. Dr. Reddy welcomed members and provided an overview of NIASM's scientific progress and ongoing activities. Key agendas included research highlights, confirmation and review of the 12th IMC proceedings, replacement of biosafety cabinet, IR imaging system, and spray dryer, purchase of a utility vehicle (ambulance) for students, staff position as of 01.05.2024, fund utilization up to 31.03.2024, and a statement on pending advances with government bodies (01.01.2023 to 31.03.2024). The meeting concluded with a vote of thanks to the Chairman and members.

14th Institute Management Committee (IMC) Meeting

The 14th IMC meeting was held on October 28, 2024, at ICAR-NIASM, Baramati. The meeting was chaired by Dr. K Sammi Reddy, Director, ICAR-NIASM, and Members, Dr. PG Patil, Vice-chancellor, Mahatma Phule Krishi Vidyapeeth, Rahuri, 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. Aniruddha Vasant Pujari, Progressive Farmer, Pujari Farm, 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 13th IMC meeting, review of action taken report on the proceedings of previous 13th IMC meeting, condemnation and procurement of four wheeler vehicle of the office and proposal for procurement of one utility vehicle, utilization of fund for the period ending 31st March 2024 and current financial year upto 30th September 2024, staff position as on 28.10.2024 and statement of pending advances with government departments and other bodies from 01.01.2024 to 31.03.2024 were discussed. The meeting was concluded with a vote of thanks to the chairman and members.

राजभाषा अनुभाग

हिन्दी कार्यशाला का आयोजन

राजभाषा कार्यान्वयन समिति के अध्यक्ष एवं राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान के निदेशक डॉ के सम्मि रेड्डी के मार्गदर्शन में संस्थान में हिन्दी भाषा के रुझान हेतु इस वर्ष कुल चार हिन्दी कार्यशालाओंका आयोजन किया गया। मार्च १४, २०२४ को हुए प्रथम कार्यशाला में सभी कम्प्युटर पर हिन्दी यूनिकोड का अनावरण एवं कार्यान्वयन निश्चित किया गया। संस्थान के तकनीकी अधिकारी श्री। प्रवीण मोरे जी ने ई-ऑफिस में हिन्दी के प्रयोग पर आसान तरीकों का उपस्थित ३५ कर्मचारियों को प्रशिक्षण दिया। द्वितीय कार्यशाला का आयोजन जून २१, २०२४ को अंतरराष्ट्रीय योग दिवस के अवसर पर किया गया। इसमें कुल ५८ कर्मचारी उपस्थित रहे और संस्थान के सहायक मुख्य तकनीकी अधिकारी डॉ प्रवीण तावरे जी ने 'सम्पूर्ण स्वास्थ्य के लिए योग' इस विषय पर मार्गदर्शन किया। सितंबर १९, २०२४ को आयोजित तृतीय कार्यशाला में उपस्थित २७ कर्मचारियों को संस्थान के प्रशासनिक अधिकारी श्री दिनेश टेकवानी जी ने हिन्दी टिप्पण लेखन के बारे में प्रशिक्षण दिया। दिसंबर ११ और १२, २०२४ को आयोजित चतुर्थ कार्यशाला में संस्थान के सभी कर्मचारियों को ई-एचआरएमएस के प्रयोग के बारे में अवगत किया गया। संस्थान के प्रशासनिक अधिकारी श्री जुनैद पठान जी ने कुल ५६ कर्मचारियों को प्रशिक्षित करते हुए अवकाश आवेदन प्रणाली के बारे में जानकारी प्रदान की।

