Annual Report 2022

वार्षिक प्रतिवेदन

भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

ICAR-National Institute of Abiotic Stress Management

राअस्ट्रैप्रसं

NIASM

MISSION

Managing abiotic stresses for sustainable agriculture.

MANDATE

Basic & strategic research to manage abiotic stresses in crops, livestock & fisheries.

Repository of information on abiotic & biotic stresses, adaptation & mitigation strategies & policies.

Building sustainable agriculture in multi-stressed agro-ecosystems.

Serve as Center of Academic Excellence in managing multiple stresses in agriculture.

Annual Report 2022

वार्षिक प्रतिवेदन २०२२

भारत 2023 INDIA
वसुधैव कुटुम्बकम्
ONE EARTH • ONE FAMILY • ONE FUTURE

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NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT
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Preface

Global food security is challenged by abiotic stresses, which are becoming more frequent, intense and aggravating due to climate change. These stresses have severe implications across the agriculture sectors, including crops, horticulture, livestock, aquaculture and related value chain. To minimize the impact of these stresses, strategies must be developed to increase the productivity, resilience and efficiency of production systems. ICAR-NIASM has been pursuing this unifying goal through its incremental scientific investigations to develop insights and sustainable management options in crop plants, livestock, fish and poultry. The multidisciplinary research team at the institute has the unique advantage of developing the multi-pronged approach required to comprehend the complex scenarios of abiotic stresses and their sustainable management. This Annual Report highlights the work of multidisciplinary researchers, teaching, extension, institutional building, and other supporting activities during 2022, including details of research activities carried out under major research programmes. The institute has published 54 research papers, 05 review papers, 18 technical/popular articles, 36 book chapters, 01 book, 04 technical bulletins and 10 technical/extension folders. The institute took new initiatives of publishing Project Coordinator, Farm Coordinators and Agro Advisory. The institute has established external linkages and is engaging in scholarly partnerships with relevant organizations. Institute has won many prizes and accolades during the year, including Ganesh Shankar Vidyarthi Puraskar of ICAR.

I sincerely thank Dr Himanshu Pathak, Secretary (DARE) & Director General (ICAR); Sh. 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 S Bhaskar, Assistant Director General (Agronomy, Agro-Forestry and Climate Change) and Dr Adlul Islam, Assistant Director General (Soil & Water Management for their continued support and guidance. Valuable guidance, encouragement and support received from Dr B Venkatswarlu, Chairman and other esteemed members of the Research Advisory Committee (RAC); members of the Institute Management Committee (IMC) and Institute Research Council (IRC) of the Institute are sincerely acknowledged. I sincerely thank the Heads of the School; Scientists, Technical, Administration and Finance staff for their wholehearted efforts and dedication in progressing this institute. I also appreciate the efforts made by the members of the Publication Committee in compiling this Annual Report.

I sincerely hope this Annual Report will be useful for the researchers, policymakers, development functionaries, farmers and students and overall aid in promoting sustainable agriculture.

Date: 31-12-2022
Baramati

(K Sammi Reddy)
Director

प्रस्तावना

वैश्विक खाद्य सुरक्षा को अजैविक तनावों द्वारा चुनौती दी जाती है, जो जलवायु परिवर्तन के कारण लगातार, तीव्र और गंभीर होते जा रही हैं। इन तनावों का फसलों, बागवानी, पशुधन, मछली पालन और संबंधित मूल्य श्रृंखला सहित कृषि क्षेत्रों पर गंभीर प्रभाव पड़ता है। इन तनावों के प्रभाव को कम करने के लिए, उत्पादन प्रणालियों की उत्पादकता, लचीलापन और दक्षता बढ़ाने के लिए रणनीति विकसित की जानी की जरुरत है। भाकृअनुप-राष्ट्रीय अजैविक तनाव प्रबंधन संस्थान अपनी वृद्धिशील वैज्ञानिक जांच के माध्यम से इस एकीकृत लक्ष्य का पीछा कर रहा है, जिसका उद्देश्य फसल पौधों, पशुधन, मछली और कुक्कुटपालन में अंतर्दृष्टि विकसित करना और स्थायी प्रबंधन विकल्प विकसित करना है। संस्थान में बहु-विषयक अनुसंधान टीम को अजैविक तनावों और उनके स्थायी प्रबंधन के जटिल परिदृश्यों को समझने के लिए आवश्यक बहु-आयामी दृष्टिकोण विकसित करने का अनूठा लाभ है।

यह वार्षिक रिपोर्ट २०२२ के दौरान बहु-विषयक शोधकर्ताओं के कार्य, शिक्षण, विस्तार, संस्थागत निर्माण और अन्य सहायक गतिविधियों पर प्रकाश डालती है, जिसमें प्रमुख अनुसंधान कार्यक्रमों के तहत की गई अनुसंधान गतिविधियों का विवरण शामिल है। संस्थान ने इस वर्ष ५४ शोध पत्र, ५ समीक्षा पत्र, १८ तकनीकी/लोकप्रिय लेख, ३६ पुस्तक अध्याय, १ पुस्तक, ४ तकनीकी बुलेटिन और १० तकनीकी/विस्तार फोल्डर प्रकाशित किए हैं। संस्थान ने मासिक परियोजना समन्वयक, मासिक कृषि समन्वयक और पाक्षिक कृषि सलाह के प्रकाशन जैसी नई पहल शुरू की है। बाहरी संस्थाओं के साथ संबंध स्थापित करने और विद्वानों की भागीदारी में संलग्न होने के अलावा, संस्थान ने भाकृअनुप के गणेश शंकर विद्यार्थी पुरस्कार सहित कई पुरस्कार और सम्मान पाएं है।

मैं आभारी हूँ डॉ हिमांशु पाठक, सचिव (कृषि अनुसंधान एवं शिक्षा विभाग) एवं महानिदेशक (भाकृअनुप); श्री संजय गर्ग, अतिरिक्त सचिव (कृषि अनुसंधान एवं शिक्षा विभाग) एवं सचिव (भाकृअनुप), शुश्री अलका नांगिया अरोड़ा ,अतिरिक्त सचिव (कृषि अनुसंधान एवं शिक्षा विभाग) एवं वित्त सलाहकार (भाकृअनुप), डॉ सुरेश कुमार चौधरी, उप महानिदेशक (प्राकृतिक संसाधन प्रबन्धन), डॉ एस भास्कर, सहायक महानिदेशक (एग्रोनॉमी, एग्रोफोरेस्ट्री एंड क्लाइमेट चेंज) और डॉ अदलुल इस्लाम, सहायक महानिदेशक (मृदा, जल प्रबंधन) इनका उनके निरंतर समर्थन और मार्गदर्शन के लिए। संस्थान की अनुसंधान सलाहकार समिति के अध्यक्ष डॉ बी वेंकटस्वरलू और अन्य सम्मानित सदस्य एवं संस्थान प्रबंधन समिति के सदस्यों से प्राप्त मूल्यवान मार्गदर्शन, प्रोत्साहन और समर्थन संस्थान के लिए मूल्यवान है।

मैं संस्थान की गतिविधियों को अंजाम देने के लिए स्कूलों के प्रमुख, वैज्ञानिक, तकनीकी, प्रशासन और वित्त कर्मचारियों को उनके पूरे दिल से प्रयास और समर्पण के लिए दिल से धन्यवाद देता हूं। मैं इस वार्षिक प्रतिवेदन को संकलित करने में प्रकाशन समिति के सदस्यों द्वारा किए गए प्रयासों की सराहना करता हूं।

मुझे पूरी उम्मीद है कि यह वार्षिक प्रतिवेदन शोधकर्ताओं, नीति निर्माताओं, विकास कार्यकर्ताओं, किसानों और छात्रों के लिए उपयोगी होगी और स्थायी कृषि को बढ़ावा देने में समग्र सहायता करेगी।

ksreddy

(के सम्मी रेड्डी)
निदेशक

दिनांक: ३१-१२-२०२२
बारामती

Executive Summary/ कार्यकारी सारांश

During the year 2022, 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 overall achievements of these and others activities during the year are briefly summarized below.

वर्ष २०२२ के दौरान संस्थान में विभिन्न सांस्थानिक और बाह्य वित्तपोषित परियोजनाओं के तहत विभिन्न प्रयोग किए गए। सामुदायिक विकास कार्यक्रम के अंतर्गत, अनुसूचित जाति विकास कार्य योजना और आदिवासी उप योजना के कार्य किए गए। गतवर्ष के दौरान संसथान की विभिन्न गतिविधियों की समग्र उपलब्धियों का संक्षिप्त विवरण नीचे दिया गया है।

- The α-version Abiotic Stress Information System (ASIS) with framework to depict geo-spatial extent of abiotic stresses related to atmosphere, soil and water was developed.
- वायुमंडल, मिट्टी और पानी से संबंधित अजैविक तनावों की भू-स्थानिक सीमा को दर्शाने के लिए रूपरेखा के साथ प्रथम-संस्करण अजैविक तनाव सूचना प्रणाली विकसित की गई थी।
- The α-version of Atmospheric Stress Information System that includes sub modules on district level weather warnings, 5-day forecast and nowcast sourced from IMD, Pune was developed.
- वायुमंडलीय तनाव सूचना प्रणाली का पहला संस्करण जिसमें जिला स्तर पर मौसम की चेतावनी का उप मॉड्यूल शामिल हैं, आईएमडी, पुणे से ५-दिवसीय पूर्वानुमान और नाउकास्ट विकसित किया गया है।
- The α-version of Soil Stress Information System that depicts interactive district level maps on soil nutrient index and soil fertility index was developed.
- मृदा तनाव सूचना प्रणाली का पहला संस्करण विकसित किया गया था जो मिट्टी के पोषक तत्व सूचकांक और मिट्टी की उर्वरता सूचकांक को परस्पर संवादात्मक जिला स्तरीय मानचित्रों को दर्शाता है।
- The investigations on suitable day hours available for RPAS applications in Indian agriculture as impacted by local weather parameters revealed around 610.5 to 1355 annual hours only available across agro-climatic regions for drone applications in agriculture.
- भारतीय कृषि में आरपीएएस अनुप्रयोगों के लिए उपलब्ध उपयुक्त दिन के घंटों की जांच स्थानीय मौसम के मापदंडों से प्रभावित होती है। इसिके जाँच से पता चला की कृषि में ड्रोन अनुप्रयोगों के लिए केवल कृषि-जलवायु क्षेत्रों में लगभग ६१०.५ से १३५५ वार्षिक घंटे उपलब्ध हैं।
- District level methane emissions from livestock through enteric fermentation were estimated using the IPCC (2019) Tier I and Tier II protocol for India's cattle, buffalo, sheep, goats, and pigs population along with geo-spatial maps depicting these.
- भैंसों, भेड़ों, बकरियों और सूअरों की आबादी के लिए IPCC (२०१९) टियर I और टियर II प्रोटोकॉल का उपयोग करके इन्हें दर्शाने वाले भू-स्थानिक मानचित्रों के साथ, आंतों के किण्वन के माध्यम से पशुधन से जिला स्तर के मीथेन उत्सर्जन का अनुमान लगाया गया।
- Prototype of animal monitor v1.0 was developed for monitoring abiotic stress in livestock which
- पशुधन में अजैविक तनाव की निगरानी के लिए पशु मॉनिटर v1.0 का प्रोटोटाइप विकसित

records parameters viz. pulse rate and body temperature along with date and time.

किया गया है जो मापदंडों को रिकॉर्ड करता है। जिसमे नाड़ी की दर और शरीर का तापमान तारीख और समय एक साथ प्रदर्शित होती है।

- Alternate fodder unit comprising of fodder plants viz., *Azolla microphylla*, *Lemna minor*, *Spirodela polyrhiza* and *Fagopyrum esculentum* was established under institute's livestock farm.

- संस्थान के पशुधन फार्म के तहत वैकल्पिक चारा इकाई की स्थापना गयी जिसमें चारे के पौधे जैसे की एजोला माइक्रोफिला, लेम्ना माइनर, स्पिरोडेला पोलिरिजा और फागोपाइरम एस्कुलेंटम शामिल हैं।

- Spatial modelling of time required for advancement of chickpea generations in India using DSSAT model revealed the geo-spatial areas of India having potential for advancement of five generations of chickpea in shorter time.

- डीसॅट मॉडल का उपयोग करके भारत में चने की पीढ़ियों की उन्नति के लिए आवश्यक समय के स्थानिक मॉडलिंग से पता चला कि भारत के भू-स्थानिक क्षेत्रों में कम समय में चने की पांच पीढ़ियों की उन्नति की क्षमता है।

- A methodology based on identification of farm ponds using sentinel 2A satellite imagery and deep learning models for identification and localization of farm ponds was developed.

- खेतीतालाबों की पहचान और स्थानीयकरण के लिए सेंटिनल २ए उपग्रह बिम्बसृष्टि और डीप लर्निंग मॉडल का उपयोग करके खेतीतालाबों की पहचान पद्धति विकसित की गई।

- The comparative growth rate performance assessment of four breeds of goat namely Osmanabadi, Sangamneri, Konkan kanyal and Boer with exposure to various atmospheric stressors inferred that these breeds can sustain the climatic stress prevalent in the region.

- विभिन्न वायुमंडलीय तनावों के संपर्क में बकरी की चार नस्लों नामत: उस्मानाबादी, संगमनेरी, कोंकण कन्याल और बोअर के तुलनात्मक विकास दर के प्रदर्शन मूल्यांकन से अनुमान लगाया कि ये नस्लें इस क्षेत्र में प्रचलित जलवायु तनाव में भी पनप सकती है।

- The study was conducted to assess effect of exposure to heat stress on HSP70 gene expression pattern in chickens revealed the protective role of HSP70 against deleterious effects of heat stress in chicken PBMCs.

- मुर्गियों में गर्मी के तनाव के कारन एचएसपी७० जीन के प्रकटन स्वरूप पर होने वाले प्रभाव का आकलन करने के लिए अध्ययन किया गया। परिधीय रक्त मोनोन्यूक्लियर सेल में गर्मी तनाव के हानिकारक प्रभावों के खिलाफ एचएसपी७० की सुरक्षात्मक भूमिका उजागर हुई ।

- The proximate composition analysis of the by-products derived from mass culture of Black soldier fly viz. BSF meal (without defatting), BSF meal (with defatting), BSF oil, Empty pupal shell meal, BSF adult fly meal and BSF fertilizer was done.

- बड़े पैमाने पर उत्पादित ब्लैक सोल्जर फ्लाई से प्राप्त उप-उत्पादों जैसेकी बीएसएफ मील (बिना डीफेटिंग और डिफेटिंग वाले), बीएसएफ का तेल, खाली प्यूपा शेलमील, एडल्ट फ्लाई मील और फर्टिलाइजर का निकटस्थ संरचना विश्लेषण किया गया।

- Halophyte Sesuvium portulacastrum (P4) showed cooler canopy and higher accumulation of proline under 3% NaCl level while Halophyte Avicennia marina (P3) had higher canopy temperature compared to other halophytes under 3% NaCl level.

- हेलोफाइट्स सेसुवियम पोर्टुलाकास्ट्रम (पी४) ने ३% नमक स्तर तहत कूलर कैनोपी और प्रोलाइन उच्च संचय को दिखाया, जबकि अविसिंनिआ मरीना (पी३) में अन्य हेलोफाइट्स तुलना में उच्च कैनोपी तापमान पाया गया।

- Candidate genes were identified for salt tolerance in halophytes Sesuvium portulacastrum, Avicennia marina, Spartina alterniflora and Ipomoea pes-caprae.

- हेलोफाइट्स सेसुवियम पोर्टुलाकास्ट्रम, एविसेनिया मरीना, स्पार्टिना अल्टरनिफ्लोरा और इपोमिया पेस-कैप्रे में नमक सहिष्णुता के लिए कैंडिडेट जीन की पहचान की गई।

- The application of Bioformulation, Biomolecules and Biopolymer showed significant influence on overall growth and development of Mung bean with improvements in protein and phenol content, seed test weight, and overall yield as compared to control.

- बायोफॉर्मुलेशन, बायोमोलेक्युलस और बायोपॉलिमर के अनुप्रयोग से मूंग की प्रोटीन और फिनोल सामग्री, बीज परीक्षण वजन और समग्र उपज में सुधार के साथ समग्र वृद्धि और विकास पर नियंत्रण की तुलना में महत्वपूर्ण प्रभाव देखा गया।

- The cost economics, carbon footprints of cropping systems/crops and its effect on soil properties, water productivity and nutritional aspect of the components of one hectare model of CIFS were measured/calculated. The overall cost of cultivation (Rs.227395), gross income (Rs.369265), net income (Rs.141870) cumulated a B:C ratio of 1.62 for the one hectare CIFS model at ICAR-NIASM with livestock contributing majorly (79%), followed by crops (14%) and fisheries (7%) towards the gross income obtained under CISF

- CIFS के एक हेक्टेयर मॉडल के घटकों की लागत अर्थशास्त्र, फसल प्रणालियों/फसलों के कार्बन फुटप्रिंट्स और मिट्टी के गुणों पर इसके प्रभाव, जल उत्पादकता और घटकों के पोषण संबंधी पहलू को मापा गया। खेती की कुल लागत (रु. २२७३९५), सकल आय (रु. ३६९२६५), शुद्ध आय (रु. १४१८७०) से संस्थान में एक हेक्टेयर मॉडल के लिए १.६२ का बी:सी अनुपात पाया गया जिसमें पशुधन का प्रमुख योगदान था (७९%), इसके बाद सकल आय के लिए फसलें (१४%) और मत्स्य पालन (७%) पाया गया।

- The concept of multilayer integrated farming system for multiple abiotic stress region was developed in which the overall cost of cultivation, gross income net income and B:C ratio of Multilayer integrated farming system was, Rs. 38209, Rs. 46213, Rs. 8004 and 1.20, respectively.

- बहुअजैविक तनावक्षेत्र हेतु बहुपरत एकीकृत कृषि प्रणाली की अवधारणा विकसित की गई जिसमें खेती की कुल लागत, सकल आय शुद्ध आय और बहुपरत एकीकृत कृषि प्रणाली का बी:सी अनुपात रु. ३८२०९, रु. ४६२१३, रु. क्रमश: ८००४ और १.२० पाया गया।

- The chia + fenugreek intercropping was found to be advantageous over chia monocrop under well-watered or water deficit conditions in Deccan plateau regions of India.

- भारत के डेक्कन पठारी क्षेत्रों में अच्छी मात्र में पानी वाली या पानी की कमी की स्थिति के तहत चिया + मेथी इंटरक्रॉपिंग को चिया मोनोक्रॉप से अधिक फायदेमंद पाया गया।

- The comparative change of soil properties of orchards at ICAR-NIASM measured during 2011 and 2022 revealed that the introduction of fruit species accelerated parent materials weathering and soil development. Similarly, to benchmark the initial soil properties, soil properties profile of Malad farm of ICAR-NIASM has also been done

- २०११ से २०२२ के दौरान मापे गए संस्थान के बगीचों की मिट्टी के गुणों के तुलनात्मक परिवर्तन से पता चला है कि फलों की प्रजातियों की शुरूआत ने मूल सामग्री के अपक्षय और मिट्टी के विकास को गति दी है। इसी तरह प्रारंभिक मिट्टी के गुणों को बेंचमार्क करने के लिए, संस्थान के मलाड फार्म की मिट्टी के गुणों का प्रोफाइल भी बनाया गया है।

- The detection, etiology and phylogenetic analysis of stem canker (Neoscytalidium dimidiatum) (as first report from India) and also for anthracnose (Colletotrichum truncatum) in dragon fruit was done at ICAR-NIASM.

- संस्थान में स्टेम कैंकर (नियोस्साइटेलिडियम डिमिडियाटम) (भारत से पहली रिपोर्ट) और एन्थ्रेक्नोज (कोलेटोट्रिचम ट्रंकैटम) का पता लगाया गया और इसका एटियलाजि और फाइलोजेनेटिक विश्लेषण किया गया।

- The quantification of net CO_2 mitigation potential for rehabilitation of degraded lands in semi-arid region revealed the maximum potential in mango orchard (164.25 Mg CO_2-eq ha^{-1}) followed by

- अर्ध-शुष्क क्षेत्र में अवक्रमित भूमि के पुनर्वास के लिए शुद्ध कार्बन डाईऑक्साइड शमन क्षमता के परिमाणीकरण से आम के बाग (१६४.२५ Mg CO_2-eq ha^{-1}) में अधिकतम

pomegranate orchard (101.34 Mg CO_2-eq ha^{-1}) and coconut orchard (68.59 Mg CO_2-eq ha^{-1}).

क्षमता का पता चला, इसके बाद अनार के बाग (१०१.३४ Mg CO_2-eq ha^{-1}) और नारियल बाग (६८.५९ Mg CO_2-eq ha^{-1}) पाया गया।

- To quantify the biomass, allometry equation (Biomass (kg $tree^{-1}$) = 0.4857 ×$(DBH)^{2.0428}$) R^2 = 0.97 was developed for Melia Dubia. It was found that diameter at breast height was the best independent predictor over tree height.

- बायोमास की मात्रा निर्धारित करने के लिए, एलोमेट्री समीकरण (बायोमास (किग्रा ट्री-१)= ०.४८५७×(DBH)२.०४२८) R^2 = ०.९७ मेलिया दुबिया के लिए विकसित किया गया था। यह पाया गया कि स्तन ऊंचाई व्यास पेड़ की ऊंचाईका सबसे अच्छा स्वतंत्र सूचक था।

- The Nano-copper at 1.5 mg kg^{-1} diet enhanced the thermal efficiency and stimulated the gene expression in response to multiple stresses in Pangasianodon hypophthalmus .

- पैंगासियनोडोन हाइपोफथाल्मस में १.५ मिलीग्राम kg^{-1} आहारमें नैनोकॉपर ने तापीय दक्षता को बढ़ाया और कई तनावों के जवाब में जीन अभिव्यक्ति को उत्तेजित किया।

- Zinc nanoparticles at 4.0 mg kg^{-1} diet has enormous potential to modulates arsenic, ammonia and high temperature stress, and protect against pathogenic infections in fish.

- जिंक नैनोपार्टिकल्स ४ मिलीग्राम kg^{-1} आहार में आर्सेनिक, अमोनिया और उच्च तापमान तनाव को नियंत्रित करने और मछली में रोगजनक संक्रमण से बचाने की क्षमता है।

- The chronic toxicity of Cr enhanced with low pH and high temperature in A. testudineus.It has led to understanding the multi-approach of Cr toxicity and its affect on stress biomarkers, cellular metabolic stress and thermal tolerance in A. testudineus.

- ए टेस्टुडाइनस में कम पीएच और उच्च तापमान के साथ सीआर की पुरानी विषाक्तता बढ़ जाती है। इससे सीआर विषाक्तता के बहु-दृष्टिकोण और ए टेस्टुडीनस में तनाव बायोमार्कर, सेलुलर चयापचय तनाव और थर्मल सहिष्णुता पर इसके प्रभाव को समझने में मदद मिली है।

- Soybean genotypes having lower expression of *EIN2* gene which indicates less sensitivity to ethylene, cooler canopy and higher PS-II efficiency, higher RWC and more canopy greenness may be good plant types for adaptation to limited soil moisture conditions.

- EIN2 जीन की कम अभिव्यक्ति वाले सोयाबीन जीनोटाइप जो एथिलीन के प्रति कम संवेदनशीलता, कूलर कैनोपी और उच्च PS-II दक्षता, उच्च RWC और अधिक कैनोपी ग्रीननेस इंगित करते हैं और सीमित मिट्टी की नमी की स्थिति के अनुकूलन के लिए अच्छे पौधे प्रकार हो सकते हैं।

- The GmFnsl, GmEIN2 and GmWRKY-silenced plants showed higher chlorophyll content and photosynthetic efficiency as compared to vector-controlled and mock-inoculated soybean plants.

- GmFnsl, GmEIN2 और GmWRKY-साइलेंट पौधों ने वेक्टर-नियंत्रित और मॉक-इनोक्युलेटेड सोयाबीन पौधों की तुलना में उच्च क्लोरोफिल सामग्री और प्रकाश संश्लेषक दक्षता पाई गई।

- A total of 33 genotypes screened from 168 pigeonpea genotypes showed higher survival ability for submergence tolerance in pot experiment. ICP-16309, 7148, 8255, 6845, 6815, 10228, 6370, 10397, 4903, 7869, 7507 exhibited higher stress tolerance index, mean relative performance, yield stability index, lower percent yield reduction across the two years (2020 and 2021).

- अरहर की 168 प्रजातियों में से कुल 33 जीनप्ररूपों की जांच में पॉट प्रयोग में जलमग्नता सहिष्णुता के लिए उच्च जीवित रहने की क्षमता दिखाई दी। आईसीपी-१६३०९, ७१४८, ८२५५, ६८४५, ६८१५, १०२२८, ६३७०, १०३९७, ४९०३, ७८६९, ७५०७ ने उच्च तनाव सहिष्णुता सूचकांक, माध्य प्रदर्शित सापेक्ष प्रदर्शन, उपज स्थिरता

सूचकांक, दो वर्षों (२०२० और २०२१) में कम प्रतिशत उपज में कमी पाई गई।

- Large collections of 257 diverse core set of cowpea germplasms were screened for high temperature stress under the field condition during summer season of 2022 (Feb-June2022).

- २०२२ के ग्रीष्म ऋतु (फरवरी-जून) के दौरान खेत की स्थिति के तहत उच्च तापमान तनाव के लिए लोबिया जर्मप्लाज्म के २५७ विविध कोर सेट के बड़े संग्रह की जांच की गई।

- The nitrogen use efficiency and partial factor productivity was found to be higher under 60% Agrotain incorporated urea (AIU) followed by 80% AIU.

- नाइट्रोजन उपयोग दक्षता और आंशिक कारक उत्पादकता ६०% एग्रोटेन निगमित यूरिया (AIU) के तहत ८०% AIU के बाद अधिक पाई गई।

- The delay in sowing of quinoa after first November has reduced advantage of water and nitrogen input. The highest seed yield of 1700 kg ha^{-1} was found in plots sown in 1st November with 80% ETc and 200 kg N ha^{-1}, while maximum water productivity of 1.13 kg m^{-3} was observed in plots sown on 1st November with 40% ETc and 200 kg N ha^{-1}.