हिन्दी टिप्पण लेखन कार्यशाला

राजभाषा निरीक्षण समिति बैठक

राजभाषा विभाग, गृह मंत्रालय द्वारा वार्षिक कार्यक्रम के अंतर्गत निर्धारित लक्ष्य के अनुसार प्रत्येक मंत्रालय/विभाग द्वारा अपने अधीनस्थ कार्यालय का निरीक्षण किया जाता है। फरवरी १३, २०२४ को राजभाषा कार्यान्वयन समिति के अध्यक्ष एवं राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान के निदेशक महोदय डॉ के सम्मि रेड्डी, निरीक्षण अधिकारी श्री मोहिंदर कुमार, परामर्शदाता, महानिदेशक, भारतीय कृषि अनुसंधान परिषद, श्री राम दयाल शर्मा, संयुक्त उपनिदेशक (राजभाषा) और श्री हरी ओम, प्रधान निजी सचिव, अपर सचिव एवं वित्त सलाहकार इनके उपस्थिती में राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान, बारामती, पुणे में राजभाषा निरीक्षण समिति की बैठक सम्पन्न हुई। बैठक के शुरवात में संस्थान के निदेशक महोदय ने राजभाषा संबंधित कार्य का ब्योरा प्रस्तुत किया। निरीक्षण अधिकारियों ने संस्थान में हो रही राजभाषा कार्यान्वयन संबंधित गतिविधियों का निरीक्षण किया। संस्थान के हिन्दी कार्यान्वयन संबंधित

उपलब्धियों पर निरीक्षण अधिकारियों द्वारा समाधान जताया गया और बहुमूल्य मार्गदर्शन किया गया। इस बैठक में राजभाषा कार्यान्वयन समिति के सभी सदस्य उपस्थित रहे। डॉ वनिता सालुंखे (पूर्व सदस्य सचिव, राजभाषा कार्यान्वयन समिति) ने बैठक का सूत्रसंचालन किया। डॉ प्रवीण तावरे एवं श्री त्रिलोक सैनी ने बैठक का आयोजन किया।

राजभाषा निरीक्षण समिति बैठक

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. २५ मार्च, १३ जून, १० सितंबर और ११ दिसंबर को बैठक का आयोजन किया गया। इसमें तिमाही रिपोर्ट के समीक्षण पर तथा उसमें सुधार हेतु चर्चा की गई। नगर राजभाषा कार्यान्वयन समिति, पुणे (का २) की सदस्यता प्राप्त होने के बाद संबन्धित बैठकों, कार्यशाला, प्रतियोगिता, आदि कार्यक्रमों में हमारे संस्थान की उपस्थिती अधोरेखित की गई। नगर राजभाषा कार्यान्वयन समिति (नराकास) स्तर पर २३ एप्रिल २०२४ को आयोजित कार्यशाला में संस्थान के डॉ सुशील चांगन और डॉ प्रवीण तावरे उपस्थित रहे। अप्रैल ४, २०२४ को नराकास कार्यालयों की वैज्ञानिक संगोष्ठी में डॉ के एम बोरैया ने “ड्रैगन फ्रूट की उत्पादकता बढ़ाने के लिए पूरक परागण: एक संभावित तकनीक” विषय पर अपना शोध सारांश प्रस्तुत किया। जुलाई १८, २०२४ को आयोजित हिन्दी निबंध लेखन प्रतियोगिता में तकनीति सहायक श्री अभय कुमार अवस्थी जी ने द्वितीय परितोषिक हासिल किया।

डॉ के एम बोरैया द्वारा शोध सारांश प्रस्तुति

हिन्दी पखवाड़ा समारोह

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान में १४ सितंबर से ३० सितंबर २०२४ के दौरान हिन्दी पखवाड़ा बड़े उत्साह से मनाया गया। इस बार हिन्दी पखवाड़ा मानते समय स्वच्छता विषय पर आधारित प्रतियोगिताएं तथा कार्यशाला का आयोजन किया गया। कार्यक्रम का उदघाटन निदेशक महोदय ने कराते हुए इस में पूरा सहभाग अधोरेखित किया। पखवाड़े के दौरान कई प्रतियोगिताएं आयोजित की गई जिसमें टिप्पण लेखन, टंकण, निबंध लेखन, काव्य प्रस्तुति, आशुभाषण एवं प्रश्नोत्तरी प्रतियोगिताएं आयोजित की गई। हिन्दी पखवाड़ा समापन समारोह में विजेता प्रतिभागियोंकों पुरस्कार देकर सम्मानित किया गया।