- पहली नवंबर के बाद क्विनोआ की बुवाई में देरी से पानी और नाइट्रोजन इनपुट का लाभ कम हो गया। १७०० किग्रा प्रति हेक्टेयर की उच्चतम बीज उपज १ नवंबर को बोए गए भूखंडों में ८०% ETc और २०० किलोग्राम एन प्रति हेक्टेयर के साथ पाई गई, जबकि १.१३ किलोग्राम एम-३ की अधिकतम जल उत्पादकता १ नवंबर को बोए गए भूखंडों में ४०% ETc के % ETc और २०० किग्रा एन प्रति हेक्टेयर में देखि गयी ।

- A climate-smart extra early maturing germplasm (EC 93-2021) of Rajmash which is fully determinate type and matures within 56 days giving a yield of 1251 kg ha^{-1} was identified as a potential drought tolerant germplasm through field evaluation.

- राजमाश का एक जलवायु-स्मार्ट अतिरिक्त जल्दी परिपक्व होने वाला जर्मप्लाज्म (ईसी ९३-२०२१) जो पूरी तरह से निर्धारित प्रकार का है और ५६ दिनों के भीतर परिपक्व होकर १२५१ किलोग्राम प्रति हेक्टेयर की उपज देता है, को क्षेत्र मूल्यांकन के माध्यम से एक संभावित सूखा सहिष्णु जर्मप्लाज्म के रूप में पहचाना गया।

- The field evaluation of identified Kharif Chickpea genotypes (JG-14 and GNG 2171) as a new introduction to vegetable pulses in Western Maharashtra showed highest raw green chickpea pod yield of 45 and 24 q ha^{-1} under irrigated and rainfed conditions, respectively.

- पश्चिमी महाराष्ट्र में सब्जी दालों के नए परिचय के रूप में पहचाने गए खरीफ चने के जीनोटाइप (JG-१४ और GNG २१७१) के क्षेत्र मूल्यांकन में क्रमशः सिंचित और वर्षा आधारित परिस्थितियों में कच्चे हरे चने की उच्चतम उपज ४५ और २४ क्विंटल प्रति हेक्टेयर देखी गई।

- The foliar application of 4-, 2- and 6-ml L^{-1} of vegetal protein hydrolysate was found to be beneficial for soybean, chickpea and chilli, which exhibited 17, 30 and 25% yield improvement, respectively over untreated plants under water deficit stress.

- वनस्पति प्रोटीन हाइड्रोलाइज़ेट के ४, २ और ६ मिलि प्रतिलीटर का पर्णीय अनुप्रयोग सोयाबीन, चना और मिर्च के लिए फायदेमंद पाया गया, जिसने पानी की कमी के तनाव के तहत अनुपचारित पौधों पर क्रमशः १७, ३० और २५% उपज सुधार दिखा।

- The genotypes of chickpea, namely ICE 15654-A, IPC 06-11, JG-14, ICCV 92944, Vishal, Vijay, JG-11 and JG-16, were identified as photo-thermo-insensitive and early maturing genotypes during the field evaluation of late *Kharif* 2021, Rabi 2021-22, summer 2022 and early *Kharif* 2022.

- छोले के जीनोटाइप, अर्थात् आईसीई १५६५४-ए, आईपीसी ६-११, जेजी-१४, आईसीसीवी ९२९४४, विशाल, विजय, जेजी-११ और जेजी-१६, की फोटो-थर्मो-असंवेदनशील और जल्दी परिपक्व होने वाले जीनोटाइप के रूप में पहचान की गई थी। पछेती खरीफ २०२१, रबी

२०२१-२२, ग्रीष्म और प्रारंभिक खरीफ २०२२ का क्षेत्र मूल्यांकन किया गया।

- The special and promising M2 and M_3 mutants of Chia crop lines/plants obtained through exposure to three levels of γ-radiation dose were identified and have potential to be registered as genetic stocks/ mutant lines, ornamental type and genetic resources (germplasm).

- विकिरण खुराक के तीन स्तरों के संपर्क के माध्यम से प्राप्त चिया फसल लाइनों/पौधों के विशेष और आशाजनक एम२ और एम३ म्यूटेंट की पहचान की गई जिसमें आनुवंशिक स्टॉक/उत्परिवर्ती लाइनों, सजावटी प्रकार और आनुवंशिक संसाधनों (जर्मप्लाज्म) के रूप में पंजीकृत होने की क्षमता है।

- Supplementary pollination in dragon fruit unlocks the potential yield (up to 18 tons $acre^{-1}$) besides enhancing the fruit quality (color, shape, pulp and seed set). An additional yield of 3.0 (33%) and 9.0 tons (100%) per acre can be obtained in hand self and cross pollination, respectively, over and above the actual yield of natural pollination (9 tons $acre^{-1}$).

- ड्रैगन फ्रूट में पूरक परागण फलों की गुणवत्ता (रंग, आकार, गूदा और बीज सेट) को बढ़ाने के अलावा उपज (१८ टन प्रति एकड़ तक) संभावित है। प्राकृतिक परागण (९ टन प्रति एकड़) की वास्तविक उपज के अतिरिक्त हाथ से स्वयं और पर-परागण में क्रमश: ३ (३३%) और ९ टन (१००%) प्रति एकड़ की अतिरिक्त उपज प्राप्त की जा सकती है।

- High nutrient use efficient foxtail millet accessions were identified based on field evaluation of 118 accessions of foxtail millets for physiological and growth parameters.

- शारीरिक और विकास मापदंडों के लिए फॉक्सटेल बाजरा के ११८ प्राप्तियों के क्षेत्र मूल्यांकन के आधार पर उच्च पोषक उपयोग कुशल फॉक्सटेल मिलेट एक्सेसन की पहचान की गई।

- Crop cafeteria to display important and popular varieties of cereals including small millets, pulses, oil seed and spice crops was established.

- छोटे बाजरा, दलहन, तिलहन और मसाला फसलों सहित अनाज की महत्वपूर्ण और लोकप्रिय किस्मों को प्रदर्शित करने के लिए फसल कैफेटेरिया की स्थापना की गई।

- More than 1600 germplasm/ genotypes/ accessions of different crops and vegetables were collected from different organizations under umbrella project on “Genetic garden and gene bank for abiotic stress tolerant plants, animals and fisheries for food security and sustainability”.

- खाद्य सुरक्षा और स्थिरता के लिए अजैविक तनाव सहिष्णु पौधों, जानवरों और मत्स्य पालन के लिए आनुवंशिक उद्यान और जीन बैंक पर छत्र परियोजना के तहत विभिन्न फसलों और सब्जियों के १६०० से अधिक जर्मप्लाज्म/जीनोटाइप/परिग्रहण विभिन्न संगठनों से एकत्र किए गए।

- RACH-P-18, MIHC-98-4, MIHC-399-5 and RAH-14292 were identified as early, drought tolerant and high-yielding lines of cotton which mature in140-145 DAS with the estimated yield of 31.9, 30.0, 33.0 and 30.3 q ha^{-1}, respectively.

- रैच-पी-१८, एमआईएचसी-९८-४ और ३९९-५, और आरएएच-१४२९२ को कपास की प्रारंभिक, सूखा सहिष्णु और उच्च उपज देने वाली किस्मों के रूप में पहचाना गया जो ३१.९, ३० की अनुमानित उपज के साथ १४०-१४५ डीएएस में परिपक्व हुई क्रमशः ३३ और ३०.३ क्विंटल प्रति हेक्टेयर है।

- Cluster bean genotypes RHRCB 01, RHRCB 04, RHRCB 11, RHRCB 15, RHRCB 17, RHRCB 23, RHRCB 24, and Phule Guar were observed to be relatively tolerant to drought in pot experiments.

- ग्वार जीनोटाइप RHRCB 01, 04, 11, 15, 17, 23, 24 और फुले ग्वार पॉट प्रयोगों में सूखे के प्रति अपेक्षाकृत सहिष्णु पाए गए।

- Sixty germplasm accessions and ten wild species accessions of *Solanum lycopersicum* and thirty accessions of improved line and local varieties, and wild species are collected, conserved and multiplied.

- सोलेनम लाइकोपर्सिकम के साठ जननद्रव्य परिग्रहण और दस वन्य प्रजाति परिग्रहण और उन्नत वंशक्रम और स्थानीय किस्मों के तीस परिग्रहण और जंगली प्रजातियों को एकत्र, संरक्षित और गुणा किया गया।

- The eggplant grafted onto *S. sisymbriifolium* rootstocks changes scion morphology and physiology under drought stress and increases yield upto 20% more under deficit irrigation (60% ETc) than non-grafted plants.

- एस सिसिम्ब्रिफोलियम रूटस्टॉक्स पर ग्राफ्ट किए गए बैंगन सूखे तनाव के तहत स्कोन मॉर्फोलॉजी और फिजियोलॉजी को बदलते हैं और गैर-ग्राफ्टेड पौधों की तुलना में कम सिंचाई (६०% ईटीसी) के तहत २०% अधिक उपज बढ़ाते हैं।

- In comparison to grapevines grown in native soil without biostimulants application (0.48 kg/vine), vines grown in mixed soil and black soil with sea algae treatment yielded up to 6.46 kg/vine and 6.08 kg/vine respectively.

- बायोस्टिमुलेंट्स के बिना देशी मिट्टी में उगाई गई अंगूर की बेलों की तुलना में (०.४८ किग्रा/बेल), मिश्रित मिट्टी में उगाई गई बेलें और समुद्री शैवाल उपचार वाली काली मिट्टी में क्रमशः ६.४६ किग्रा/बेल और ६.०८ किग्रा/बेल उपज होती है।

- The studies on effect of deficit irrigation strategies on water use efficiency, yield and quality of pomegranate (Cv. Bhagwa) in shallow basaltic soils showed higher fruit yield per plant in plants treated with PRD-80+SA+NAA as compared to other treatments and control.

- कम सिंचाई रणनीतियों के प्रभाव के अध्ययन से पता चला की उथली बेसाल्टिक मिट्टी में अनार (सीवी भगवा) की जल उपयोग दक्षता, उपज और गुणवत्ता पर अन्य उपचारों की तुलना में पीआरडी-८० + एस ए + एन ए ए के साथ उपचारित पौधों में उच्च फल उपज देखा गया।

- Among the coating materials tested for enhancing shelf-life of custard apple, mineral oil (MO) was found effective in minimizing fruit weight losses (7.2%) over control (10.3%).

- सीताफल की शेल्फ-लाइफ बढ़ाने के लिए कोटिंग सामग्रियों का परीक्षण किया गया, जिसमें खनिज तेल (MO (१०.३%) पर फलों के वजन में कमी (७.२%) को कम करने में प्रभावी पाया गया।

- A hand held and cost-effective device with high accuracy (99%) for detecting maturity stages of custard apple was developed.

- सीताफल की परिपक्वता अवस्थाओं का पता लगाने के लिए उच्च सटीकता (९९%) के साथ हाथ से पकड़ने योग्य और लागत प्रभावी उपकरण विकसित किया गया।

- The water productivity (WP) in eggplant improved by 5.8-11.1 kg m^{-3} in grafted treatments under medium and severe water deficits owing to its better growth canopy and physiological traits.

- बैंगन में पानी की उत्पादकता (डब्ल्यूपी) में ५.८-११.१ किलोग्राम एम-३ का सुधार हुआ, जो मध्यम और गंभीर पानी की कमी के तहत ग्राफ्टेड उपचारों में बेहतर वृद्धि चंदवा और शारीरिक लक्षणों के कारण होता है।

- The practice of creating trenches and filling with mixed soil for cultivation of dragon fruit had a B:C ratio of 1.85 and thus could be recommended for degraded land.

- ड्रैगन फ्रूट की खेती के लिए खाइयाँ बनाने और मिश्रित मिट्टी से भरने की प्रथा का बी:सी अनुपात १.८५ पाया गया और निम्नीकृत भूमि के लिए इसकी सिफारिश की जा सकती है।

- The conjunctive use of PGRs and optimizing regional specific soil filling mixtures could be recommended as efficient strategy for improving fruit yields, sustaining marketable quality and

- फलों की पैदावार में सुधार, विपणन योग्य गुणवत्ता को बनाए रखने और भंडारण के दौरान ड्रैगन फ्रूट के शेल्फ जीवन को बढ़ाने के लिए पीजीआर के संयुक्त उपयोग और क्षेत्रीय

prolong the shelf life of dragon fruit during storage.

विशिष्ट मिट्टी भरने के मिश्रण को अनुकूलित करने की सिफारिश की जा सकती है।

- Reduced tillage in sugarcane ratoon with 50% application of RDF as basal with SORF in band placement and remaining 50% RDF through fertigation in standing crop with mulching and non-mulching were found to improve the ratoon cane yields by 30 and 38.5% over farmers practice with mulch (M) and non-mulch (NM), respectively.

- बैंड प्लेसमेंट में सोर्फ के साथ बेसल के रूप में आरडीएफ के ५०% आवेदन के साथ गन्ने के पेड़ी में कम जुताई और मल्चिंग और गैर-मल्चिंग के साथ खड़ी फसल में फर्टिगेशन के माध्यम से शेष ५०% आरडीएफ किसानों की मल्च (एम) और गैर-मल्च (एनएम) के तुलना में पेड़ी गन्ने की पैदावार में ३० और ३८.५% तक सुधार पाया गया।

- Survey of dragon fruit farmers from Pune, Satara and Solapur districts of western Maharashtr revealed majority (98.11%) having adopted red type variant of dragon fruit for cultivation due to high market demand and consumer preference. The incidence of fruit fly (100%) pest and soft rot (77.34%) disease along with sun burning (58.49%) were also reported as major problems faced.

- पश्चिमी महाराष्ट्र के पुणे, सतारा और सोलापुर जिलों के ड्रैगन फ्रूट किसानों के सर्वेक्षण से पता चला कि अधिकांश (९८.११%) ने उच्च बाजार मांग और उपभोक्ता वरीयता के कारण ड्रैगन फ्रूट की लाल किस्म को खेती अपनायी है। सन बर्निंग (५८.४९%) के साथ-साथ फल मक्खी (१००%) कीट और नरम सड़न (७७.३४%) की घटनाओं को भी प्रमुख समस्याओं के रूप में बताया गया।

- Majority of the dragon fruit farmers surveyed perceived high capital cost (76.66%) as major constraints followed by flower drop due to untimely rainfall (63.33%) and poor linkage with agro processing industries (46.66%).

- ड्रैगन फ्रूट के अधिकांश किसानों ने उच्च पूंजी लागत (७६.६६%) को प्रमुख बाधाओं के रूप में देखा, जिसके बाद बेमौसम बारिश (६३.३३%) और कृषि प्रसंस्करण उद्योगों (४६.६६%) के साथ खराब जुड़ाव के कारण फूल गिर जाना बताया ।

- A methodology based on identification of fisheries cage culture in inland open water bodies using sentinel 2A satellite imagery and deep learning models for identification and localization of fisheries cage cultures was developed.

- सेंटीनेल २ए उपग्रह इमेजरी और मात्स्यिकी केज कल्चर की पहचान और स्थानीयकरण के लिए डीप लर्निंग मॉडल का उपयोग करके अंतर्देशीय खुले जल निकायों में मात्स्यिकी केज कल्चर की पहचान के हेतु एक पद्धति विकसित की गई है।

- More than 5000 visitors visited ICAR-NIASM under the trainings demonstrations and field visits conducted during year 2022.

- वर्ष २०२२ के दौरान आयोजित प्रशिक्षण प्रदर्शनों और क्षेत्र यात्राओं के तहत ५००० से अधिक आगंतुकों ने संस्थान का दौरा किया।

- About 9 training/demonstration/ awareness/ input distribution programmes and Interaction meet were carried under DAPSC programme of ICAR-NIASM during year 2022.

- वर्ष २०२२ के दौरान संस्थान के अनुसूचित जाति विकास कार्य योजना के तहत लगभग ९ प्रशिक्षण/प्रदर्शन/जागरूकता/सामग्री वितरण कार्यक्रम और पारस्परिक मुलाकात का आयोजन किया गया।

- About 7 training/ demonstration/ input distribution programmes were carried under TSP of ICAR-NIASM during year 2022.

- वर्ष २०२२ के दौरान संस्थान के आदिवासी उप योजना के तहत लगभग ७ प्रशिक्षण/ प्रदर्शन/ सामग्री वितरण कार्यक्रम आयोजित किए गए।

Abbreviations

AIU	Agrotain Incorporated Urea
BSF	Black Soldier Fly
CEC	Cation Exchange Capacity
CFP	Carbon Footprint of Product
CIFS	Climate Smart Integrated Farming System
DSSAT	Decision Support System for Agrotechnology Transfer
FRP	Fibre Reinforced Plastic
GAPDH	Glyceraldehyde 3-Phosphate Dehydrogenase
GHG	Greenhouse Gas
IBR	Integrated Biomarker Response
IMD	Indian Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
ITS	Internal Transcribed Spacer
MAE	Mean Absolute Error
NAA	Naphthaleneacetic Acid
NDVI	Normalized Difference Vegetation Index
PFB	Predicted Fresh Biomass
PHs	Protein Hydrolysates
PS II	Photosystem II
RF	Random Forest
RMSE	Root Mean Square Error
RPAS	Remotely Piloted Aircraft System
RWC	Relative Water Content
SA	Salicylic Acid
DAPSC	Development Action Plan for Scheduled Castes
SOC	Soil Organic Carbon
TNZ	Thermal Neutral Zone
TSP	Tribal Sub-Plan
WUE	Water Use Efficiency

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1. Introduction

Global warming can be slowed down only with corrective measures not by option but by commitments across the globe. Even if successful with all cautious effort, the warmer globe may prevail to exist in the present form as it may take several years to cool down to reach desired level of ambient temperature that can make the earth's inhabitants comfortable. The recent report of the Intergovernmental Panel on Climate Change (IPCC, 2021) revealed that the average surface temperature of the earth will cross 1.5°C over pre-industrial levels by 2040 and by 2°C by the middle of the century without any sharp reduction of emissions. Every additional 0.5°C of global warming is projected to cause discernible increases in the intensity and frequency of hot extremes, including heatwaves and heavy precipitation, as well as agricultural and ecological droughts in some regions. Thus, the agriculture needs to be fine-tuned to meet the exigencies emerging from global warming throughout this century. With more number of extreme weather events relative to the past, the current century and the current decade convincingly hint at the possible impact of change in climate on agriculture through abiotic stresses caused by deficit or excess precipitation. It can be directly or indirectly related to spatial differences in earth's surface temperature, which have often crossed the limits resulting in more number of warmer years of the century or the recent decades and warmest days in a crop season. Their implications often get manifested in a long dry spell and short but intense wet spells causing drought and waterlogging, respectively. Besides other abiotic stresses like extreme temperature, soil salinity, acidity, and nutrient deficiency are likely to be exacerbated by climate change which in turn will limit the growth, development, and productivity of majority of crop plants. More than 50% of potential crop yield is reduced by adverse environmental factors. In addition, there exists a pressure for enhanced food production by 2050 to feed a growing population of about 9.3 billion without depleting the natural resource base. To address this challenge, there is need of well-planned basic and strategic research to manage abiotic stresses in agricultural commodities viz., crop plants, livestock, fish and poultry especially in arid and semiarid regions. In order to address these concerns, National Institute of Abiotic Stress Management (NIASM), established on February 21, 2009 as one of the national institutes under Indian Council of Agricultural Research (ICAR). With limited opportunities to overuse natural resources and no provision for indiscriminate human intervention into the agro-ecology, the current food security dilemma has taken on new dimensions. This is especially true given that the severe effects of climate change are looming due to the unprecedented carbon load in the atmosphere. The current management procedures must be adjusted to the current trend of weather and agro-ecologies, which are significantly different from those that prevailed in the previous similar season or month, even though they have a significant potential to contribute to food production. Deeper insights, mitigation and adaptation strategies that are tailored to manage any of these abiotic stresses can contribute immensely to sustainable agriculture even in the context of changing climate. ICAR-NIASM has been continuously working to strengthen its programmes for academic reorientation, research, and extension. Several stakeholder interface, farmer awareness, and training workshops were organised despite the post-COVID-19 concerns and challenges. Current Annual Report gives an overview of the research, teaching and extension efforts done in 2022.

Role of the Institute

The institute has a focus on stresses caused by factors like excess or deficit of soil moisture, soil salinity, sodicity, acidity, water logging, declining water quality, heat stress, cold wave, floods, sea water inundation, and other things like that. It does this by employing methods that are both conventional and novel in order to improve crop quality, manage resources, and develop policies. Through its four schools namely, School of Atmospheric Stress Management (SASM), School of Water Stress Management (SWSM), School of Soil Stress Management (SSSM) and School of Social Science & Policy Support (SSSPS), the institute has successfully applied a thematic approach to the implementation of significant research programmes. In addition, the institute has plans for the strategic development of human resources, with the goal of managing abiotic stresses over the long term through networking with other national and international institutes. The institute has been making efforts to complement the ongoing research and development that is being conducted as part of the National Agricultural Research and Education System, while at the same time concentrating on abiotic stresses (NARES). Additionally, the institute intends to produce intermediate products for tolerance to multiple stresses. These products will be utilised by other institutes in order to obtain end products of the crop, livestock, fisheries, and so on.

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 Water 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 Soil 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 Science 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

A six-point hexagonal interlinked strategy is adopted to enhance the effectiveness of research, extension and academic activities (Fig. 1.1). It includes defining targets environments, adaptive techniques, mitigation strategies, policy support and synergies through networking. The operational strategy of the institute is to focus on basic research on abiotic stresses faced by the country, strategic human resource development, robust databases and amelioration approaches using frontier technologies with the participation of a wide network of national and international centres. Institute's comprehensive strategy of prioritizing characterization of the occurrence and magnitude of various abiotic stresses impacting the agriculture sector provides rationale for basic and strategic research on agro-ecology specific stress mitigation and adaptation technologies for crops, horticulture, livestock and fisheries. This will be facilitated by continuing efforts to develop world-class infrastructures and scientific manpower necessary for the center of excellence in abiotic stress management. Assessment of available inputs and their use synergistically, preventing losses, judicious allocation of inputs among the competing demands for maximizing returns and development of site-specific technologies are the means of achieving high resource use efficiencies for sustainable agriculture. In addition, joint adaptation and mitigation actions against climate change that can be implemented today across a wide range of land and water resource management solutions should provide both adaptation benefits in the short-term and mitigation strategies on a long-term basis.

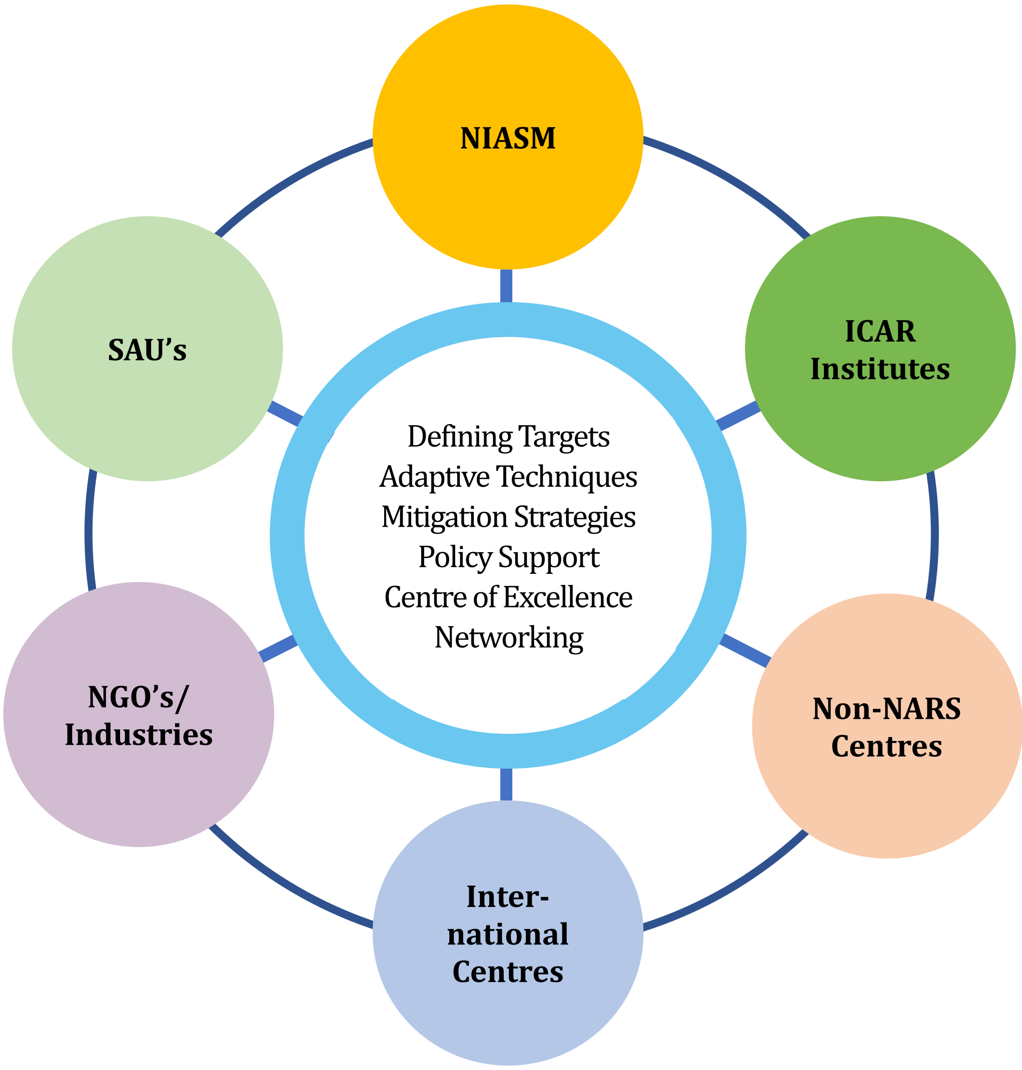


Fig. 1.1: Institute's strategy for achieving the mandate

Status of the Institute

In the XIth Five Year Plan, the Union Cabinet approved the proposal of 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, MS. After being established as a new institute for abiotic stress management in 2009, NIASM initiated its activities at the camp office at KVK, Baramati. The office was then shifted to Gat No. 35, Malegaon, Khurd, on November 1, 2010, after the inauguration of the

Engineering Workshop by 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. Subsequently, institute staff have shifted to the new Office-cum-Admin block and two school buildings. Substantial efforts have been made to strengthen human resources for carrying out research, administrative and technical activities of the institute. The institute has carrying out the research through four schools with a multidisciplinary approach (Fig. 1.1). Presently, the scientific, technical, and administrative staff strength is 30, 10 and 6, respectively. The filled-up cadre strength is 46 against 116 sanctioned posts (Table 1.1).

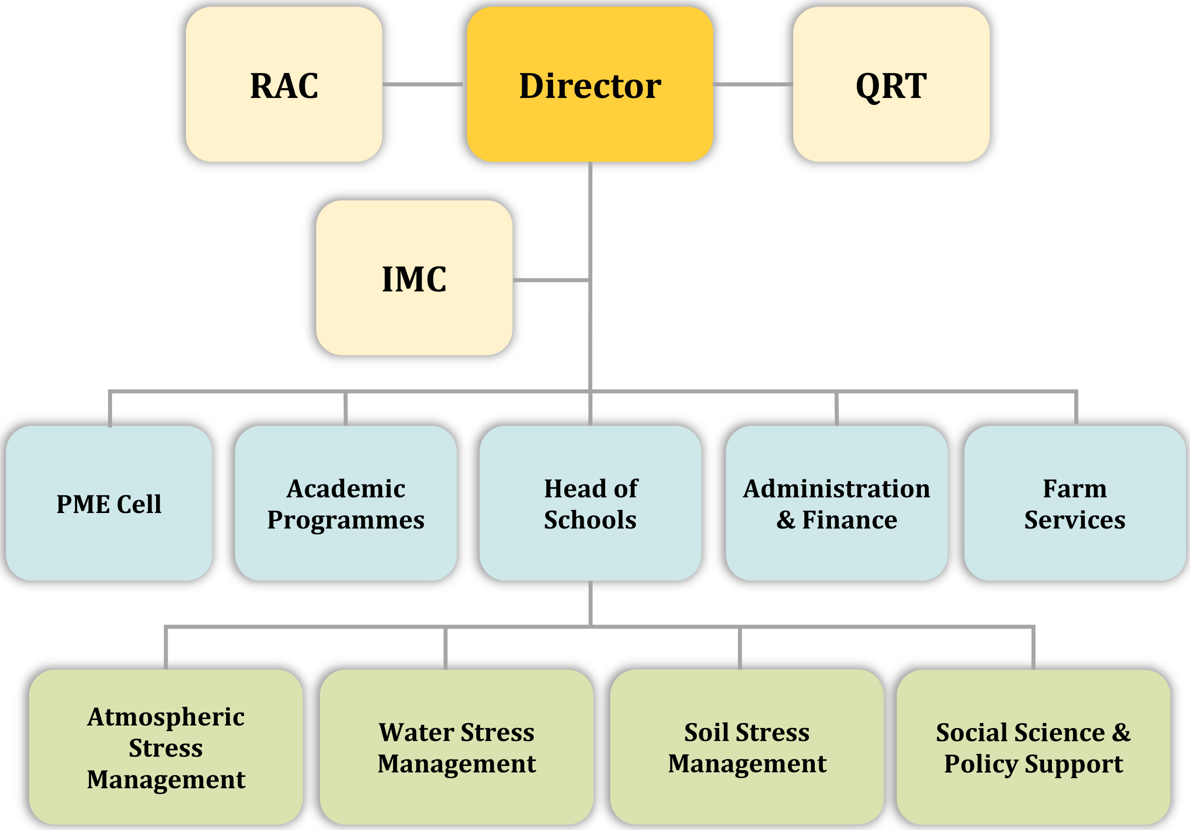


Fig. 1.2: Organogram of the Institute

Table 1.1: Cadre strength of the Institute as on December 31, 2022.

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	29	21
Technical	33	10	23
Administrative	32	06	26
Grand Total	**116**	**46**	**70**

Infrastructure for Research and Academics

Office-cum Administrative Building

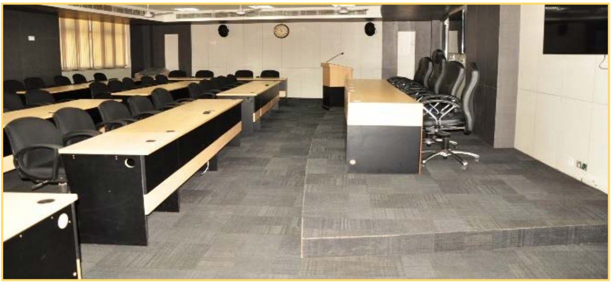
The office-common administration building is an architectural marvel. The buiding is equiped with centralized air-conditioning system and a centrally located open-air amphitheatre with a public address system. On safety aspect front, the building is fitted with a fire detection and alarm system.

Auditorium

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

Conference Rooms

In addition to auditorium, the Institute has four conference rooms equipped with audio-visual systems, which can allow parallel sessions for conferences and training.



School Buildings

Two schools, School of Water Stress Management (SWSM) and School of Soil Stress Management (SSSM) have been built presently. Each school has a reception hallway, two laboratories with a storage room, one HoD room, 12 scientific staff rooms, two technical staff rooms, one class room, one reading room, a pantry, and a record room.

Guest House

Nira Guest House is furnished with furniture in each room and linen material and has been made ready to accommodate at least 30 guests at any given time. The guest house has a well-furnished kitchen and dining halls.

Staff Quarters

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


Director residence


Staff quarter (on-campus)


Type III & IV Quarter, MIDC, Baramati


Type V Quarter, MIDC, Baramati


Type VI Quarter, MIDC, Baramati

Hostels

The hostel building has 72 rooms in two blocks with an attached bathroom in each room with provision of solar water heater. The dining block of these hostels is equipped with modular commercial kitchen with a seating capacity of around 100 persons.

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.

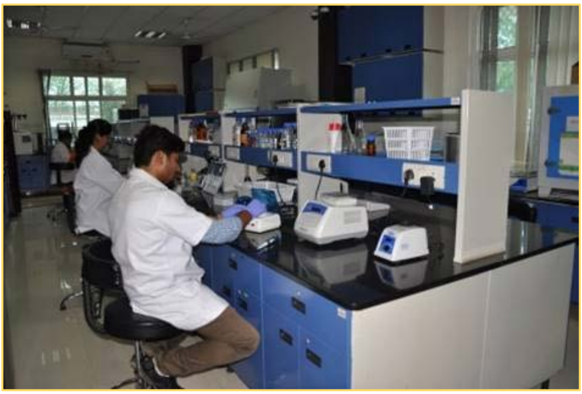
State-of-the-Art Research Facilities

Plant Phenomics Facility

The plant phenomics facility established under NICRA program is now fully functional. The Plant Phenomics facility with a capacity to house 225 pots is equipped with three imaging sensors viz., Infra-Red (IR), Visible (VIS) and Near-Infra Red (NIR). The facility is also equipped with automated weighing and precise watering stations. The system utilizes a conveyor belt system to move the plants with in the facility to and fro from growth chambers to the imaging cabinet. The entire facility is computer operated through Lemna Control Software.

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, CO_2 incubator, GC, HPLC, BIOLOG, Nanodrop, Root scanner, Automatic Nitrogen analyser, Fluorescent microscope and light microscope, etc. Plant Genetic Engineering and Molecular Biology (PGEN & Mol. Bio) Laboratory has been developed to carry out basic and strategic research to address plants response to various abiotic stresses. The PGEN and Molecular Biology laboratory has facilities for genomics, proteomics and for generating transgenic plants. 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.



Greenhouse Facility

There are four Hi-tech greenhouses with area of 240 m^2. Each Greenhouse is having three chambers of 10 m x 8 m. 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 season 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.

Model Herbal Garden

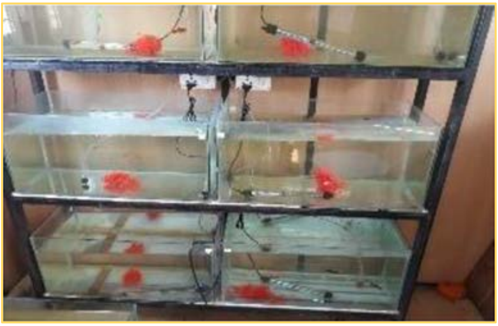
Model herbal medicinal garden named as 'Sanjeevani Garden' was developed under the financial assistance of NMPB, New Delhi. Medicinal plant species are Bonduc, Bael, Coral tree, Neem, Palash, Simaruba, Skikakayi, Putranjeeva, Soap nut, Shami, Shivan, Terminalia species, Wood apple, Mahua, Hirda, Behda,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

Experimental Livestock Research Facility

The institute has developed an Experimental Livestock Research Facility for conducting various experiments related to abiotic stress management in livestock. The facility consists of cattle, goat and poultry sheds, that are used for housing the animals for carrying out studies in large and small ruminants and poultry birds. The Committee for Purpose of Control and Supervision of Experiments on Animals (CPCSEA) has recognized and approved the registration of the institute's animal house facility purpose of research & in-house Breeding of small animals and large animals.

Fisheries Research Farm

The ICAR-NIASM has a modern facility to study the effect of abiotic stresses on fish. The glass aquarium, plastic rectangular tank, FRP tank and other kinds of facilities are available with this Institute. The wet laboratories have facilities to conduct experiments in both ornamental and food fishes. The wet laboratory also has dissection unit for collection of different samples after completion of experiments. The institute has three farm ponds for fish rearing and maintenance of fish brood stock and screening of different abiotic stress management in pond systems.



Institute Technology Management Unit (ITMU)

ITMU has done various activities during the year 2022. ITMU held meetings for routine tasks and identifying potential institute technologies. ITMU's publications have ISSN and ISBN for wider distribution. ICAR-NIASM has identified the commercialization-ready technologies, that inventors have demonstrated on farmers' fields. The various activities of ITMU are given in tables 1 and 2.

Table 1. Patents, RNI and ISBN registration details.

IPRs	Name of Innovation/ Technology/ Product/ Variety (Application/ Registration No.)	Date of Filing/ Registration	Progress
Patents	- Novel Micro-stimulant and Stress Alleviator for Aquaculture (202121048471)	25.10.2021	Application not yet published
	- A process for the development of nano-scaled metallic formulations for aquaculture. (202121041218)	14.09.2021	Application not yet published
	- Process for one step synthesis of bactericidal silver nano-particles from tissue extracts of Labeorohita (3255/MUM/2012)	09.11.2012	Registered
RNI registration for title ver- -ification of publication	- Abiotic Stress Management News (Print media) 1347075	14.06.2019	In Process
	- Annual Report (Print media) 1347075	14.06.2019	In Process
	Krishi Stress Patrika (Print media) 1347075	18.06.2019	In Process
ISBN registration of books	- Alternative crops for augmenting farmers' income in abiotic stress regions (978-81-949091-6-3)	-	Registered
	- Conservation Agriculture for Enhancing Productivity, Resource Use Efficiency & Environmental Quality of Sugarcane Cropping System (978-81-949091-7-0)	-	Registered
	- Abiotic Stresses in Agriculture: Impacts and Management (978-81-949091-0-1)	-	Registered

Table 2: Potential technologies of ICAR-NIASM

SN.	Name of technology (Inventors)	Technology ID (Krishi portal)	Year of Release
1.	*Enhancement of fruit size and quality in Dragon Fruit through supplementary pollination.* Boraiah KM, Basavaraj PS, Kakade VD, Harisha CB, Kate PA, J Rane, H Pathak	201655802341202	2022
2.	*Cultivation of Kharif chickpea: A novel practice for rising farmers' income in Western Maharashtra.* Gurumurthy S, Soren KR, Mahesh Kumar, Bohraiah KM, J Rane, H Pathak	201664861284183	2022
3.	*Micro-blasting and soil-mix technique for pomegranate cultivation in abiotic-stressed basaltic terrain.* Taware PB, Nangare DD, Mahesh Kumar, H Pathak	201628730570552	2021
4.	*Cultivating medicinal and aromatic plants in shallow basaltic soil.* Harisha CB, Nangare DD, Taware PB	201629540781386	2021
5.	*High-density planting in mango for enhancing yield and resource use efficiency under abiotic stress conditions.* Kakade VD, Nangare DD, Taware PB, Chavan SB, RajKumar, H Pathak	201629534409748	2021
6.	*Micro-blasting and soil-mix technique for guava cultivation in abiotic-stressed basaltic terrain.* Kakade VD, Y Singh, Nangare DD, Minhas PS, P Suresh Kumar, Taware PB, Chavan SB, H Pathak	201629536617536	2021
7.	*Rehabilitation of abiotic-stressed basaltic terrain with aonla (emblica officinalis).* Chavan SB, Nangare DD, Taware PB, Aliza Pradhan, P Suresh Kumar, Kakade VD, RS Gophane, H Pathak	201633497056286	2021
8.	*Preparation of dragon fruit saplings.* Wakchaure GC, Jadhav AR, Nangare DD, Kakade VD, J Rane, H Pathak	201633501439931	2021
9.	*Prevention of flower and immature fruit drop in Dragon Fruit through bagging, sheltering and supplementary pollination* Boraiah KM, Basavaraj PS, Vijaysinha Kakade, Harisha CB, Wakchaure GC, J Rane	201636529641652	2021
10.	*Micro-blasting and soil-mix technique for sapota cultivation in abiotic-stressed basaltic terrain.* Nangare DD, Kakade VD, Taware PB, P Suresh Kumar, Y Singh, PS Minhas, H Pathak	201628669987978	2020
11.	*Deficit irrigation management with plastic mulch in pomegranate orchard in abiotic-stressed basaltic terrain.* Nangare DD, PB, Mahesh Kumar, Y Singh, PS Minhas, Kakade VD, H Pathak	201628674653663	2019
12.	*Dragon fruit: wonder crop for rocky barren lands and water scarce areas.* Nangare DD, Mahesh Kumar, Taware PB, Kakade VD	201628672037221	2018
13.	*Deficit irrigation management in grape orchard in abiotic-stressed basaltic terrain.* Nangare DD, Taware PB, Mahesh Kumar, Y Singh, PS Minhas, P Suresh Kumar, H Pathak	201628678020305	2018

Budget Utilization

The financial statement (budget) and the revenue generated during the period of financial year 2021-22 are given in respective table 1.2 and 1.3.

Table 1.2: Budget utilization during the financial year 2021–2022

Head/Sub-head	Allocation (in lakhs)	Expenditure (in lakhs)
Grants in aid-Capital	56.06	
Office Building		14.21
Works		9.54
Equipment		17.69
Information Technology		12.47
Furniture and Fixtures		2.15
Sub Total-1	**56.06**	**56.06**
Grants in aid-Salary		
a) Establishment Charges	725.38	725.38
Sub Total-2	**725.38**	**725.38**
Grants in aid-General		
Pension and other retirement Benefits	2.52	2.52
Travelling allowance	577.35	1.58
Research and Operational Expenses		172.14
Administrative Expenses		402.42
Miscellaneous Expenses		1.21
Sub Total-3	**579.87**	**579.87**
Tribal Sub-Plan		
Grants in aid-Capital	10.38	9.08
Grants in aid-General	31.33	31.33
Sub Total-4	**41.71**	**40.41**
Scheduled Castes Sub-Plan		
Grants in aid-Capital	59.93	55.40
Grants in aid-General	43.69	38.55
Sub Total-5	**103.62**	**93.95**
Grand Total	**1506.64**	**1495.67**

Table 1.3: Revenue generated during the financial year 2021–2022

Particulars	Amount (in lakhs)
Sale of farm produce	13.82
License fee	6.41
Unspent Balance of Grants of Previous Year	3.08
Interest on short term deposits	1.26
Recoveries from loans and advances	2.18
Miscellaneous receipts	1.39
Grand Total	**28.14**

2. Research Highlights

2.1 SCHOOL OF ATMOSPHERIC STRESS MANAGEMENT

The production and productivity of crops, livestock, and fisheries are all directly impacted by weather anomalies produced mostly by atmospheric shifts. However, linked population dynamics of biotic variables like pests and illnesses also have an indirect impact on production and productivity. Accordingly, the research programme on atmospheric stress management has largely concentrated its research activities on comprehending the effects of atmospheric stress and developing assessment and management strategies in crops, and livestock using geospatial mapping approaches, fundamental research, and strategic investigations in areas focusing on thermal stress. This includes gathering geospatial information and creating tools for mapping abiotic stresses, calculating GHG emissions from livestock; developing hardware for monitoring physiology of cattle, examining heat tolerance in goats, and deriving products from insects as potential new sources of protein. The major research findings emerging out and the progress made under this programme during the past one year is summarized below.

Weather conditions at ICAR-NIASM Research Farm

Information on weather is of paramount importance for agriculture production. Observations of weather parameters are being recorded at Institute on regular basis. Observations recorded during January to December 2022 are discussed below.

Temperature

The Long Period Average (LPA) of annual mean temperature of Baramati is 26.3 °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 25.5 °C and the monthly mean temperatures varied between 20.3 °C (January) to 30.5°C (April). The monthly mean temperature increased linearly from February to April-May followed by reduction during June to September due to cooling effect of the monsoon winds, after which it started decreasing and attained a value of 22.8°C in December. Monthly maximum temperature reached its peak in April (39.0°C) and dipped to 27.8°C in January. For minimum temperature, May recorded the maximum (22.6°C) and January recorded the minimum (12.8°C) values (Table 2.1.1).

Relative humidity

Relative humidity measured, at standard hours in the morning (0700 LMT) and afternoon (1400 LMT), during the year 2022 were used for computation of monthly statistics. Monthly mean relative humidity during the different months has been depicted in Fig. 2.1.1. Relative humidity at morning varied between 70% (April) and 93% (September). On the other hand, variation in afternoon relative humidity was between 18 % (April) to 71 % (July). 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 to its highest value during monsoon months, and again decreased in post monsoon months. Annual mean relative humidity averaged over the entire year stood at 63 % and ranged between 44 % to 81 %. Higher diurnal ranges (more than 50%) in RH were observed in February to April. The lowest diurnal range was observed in July (20%).

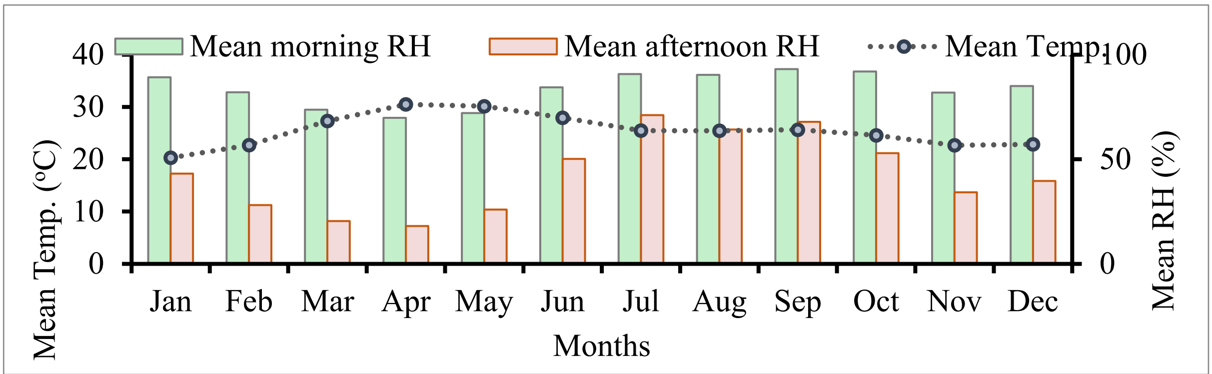


Fig. 2.1.1: Variations of monthly mean temperature, mean morning and afternoon relative humidity during 2022 at ICAR-NIASM Baramati.

Rainfall

The Long Period Average (LPA) annual total rainfall of Baramati is 596.9 mm with an average of 34 rainy days per year. This year, Baramati received about 92% of its average annual rainfall, distributed among 33 meteorological rainy days, which yielded 546.2 mm of total rainfall in 2022. 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 (109.2 mm), followed by August, September and July (Table 2.1.1). In the monsoon season, there were 27 rainy days with total rainfall of 373.6 mm, which is 90% of normal rainfall of the region. Late withdrawal of monsoon resulted in incessant rains during October. In the post-monsoon season, highest rainfall occurred in October (169.2 mm) and during the summer season, 2.2 mm of rainfall was received (Fig. 2.1.2.).

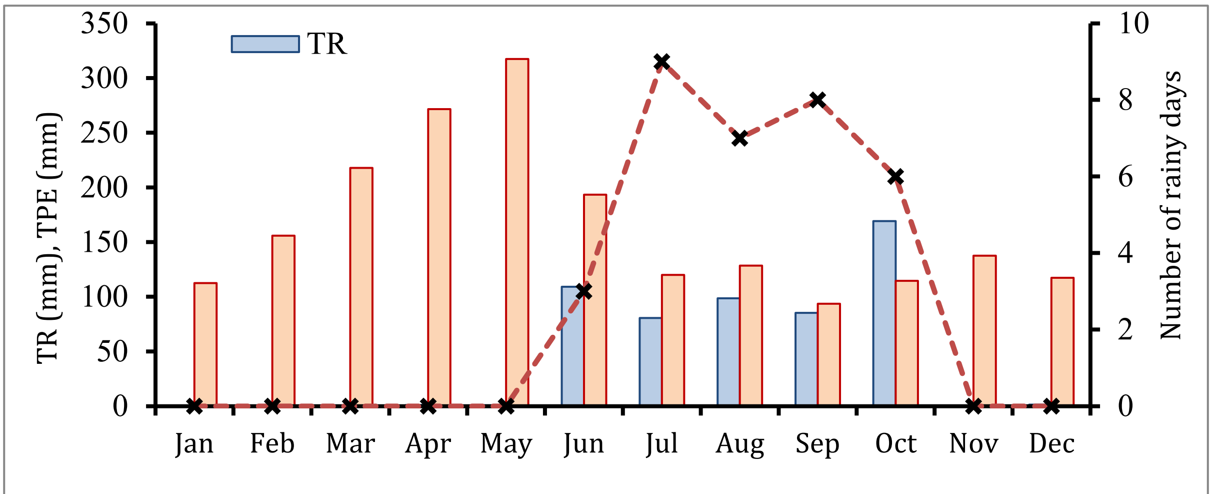


Fig. 2.1.2: Variations of monthly total rainfall (TR), total pan evaporation (TPE) and number of rainy days during 2022 at ICAR-NIASM Baramati.

Wind speed, Pan Evaporation and Sunshine duration

Monthly averages of the wind speed, pan evaporation and bright sunshine hours recorded in this year at ICAR-NIASM are presented in Table 2.1.1. Monthly average wind speed values have been found to vary from 3.6 (November) to 11.7 kmph (May), and the annual average for the daily wind speed stood at 6.8 kmph. It is observed that wind velocity was higher during May-July (>9.0 kmph) compared to the rest of the months (Table 2.1.1). Annual total open pan evaporation (TPE) aggregates to 1980 mm, which was around 4 times of the total rainfall of this year. The evaporative demand gradually increased from January and achieved its highest value in May (10.2 mm/d). It declined thereafter to 6.4 mm/d in June and from July to December average daily pan evaporation varied between 3.1 to 4.6 mm/d. The lowest evaporation rate was recorded in September (3.1 mm/d). The annual average of daily PE was 5.3 mm. During the year, the daily average of bright sunshine duration remained 5.7 hrs and monthly average values have been found to vary between 2.2 hrs (July) and 9.3 hrs (February) (Fig. 2.1.3).

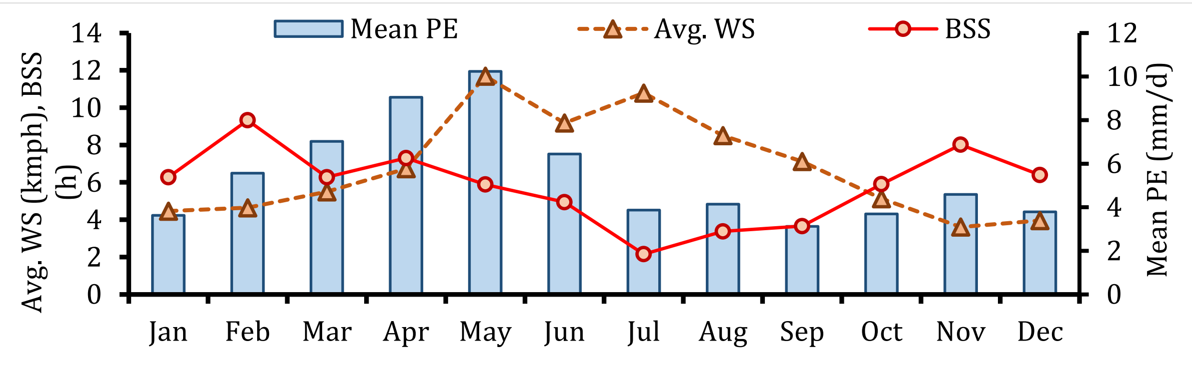


Fig. 2.1.3: Variations of monthly mean pan evaporation (PE), average wind speed (WS) and mean bright sunshine hours (BSS) during 2022 at ICAR-NIASM Baramati.

Table 2.1.1: Mean monthly weather parameters recorded at ICAR-NIASM from Jan to Dec, 2022

Parameter	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmax (°C)	27.8	31.9	35.9	39.0	37.7	33.7	29.3	29.9	30.0	30.1	30.5	30.4
Tmin (°C)	12.8	13.5	18.7	22.0	22.6	22.1	21.6	21.0	21.3	19.1	14.8	15.2
RH I (%)	89	82	74	70	72	84	91	90	93	92	82	85
RH II (%)	43	28	20	18	26	50	71	64	68	53	34	40
Avg. WS (kmph)	4.5	4.6	5.5	6.7	11.7	9.2	10.8	8.5	7.1	5.1	3.6	4.0
BSS (h)	6.3	9.3	6.3	7.3	5.9	4.9	2.2	3.4	3.7	5.9	8.0	6.4
Total rain (mm)	0.0	0.0	0.4	1.0	0.8	109.2	80.6	98.6	85.2	169.2	0.0	1.4
Total rainy days	0	0	0	0	0	3	9	7	8	6	0	0
Mean PE (mm/d)	3.6	5.6	7.0	9.1	10.2	6.4	3.9	4.1	3.1	3.7	4.6	3.8

Extreme weather observation recorded in 2022

The warmest and coldest days in the entire year were obtained based on daily mean temperature data, and it was found that 10th May (33.3°C) and 25th Jan (16.7°C), were the warmest and coldest days, respectively (Table 2.1.2). Daily maximum temperature reached up to 41.4°C (29th Apr), while lowest daily minimum temperature dipped to 8.5°C (9th Dec). The warmest and coldest months were calculated based on monthly mean maximum and minimum temperatures, respectively. Apr (30.5°C) was the warmest and Jan (20.3°C) was the coldest month during this year (Table 2.1.1). The cumulative monthly rainfall was highest in October (169.2 mm). The highest rainfall, pan evaporation and wind speed events were reported on 20th October (66.2 mm), 10th May (13.5 mm/d) and 23th May (19.4 kmph), respectively.