हिन्दी काव्य प्रतियोगिता

हिन्दी पखवाड़ा समापन समारोह

Major Events of 2024

Organisation of NABARD-BIRD, Lucknow Sponsored Training Programme (8th -10th Jan.)

Training cum Technology Demonstration on "Preparation of Mixed Silage of Sugarcane Tops" (11th Jan.)

Field day cum farmers scientist interaction meet with SC beneficiaries at Malad village (16th Jan.)

राजभाषा निरीक्षण समिति बैठक: (13 फरवरी)

Unveiling of Selfie Point at ICAR-NIASM (16th Feb.)

Celebration of 16th Foundation Day and ICAR-NIASM -KVK Interface Meeting (2nd Feb.)

ICAR-NIASM joins in organising National Conference at ICAR-NIBSM, Raipur (28th -29th Feb.)

Heath Checkup Camp on occasion of International Women's Day Celebrations (14th March)

High End Workshop on Advanced Instrumentation in Abiotic Stress Management (11th-20th March)

State Level Workshop (SLW) on Commercial Dragon Fruit Farming (17th March)

One-day Workshop on Management Techniques of Mahogany Agroforestry System (23rd March)

Awareness Program on Conservation Agriculture and Distribution of Household Inputs (29th March)

Meeting with TechnoServe India (16th April)

Celebration of World Environment Day (5th June)

Organisation of Blood Donation Camp (14th June)

Capacity Building Programme for Administrative Personnel of KVKs in India (19th June)

Celebration of International Day of YOGA – 2024(21st June)

Pre-Examination Training for LDCs (21st Aug.)

Tree Plantation Programme "Plant4Mother"(29th Aug.)

Training Programme for Agriculture Officers of Odisha Government (2nd -7th Nov.)

Training cum Technology Demonstration on "Mixed Silage of Sugarcane Tops" (9th Sep.)

Swachhata Hi Seva campaign(14th Sep -3rd Oct..)

Plantation Drive at ICAR-NIASM (17th Sep.)

Foundation Stone Laying of-Type-V Quarters (27th Sep.)

Inauguration of 'Sanitary Pad Machine' under DAPSC 2024-25 (9th Oct.)

Training for Agriculture Officers of Odisha Government (14th -19th Oct.)

Training on Sustainable Nutrient Management and Agroforestry for Soil Restoration(21st-22nd Oct.).

Monitoring Visit to NABARD Fodder Systems Project Area (9th Nov.)

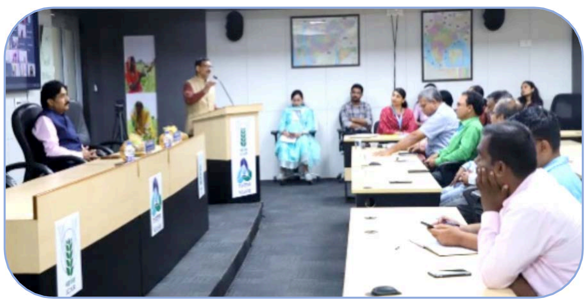
Training Programme for Agriculture Officers of Odisha Government (11th -16th Nov.)

ICAR-NIASM participated in Global Soils Conference (19th-22nd Nov., 2024)

Celebration of World Soil Day 2024 (5th Dec.)

Frontline demonstration of multifunctional ratoon drill (MRD) (13th Dec.)

ICAR-NIASM participated in exhibition at ATARI, Pune (23rd Dec.)