Table 2.1.2: Important meteorological events of the year 2022

Particulars of weather parameter	Value	Date
Highest daily mean temperature	33.3 °C	10 May 2022
Lowest daily mean temperature	16.7 °C	25 Jan 2022
Highest daily maximum temperature	41.4 °C	29 Apr 2022
Lowest daily minimum temperature	8.5 °C	9 Dec 2022
Highest monthly mean temperature	30.5 °C	Apr 2022
Lowest monthly mean temperature	20.3 °C	Jan 2022
Highest daily rainfall	66.2 mm	20 Oct 2022
Highest monthly cumulative rainfall	169.2 mm	Oct 2022
Highest monthly cumulative PE	317.4 mm	May 2022
Highest rate of daily PE	13.5 mm	10 May 2022
Highest daily wind speed	19.4 kmph	23 May 2022

α-version Atmospheric Stress Information System

The α-version Atmospheric Stress Information System comprising of sub modules on district level weather warnings, 5-day forecast and nowcast sourced from IMD, Pune has been developed. Other sub modules of products based on past weather datasets and weather forecast namely livestock heat stress vulnerability and its management options is being integrated from spreadsheet module to web based module.

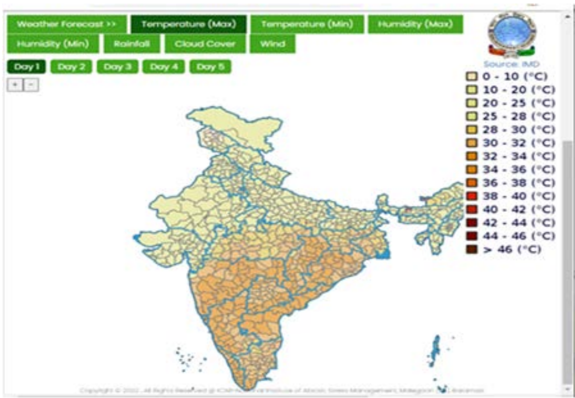


Fig. 2.1.4: α-version Abiotic Stress Information System

α-version Soil Information System

The georeferenced datasets of soil parameters were collected from soil health card (SHC) programme of the Govt. of India for entire country. These datasets (more than 16 crore soil samples across years 2015-2019) were curated using multiple criteria (minmax thresholds, geofencing, LULC, duplicates) using custom built python codes. The curated dataset was interpolated using inverse distance weighting (IDW) technique and averaged spatially to prepare tehsil level soil nutrient maps for each soil parameter using standardized formula (MOSPI, 2019; Pathak, 2010).

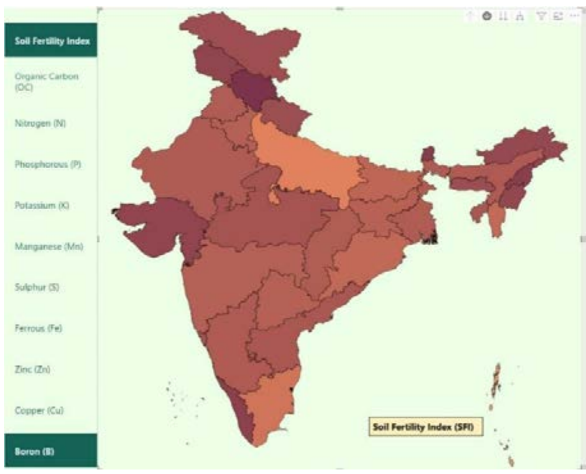


Fig. 2.1.5: Soil Nutrient and Soil Fertility Index maps for India

These were further integrated into a weighted sum Soil Fertility Index (SFI). All the processed datasets have been hosted on α-version Soil Information System (SIS) as maps at http://niam.res.in/ASIS/SIS. The SIS is being transitioned and merged as submodule in the α-version of Abiotic Stress Information system.

α-version Abiotic Stress Information System (ASIS)

The α-version Abiotic Stress Information System (ASIS) with sub modules has been hosted at www.niasm.icar.gov.in under the ASIS Quick Links. This version is planned to provide user input based interactive maps with sub-modules on atmosphere, soil and water stress information system along with management options and future scenarios.

Fig. 2.1.6: α-version Abiotic Stress Information System (ASIS)

Databases for geospatial mapping of multiple components under Abiotic Stress Information System

The raw datasets of parameters pertinent to Abiotic stress information system (ASIS) viz. delineating boundaries, Meteorological parameters, LULC and soil layers were sourced from several open access sources and compiled into databases to create respective geospatial layers and maps.

Delineating boundary layers: The updated geographical delineating boundaries namely, administrative boundaries (644749) village, (6310) tehsil/block, (737) district and (37) state boundaries were collected from GOI sources and converted to GIS layers of ASIS.

Meteorological parameters: The maps sourcing weather parameters pertaining to district level weather warnings, 5-day forecast, nowcast and data pertaining to automatic weather stations of IMD are now accessible via ASIS server. Additionally API access to 5-day weather forecast sourced from third party services have also been obtained.

LULC and Soil Layers: The latest land use and land cover (LULC) raster map for year 2018 was sourced from GOI sites for use as geospatial layer for data curation and imposing decision rules pertaining to LULC. Also soil datasets pertaining to soil depth, texture, erosion and productivity for India have been extracted from GOI sources in form of geo-spatial raster layers for developing soil stress index. All the compiled datasets is further being used in synthesis of products that would simplify depiction and interpretation of abiotic stresses and its management options at regional and national scale by the academic and administrative stakeholders.

Investigations on suitable day hours available for RPAS applications in Indian agriculture as impacted by local weather parameters

The economic feasibility of using a remotely piloted aircraft system (RPAS)/drone for agricultural applications depends on its annual use hours and is yet to be established for Indian agriculture. The day hours suiting RPAS application (spraying chemicals, crop assessment) are region specific due to dependency on local weather parameters for effective operation. This study investigated the spatio-temporal zonal statistics to derive mean day hours suiting three usage scenarios viz., chemical pesticide spraying (U1); crop assessment using passive optical sensors (U2); and research studies requiring use of additional multispectral/ hyperspectral on-board sensors (U3) using thresholds for hourly gridded meteorological data of 2010-2021 for India. The threshold values for each weather parameter (wind speed, rainfall, total solar radiation, maximum temperature, minimum temperature and minimum all-sky isolation index (KT) values) were selected based on the literature reviewed for increasing spray efficacy, minimizing spray drift and avoiding repeat applications due to rains. Similarly, the threshold for crop assessment and research purposes was defined to minimize errors arising in captured data due to low solar irradiation, cloud cover, and destabilizing wind velocities. The annual day hours suitable for RPAS application ranged from 610.5 to 1355 for the agro-climatic regions. However, the monthly day hours suiting drone usage had larger deviations across the year for the majority of geographical aggregations, with monthly use hours as low as 20 hours during monsoon months owing to higher wind speeds and rainfall and contrasts the anticipated maximum utility desired during the Kharif season. This study provides additional analytics needed for data-driven policy formulations as the estimates were found much lower than the minimum 6-hour daily RPAS usage estimated by DA&FW, GOI for affordable spraying application. Additional RPAS applications, therefore, need to be explored to increase utility hours during lean periods found in the study.

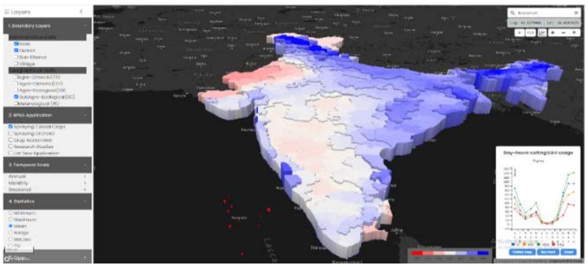


Fig. 2.1.7: Interactive web-maps depicting geospatial monthly and annual utility hours of RPAS as impacted by local weather

APY interactive web-maps for selected crops of India.

Agricultural Area, Production and Yield (APY) Maps of selected crops (rice, gram and sugarcane) of India are made available as interactive maps based on APY datasets of DAC&FW, GOI. The maps were prepared to support the crop diversification activity being carried out by ICAR-IIFSR Modipuram. The interactive maps will help policy makers visualize the data and help understand the distribution pattern and statistics of APY datasets in an interactive manner. The datasets are hosted on www.niasm.icar. gov.in.

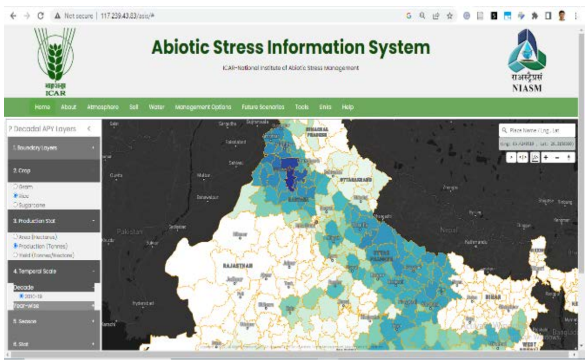


Fig. 2.1.8: APY interactive web-maps

GHG emission maps from livestock based on Tier I and Tier II Protocol (IPCC)

District level methane emission from livestock through enteric fermentation was estimated using the IPCC (2019) Tier I and Tier II protocol for India for cattle, buffalo, sheep, goats, and pigs. The resulting maps of district level GHG emission from livestock through enteric fermentation using Tier I protocol for India is loaded to ASIS website for intereactive visualization. Also Tier II calculations based on IPCC protocol were done and the resulting maps are depicted in Fig. 2.1.9.

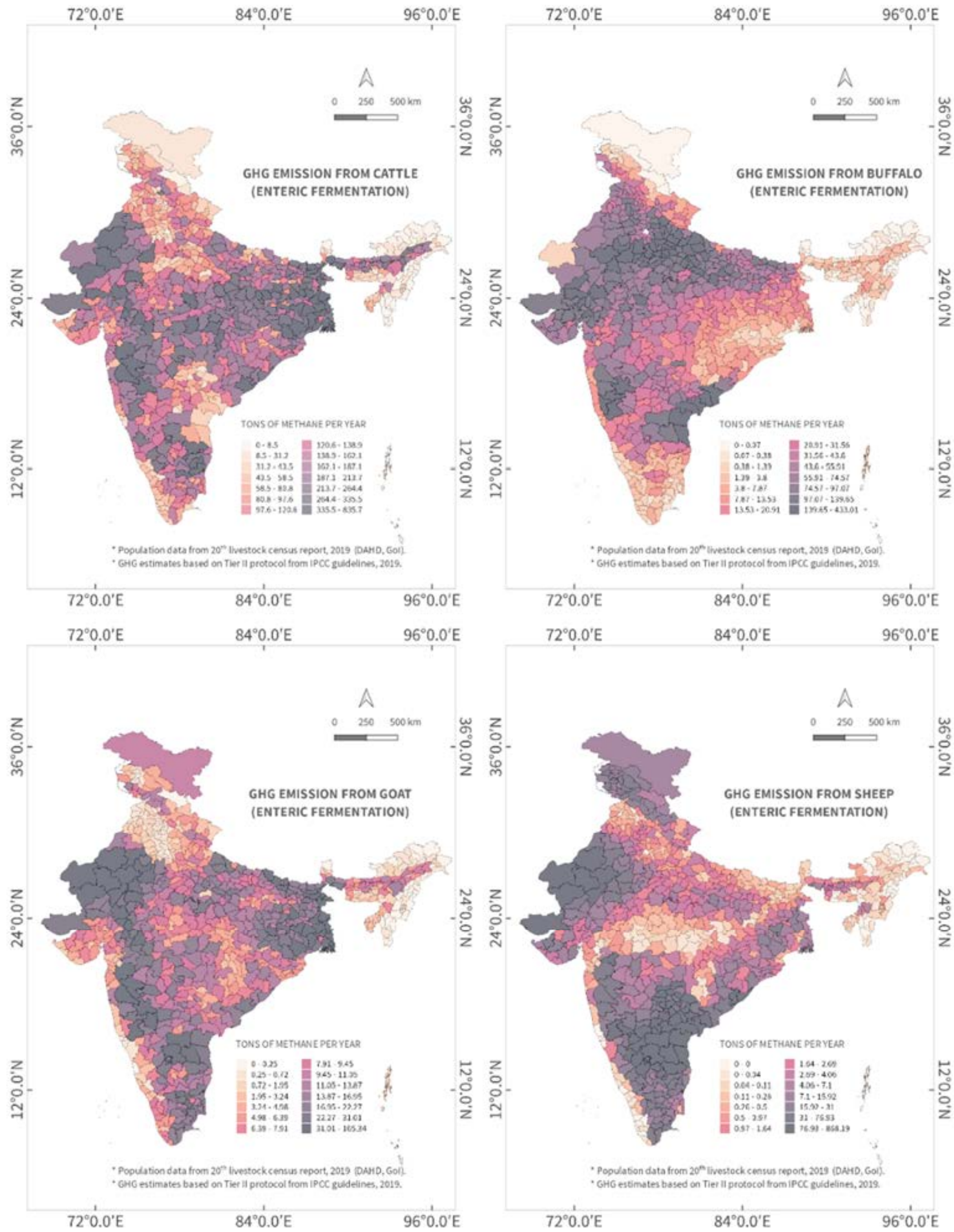


Fig. 2.1.9: GHG emission from livestock Tier II

Prototype of Animal Monitor (V1.0)

A working prototype was developed for monitoring abiotic stress in livestock. The prototype includes Arduino micro controller, pulse rate sensor (MAX30102), temperature sensor (MAX30205), timer module, data logger module and a battery pack (9v). The prototype records parameters viz. pulse rate and body temperature along with date and time. The laboratory trials found the performance of unit satisfactory.

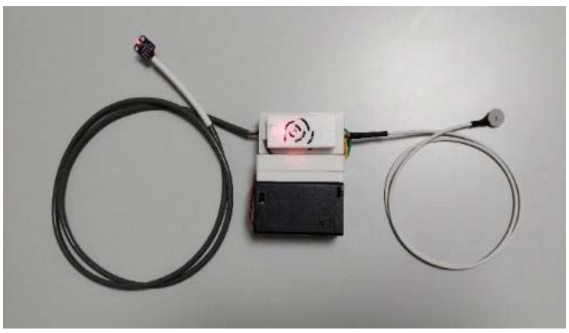


Fig. 2.1.10: Animal Monitor prototype (Ver. 1.0)

Establishment and monitoring of alternate fodder unit

An alternate fodder unit was established under the livestock farm of ICAR-NIASM to provide supplementary fodder resources to the conventional fodder fed to livestock. Four species of fodder plants viz., *Azolla microphylla*, *Lemna minor*, *Spirodela polyrhiza* and *Fagopyrum esculentum* were introduced for mass multiplication and utilisation as alternate fodder for livestock as per standard protocol using using soil, cow dung and water. The proximate analysis of the fodder species is given in Table 2.1.3.

Fig. 2.1.12: Azolla in 6m×1m×1ft beds

Fig. 2.1.13: Lemna minor and Spirodela polyrhiza growing in FRP

Fig. 2.1.11: Buck wheat plot in Grass Cafeteria

Table 2.1.3: Proximate analysis of fodder

Parameters	Azolla mic rophylla	Lemna minor	Spirodela polyrhiza
Moisture	7.23	6.11	8.21
Crude Protein	19.11	32.18	28.22
Ether extract	3.2	3.82	3.2
AIA	0.4	0.5	0.4
Crude Fibre	13.1	11.89	10.11
Total Ash	11.89	14.5	13.21
Nitrogen	3.06	5.15	4.52

Spatial modelling of time required for advancement of chickpea generations in India

The number of days required for advancement of five generations across geographical extend of India was simulated using DSSAT model to explore the locations suited to undertake chickpea breeding trials. The model cultivar coefficients for chickpea were modified using sensitivity analysis module to minimize the RMSE and percent error across five generations of Vijay variety against the observed values of generation advancement trials carried out at ICAR-NIASM. Daily weather data, *viz.*, precipitation, maximum temperature, minimum temperature, relative humidity, solar radiation, and sunshine hours for year 2021 recorded at IMD (Indian Metrological Department) metrological station located within 200m of experimental site within ICAR-NIASM (Latitude: 18.1529, Longitude 74.5002) were used as inputs in the process. These modified cultivar coefficients reduced the per cent error and RMSE across all generations except those coinciding with rainy season (2nd generation) and summer season (5th generation). Empirical evidence suggests that soil water can influence flowering time in chickpea, but DSSAT does not account for this effect and therefore limited reducing RMSE and percent error by modifying cultivar coefficients alone. With the modified cultivar coefficients the simulation was run across spatial grid of 1455 points spaced 50 km covering India for forecasting anthesis day, first pod day, days to first seed formation. The data was filtered for grid points with abnormal values and with null values for any of the five generations reported by model.

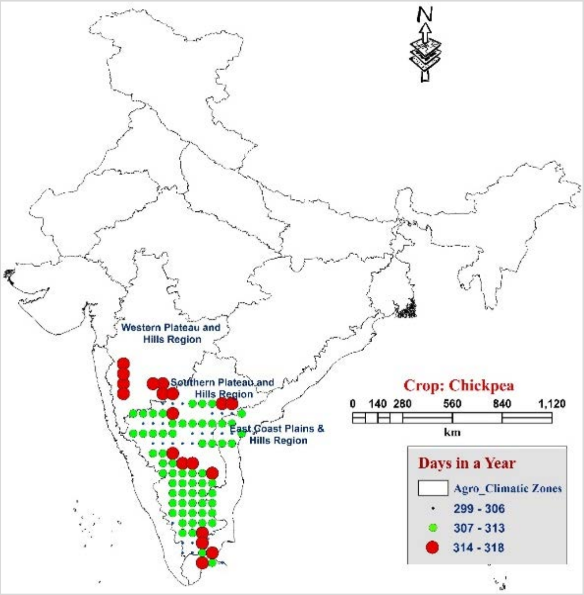


Fig. 2.1.14: Days for 5 generations of Chickpea

Table 2.1.4: Model performance (% error) for five generations with modified cultivar coefficients

Generations	G1	G2	G3	G4	G5
EMFL	4.41	25	6.94	-5.41	-25
FLSH	-1.04	12.5	2	-6.48	-28.07
FLSD	-7.69	13.46	9.26	-4.31	-25

The resulting data was further filtered by discarding the areas having consecutive planting day falling before the availability of germinable seeds from previous generation and annual rainfall within 300-900 mm, considered favourable for chickpea growth. The filtered dataset was further narrowed to the datasets that were within the days required for seed formation at Baramati experimental site, so as to know the areas having potential for advancement of five generations in shorter time. The filtered dataset was used to prepare the spatial map using QGIS software. The Southern plateau and hilly regions and limited areas of Western plateau and hilly regions and East coast plains and hilly region were the most suitable agro-climatic zones for rapid generation advancement in Chickpea (Fig. 2.1.14) as similar to experimental site at Baramati. However this requires field to have good soil drainage arrangements to reduce possibilities of delayed flowering. Ideally simulating the days to first seed formation for weekly planting across year should allow theoretically calculating maximum number of generations that can be taken in quick succession across spatial extent of India. These findings should help aid in process of scientific policy planning to setup chickpea breeding locations at lower cost of establishment.

Identification of farm ponds and storage water tanks using satellite imagery and deep learning.

The farm pond-based aquaculture is potential option to improve farmer's surplus income and ensure their sustainable livelihood. Fish culture in such water bodies can increase fish production and economic returns per unit area of land. To access the potential of this possibility, methodology for identification of farm ponds using satellite imagery was worked out, using sentinel 2A bands (B3 and B8) to calculate the NDWI and delineate the inland water bodies using Google Earth Engine (GEE) platform. Area based filters were used to eliminate the larger water bodies to create vector polygons of water bodies smaller than 8000 m^2. The tiles of these potential farm pond locations were further downloaded using custom built geojson tile downloader and, annotated to create training dataset and

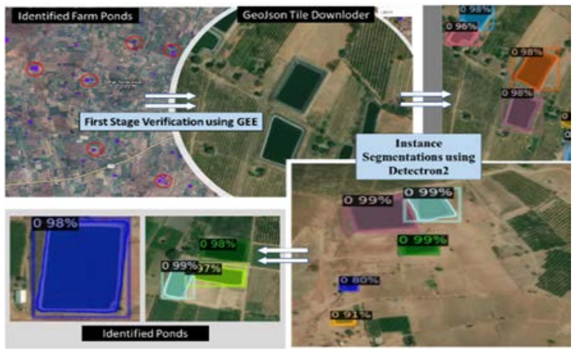


Fig. 2.1.15: Methodology for identification of farm ponds and storage water tanks using satellite imagery and deep learning

subjected to deep learning models (Mask_RCCN of Detectron 2) for identification and geo-tagging of farm ponds in image for second stage of verification (Fig. 2.1.15). The 'MASK_RCNN' model identified farm ponds in the images with a threshold test value = 0.8. This methodology will help generate the database of farm ponds and storage water tanks which can be utilized for the farm pond aquaculture model in rainfed areas of Maharashtra.

Assessment of seasonal variations in physiological, haematological and growth parameters in different breeds of goats

Experiment was continued in four breeds of goat *viz.* Osmanabadi, Sangamneri, Konkan kanyal and Boer to assess comparative performance of these breeds with exposure to various atmospheric stressors particularly heat stress during the year. The monthly average temperature and humidity data and daily weather parameters viz. temperature (max/min), Humidity (max/min) and rainfall recorded during the experimental period was compared to the thermo-neutral zone (TNZ) for goats (14 to 24°C). The monthly average maximum temperature prevailing in the area is higher than TNZ of goats during all the months. The monthly average mean temperature was higher than TNZ during all the months except from December to February. This indicated exposure of goats under experiment to variable degree of thermal stress throughout the year. The monthly average minimum temperature was within the TNZ of goats throughout the year. This indicated that goats get sufficient time during nights for adjusting its physiology altered due to exposure to heat stress during day time.

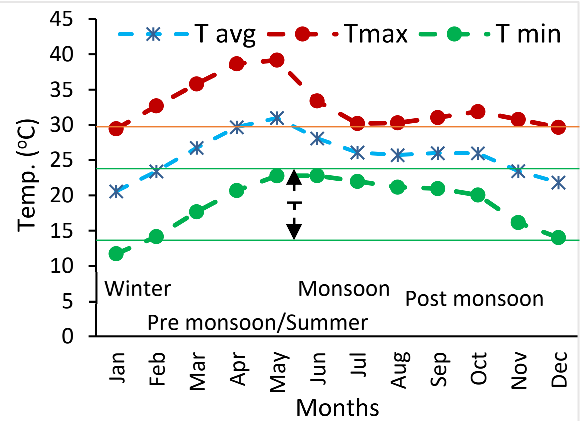


Fig. 2.1.16 a: The monthly mean (35 years) temperature of study area along with thermos-neutral zone (TNZ) for goats

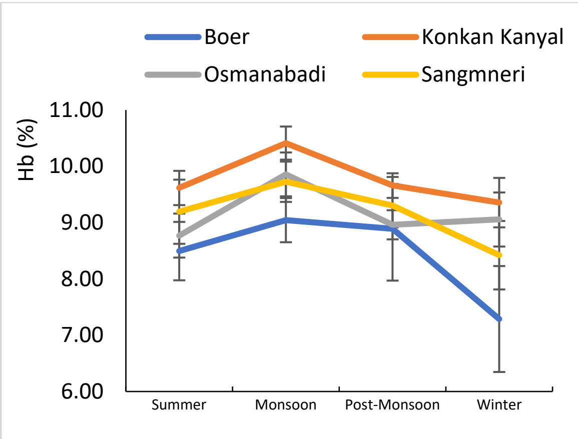


Fig. 2.1.16 b: Seasonal variation of haemoglobin in different breeds of goat during 2021 to 2022

Data was recorded for abnormal signs and symptoms; parasitic infestations; kids born in all the groups; their weekly body weights and monthly Hemato-biochemical and physiological parameters during July 2020 to Dec 2022. Higher haemoglobin levels were observed in Konkan kanyal than other breeds and during monsoon period as compared to lowest values during winter in all the breeds.

Physiological parameters *viz.,* heart rate, respiration rate and rectal temperature recorded at 9 am, 12 pm and 3 pm three increase at 12 and 3 pm compared with 9 am values. However further studies during various seasons, with more number of animals are required for evaluating times a implications of these preliminary observations. The overall growth rate, kidding rate was higher for Boer goats during 2021-2022. Across breeds, the overall growth rate was minimum during summer and monsoon period which increased during post monsoon and winter seasons.

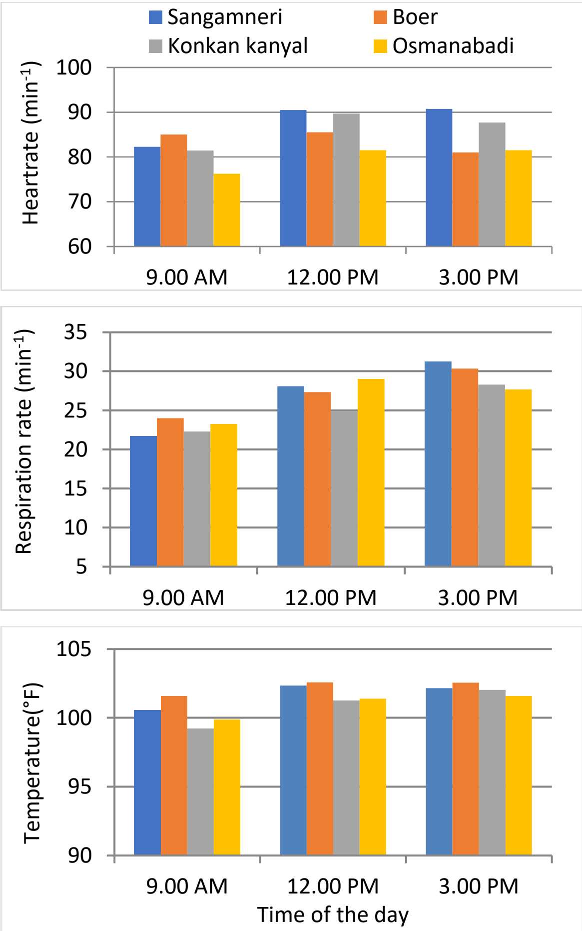


Fig. 2.1.17: Average variation of physiological parameters across day in different breeds of goat during 2021 to 2022

Boer goats showed higher growth rate during summer and winter. Sangamneri goats revealed highest growth rate during monsoon than other breeds whereas Osmanabadi goats showed better growth rate during post monsoon period. The overall growth rate, kidding rate was found higher for Boer goats. In all breeds,the overall growth rate was higher during winter, post monsoon period followed by summer and monsoon. Boer goats showed higher growth rate during summer and winter. Sangamneri goats revealed highest

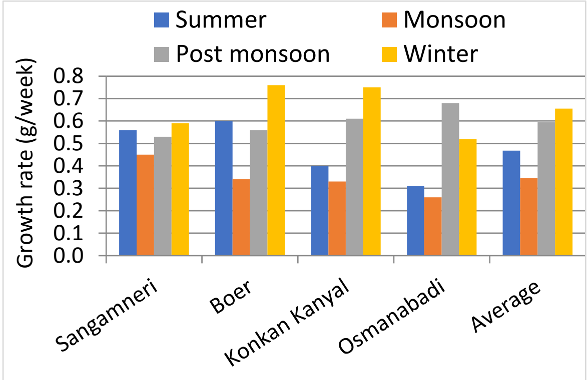


Fig. 2.1.18: Growth rate (g/week) in different breeds of goats across seasons

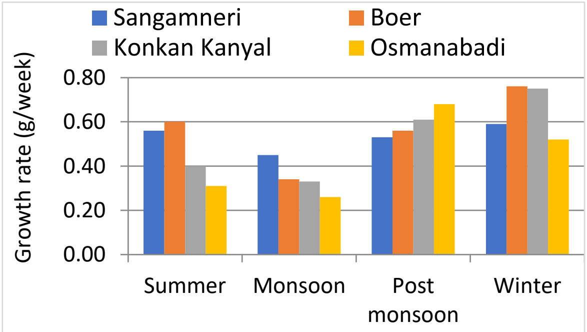


Fig. 2.1.19: Growth rate (g/week) in different seasons across breeds

growth rate during monsoon than other breeds whereas Osmanabadi goats showed better growth rate during post monsoon period. Based on all other growth, physiological, haemato-biochemical and reproduction parameters it may be inferred that all the four breeds of goats can sustain the climatic stress prevalent in the region and may be suitable for rearing in similar climatic regions. A survey on goat farming conducted using a detailed proforma for farmer's profile and goat husbandry practices in various villages nearby Baramati, revealed very high prevalence of anaemia in goats. In order to reduce prevalence of anaemia in goats herbal mixture of 10 different plant leaves has been prepared and being evaluated for its performance in field goats for treatment of anaemia. Samples were collected for nutritional and micronutrient analysis as well as parasitic prevalence. Further to study the prevalence and pattern of occurrence of anaemia along with its etio-pathology, a survey of goat farmers has been planned. A detailed proforma for farmer's profile and goat husbandry practices was prepared and survey was conducted at Undvadi (Supe) village.