Swachhata Pakhwada at ICAR-NIASM (16th -31st Dec. 2024)

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 (as on 31st December 2024)

Director	
	Dr K Sammi Reddy
SCIENTIFIC STAFF	
School of Atmospheric Stress Management	
1.	Dr Ajay K Singh, Head & Principal Scientist (Agricultural Biotechnology)
2.	Dr Nitin P Kurade, Principal Scientist (Veterinary Pathology)
3.	Dr Sachinkumar S Pawar, Senior Scientist (Animal Biotechnology)
4.	Dr Bhaskar B Gaikwad, Senior Scientist (Farm Machinery and Power)
5.	Dr Sushma M Awaji, Scientist (Plant Physiology)
6.	Dr Gopalakrishnan B, Scientist (Environmental Science)
7.	Mr Rajkumar, Scientist (Agricultural Entomology)
8.	Mr Mukesh P Bhendarkar, Scientist (Fisheries Resource Mgmt.) (On study leave)
9.	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, Senior Scientist (Agricultural Structure & Process Eng.)
4.	Dr Boraiah KM, Scientist (Genetics and Plant Breeding)
5.	Dr Prashantkumar S Hanjagi, Scientist (Plant Physiology)
6.	Dr Gurumurthy S, Scientist (Plant Physiology)
7.	Dr Pratapsingh S Khapte, 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)

School of Edaphic Stress Management

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

School of Social Science and Policy Support

1. Dr Dhananjay D Nangare, I/c Head & Principal Scientist (Soil & Water Conservation Engg.)
2. Dr Sachinkumar S Pawar, Senior Scientist (Animal Biotechnology)
3. Dr Bhaskar B Gaikwad, Senior Scientist (Farm Machinery and Power)
4. Dr Sanjivkumar A Kochewad, Senior Scientist (Livestock Production Management)
5. Dr Boraiah KM, Scientist (Genetics and Plant Breeding)
6. Mr Karthikeyan N, Scientist (Agricultural Microbiology)
7. Mr Ravi Kumar, Scientist (Agricultural Extension)
8. Dr Nobin Chandra Paul, Scientist (Agricultural Statistics)
9. Ms Ponnaganti Navyasree, Scientist (Agricultural Business Management)

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.	Dr Sunil Kumar Das, Chief Finance & Accounts Officer
2.	Mr Dinesh Tekwani, Administrative 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

Joining, Transfer and Promotion of Staff

Name of the staff	Date	Previous Institute
Joinings		
Dr JH Kadam, Principal Scientist (Fruit Science)	05.09.2024	Dr BSKKV, Dapoli
Dr Prashantkumar S Hanjagi, Scientist (Plant Physiology)	01.01.2024	ICAR-CRRI, Cuttack
Dr Sushma M Awaji, Scientist (Plant Physiology)	01.01.2024	ICAR-CRRI, Cuttack
Mr Dinesh Tekwani, Administrative Officer	22.04.2024	New Joining
Mr Junaid Pathan, Administrative Officer	24.04.2024	New Joining
Mr Prakhar Tiwari, Assistant	30.09.2024	New Joining
Mr Pratik Chandan, Assistant	01.10.2024	New Joining
Mr Vikas Chaudhary, Assistant	01.10.2024	New Joining
Mr Jayant Khaiwal, Assistant	04.11.2024	New Joining
Mr Abhaykumar Awasthi, Technician (T-1)	03.06.2024	New Joining
Mr Ashutosh Chandra, Technician (T-1)	03.06.2024	New Joining
Mr Durub Kumar, Technician (T-1)	25.06.2024	New Joining
Ms Pradnya Deshpande, Technician (T-1)	09.07.2024	New Joining
Ms Suman Kumari, Technician (T-1)	22.07.2024	New Joining
Superannuation		
Mr Charles Ekka	31.08.2024	