Modulation of Heat Shock Protein 70 (HSP70) gene expression in chickens under heat stress

The study was conducted to assess effect of exposure to heat stress on HSP70 gene expression pattern in chickens. The adult healthy birds (n=15) grouped into three replicates of n=5 each were used to isolate peripheral blood mononuclear cells (PBMCs). The PBMCs were subjected to heat stress at 42 °C for 1 h, and cells without heat stress (NHS) were taken as control. The cells were seeded in 24 well plates and incubated in a humidified incubator at 37 °C under 5% CO_2 for recovery. HSP70 expression kinetics were evaluated at 0, 2, 4, 6 and 8 h of recovery period. Compared with NHS, expression pattern of HSP70 was upregulated gradually from 0 to 4 h with peak ($p<0.05$) expression recorded at 4 h of recovery time. mRNA expression of HSP70 escalated in a time-dependent manner from 0 to 4 h of heat exposure and thereafter exhibited a gradually decreasing pattern till 8 h of recovery period. The findings from this study highlights protective role of HSP70 against deleterious effects of heat stress in chicken PBMCs.

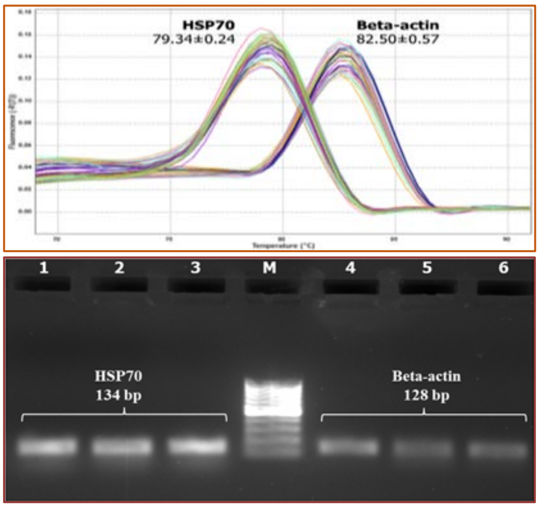


Fig. 2.1.20: SYBR-Green based real-time PCR for amplification of HSP70 and β-actin genes. Melt curves and agarose gel electrophoresis for HSP70 and Beta-actin

Black soldier Fly (BSF); *Hermetia illucens* as a novel source of protein

In the recent years, one of the insect species that is gaining attention as potential food and protein source both for humans and livestock is the Black soldier Fly (BSF); *Hermetia illucens L*; (Diptera; Stratiomyidae). Various byproducts were prepared from BSF larvae, after reducing 70% water content to safe limits using oven heating. The larvae were slowly dehydrated at 65°C for 24 hours using hot air to prevent the loss of valuable nutrients. To ensure uniform heating inside the oven, use of fan for proper air circulation is recommended. Byproducts such as BSF meal (with and without defatting), BSF oil, Empty pupal shell meal, BSF adult fly meal and BSF fertilizer were prepared from the dried BSF larve.

BSF meal (without defatting): The larvae with dry matter of 25-30%, were taken out and powdered using mixer grinder. The powder was stored in the airtight containers in the laboratory. The preliminary proximate composition analysis showed 6.27% moisture content, 34.21% crude protein, 1.30% crude fiber, 6.89% ash and 5.47% of nitrogen.

BSF meal (with defatting): The dried larvae was subjected to oil extraction using oil extraction machine. The leftover BSF cake after oil extraction was sun dried, powdered using mixer grinder and stored in air tight containers at room temperature in the laboratory. The preliminary proximate composition analysis revealed 3.28%

moisture content, 57.64% crude protein, 1.98% crude fiber, 7.13% ash and 9.22% of nitrogen.

BSF oil: BSF oil was obtained during defatting of BSF meal and is stored in air tight container at room temperature in laboratory. The proximate composition analysis of BSF oil is being carried out.

Empty pupal shell meal: 20% of the pupal population is used in further mass production of BSF. The adult flies that emerge from the pupae leave behind nutrient rich empty pupal shells. After the complete emergence of flies from the pupa, the empty pupal shells were collected from the rearing cages and were oven dried at 65°C for 24 hours, further powdered using mixer grinder and stored in air tight containers at room temperature in the laboratory. The preliminary proximate composition analysis of the product found 6.78% of moisture content, 36.43% crude protein, 1.60% crude fiber, 7.30% ash and 5.83% of nitrogen.

BSF adult fly meal: The BSF adult flies that emerge from the pupa mate on the 3 or 4th day of their emergence to lay the eggs and later die after adult life span is 8-10 days. After the completion of egg production cycle in the cage, the dead flies were collected and oven dried at 65°C for 24 hours, further powdered using mixer grinder and stored in air tight containers at room temperature in the laboratory. The preliminary proximate composition analysis of the product found 8.45% of moisture content, 64.74% crude protein, 1.43% crude fiber, 7.40% ash and 10.52% of nitrogen.

BSF fertilizer: In the BSF mass production process, mostly organic substrates such as fruits vegetables and kitchen waste etc were used in feeding the BSF larvae from 6th day of their hatching till 18-20 days. When the BSF larvae reaches pupal stage, the left over feed is collected from the feeding trays and is processed to make it into a fine organic fertilizer. The BSF fertilizer consists of unfed organic material, BSF casting, moulted skin and other organic residues. To ascertain its nutritive value in order to use it as a source of organic fertilizer, the BSF fertilizer was found to have pH- 5.87; EC (mhos/cm)- 11.34; TDS (ppt)-6.14; Salinity (ppt)-7.06; Cu (mg/L)-0.13; Na (mg/L)- 9.10; K (mg/L)- 142.90; Zn (mg/L)- 0.18; Fe (Mg/L)- 6.80 and Mn (mg/L)- 0.20. The byproducts BSF meal (without defatting), BSF meal (with defatting), BSF oil, empty pupal shell meal, BSF adult fly meal and BSF fertilizer will be further used in conducting the experiments on percent replacement of feed used in aquaculture and poultry farming.

Fig. 2.1.22: By-products prepared from Black Soldier Fly (BSF)

2.2 SCHOOL OF SOIL STRESS MANAGEMENT

Salinity, mineral toxicity, and nutrient shortage are three significant soil stresses that have been identified as important hazards to the production of crops, cattle, fisheries, and other commodities. The school of soil stress management has focused on conducting basic and strategic research on soil-related stresses in crop plants, animals, and fisheries in order to manage these stresses. The work in the areas of elucidating the mechanisms and traits of soil stress response using a microbiome-based approach, adaptation strategies using integrated farming systems that are climate resilient, and pollution mitigation techniques in soil and water have generated a significant amount of basic understanding of the underlying processes. The research activities and findings of the school progressed over the pastyear are outlined here.

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

Evaluation of halophytic plants for traits associated with salinity and limited water stress:

Halophytes, *viz., Ipomoea pes-caprae* (P1), *Typha minima* (P2), *Avicennia marina* (P3), *Sesuvium portulacastrum* (P4), *Portulaca oleracea* (P5), *Spartina alterniflora* (P6) were grown in green house and evaluated for canopy coolness and proline content. Halophyte *Sesuvium portulacastrum* (P4) showed cooler canopy and higher accumulation of proline under 3% NaCl level while Halophyte *Avicennia marina* (P3) had higher canopy temperature compared to other halophytes under 3% NaCl level.

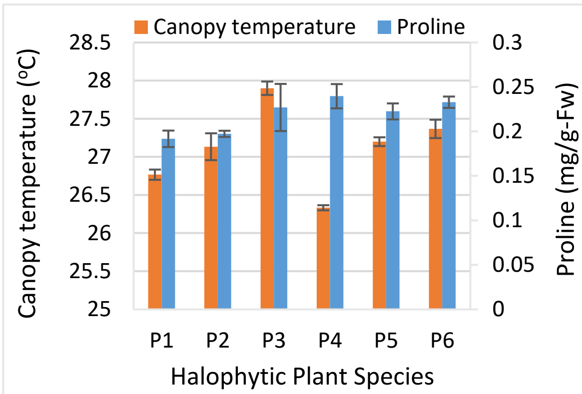


Fig. 2.2.1: Canopy temperature and proline content of halophytes under under 3% NaCl

Candidate genes for salinity tolerance from halophytic plants:

Genes induced under saline conditions were identified in *Sesuvium portulacastrum, Avicennia marina, Spartina alterniflora* and *Ipomoea pes-caprae* as mentioned in Table 2.2.1. These genes will be characterized for expression level using RT-qPCR.

Table 2.2.1: Candidate genes identified for salt tolerance from halophytic plants

Halophytes Species	Candidate genes for salt tolerance
Sesuvium portulacastrum	*SRTG152* (*Salt tolerance protein*) *NHX1* (*Vacuolar Na^+/H^+ Antiporter*) *NAC domain protein 6* *Zinc Finger Protein* (*ZFP*) *CBL* (*Calcineurin B-like protein*) *CIPK* (*CBL-interacting protein kinase*)
Avicennea marina	*Monodehydroascorbate Reductase* (*MDAR*)
Spartina alterniflora	*L-Myo-inositol 1-phosphate synthase* (*INO1*)
Ipomoea pes-caprae	*Salt tolerance Receptor-like cytoplasmic kinase* (*RLK*)

Fodder potential of halophytes:

Halophytes *Ipomoea pes-capre, Sesuvium portulacastrum* and *Spartina alterniflora* were evaluated for micronutrients (Cu, Zn and Fe) and also calcium and phosphorus content. Halophyte Sesuvium had higher level of copper, zinc, iron, calcium, and phosphorus.

Table 2.2.2: Nutrient content of halophytes

Halophyte Species	Copper (mg kg^{-1})	Zinc (mg kg^{-1})	Iron (mg kg^{-1})	Calcium (%)	Total P (%)
Ipomoea Pes-capre	10.13	27.26	72	1.24	0.21
Sesuvium portulacaastrum	11.46	27.76	84.7	1.34	0.22
Spartina alterniflora	10.2	29.2	44.63	0.13	0.21

Response of bacterial biomolecules, bioformulation and biopolymer on growth and development of mung bean under field condition

Microbe-based strategies are increasingly thought upon due to the ability of microbes to sustain under diversity of adverse environmental conditions and induce the stress tolerance mechanisms in plants. Thus, application of stress resistant microbes having plant growth promoting traits in crop plants cultivated in field condition could induce a general abiotic stress tolerance in plants. To extend the choice of microbe-based products bioformulation, biomole-cules, and biopolymer-application in a range of agricultural crops, a Bioformulation was formulated by amending a variety of synthetic and semi-synthetic components including plant growth hormones, carbohydrates, and amino acids, and peptides with the bioformulation of other two microbial products *viz.,* Biomolecules of secreted from PGPR, and biopolymer extracted from PGP rhizobium. This experiment investigated the performance of microbial biomolecules-based bio formulation, biomolecules, and biopolymer towards improvement in crop productivity and yield in mungbean under field conditions. The mung bean seeds were sown in an experimental field facility at the ICAR-NIASM campus in kharif 2022. Then the plants were harvested and subjected to measurement of yield attributes. Microbial products were applied on the Mung bean in four foliar spray at 10days interval till flowering. Every 15 days of interval samples were collected for biochemical analysis. The application of Bioformulation, Biomolecules and Biopolymer showed significant influence on overall growth and development of Mung bean.

Protein content in leaves: After 45 DAS of sowing protein in Biopolymer treated Mung bean showed higher increase in protein over the control and other treatments (Fig.2.2.2).

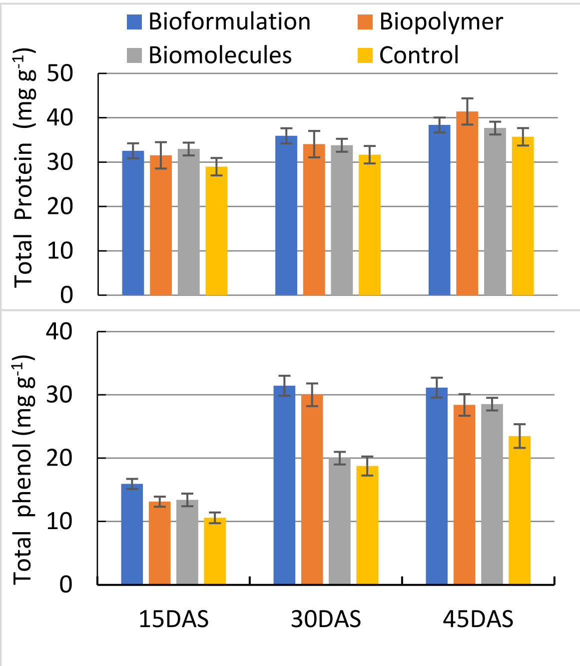


Fig. 2.2.2: Influence of microbial products on (a) total protein content and (b) total phenol content of mung bean leaves

Phenol content: Phenol content of the bio formulation-treated mung bean also exhibited significant variation over the control. Biomolecules and biopolymer treated mung bean also showing higher phenol content (Fig. 2.2.2).

Test Weight: The analysis of yield attributes after harvesting shows the improvement in test weight and yield of treated mung bean as compared to untreated control. Biopolymer treated mung bean (47.91gm) showing relatively higher test weight than bioformulation (43.99gm) and biomolecule (43.72gm) treatment (Fig. 2.2.3).

Yield: Overall yield results of mung bean indicated that all treatments significantly enhancing the yield over the control and bioformulation showing increased yield (13.72qa ha^{-1}) compared to both Biopolymer (12.80 qa ha^{-1}) and Biomolecules (12.49 qa ha^{-1}) (Fig. 2.2.3). Promising performance of the bio-formulation, biopolymer and biomolecules in mung bean in field condition shows the systematic use of microbially-derived products for improving sustainable agriculture productivity in different abiotic stresses.

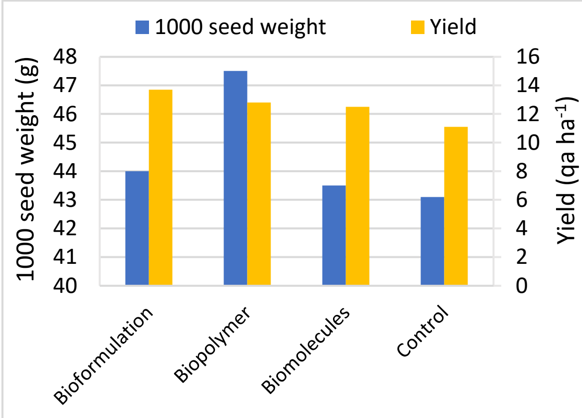


Fig. 2.2.3: Influence of microbial products on test weight and yield of mungbean

Climate-smart integrated farming system (CIFS) model for semi-arid region

Cost economics and soil properties, water, nutritional aspects and carbon footprints of the components of one hectare model of CIFS being carried out from July 2020 at ICAR-NIASM, were calculated and are given in Table 2.2.3 to 2.2.8 and Fig. 2.2.5, respectively. The CIFS includes, crop (6250 sq.m), horticulture(3000 sq.m), livestock (Indigenous cow-02, Goats-10, Native poultry birds-50 nos), Fisheries (400 sq.m) and agroforestry (boundary plantations). The overall cost of cultivation (Rs.227395), gross income (Rs.369265), net income (Rs.141870) cummulated a B:C ratio of 1.62 for the one hectare CIFS model. Livestock contributed majorly (79%) followed by crops (14%) and fisheries (7%) towards the gross income obtained under CIFS.

Table 2.2.3: Economics of CIFS (in Indian rupees)

Components	Details	Cost of cultivation	Gross Income	Net Income	B:C Ratio
Crops	Pearl millet-Chickpea	7412	8090	677	1.09
	Green gram-Sorghum	8352	9006	653	1.08
	Sorghum- Safflower	6300	6764	463	1.07
	Black gram-Groundnut	8104	10778	2673	1.33
	Redgram+Sorghum-Cluster bean	8744	16082	7337	1.84
	Sub Total	38913	50720	11806	**1.30**
Livestock	Gir cow	114482	161404	46922	1.41
	Goat	38070	105512	67442	2.77
	Poultry	21075	26871	5796.25	1.28
	Sub Total	173627	293787	120160	**1.69**
Fisheries	Gift Tilapia	14855	24758.5	9903.5	**1.67**
	Total	227395.05	369265	141870	**1.62**

Effect of cropping system/crop on soil properties:

Soil chemical Properties: The soil pH range showed slight increase in pH from 7.8- 8.2 to 7.9- 8.3 after harvesting with lowest value of pH (7.8, depth 0-15) recorded in black gram-ground cropping system. Soil EC showed slight decrease after harvesting and ranged from 0.17- 0.19 dS m^{-1}. Both available soil N and organic carbon showed slight increase after harvesting.

Table 2.2.4: Effect of cropping system/crop on soil properties

Soil Parameters >	Depth (cm)	pH		EC (dS m^{-1})		N (kg ha^{-1})		Organic carbon (%)	
Cropping system/crop		I	A	I	A	I	A	I	A
Pearl millet -Chickpea	0-15	8.0	8.0	0.22	0.18	164.5	171.2	0.44	0.45
	15-30	8.2	8.1	0.18	0.17	157.2	161.8	0.42	0.43
Pigeon pea	0-15	8.1	8.17	0.20	0.18	144.8	153	0.44	0.45
	15-30	8.0	8.14	0.19	0.17	142.5	146.2	0.43	0.43
Sorghum- Safflower	0-15	7.8	8.0	0.17	0.17	150.3	151.2	0.43	0.44
	15-30	8.0	8.11	0.17	0.16	148.4	147.6	0.42	0.43
Mungbean-Sorghum	0-15	7.8	7.98	0.22	0.20	145.4	156.2	0.43	0.44
	15-30	8.1	8.15	0.19	0.19	143.2	146.2	0.42	0.42
Multilayer cropping system	0-15		8.01		0.24		130.5		0.33
	15-30		7.93		0.17		122.9		0.32
Black gram-Groundnut	0-15	7.8	7.8	0.19	0.15	138.6	142.1	0.45	0.45
	15-30	8.0	8.08	0.16	0.14	135.2	136.3	0.41	0.41
Pomegranate, Custard apple, Sapota	0-15		8.19		0.15		150.5		0.37
	15-30		8.23		0.13		145.5		0.36
Sugarcane (Control)	0-15		8.32		0.14		158.6		0.43
	15-30		8.29		0.14		151.8		0.41

(I- Initial , A-After : soil properties)

Soil physical properties: Slight decrease in bulk density was observed in upper soil layer (0-15cm) than the lower layer (15-30cm). The lowest bulk density showing optimum porosity was found in Mungbean +Sorghum and Sorghum +Safflower cropping system (1.4 Mg m^{-3}). WHC also shows slightly higher percentage in upper soil layer than in lower layer. The highest WHC was shown by Bajra + chickpea cropping system (47.8 %) followed by Sorghum +Safflower cropping system (46.8%). SOC stock depends upon BD and OC present in soil. SOC stock was found more in 15-30 cm depth of soil than 0-15 cm depth. It was found highest in Drumstick+ Napier+ Stylo plot having 12.04 (0-15cm) and 22.39 (15-30cm) Mg ha^{-1} followed by Black-gram +Groundnut showing 10.92 (0-15cm) and 21.06 (0-15cm) Mg ha^{-1}.

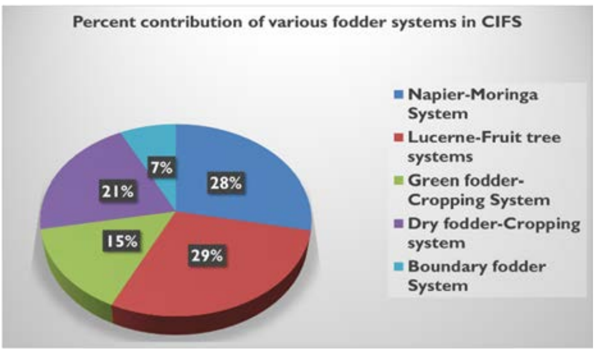
Soil Biological properties: Microbial count *i.e.,* bacteria, fungi and actinomycetes was found slightly more in 0-15 cm soil layer than the soil below it. Bacterial count ranged from 10.53×10^{-10} – 10.94×10^{-10} and higher in bajra+chickpea cropping system. Range of fungal count was 7.52×10^{-10} – 7.84×10^{-10} and found higher in sorghum+ safflower cropping system while actinomycetes count was higher in black gram+groundnut crops (7.38×10^{-10} – 7.52×10^{-10} g^{-1} of soil) in 0-15 cm depth. In all cropping systems slight difference was observed in microbial count at both depths.

Table 2.2.5: Soil physical properties, Soil organic carbon stock and soil microbial biomass count for cropping system used in CIFS

	Physical Properties						*Microbial biomass Count ($\times 10^{-10}$/g of soil)*					
Cropping System	**BD ($Mg\ m^{-3}$)**		**WHC (%)**		**SOC Stock ($Mg\ ha^{-1}$)**		**Bacterial**		**Fungal**		**Actino-mycetes**	
Depth (cm)	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
Bajra + Chickpea	1.5	1.7	47.8	46.8	9.68	22.3	10.9	10.8	7.62	7.49	7.38	7.41
Mungbean + Sorghum	1.4	1.5	44.8	42.8	9.68	19.9	10.9	10.9	7.73	7.76	7.45	7.39
Sorghum+ Safflower	1.4	1.4	46.8	46.8	9.06	18.7	10.7	10.9	7.66	7.66	7.47	7.48
Black-Gram + Groundnut	1.6	1.7	42.8	38.8	10.9	21.1	10.9	11	7.59	7.57	7.52	7.49
Pigeon-pea+ Cluster bean	1.5	1.4	41.8	40.8	10.1	18.6	10.8	10.8	7.49	7.57	7.34	7.41
Multi Layered Farming	1.8	1.9	36.8	35.8	8.9	18.4	10.8	10.9	7.53	7.68	7.48	7.53
Drumstick+ Napier+ Stylo	2	1.9	37.8	38.8	12.0	22.4	10.5	10.9	7.52	7.68	7.46	7.48
Custard apple	1.7	1.8	40.8	39.8	8.98	17.9	10.7	10.6	7.67	7.72	7.52	7.52
Sapota	1.5	1.7	38.8	36.8	7.41	15.4	10.7	10.6	7.84	7.89	7.41	7.47
Pomegranate	1.7	1.5	40.8	41.8	8.64	15.1	-	-	-	-	-	-
Sugarcane (Control)	1.6	1.5	43.8	44.8	10.3	19.3	-	-	-	-	-	-

(BD- Bulk Density, WHC- Water Holding Capacity, SOC- Soil Organic Carbon)

Performance and production of various Fodder-based systems in CIFS: Fodder requirement is the most crucial aspect of agricultural-based livelihood. Various fodder systems such as Moringa-Napier, Pomegranate-Lucerne, Custard apple-Lucerne and boundary-based fodders were established to fulfil the fodder requirements of animals in CIFS. Out of five fodder systems, the Lucerne-fruit system and Napier-Moringa silvipasture systems provided about 29 and 28 % of total fodder, respectively. Animal-wise fodder consumptions from different fodder systems were also analysed and presented in the Fig. 2.2.5.



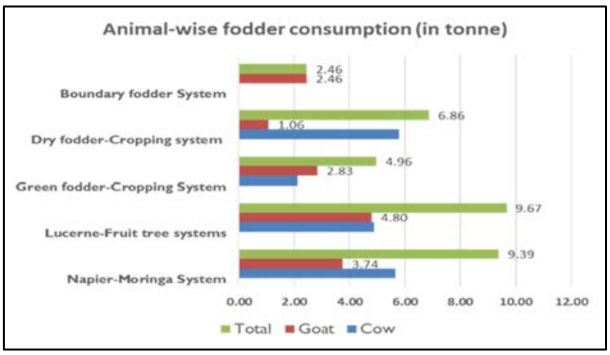


Fig. 2.2.5: (a) Percent contribution of Fodder systems (b); Animal-wise fodder consumption in CIFS

Performance of fisheries in CIFS: G. Tilapia was reared for six months which gained body wet weight from 10g to 590g for stocking density of 2 No.s/m^2 and survival rate of 100%. The gross income obtained from total harvest of 278.5 kg fish was Rs. 24758

Water productivity of CISF components: The water productivity (Produce unit / m^3) for livestock produce for milk, meat and egg was 0.29, 0.027 and 0.155 respectively. The Crop Water productivity (kg (biomass)/m^3) for rabi season crops Chickpea, Sorghum, Sunflower and Safflower was 1.668, 2.635, 0.895 and 0.723, respectively.