Project Activities

Sl.	Project activities	Investigators
1.	Abiotic stress level maps for western Maharashtra	BB Gaikwad, NC Paul, RN Singh, Sonam, V Rajagopal, KS Reddy, ICAR-NBSS&LUP
2.	Spatiotemporal analysis of maximum and minimum temperatures in agro-climatic zones of India	RN Singh, Sonam, Lata Vishnoi, AK Singh, KS Reddy
3.	Teleconnections of rainfall with ENSO and IOD in agro-climatic zones of India	RN Singh, Sonam, Lata Vishnoi, AK Singh, KS Reddy
4.	Assessment of effect of heat stress on physiological and hematological parameters in Indigenous goats.	SS Pawar, NP Kurade, SA Kochewad, AV Nirmale
5.	Herbal formulation feeding for alleviating multiple stress in goats	NP Kurade, SS Pawar, AV Nirmale, SA Kochewad
6.	Experiment with optimizing the distillery spentwash concentration for maximum biomass productivity in duckweed	B Gopalakrishnan, SS Pawar, NP Kurade, V Rajkumar, BB Gaikwad, AV Nirmale
7.	Spreadsheet tool for Energy budgeting under CIFS	B Gopalakrishnan, SA Kochewad, SB Chavan, Aliza Pradhan, HM Halli, VD Kakade, GC Wakchaure, VN Salunkhe, Rajkumar, V Rajagopal, Neeraj Kumar, Ravi Kumar
8.	Optimization of Agrobacterium-mediated transformation protocol in Soybean using cotyledon as an explant	AK Singh
9.	Targeted knockout of negative regulators	AK Singh
10.	Genomics, genetic, and molecular approaches to improve water stress tolerance in soybean and wheat	AK Singh
11.	Exploitation of halophytic plant and associated microbiome for amelioration of saline agricultural land of arid & semiarid regions	AK Singh
12.	Low and Medium Nutrient Index Maps for India	BB Gaikwad, KS Reddy
13.	Agriculture Drone Demonstrations	BB Gaikwad, Agriculture-Drone Project Team (ICAR-NIASM)
14.	Image based Tree/Fruit/Livestock Counting	
15.	Alleviation of drought- and salinity- stress in groundnut by habitat-adapted endophytic bacteria	KK Pal, Rinku Dey

16.	Exploring the possibility of finding CAM-photosynthetic transition in drought-stressed chickpea, pigeon pea, and soybean	KK Pal, PS Basavaraj, SS Changan, R Dey, KM Boraiah, PS Hanjagi, KS Reddy
17.	Deficit irrigation strategies combined with plant growth regulators for yield and water use efficiency (WUE) in a high-density mango orchard (Variety: Kesar)	DD Nangare, VD Kakade, AS Morade, SB Chavan, HM Halli
18.	Mitigating water stress effects in vegetable and orchard crops	GC Wakchaure, DD Nangare, Aliza Pradhan, KM Boraiah, PS Khapte
19.	Conservation agriculture for enhancing resource-use efficiency, environmental quality, and productivity of sugarcane cropping system	GC Wakchaure, A Pradhan, P Kumar, KS Reddy
20.	Identification of promising foxtail millet accessions suitable for low soil available nitrogen	KM Boraiah, PS Basavaraj, CB Harisha, HM Halli
21.	Generation advancing and on-station evaluation trials of chia mutants	KM Boraiah, CB Harisha, PS Basavaraj, HM Halli
22.	Evaluation of soybean germplasms for photo-thermo insensitivity and drought tolerance	KM Boraiah, PS Basavaraj, CB Harisha, HM Halli, KK Pal
23.	Creating genetic variability in dragon fruit by mutation breeding	K M Boraiah, P S Basavaraj, C B Harisha, H M Halli, K K Pal
24.	Creating genetic variability in groundnut by mutation breeding	K M Boraiah, P S Basavaraj, C B Harisha, H M Halli, K K Pal
25.	Collection, multiplication and evaluation of the germplasm for different abiotic stresses	K M Boraiah, P S Basavaraj, PS Khapte, CB Harisha, VD Kakade, KK Pal
26.	Collection, conservation and maintenance of vegetable germplasm	P S Khapte, SS Changan
27.	Identification of promising brinjal genotypes from local collection	P S Khapte, SS Changan
28.	Evaluation of dragon fruit hybrids (F1) for fruit quality and consumer acceptability	KM Boraiah, PS Basavaraj, CB Harisha, HM Halli, KK Pal
29.	Synergistic effect of melatonin and proline on growth, physio-biochemical and yield traits on potato under water deficit stress: a novel technique	SS Changan, PS Khapte
30.	Inclusion of quinoa in cropping systems for ensuring food and nutrition security in drought prone semi-arid regions of India	Aliza Pradhan, J Rane, G C Wakchaure, K K Pal, K Sammi Reddy
31.	Identification of novel cowpea genotypes for photo-thermo-insensitivity and high-temperature stress tolerance based on multilocation screening.	PS Basavaraj, KM Boraiah, CB Harisha, HM Halli, RN Singh
32.	Identification marker-trait association for photo-thermo-insensitivity and high temperature stress tolerance in cowpea	PS Basavaraj, KM Boraiah, CB Harisha, HM Halli, RN Singh
33.	Identification of mungbean genetic resources for drought tolerance	PS Basavaraj, KM Boraiah, CB Harisha, HM Halli, RN Singh
34.	Enhancing nutrient uptake and yield of quinoa by application of mineral solubilizers	Rinku Dey, Aliza Pradhan, V Rajagopal V, KK Pal, K Sammi Reddy
35.	Identification of novel pigeon pea genotypes for waterlogging tolerance at different crop growth stages	PS Basavaraj, KM Boraiah, CB Harisha, HM Halli, RN Singh
36.	Screening of local mango germplasm for salinity tolerance	AS Morade, VD Kakade, KM Boraiah, SS Changan, SB Chavan, Neeraj Kumar

37.	Comparative analysis of pot cultivation and mulching system for summer tomato cultivation under water deficit and heat stress	AS Morade, VD Kakade, PS Khapte, SB Chavan, DD Nangare, KS Reddy
38.	Climate resilient integrated farming system (CIFS) for semi-arid regions	SA Kochewad, GC Wakchaure, VN Salunkhe, Rajkumar, Aliza Pradhan, SB Chavan, VD Kakade, V Rajagopal, H M Halli, Neeraj Kumar, Gopalakrishnan B, Ravi Kumar, N Subash (IARI), LR Meena (IIFSR), PB Taware, P Chahande
39.	Effect of feeding sugarcane trash-based complete feed on the growth performance of Osmanabadi goat kids	SA Kochewad
40.	Host-sandalwood interactions under water stress environment	SB Chavan, CB Harisha, VD Kakade, AS Morade, SS Changan, K Ravi Kumar
41.	Carbon sequestration and Economic analysis of Mahogany based agroforestry systems	SB Chavan, VD Kakade, AS Morade, Ravi Kumar, Vanitha Salunkhe, KS Reddy
42.	Development of Climate Resilient CHARA Bank (Fodder system) in Drought Prone Regions	SB Chavan, BB Gaikwad, HM Halli, VD Kakade, AS Morade, K Ravi Kumar, NP Kurade, SS Pawar, SA Kochewad, KS Reddy
43.	Genotypic responses to salt stress in dragon fruit	VD Kakade, AS Morade, SB Chavan, KM Boraiah
44.	Conservation and evaluation of Allium species for waterlogging tolerance	Vanitha Salunkhe, PS Khapte, SS Changan
45.	Moisture deficit tolerant fennel genotype identification using stress Indices	CB Harisha
46.	Waterlogging effects on root morphology, yield, and stress tolerance in cowpea (*Vigna unguiculata* L. Walp) grown on semi-arid vertisols	Boraiah K. M., Basavaraj PS, Harisha CB, H M Halli
47.	Water productivity of small millets on poor soils of semi-arid vertisols	Boraiah K. M., Basavaraj PS, Harisha CB, H M Halli
48.	Isolation and characterization of microbes from Sugarcane and Soybean Rhizosphere and Endo-rhizosphere	Rinku Dey, KK Pal, N Karthikeyan, V Rajagopal
49.	Copper and copper nanoparticles toxicity and multi-biomarker approach using integrated biomarker response in fish: a comparative study	Neeraj Kumar
50.	Eco-friendly synthesis of iron nano-particles for mitigation of abiotic and biotic stress in fish using gene regulation	Neeraj Kumar
51.	Development of integrated drought index & stress mapping for selected drought-prone areas of Western Maharashtra	NC Paul, P Navyasree, BB Gaikwad
52.	Mapping and Assessment of Abiotic Stresses in Pune District, Maharashtra using Geospatial Techniques	NC Paul, BB Gaikwad
53.	Quantifying drought and salinity induced crop yield losses and crafting policy framework in selected drought-prone areas of Western Maharashtra.	P Navyasree, NC Paul, DD Nangare, PS Khapte, HM Halli
54.	Targeting prospective technologies for abiotic stress resilience in rainfed and dryland regions	K Ravi Kumar
55.	Growth Dynamics and Sectoral Instability in Livestock and Poultry: A Policy-Centric Analysis with Focus on Maharashtra	P Navyasree, NC Paul, K Ravi Kumar