Table 2.2.6: Component-wise water productivity in climate smart and multilayer IFS

Nutritional requirement and availability:

IFS Components	Water productivity	
	Rs/m^3	Produce unit m^{-3}
Cattle	15.22	Milk- 0.223 (ltr m^{-3})
Goat	13.49	Meat - 0.033 (kg m^{-3})
Poultry	42.12	Egg- 2.45 (Nos m^{-3})
		Poultry- 0.14 (kg m^{-3})
Crop	206.95	5.64 (kg m^{-3})
Multilayer IFS	63.18	-

The nutritional requirement of four-member farm family was met from CIFS project and surplus Cereals, Oilseed, Pulses, Vegetables and fruits, Milk (Lit.), Eggs (No.), Poultry meat (kg), Goat meat (Live wt. kg), Fishery (kg.) was 38,157, 256,31,1996,2.7,258.8 and 278.5 respectively.

Table 2.2.7: Nutritional requirement and availability of CIFS farm family

Nutrient Recycling	Qty. (kg)	Nutrient supply (kg)		
		N	P	K
FYM	8760	43.8	17.52	43.8
Goat manure	5840	90.52	37.96	113.9
Poultry manure	150	3.75	2.4	2.55
Vermicompost	1143	18.29	8.0	9.144
Vermiwash (L)	164	0.853	0.574	1.148
Total	-	157.2	66.45	170.5

(ANR- Annual Nutritional Requirement)

Nutrient recycling: The total nutrient recycling in CIFS project from different components such as farm yard manure, goat manure, poultry manure, vermicompost and vermi-wash was 157.21 kg of Nitrogen, 66.45 kg of Phosphorus and 170.52 kg of potassium produced.

Table 2.2.8: Nutrient recycling in CIFS model

Name of the food item	Qty.(kg)	ANR (kg)	Surplus (kg)
Cereals	250	211	38
Oilseed	186	28	157
Pulses	309	52	256
Vegetables, fruits	615.8	584	31
Milk (L)	2361.5	365	1996
Eggs (No.)	1565	-	-
Poultry meat	89.77	87	2.7
Goat meat live wt.	258.8	-	258.8
Fishery	278.5	-	278.5

Multilayer integrated farming system for multiple abiotic stress region:

The concept of cultivating/rearing different components of IFS at different levels was developed. The components were integrated for generating sustainable agriculture income while addressing multiple abiotic stresses *viz.,* shallow basaltic soil and small size land holding with less irrigation facility. The model includes cultivation of seasonal vegetables and fruit components integrated with backyard poultry production. Micro-irrigation system is used for irrigation of crops and scavenging of poultry is allowed for production of eggs and birds. The cost of feeding poultry birds will be reduced as well as the soil properties will be improved over the time and sustainable income will be generated.

Table 2.2.9: Evaluation of Multilayer farming in CIFS

Components	Cost of cultivation	Gross income	Net income	B:C ratio
Vegetables and fruits	17134	19342	2208	1.13
Poultry	21075	26871	5796	1.28
Total	38209	46213	8004	1.20

The cost of cultivation, gross income, net income and B:C ratio of vegetables and fruit component was Rs. 17134, Rs. 19342, Rs. 2208 and 1.13 respectively. The, cost of cultivation, gross income, net income and B:C ratio of poultry component was Rs. 21075, Rs. 26871, Rs. 5796 and 1.28 respectively. The overall cost of cultivation, gross income net income and B:C ratio of Multilayer integrated farming system was, Rs. 38209, Rs. 46213, Rs. 8004 and 1.20, respectively as depicted in Table 2.2.9. The crop water productivity (Rs m^{-3}) and water productivity for Poultry (Rs m^{-3}) was 206.95 and 42.12, respectively. The system water productivity (Rs m^{-3}) was 63.18.

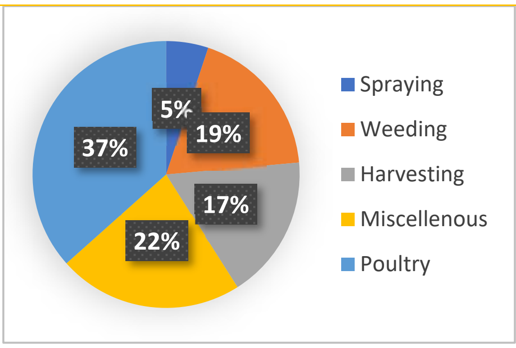


Fig. 2.2.5 (c): Employment generation in multilayer farming

The share of employment generation in poultry component in multilayer farming was maximum *i.e.,* 37% followed by 22% in miscellaneous work, 19% in weeding, 17% in harvesting and 5% in spraying operation.

Quantification of carbon footprints for major rainfed cropping system in the central Deccan plateau region:

Environmental impact due to crop cultivation is one of the drivers of climate change that has been quantified and expressed as Carbon footprint (CFP). The five major cropping systems representing rainfed agriculture of the Central Deccan Plateau region were calculated (Fig. 2.2.6) for kharif (pearl millet, green gram, hybrid sorghum, black gram and red gram) and rabi crops (chickpea rabi sorghum, safflower ground nut and cluster bean). The highest CFP was from rabi sorghum (370.65 kg CO_2 eq. ha^{-1}) while lowest was from black gram (293.75 kg CO_2 eq. ha^{-1}). Similarly, the highest yield-based CFP were for Rabi sorghum (0.75 kg CO_2 eq. per kg of yield) and lowest for green gram (0.33 kg CO_2 eq. per kg of yield). Based on the botanical classification of plants, the crops were grouped into food grain cereal crops, pulses, oil seeds and vegetables.

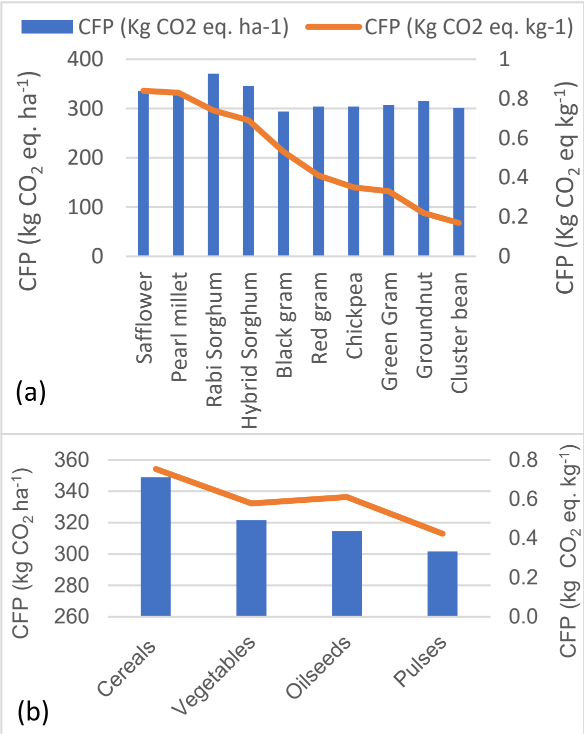


Fig. 2.2.6: Carbon footprints for crops under CIFS

The cereal crop cultivation impacted largely the environment due to higher consumption of nitrogenous fertilizers and it was 348.8 kg CO_2 eq. ha[-1]. Similarly, the CFP were 321.6, 314.7 and 301.6 kg CO_2 eq. ha^{-1} for vegetables, oilseeds and pulses, respectively.

Effect of deficit irrigation and chia based intercropping systems on seed yield of chia and competition indices

Chia is an emerging industrial crop in India and gaining popularity among consumers due to its health benefits in terms of high Omega-3 (55% in oil), dietary fiber (34%) and protein (17-20%). It is necessary to develop a suitable cropping system for the chia to make its cultivation profitable and sustainable in semi-arid regions under water scarcity conditions. Therefore, chia-based inter-cropping with short-duration vegetable crops such as amaranthus, spinach, coriander, dill, fenugreek and radish was studied to assess the intercrop suitability in chia. The intercrops were planted at 1:2 ratio in the interspaces of chia planted at a spacing of 60×30 cm with two irrigation levels (50 and 100% CPE). Results showed that water deficit drastically reduced seed and vegetable yields by 16 and 23%, respectively. Intercropping in chia showed yield reduction compared to chia monocropping. However, chia+ fenugreek system produced a higher seed yield (628 kg ha^{-1}) and chia equivalent yield (960 kg ha^{-1}) next to chia monocrop.

(a)

(b)

Fig. 2.2.7: (a) Chia+fenugreek at 30 DAS , (b) Chia+fenugreek at maturity

Table 2.2.10: Effect of deficit irrigation and chia based intercropping systems on seed yield of chia and competition indices

Treatments	Seed yield (kg ha^{-1})	Vegetable yield (kg ha^{-1})	CEY (kg ha^{-1})	Land equivalent ratio	Land use efficiency	Competi-tion ratio	Area Time Equivalent ratio
Irrigation (I)							
I_{50} (50% CPE)	525.2b	5700b	747.4b	1.57a	129.6a	1.71a	1.01a
I_{100} (100% CPE)	627.6a	7482a	965.0a	1.54b	126.5b	1.55b	0.98b
P value (0.05)	<.0001	<.0001	<.0001	0.0014	<.0001	<.0001	<.0001
Intercropping							
Chia + amaranthus	550.7d	2202d	651.8e	1.57c	131.2b	1.88b	1.06b
Chia + coriander	604.2bc	4569c	886.9c	1.64a	136.1a	1.97b	1.08b
Chia + dill	567.0cd	4975c	867.6c	1.65a	137.7a	1.91b	1.10a
Chia + spinach	498.2d	5663b	834.6d	1.41d	112.6c	0.97c	0.84c
Chia + radish	480.7d	11885a	936.3b	1.39d	112.3c	0.96c	0.86c
Chia + fenugreek	628.2b	4685c	959.8a	1.70a	138.3a	2.11a	1.07b
Chia monocrop	706.1a	-	-	-	-	-	-
P value (0.05)	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

The competition ratio indicated the dominant nature of spinach and radish over chia. Intercropping of spinach and radish reduced the chia yield by 29 and 20 % compared to chia monocrop and chia + fenugreek systems, respectively. ATER values < 1 in spinach and radish system indicated disadvantage of intercropping with chia. Therefore, chia + fenugreek intercropping has an advantage over chia monocrop under well-watered or water deficit conditions in Deccan plateau regions of India.

Soil property profile of the research fields of Malad farm

The soil samples of Malad farm of ICAR-NIASM were collected and analyzed from four field points randomly on each of the fourteen field plots at four soil depths and mixed uniformly depth wise to represent the field. The soil properties are given in Table 2.2.11. Malad farm is a slightly calcareous and non-saline soil. Soil organic carbon, nitrogen and phosphorous are low but the available soil potassium is high. As per the standard fertility classification system, the soil available micronutrients of iron, manganese, zinc, copper, and boron are not in the deficient range.

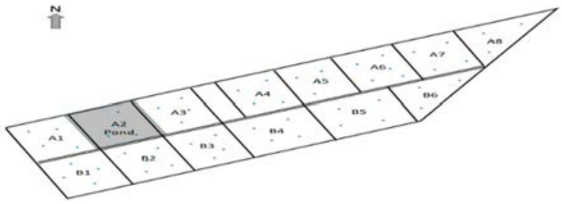


Fig. 2.2.8: Sampling points from experimental plots of Malad farm

Table 2.2.11: Soil properties of Malad farm, ICAR-NIASM

Field No.	Depth (cm)	pH (1:2)	EC (1:2)	SOC	Plant available nutrient fractions							
					N	P	K	Fe	Mn	Zn	Cu	B
A1	0-15	7.96	0.20	5.21	175.2	7.96	325.7	1.91	1.03	0.65	0.51	0.56
	15-30	7.95	0.18	5.12	168.1	7.95	320.0	1.82	0.94	0.57	0.44	0.49
	30-45	7.93	0.17	5.09	164.0	7.93	317.7	1.79	0.91	0.55	0.42	0.47
	45-60	7.91	0.16	5.08	161.8	7.91	316.8	1.77	0.89	0.54	0.40	0.45
A2	0-15	7.96	0.21	5.27	180.5	7.96	322.5	1.95	1.05	0.62	0.50	0.51
	15-30	7.94	0.17	5.22	176.3	7.95	315.1	1.86	0.95	0.53	0.41	0.42
	30-45	7.93	0.16	5.18	174.2	7.93	313.6	1.83	0.94	0.50	0.39	0.40
	45-60	7.92	0.15	5.15	171.6	7.92	313.2	1.82	0.93	0.49	0.37	0.38
A3	0-15	8.02	0.20	5.29	178.6	8.02	321.9	1.90	0.98	0.60	0.47	0.59
	15-30	7.96	0.17	5.23	174.5	7.96	317.1	1.80	0.90	0.51	0.37	0.48
	30-45	7.95	0.15	5.20	172.9	7.95	315.6	1.78	0.88	0.49	0.34	0.46
	45-60	7.94	0.14	5.16	171.6	7.94	314.9	1.76	0.86	0.47	0.32	0.43
A4	0-15	7.99	0.20	5.37	175.3	7.99	318.3	1.94	1.10	0.60	0.52	0.62
	15-30	7.95	0.16	5.29	171.2	7.95	312.5	1.87	1.01	0.49	0.42	0.53
	30-45	7.94	0.15	5.24	169.8	7.94	311.1	1.85	0.98	0.47	0.39	0.51
	45-60	7.92	0.13	5.22	168.1	7.92	310.4	1.84	0.97	0.46	0.37	0.49
A5	0-15	7.88	0.21	5.36	174.2	7.88	321.4	2.00	1.00	0.64	0.45	0.55
	15-30	7.83	0.19	5.25	170.9	7.83	316.9	1.92	0.91	0.56	0.37	0.45
	30-45	7.81	0.16	5.21	170.1	7.81	315.9	1.89	0.89	0.53	0.34	0.42
	45-60	7.80	0.15	5.18	169.0	7.80	315.4	1.87	0.88	0.52	0.32	0.41
A6	0-15	7.88	0.20	5.26	176.2	7.88	317.1	2.05	1.10	0.61	0.47	0.57
	15-30	7.84	0.16	5.17	170.5	7.84	312.6	1.96	1.01	0.51	0.42	0.46
	30-45	7.82	0.15	5.16	168.4	7.82	311.4	1.94	0.99	0.50	0.39	0.45
	45-60	7.81	0.12	5.14	167.0	7.81	310.2	1.93	0.96	0.49	0.37	0.43
A7	0-15	7.92	0.20	5.28	174.7	7.92	320.2	1.89	1.08	0.62	0.51	0.60
	15-30	7.88	0.16	5.19	166.2	7.88	314.4	1.81	0.98	0.54	0.44	0.50
	30-45	7.86	0.14	5.15	164.4	7.86	312.8	1.79	0.95	0.51	0.42	0.48
	45-60	7.86	0.12	5.13	163.9	7.86	312.0	1.77	0.93	0.50	0.40	0.47
A8	0-15	8.02	0.20	5.39	176.6	8.02	315.5	1.96	1.05	0.65	0.52	0.61
	15-30	7.92	0.16	5.18	172.0	7.92	310.1	1.89	0.96	0.59	0.45	0.53
	30-45	7.91	0.16	5.12	170.3	7.91	309.0	1.87	0.93	0.58	0.43	0.52
	45-60	7.89	0.15	5.10	169.0	7.89	308.4	1.85	0.91	0.57	0.41	0.50

Units: SOC (g kg^{-1})N,P,K (kg ha^{-1}); Fe Mn,Zn,Cu,B (mg kg^{-1})

Field No.	Depth (cm)	pH (1:2)	EC (1:2)	SOC	Plant available nutrient fractions							
					N	P	K	Fe	Mn	Zn	Cu	B
B1	0-15	7.97	0.20	5.30	174.5	8.0	330.6	1.90	1.01	0.62	0.46	0.50
	15-30	7.93	0.16	5.22	169.9	7.9	324.4	1.81	0.93	0.54	0.39	0.42
	30-45	7.92	0.14	5.19	169.0	7.9	322.6	1.79	0.91	0.52	0.36	0.40
	45-60	7.92	0.13	5.17	168.2	7.9	321.6	1.76	0.89	0.50	0.35	0.38
B2	0-15	7.99	0.23	5.35	176.8	8.0	323.6	1.96	0.96	0.59	0.46	0.49
	15-30	7.94	0.17	5.26	171.3	7.9	316.5	1.87	0.89	0.50	0.38	0.41
	30-45	7.92	0.15	5.23	168.4	7.9	315.0	1.85	0.86	0.48	0.36	0.39
	45-60	7.91	0.14	5.20	167.1	7.9	314.3	1.84	0.85	0.45	0.35	0.38
B3	0-15	8.01	0.20	5.30	178.6	8.0	321.2	1.90	1.02	0.59	0.50	0.51
	15-30	7.94	0.16	5.27	174.1	7.9	316.0	1.81	0.93	0.51	0.43	0.44
	30-45	7.92	0.15	5.24	172.4	7.9	314.4	1.79	0.92	0.49	0.41	0.42
	45-60	7.90	0.13	5.21	171.5	7.9	313.5	1.78	0.90	0.48	0.39	0.40
B4	0-15	8.01	0.21	5.35	174.8	8.0	325.1	1.94	1.06	0.65	0.50	0.49
	15-30	7.97	0.17	5.26	170.7	8.0	317.5	1.87	0.97	0.55	0.41	0.41
	30-45	7.95	0.16	5.23	169.5	7.9	315.6	1.85	0.94	0.53	0.38	0.39
	45-60	7.93	0.15	5.21	168.3	7.9	314.4	1.84	0.91	0.51	0.36	0.37
B5	0-15	7.96	0.20	5.34	175.83	7.96	327.18	1.96	1.01	0.59	0.53	0.54
	15-30	7.92	0.17	5.26	170.70	7.90	321.18	1.86	0.93	0.51	0.44	0.46
	30-45	7.89	0.16	5.23	169.16	7.88	318.90	1.81	0.88	0.49	0.41	0.44
	45-60	7.90	0.14	5.21	168.54	7.87	318.35	1.79	0.86	0.48	0.39	0.43
B6	0-15	7.92	0.20	5.21	180.29	7.94	328.43	2.00	1.06	0.61	0.50	0.58
	15-30	7.86	0.16	5.12	174.92	7.88	321.53	1.90	0.98	0.53	0.53	0.49
	30-45	7.84	0.15	5.10	173.35	7.86	319.63	1.87	0.95	0.49	0.52	0.47
	45-60	7.82	0.14	5.07	172.49	7.84	318.93	1.85	0.94	0.49	0.52	0.46

Units: SOC (g kg^{-1})N,P,K (kg ha^{-1}); Fe Mn,Zn,Cu,B (mg kg^{-1})

Effect of fruit species introduction on soil properties of gravelly barren land

Barren land of the NIASM orchard has a thin soil cover of nearly 20% and the remaining was gravel of different sizes. The soil texture is skeletal loamy sand texture. The bulk density was very high due to the high gravel content. The soil water at field capacity was very low because of poor soil texture and low clay content. The soil pH was neutral in nature and had low salt content. Because of low clay content, the CEC was low the soil matric was occupied largely with calcium and magnesium. Soil organic matter, available nitrogen and phosphorus was in the low category and the level of potassium was in the medium category.

Table 2.2.12: Initial soil characteristics of NIASM orchards (Year 2011)

Field No	Tree species	Soil	Sand	Silt	Clay	BD	WHC	pH	EC (1:2)	CEC	Ca	Mg	Na	SOC	AV. N	Av. P	Av. K
I2	Acid lime	20.0	77.1	13.3	9.6	2.25	5.9	7.3	0.1	3.3	20.0	18.3	1.9	1.8	133.0	4.2	210.0
G4	Aonla	20.6	77.2	13.7	9.1	2.27	5.7	7.2	0.1	4.2	20.6	18.4	2.2	1.8	134.7	4.4	210.4
J6	Custard apple	20.8	77.5	13.4	9.1	2.30	5.7	7.2	0.1	3.1	17.5	17.2	1.9	1.8	136.3	4.6	212.4
J7	Date palm	19.9	77.8	13.5	8.7	2.27	5.7	7.2	0.1	3.5	18.5	17.6	2.1	1.8	134.2	4.4	208.8
I4 & H5	Dragon fruit	19.4	77.7	13.2	9.1	2.25	5.9	7.3	0.1	3.5	22.3	17.9	2.2	1.8	132.2	4.2	209.5
G3 & J4	Grapes	20.3	77.7	13.4	8.9	2.30	5.8	7.3	0.1	3.3	20.1	18.7	1.9	1.8	133.5	4.2	210.2
K4 & H4	Guava	20.2	77.5	13.4	9.1	2.31	5.7	7.3	0.1	3.1	17.4	17.1	1.8	1.8	135.3	4.6	211.6
I1	Karonda	19.7	77.8	13.4	8.8	2.23	5.8	7.2	0.1	3.9	20.4	18.7	2.0	1.8	134.2	4.2	210.8
J5	Mango	20.4	77.2	13.3	9.5	2.25	5.7	7.2	0.1	3.3	20.0	18.0	1.7	1.8	136.7	4.6	211.7
J3 & K3	Pomegranate	19.9	77.4	13.6	9.0	2.27	5.8	7.3	0.1	3.4	17.9	16.6	1.9	1.8	134.3	4.3	211.2
K5	Sapota	20.5	77.3	13.2	9.5	2.29	5.7	7.3	0.1	3.5	20.6	19.1	2.3	1.8	135.8	4.6	208.2
J1 & J2	Sweet orange	20.2	77.5	13.5	9.0	2.31	5.6	7.3	0.1	3.6	20.3	18.6	2.0	1.8	134.6	4.4	209.8

Table 2.2.13: Soil characteristics of NIASM orchard fields (Year 2022)

Field No	Tree species	Soil	Sand	Silt	Clay	BD	WHC	pH	EC (1:2)	CEC	Ca	Mg	Na	SOC	AV. N	Av. P	Av. K
I2	Acid lime	25.2 e	78.4 e	12.8 a	8.8 b	2.15 cd	6.0 ef	6.3 e	0.08 a	3.7 ef	1.85 bc	1.57 bc	0.15 a	2.07 def	143.8 bcd	5.85 ef	215.8 de
G4	Aonla	26.3 e	80.8 d	11.7b c	7.5 d	2.16 cd	6.1 ef	6.6 cd	0.10 a	4.6 bc	1.88 bc	1.67 ab	0.18 a	2.19 cde	148.7 abcd	6.32 de	220.7 bcd
J6	Custard apple	29.9 c	83.5 c	10.0d e	6.5 ef	2.09 abcd	6.4 cd	6.6 cde	0.10 a	4.1 cd	1.63 de	1.37 d	0.15 a	2.41 bc	146.5 bcd	6.81 c	224.6 abc
J7	Date palm	25.7 e	85.5 b	9.0 fg	5.5 h	2.15 cd	6.3 de	6.9 abc	0.09 a	4.3 bcd	1.86 bc	1.55 bc	0.19 a	2.27 bcd	137.9 cd	6.01 e	224.1 abc
I4 & H5	Dragon fruit	20.9 g	83.3 c	10.7d	6.0 g	2.18 d	6.0 ef	7.0 a	0.11 a	4.3 cd	**2.15 a**	**1.76 a**	0.18 a	1.81 g	134.3 d	5.31 g	213.8 de
G3 & J4	Grapes	27.8 d	81.3 d	12.3 ab	6.4 f	2.10 abcd	6.0 ef	6.6 de	0.10 a	4.0 de	1.87 bc	1.66 ab	0.17 a	2.22 cde	149.5 abc	6.46 d	222.9 abc
K4 & H4	Guava	31.6 b	81.0 d	11.3 c	7.7 d	2.07 abc	6.8 b	6.5 de	0.10 a	3.9 de	1.54 e	1.33 de	0.17 a	2.45 b	158.3 ab	7.33 b	223.6 abc
I1	Karonda	22.9 f	86.6 a	8.6 g	4.8 i	2.18 d	5.8 f	6.7 bcd	0.09 a	3.4 f	1.61 de	1.21 ab	0.14 a	1.89 fg	136.5 cd	5.60 f	215.7 de
J5	Mango	34.9 a	77.6 e	12.7 a	9.7 a	2.02 a	6.8 a	6.3 e	0.10 a	4 d	1.48 e	1.26 de	0.15 a	**2.85 a**	**161.6 a**	**8.3 2a**	**227.3 a**
J3 & K3	Pomegranate	25.5 e	83.7 c	9.6 ef	6.7 e	2.14 cd	6.0 ef	7.0 ab	0.10a	4 d	1.64 de	1.37 d	0.16 a	2.04 ef	141.5 cd	6.05 e	220.5 cd
K5	Sapota	34.4 a	77.8 e	12.2 ab	10.0a	2.03 ab	6.9 b	6.4 de	0.11a	5.1 a	1.98 ab	1.66 ab	0.21 a	**2.97 a**	**157.1 ab**	**8.1 3a**	**226.8 ab**
J1 & J2	Sweet orange	29.2 c	81.4 d	10.7d	7.9 c	2.11 bcd	6.5 bc	6.4 de	0.10a	4.6 b	1.75 cd	1.53 c	0.18 a	2.34 bc	148.8 abc	6.85 c	221.5 bcd

Units: Soil, Sand, Silt, Clay, Water Holding capacity (WHC) –(%); Bulk Density (BD)- **(**Mg m^{-3}); Cation Exchange Capacity (CEC)- (Cmol (P^{+}) kg^{-1}); Ca, Mg, Na - (mmol kg^{-1}); SOC (g kg^{-1}); Available N, P,K (kg ha^{-1})

The introduction of fruit species to the barren land accelerated parent materials weathering and soil development in which Mango and sapota species had higher development over other species at plough layer soil depth. The variation in the sand, silt and clay particle distribution among tree species was related to their content, root activities, irrigation management and soil porosity. The mango and sapota had higher silt and clay particle fractions over others. Bulk density value of land was also reduced for bringing the barren land into cultivation and a higher decline was recorded under the Mango and sapota tree species. It also had a higher water holding capacity at the field capacity situation in which a higher water content of 6.8% was observed under the Mango tree. A slight decline in pH was observed over the initial soil properties for bringing the land under cultivation. The decline varied significantly among fruit species in which the intensified acidification was observed under the Mango, Guava, Grapes, Sapota and Sweet orange. The decline of exchangeable calcium and magnesium declined with the acidification process. Among the species, the Dragon fruit, Pomegranate and Date palm had higher exchangeable base cations observed. In contrast to soil pH, soil CEC, soil organic carbon, and available nitrogen, phosphorous and potassium increases were observed in the barren land in which mango and sapota had the higher content.