ICAR-NIASM Technologies

SN.	Name of technology (Inventors)	Krishi Portal ID/ ICAR-Certificate No.	Year of Release
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, Mahesh 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
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
21.	*Thiourea and Potassium Nitrate for Improving Storability and Alleviating Drought and Waterlogging Stress in Onion* GC Wakchaure, KK Meena, PS Minhas, PS Khapte, KS Reddy	201718300894588 (ICAR-HS-NIASM-Technology-2024-061)	2024

The three symbolically interlocking radial hands represent (a) the cyclic anthropogenic pressures of livestock (blue), agriculture (green) and fisheries and other water related activities (aquamarine blue) and (b) human of various creeds and colours, under taking for livelihoods on the land scape which needs consideration not in a sectional approach but a holistic way to provide customized technologies and (c) asking for forging unrelenting extensive linkages of peers through global co-operation to pact against our surmountable problem by collective action, thus generating new material represented by emerging seedling in the centre.

Raindrop in the center indicates the driving force of life but is threatened by (a) stresses of climate change and (b) associated various anthropogenic actions reflected by symbolic hands around.

The clouds crossing raindrop are (a) like Asian Brown Clouds indicative of looming climate change (b) from greenhouse effects or pollution which needs undeviating attention.

The seedling in green colour connecting earth with raindrop expresses the efforts of the scientists to tackle all the pressures through screening and developing through biotechnology or other futuristic tools to evolve abiotic stress tolerant and or adoptable plants, animals, fishes etc. and the undying optimism towards ever regenerating life regardless of forever mounting pressures of human beings.

The central triangular open space created by hands around the raindrop institutionalizes creation of unique facility under single umbrella with growth for (a) specially focused high quality research facilities embedding frontier sciences, and (b) choicest capacity building through a cutting–edge education.

Black color text राअस्ट्रैप्रसं represents the name of the institute in Hindi 'राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान'. NIASM is acronym for 'National Institute of Abiotic Stress Management'.

The brown colour surface supporting seedling represents earth is the endangered 'nature' consequential to (a) unabated land degradation resulting in edaphic stresses like drought, floods, salinity, soil acidity pollution etc. due to the forces of varying rainfall confounded by the plaguing climate change and (b) a shrinking greenery by deforestation related activities needing attention of all dwellers of 'spaceship earth' on resource conservation.

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