Detection, etiology and phylogenetic analysis of stem canker (*Neoscytalidium dimidiatum*) in dragon fruit

In recent years dragon fruit (*Hylocereus* spp), an exotic fruit crop became increasingly popular in India. However, certain production constraints may affect its marked profitability. Among these climate change invited biotic stress events are major one. During survey, *H. undatus* and *H. polyrhizus* plantations from Pune, Satara and Solapur districts of Maharashtra were found affected due to stem canker disease. Initial symptoms on infected cladodes were minute, circular, depressed chlorotic spots often with a brick red flecks followed by elevation of the centre of the lesion.

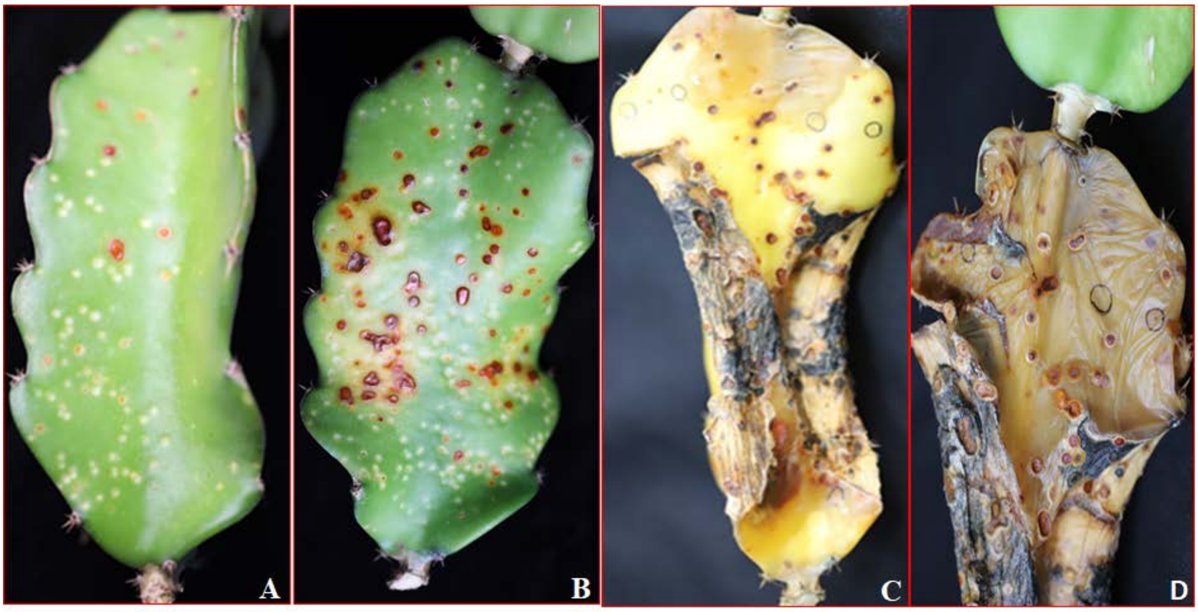


Fig. 2.2.9: Field symptoms of stem canker (A. chlorotic depressed spots often with a red flecks; B. elevation of the lesion centre turning red to gray; C. yellowing, brown scab with pycnidia; D. complete rotting of cladode) of dragon fruit

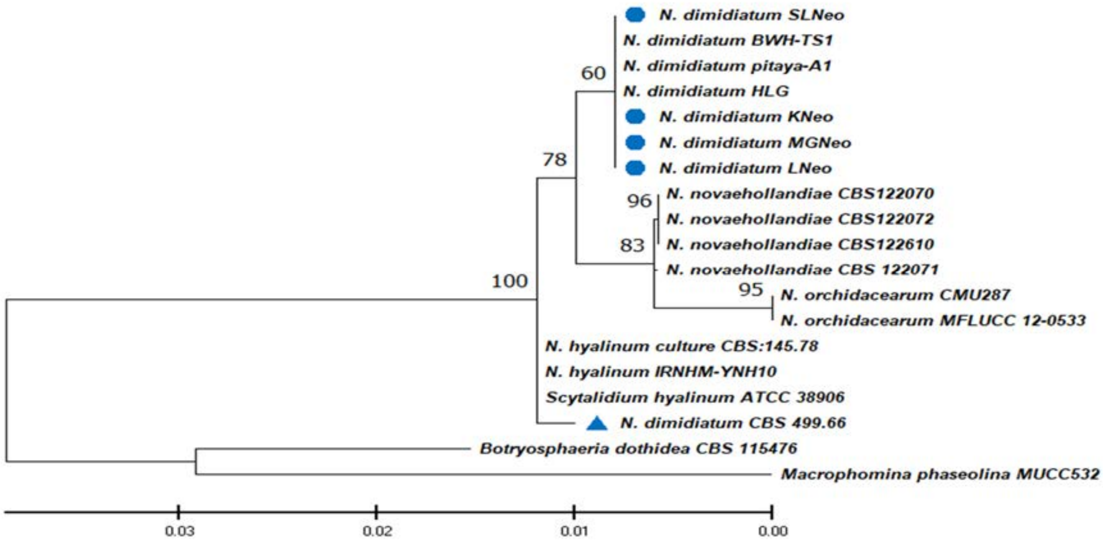


Fig. 2.2.10: Phylogeny tree from a concatenated sequences of internal transcribed spacer (ITS) region, and β-tubulin, and translation elongation factor 1-α genes of *Neoscytalidium. dimidiatum* isolates from diseased dragon fruit by using maximum likelihood analysis in MEGA11**.** Bootstrap values >50% (1,000 replication) are given at the nodes. *Botryosphaeria dothidea* and *Macrophomina phaseolina* used as the outgroups.

Later the lesions turned necrotic and contained black, erumpent pycnidia, followed by chlorosis and stem rot. Detailed diagnosis of stem canker pathogen was carried out at ICAR-NIASM. Based on morphological and phylogenetic analysis of internal transcribed spacer (ITS) region, β-tubulin (tub2) and translation elongation factor 1-α (TEF-1α) gene sequences, the pathogen was identified as *Neoscytalidium* *dimidiatum*. Pathogenicity test confirmed *N. dimidiatum* was the cause of stem canker in *H. undatus* and *H. polyrhizus*. This is the first report of *N. dimidiatum* causing dragon fruit stem canker in India. Since the disease poses a major threat to dragon fruit plantations, additional epidemiological studies may assist in developing management strategies.

Detection, etiology and phylogenetic analysis of anthracnose (*Colletotrichum truncatum)* in dragon fruit

Anthracnose caused by various *Colletotrichum* species is an emerging issue in dragon fruit cultivation and several *Colletotrichum* species associated with the disease has been already reported from various countries. Recently, in India, *C. siamense* cause of dragon fruit anthracnose was reported from Andaman region. Anthracnose is found to be very common during rainy days. Detailed phytopathological investigation of cause of dragon fruit anthracnose was carried out at ICAR-NIASM. Based on, morphological and phylogenetic analysis of internal transcribed spacer (ITS) region, Actin (ACT) and β-tubulin (tub2) gene sequences, the pathogen was identified as *Colletotrichum truncatum*. Detailed diagnosis study will help for fromulating future management strategies.

Fig. 2.2.11: Typical symptoms of anthracnose (a. infected plant; b. water soaked sunken lesion with acervuli development; c. later stage necrotic lesions with black acervuli; d. sunken water-soaked lesions on fruits).

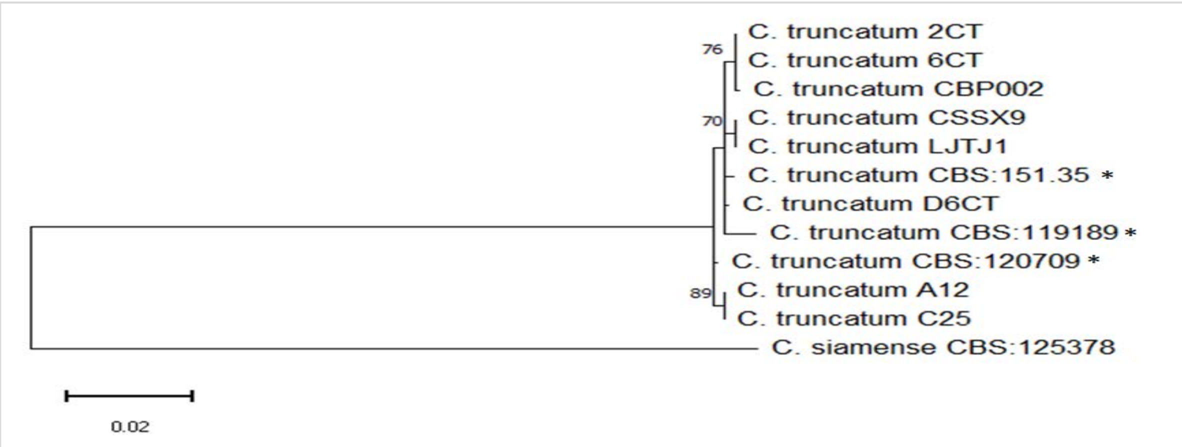


Fig. 2.2.12: Phylogeny tree of *Colletotrichum truncatum* isolates from a concatenated sequences of internal transcribed spacer (ITS) region and actin (ACT), β-tubulin (TUB2), glyceraldehyde 3- phosphate dehydrogenase (GAPDH) genes using maximum likelihood analysis in MEGA11. Bootstrap values >50% (1000 replication) are given at the nodes. C. siamense CBS: 125378 is used as the outgroup, epitype cultures are indicated by asterisks. Isolates 2CT, 6CT and D6CT were collected during the study.

Studies on horticulture crops

Sunburn management in Dragon fruit (Hylocereus spp.): In an experiment aimed at protecting dragon fruit plants from sunburn, plants have been covered with different colour shade nets (Green, black and white) having 35 and 50% shade factors. Preliminary results showed that sunburn issue can be completely reduced using artificial shading (Fig. 2.2.13a). Further shading also resulted in reduction of disease incidence to 50% (aprox.), early flowering and emergence of new sprouts. Plants have maintained their photosynthetic efficiency compare to uncovered plants (Fig. 2.2.13b). Impact of shading on flowering and fruiting is under observation

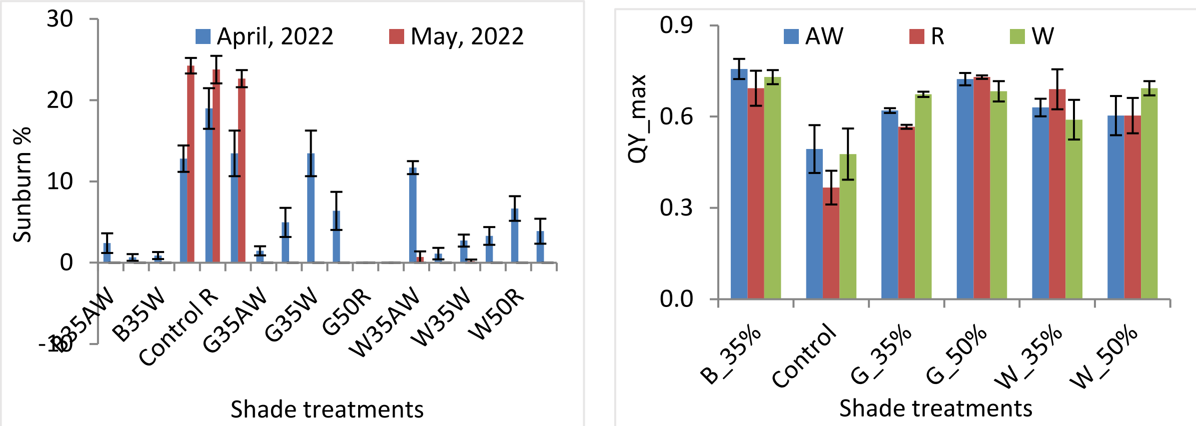


Fig. 2.2.13: Effect of different shade nets on (a) sun burn management and [b] Chlorophyll fluorescence (PS II) in dragon fruit

Canopy management in Dragon fruit (*Hylocereus* spp.): Under studies aimed to optimize canopy management practices, number of cladodes per fruit, categorizing plants with different cladode numbers, growth related observations, flowering, fruiting and sunburn and disease incidence are being recorded. It was observed that, sun burning in dragon fruit is more in plants with higher percentage of old cladodes as well as plants with sparsh canopy (Fig. 2.2.14a). Similar trend has been observed in case of disease incidence (Fig. 2.2.14b). Impact of canopy management on flowering and fruiting is under observation.

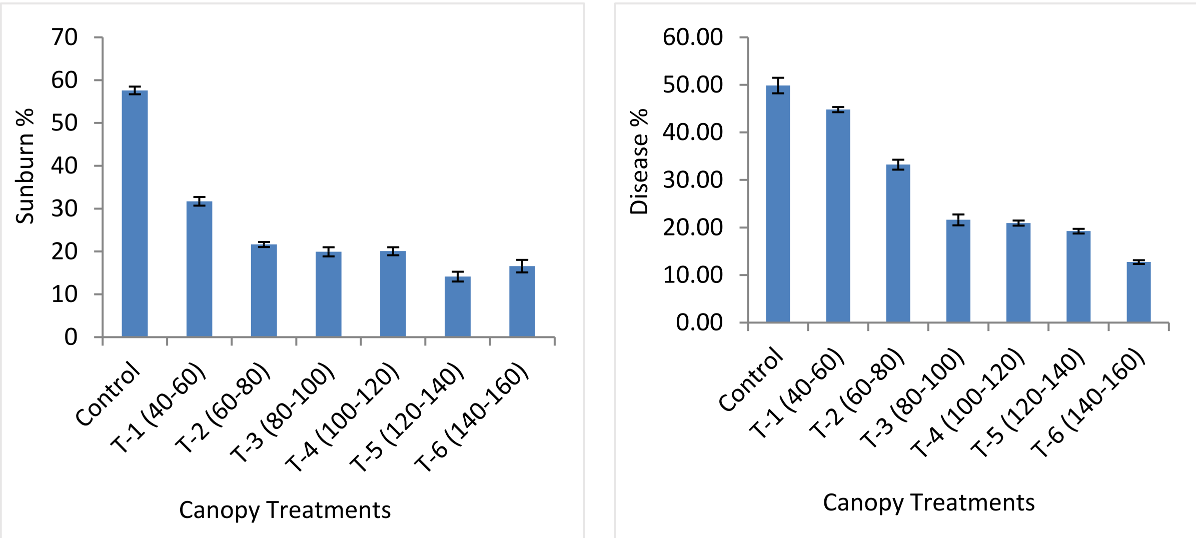


Fig. 2.2.14: Impact of canopy management on (a) sun burning and (b) disease incidence

Long term impact of planting techniques and filling mixture in Guava and Sapota:

To evaluate the performance of different planting techniques and filling mixtures in perennial fruit crops like guava and sapota; growth and yield parameters are being measured. Planting systems with enhanced depth are performing better compare to pits of 45 cm^3 in sapota (Fig. 2.2.15) and guava. Additional parameters *viz.,* total chlorophyll, relative water content, membrane stability index, and NDVI, are being recorded to confirm the effect.

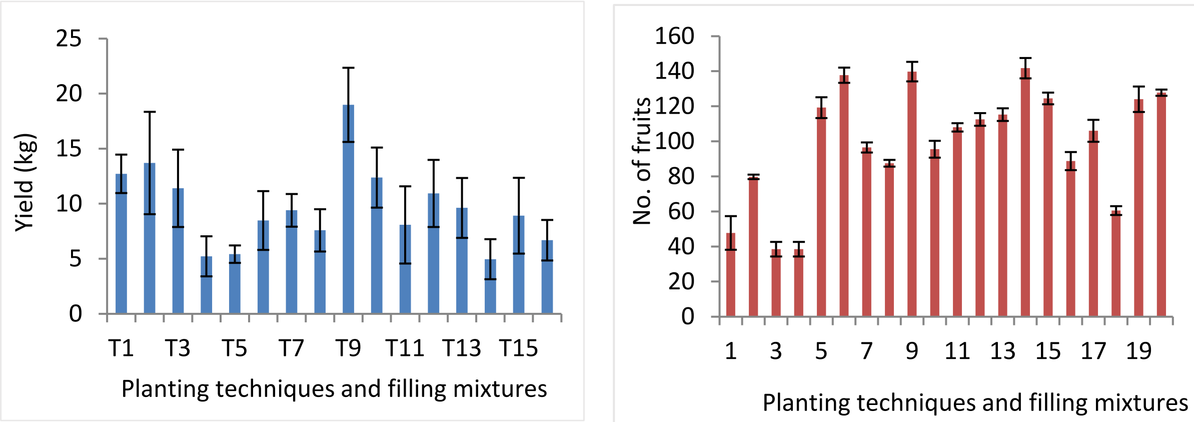


Fig. 2.2.15: Effect of planting systems and filling mixture on yield of (a) Sapota and (b) Guava

Comparative evaluation of natural, organic and conventional farming systems in fruit crops: Under studies comparing natural, organic and conventional farming systems on performance of fruit crops, new Dragon fruit (*H. polyrhizus*) plantations were done in plot no. H4 during October, 2022.

Fig. 2.2.16: Planting of Dragon fruit (*H. polyrhizus*) at ICAR-NIASM

Feasibility studies on exotic fruit crops under semi-arid conditions of Maharashtra: In order to earn better income, farmers are more interested to grow exotic fruit crops in the newer climates, therefore feasibility studies exploring suitability of few exotic fruit crops has being planned. Under this, planting of different exotic fruit crops including avocado, low chilling apple, peach, plum, Malayan apple was done at ICAR-NIASM in the month of October 2022 in plot no. J2. The details of the plantations are listed in Table 2.2.14.

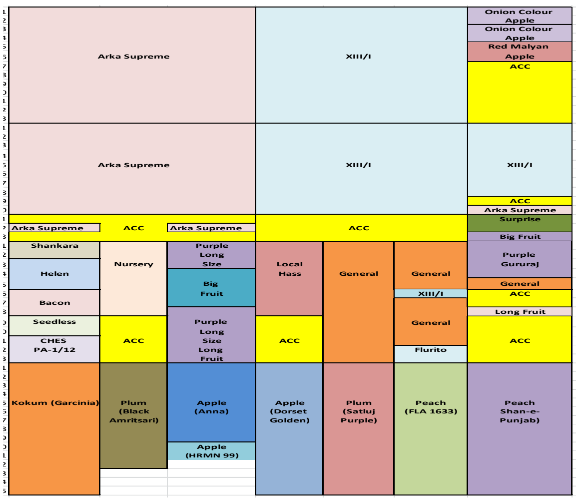


Fig. 2.2.17: Layout of exotic fruit block at ICAR-NIASM

Table 2.2.14: List of exotic fruit varieties planted at exotic fruit block of ICAR-NIASM

Crop	Variety
Avocado	Arka Supreme, XIII/I, ACC, Shankra, Helen Bacon, Seedless, CHES PA1/12, Nursery, Purple long size, Long fruit, Local Hass, Purple Gururaj and General avocado germplasm
Apple	Anna, HRMN, Dorset Golden
Peach	FLA 1633, Sha-e-Punjab
Plum	Kala Amritsari, Satlej Purple
Malayan Apple	Onion colour apple, Red Malayan apple
Kokum	-

Carbon sequestration in mango, coconut and pomegranate orchards in semi-arid region

Rehabilitation of degraded lands in India is becoming a solution to address the climate change vagaries by reducing GHG emissions through carbon sequestration. To quantify these, randomly selected fruit trees were destructively harvested, sorted, sampled and dried for component wise biomass estimation. The maximum total biomass was observed in mango (71.94 Mg ha^{-1}) followed by pomegranate (22.45 Mg ha^{-1}) and coconut (19.73 Mg ha^{-1}). Mean carbon content in mango, pomegranate and coconut was 42.01%, 42.73% and 39.84% respectively.

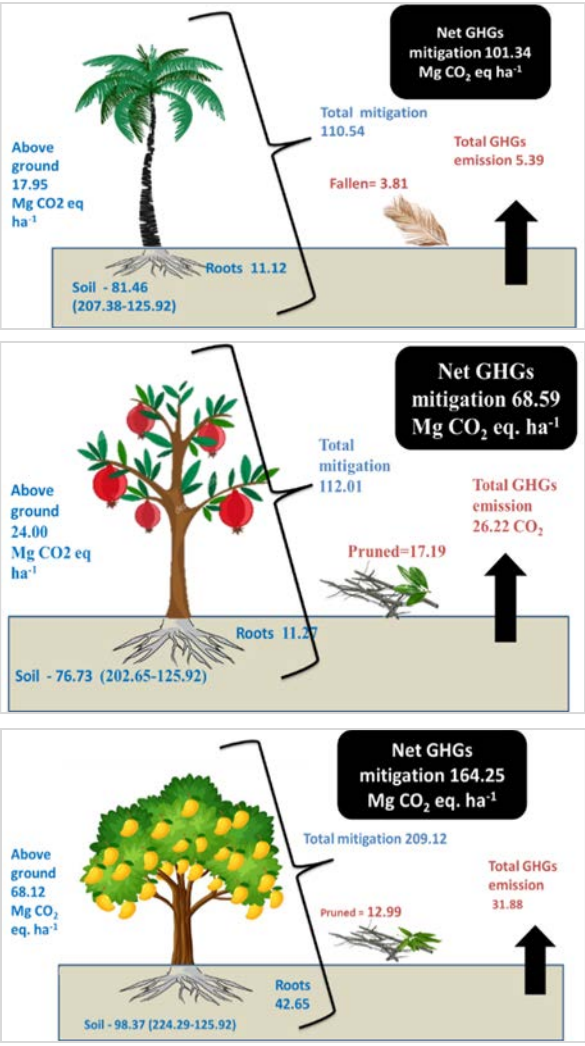


Fig. 2.2.18: Net greenhouse gas mitigation in mango, pomegranate and coconut.

The highest total carbon stock was recorded in mango (30.18 Mg C ha^{-1}) followed by pomegranate (9.60 Mg C ha^{-1}) and coconut (7.92 Mg C ha^{-1}). However, a higher carbon sequestration rate (tree+soil) was also found in mango (11.42 Mg C ha^{-1} yr^{-1}) followed by coconut (8.07 Mg C ha^{-1} yr^{-1}) and pomegranate (8.05 Mg C ha^{-1} yr^{-1}). For biomass modelling, collar diameter (CD) in mango and pomegranate was found to be the most reliable predictor for biomass estimation, whereas $DBH^2 \times H$ in coconut. Among various models, Gompertz model [Total biomass = 186.3914×exp(-exp(-(CD-13.8693)/ 5.1916))] in mango, Gompertz model [Total biomass = 36.7126×exp(-exp(-(CD-4.7788)/ 2.4443))] in pomegranate and Chapman model [Total biomass = $296.4354\times(1-\exp(-2.6362\times DBH^2\times H))^{1.6462}$] in coconut was found best fitted with high R^2 and low AICc value. Among various inputs, fuel was major contributor in GHGs emission in mango and coconut with 53% and 45 % respectively but in pomegranate fertilizer application (34%) was the major contributor. Mango cultivation on degraded lands emitted 31.88 Mg CO_2 eq. ha^{-1} greenhouse gas emissions followed by pomegranate cultivation (26.22 Mg CO_2 eq. ha^{-1}), and coconut cultivation (3.84 Mg CO_2 eq. ha^{-1}). The net CO_2 mitigation potential was maximum in mango orchard (164.25 Mg CO_2-eq ha^{-1}) followed by pomegranate orchard (101.34 Mg CO_2-eq ha^{-1}) and coconut orchard (68.59 Mg CO_2-eq ha^{-1}). Comprehensive studies are further required to improve understanding of carbon -eq and GHG emissions in fruit-based systems.

Biomass equation and Carbon storage in *Melia dubia* from farmers field

The field sampling of *Melia dubia* trees through destructive sampling was carried out in Solapur districts of Maharashtra to develop biomass estimation models for carbon sequestration studies. The DBH values of the harvested trees ranged from 16.69 to 26.75 cm and tree heights of 15.55 to 18.90 m. The independent parameter (DBH & tree height) was plotted against dry bole weight of Melia trees to testify to the regression relationship. The diameter at breast height was found to be the best independent predictor over tree height. The best regression equation was found to be power (Allometry) equation *i.e.,* Above ground Biomass (kg tree^{-1})= 0.4857 ×(DBH)$^{2.0428}$ with R^2 of 0.97. Mean absolute error (MAE) for the best-fit model comes out to be 10.22 indicating that error of only 10.22 kg may occur in the prediction of aboveground tree biomass of Melia. The average biomass and carbon stock of melia was 176.45 per kg per tree and 83.68 kg tree^{-1}

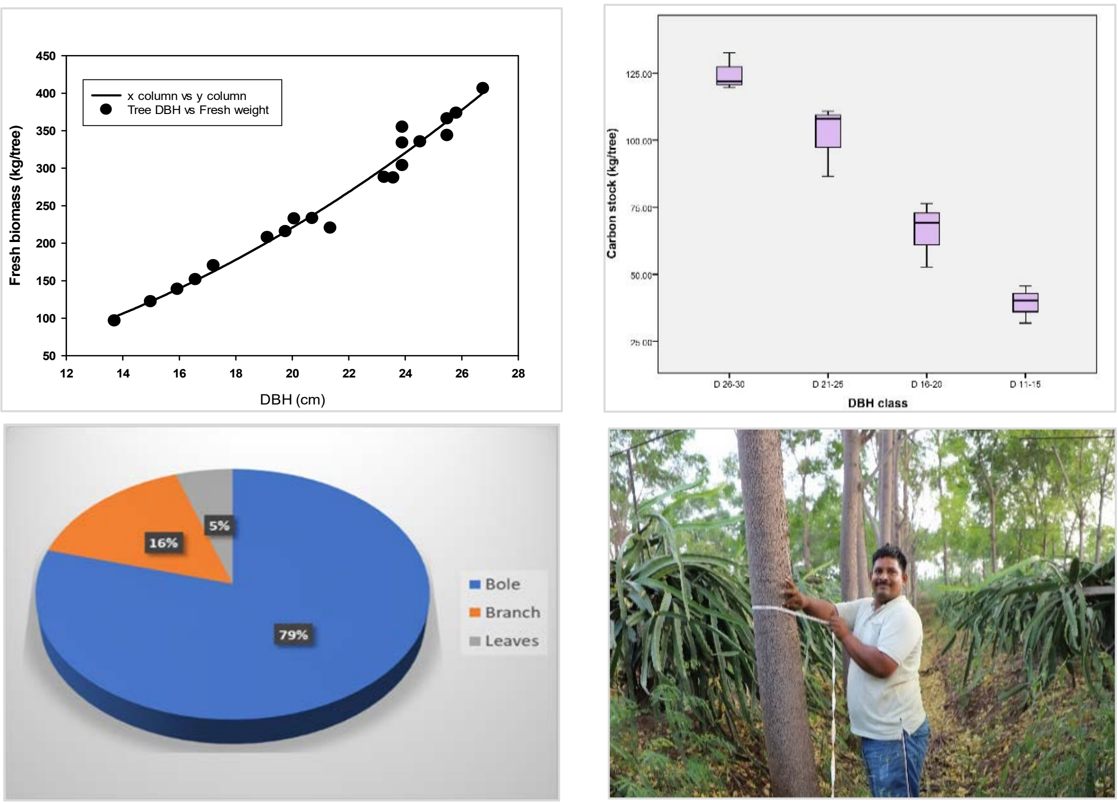


Fig. 2.2.19: Biomass model, Biomass accumulation, carbon stock in *Melia dubia*

Nano-copper enhances thermal efficiency and stimulates gene expression in response to multiple stresses in *Pangasianodon hypophthalmus* (Striped catfish)

An experiment was conducted to delineate the role of nano-copper (Cu-NPs) in the enhancement of thermal efficiency, anti-oxidative gene expression, and immunity of the *P. hypophthalmus* reared under arsenic (As), high temperature (34 ºC) and low pH (6.5) stress for 110 days. Four isocaloric and isonitrogenous diets containing Cu-NPs at 0, 1.0, 1.5, and 2.0 mg kg^{-1} were formulated and prepared. The thermal efficiency study was conducted at the end of 110 days feeding trial and determined the critical thermal minima (CTmin), lethal thermal maxima (LTmax) and lethal thermal minima (LTmin), and critical thermal maxima (CTmax). The cortisol, heat shock protein (HSP 70) gene, and neurotransmitter enzymes were noticeably affected by As, As+T and As+pH+T, whereas it improved by dietary Cu-NPs during LTmin and LTmax.

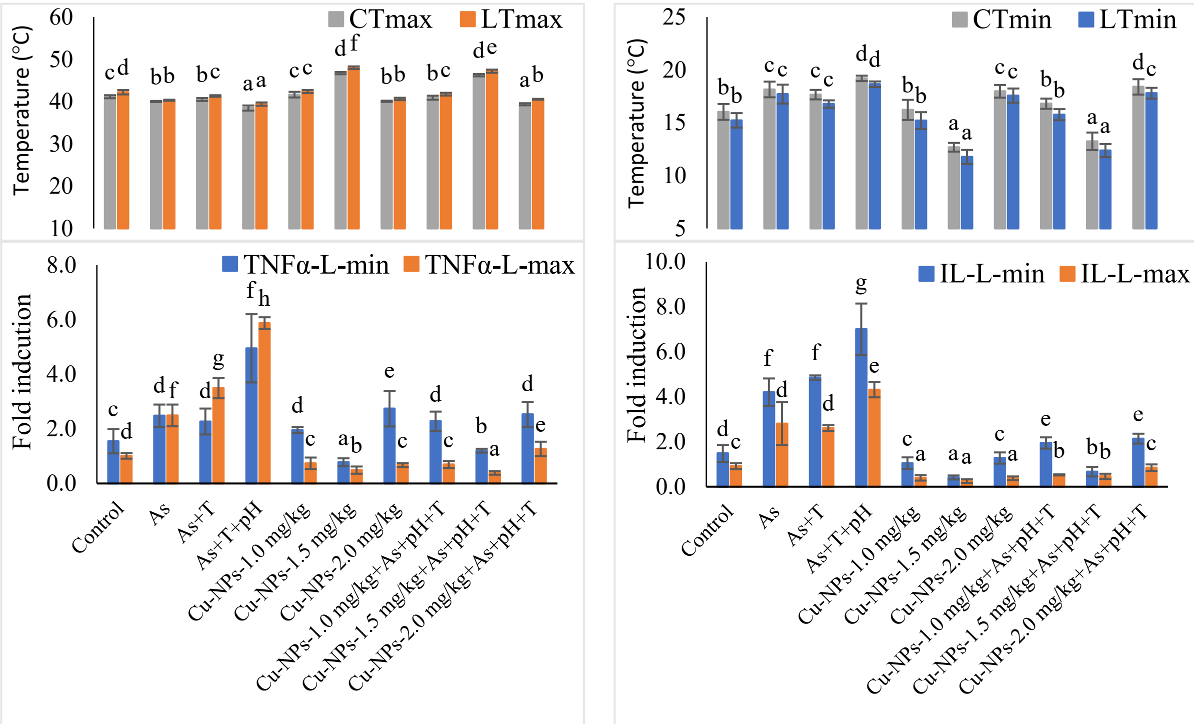


Fig. 2.2.20: Effect of copper nanoparticles (Cu-NPs) on (a) thermal tolerance and (b) gene expression of tumour necrosis factor (TNFα) and iterleukin (IL) in liver of *P. hypophthalmus* reared under arsenic, low pH and high temperature for 110 days.

The genes related to immunological index *viz.,* tumor necrosis factor (TNFα), interleukin (IL1b), inducible nitric oxide synthase (iNOS), immunoglobulin (Ig) and toll like receptor (TLR) in liver were noticeably altered with stressors. Whereas dietary Cu-NPs at 1.5 mg kg^{-1} diet improved the immune systems by improving gene expression during LTmin and LTmax. The anti-oxidative related gene expression SOD, CAT, and GPx were significantly enhanced with As, As+T, and As+pH+T, whereas Cu-NPs remarkably reduced the oxidative stress. Bioaccumulation and concentration of arsenic in *P. hypophthalmus* muscle and water were significantly reduced using dietary Cu-NPs. It also protects the tissues against DNA damage during LTmax. The present investigation revealed that supplementation of Cu-NPs at 1.5 mg kg^{-1} diet improves thermal efficiency and gene regulation related to anti-oxidative and immunity of the *P. hypophthalmus*.

Exploring mitigating role of zinc nanoparticles on arsenic, ammonia and temperature stress using molecular signature in fish

In this investigation, the growth hormone regulator 1 (GHR1), growth hormone regulator β (GHRβ), growth hormone (GR) in liver and gill as well as myostatin (MYST) and somatostatin (SMT) in muscle were noticeably altered, whereas, Zn-NPs at 4 mg kg^{-1} diet improved gene expressions. The anti-oxidant gene *viz.,* CAT, SOD and GPx in liver and gill tissues were upregulated by stressors such as As, NH_3, NH_3+T. As+T and As+NH_3+T. Therefore, anti-oxidant genes were noticeably improved with dietary Zn-NPs diet. The stress protein gene (HSP70), DNA damage inducible protein, inducible nitric oxide synthase (iNOS) was significantly upregulated, whereas, Zn-NPs diet was applied to the corrected gene regulation. Similarly, immune related genes such as interleukin (IL), tumour necrosis factor (TNFα), toll like receptor (TLR) and immunoglobulin were highly affected by stressors. Dietary Zn-NPs at 4 mg kg^{-1} diet was improved all the immune related gene expression and mitigate arsenic, ammonia and high temperature stress in fish. The study revealed that Zn-NPs at 4.0 mg kg^{-1} diet has enormous potential to modulates arsenic, ammonia and high temperature stress, and protect against pathogenic infections in fish. (For more Information please refer: https://doi.org/10.1016/j.jtemb.2022.127076)

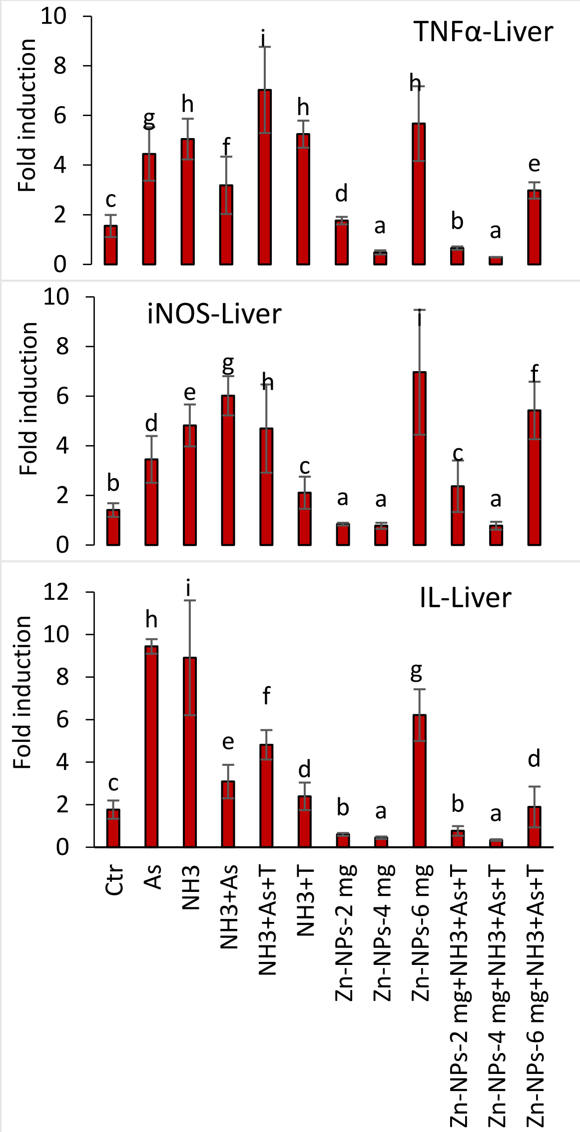


Fig. 2.2.21: Dietary zinc nanoparticles (Zn-NPs) improved TNFα, iNOS, IL in liver tissue of *P. hypophthalmus* reared arsenic, ammonia and high temperature stress for 120 days.

Multi-biomarker approach to assess chromium, pH and temperature toxicity in fish

An experiment was conducted to determine the acute and chronic toxicity of Cr, pH and high temperature in *Anabas testudineus.* Lethal concentration (LC_{50}) of Cr alone was determined as 55.02 mg/L, Cr and low pH 48.19 mg/L and Cr, low pH and high temperature 47.16 mg/L. The chronic toxicity of low dose of Cr, pH and high temperature ($1/10^{th}$ and $1/20^{th}$ of LC_{50}) was designed to execute the experiment for 72 days. The stress enzymes and biomarkers were determined *viz.,* superoxide dismutase, catalase, glutathione peroxidase, glutathione-s-transferase, lipid peroxide, acetylcholine esterase, cortisol, HSP-70, blood glucose, aspartate amino transferase, alanine amino transferase and malate dehydrogenase, lactate dehydrogenase and

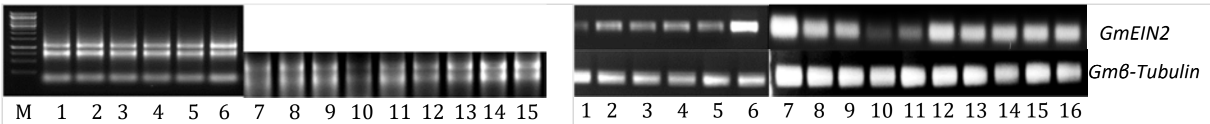
ATPase and genotoxicity in this study. The study of integrated biomarker response (IBR) revealed that Cr toxicity enhanced with concurrent exposure to pH and high temperature. All the biochemical attributes were significantly ($p<0.01$) altered with exposure to Cr alone and with low pH and high temperature except gill SOD. Further, Thermal tolerance was also determined and results revealed that thermal tolerance was significantly reduced with exposure to Cr alone and Cr and low pH exposure in *A. testudineus*. The study concluded that, the chronic toxicity of Cr enhanced with low pH and high temperature and it has led to understanding the multi-approach of Cr toxicity which affect on stress biomarkers, cellular metabolic stress and thermal tolerance of *A. testudineus*.

2.3 SCHOOL OF WATER STRESS MANAGEMENT

One of the most significant abiotic stresses in Indian agriculture is water stress, which requires a multifaceted strategy to address. In order to develop adaptation and mitigation alternatives for the management of water-related abiotic stresses, the school of water stress management has extensively concentrated its operations. These include investigations pertaining to crops namely soybean, pigeon pea, cowpea, chickpea, cluster bean, rajmash, sugarcane, quinoa, chia, chilli, dragon fruit, millets, cotton, brinjal, grapes, pomegranate and custard apple using multi-prong and multi-disciplinary approaches. The major research findings emerging out and the progress made under this programme during the past one year are summarized below.

Identification of promising soybean genotypes based on drought adaptive traits and drought responsive *GmEIN2* gene

A total number of 320 soybean genotypes were evaluated for drought adaptive traits under greenhouse conditions among which 15 promising soybean genotypes (PSG's) were identified for traits and genes contributing to drought stress tolerance. The level of water stress tolerance among this 15 PSG's was determined using drought adaptive traits and ethylene sensitivity indicator *EIN2* gene expression analyses. PSG's TGX539-2D-7, RSC10-52 and EC-291397 revealed considerably lower expression of *GmEIN2* gene, cooler canopy, more canopy greenness, higher shoot biomass and higher water status in terms of RWC as compared to drought sensitive check varieties JS-9560 and NRC-37 under well-watered conditions. PSG's TGX539-2D-7, TGX-854-429 and EC-457475 exhibited efficient photosystem-II as compared to drought tolerant check varieties JS-9752, JS-7105 and drought sensitive check varieties JS-9560 and NRC-37. Performance of genotypes TGX539-2D-7, RSC10-52 and EC-291397 was found better under non-stress and also under water stress conditions most probably due to higher water status, higher canopy greenness, lower canopy temperature and efficient PS-II and lower expression of *EIN2* gene as compared to drought sensitive check varieties JS-9560 and NRC-37. It may therefore be inferred that soybean genotypes having lower expression of *EIN2* gene which indicates less sensitivity to ethylene, cooler canopy and higher PS-II efficiency, higher RWC and more canopy greenness may be good plant types for adaptation to limited soil moisture conditions.



M: 1 kb ladder
1:TGX-539-2D-7
2:RSC-10-52
3:EC-291397
4:EC-241310
5:MACS-450
6:EC-251388
7:EC-572160
8:TGX330-325D
9: JS-9752
10: JS-7105
11: JS-9560
12: NRC-37
13:TGX-814-78D
14: V-55
15:TGX-854-429
(9,10: drought- tolerant check variety)
(11,12: drought sensitive check variety) (a)

1: TGX-539-2D-7
2: RSC-10-52
3: EC-291397
4: JS-9752
5: JS-7105
6-7: JS-9560
8:MACS-450
9 : EC-251388
10: TGX-854-429
11: EC-241310
12: NRC-37
13: TGX814-78D
14: EC-572160
15: V-55
16:TGX330-325D
(4,5 : drought- tolerant check variety)
(6,7,12: drought sensitive check variety) (b)

Fig. 2.3.1: a) Total RNA b) RT-PCR analysis of *GmEIN2* in PSG's, drought tolerant and drought sensitive check varieties

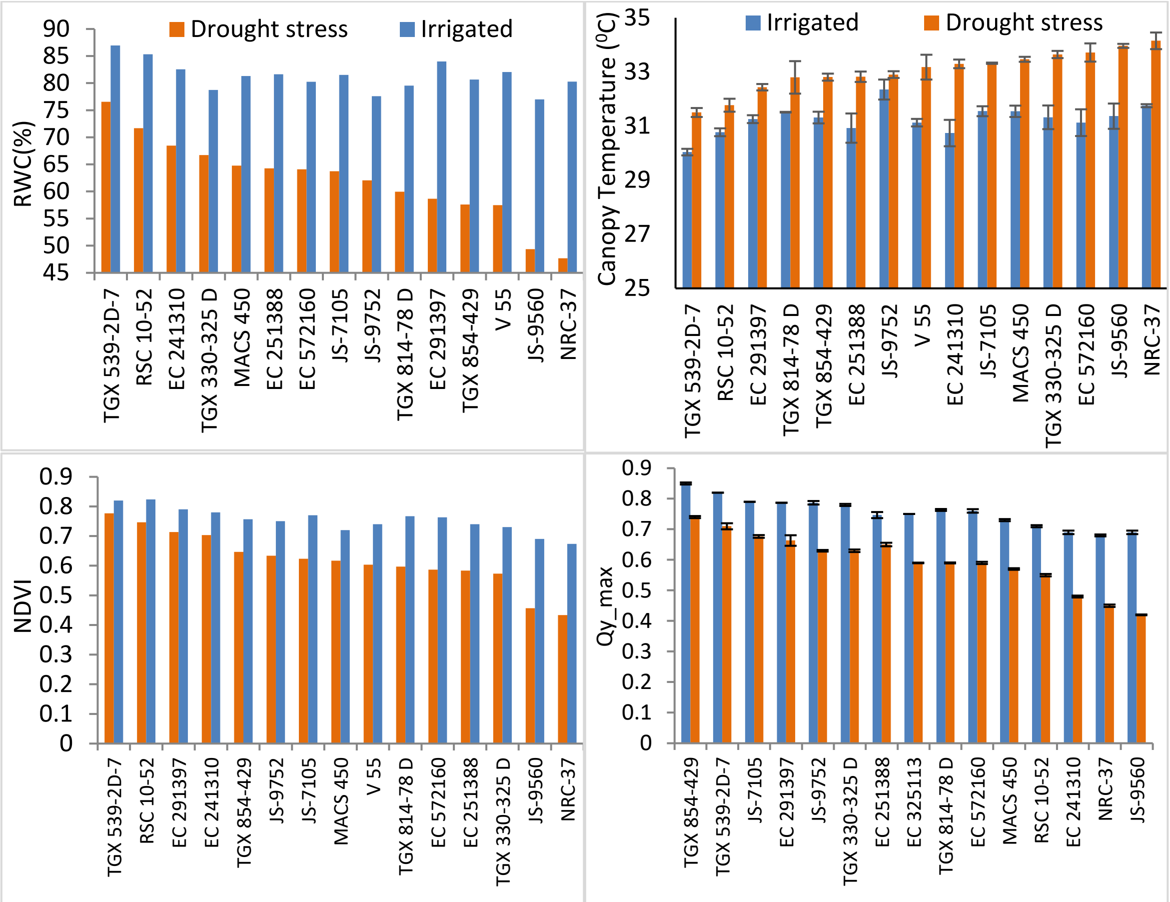


Fig. 2.3.2: Physiological analyses of promising genotypes, a). RWC, b) Canopy temperature, c). Canopy greenness (NDVI), d) Photosystem-II efficiency, in promising soybean genotypes and check varieties, i.e, JS 9560, NRC-37, JS-9752 and JS-7105.

Genetic variations in physiological response of GmEIN2, GmFnsl and GmWRKY-silenced soybean plants under no stress (irrigated) and drought stress conditions

EIN2-silenced, Farnesyltransferase (Fnsl), and WRKY-silenced soybean plants along with vector control (G7R2V) and mock-inoculated soybean plants were evaluated for chlorophyll content and photosystem-II efficiency. The GmFnsl, GmEIN2 and GmWRKY-silenced plants showed higher chlorophyll content and photosynthetic efficiency as compared to vector-controlled and mock-inoculated soybean plants.

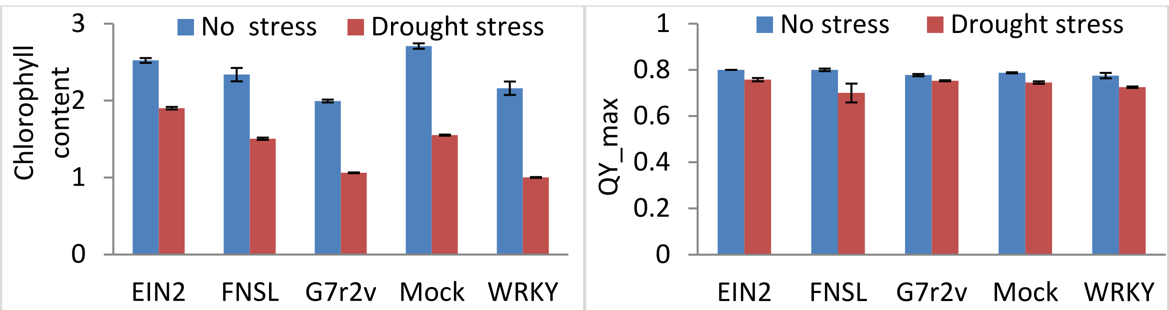


Fig. 2.3.3: Physiological response of silenced soybean plants, chlorophyll content (a) and Photosystem-II efficiency (b) of EIN2-silenced, Farnesyltransferase (Fnsl), and WRKY-silenced soybean plants as compared to vector control (G7R2V) and mock-inoculated soybean plants.

Screening and identification of waterlogging tolerant pigeonpea genotypes

A total of 168 diverse genotypes of pigeonpea were screened for submergence tolerance at seed stage in different submergence durations (2,4,6 and 8 days) during 2020. A total of 33 genotypes showed higher survival ability were further screened in a pot experiment for 10 days during 2020 and 2021 kharif season. Genotypes ICP-10397, ICP-7507, ICP-7869, ICP-7148, ICP-4903 ICP-16309, ICP-7375, ICP-6815, ICP-7507 showed significantly higher survival rate, waterlogging tolerance coefficient, retained better chlorophyll content under waterlogging condition. In addition, they possessed better Quantum efficiency of PS-II under stress compared to checks ICP-7035, MAL-15. Further based on yield under stress and control different stress indices were calculated, genotypes ICP-16309, ICP-7148, ICP-8255, ICP-6845, ICP-6815, ICP-10228, ICP-6370, ICP-10397, ICP-4903, ICP-7869, ICP-7507 exhibited higher stress tolerance index, mean relative performance, yield stability index, lower percent yield reduction across the two years (2020 and 2021).

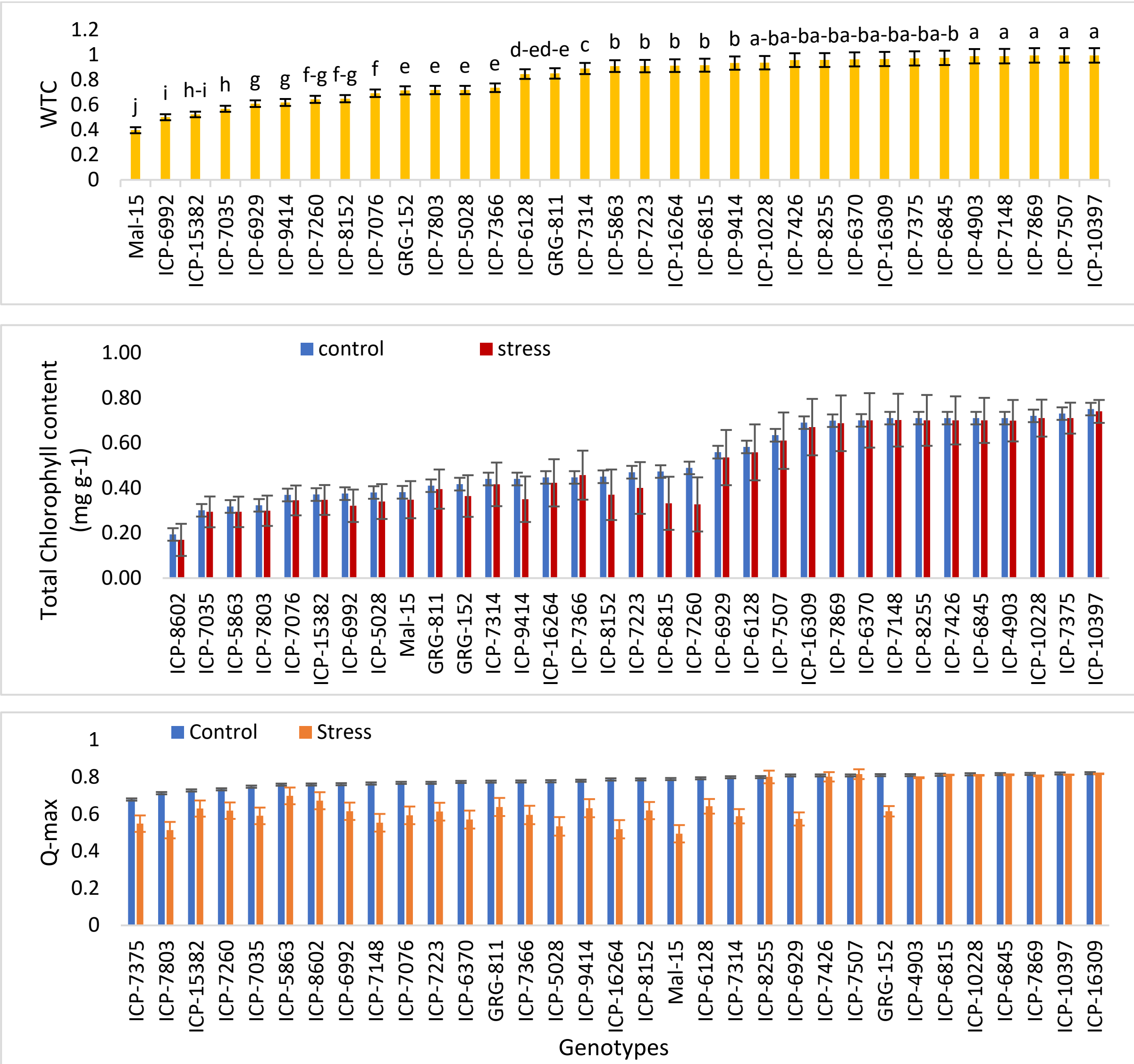


Fig. 2.3.4: a) Waterlogging tolerant coefficient b) Total chlorophyll content and c) Quantum efficiency of PS-II of diverse pigeon pea genotypes under control and transient waterlogging condition

Identification of high temperature stress tolerant cowpea genotypes

Large collections of 257 diverse core set of cowpea germplasms which were screened for high temperature stress under the field condition during summer season of 2022 (Feb-June 2022). A date of sowing was adjusted in such a way that flowering should coincide with high temperature. Preliminary screening identified trait specific high temperature tolerant cowpea germplasms.

Table 2.3.1: List of screened germplasms and its genotypes

Type of Germplasm (Trait)	Genotypes
Vegetable type (very early escape mechanism under both stress and control)	EC-724484, EC-724740, EC724484, EC-723684, IC-488084, IC488077, EC-243999, IC-259159, IC410043, IC554414
Grain type (high yield under stress and control)	Ec240930,EC-240926, EC-240884, EC-107151, EC-240874, EC-121826, EC24081, EC240741, EC240829, IC-488085, EC-240902, EC241078, EC 244133, IC 488268, IC 488222, EC 149469, EC 241035, EC 240995, EC 240989-A, EC 240878, IC 400155, IC 402101, IC 426824, IC 472252, EC 240900, EC 243995, IC 488124, EC 243927, EC 240625, IC 402176, IC 596961, IC 426824, IC 488067, IC 548288, IC 472254, IC 488124, EC 240897-1, EC 240924, EC 240625, IC 605507, IC 421917, IC 596961
Fodder type (high biomass under stress and control)	EC 240891, EC 107182, EC 240917, EC 240875, EC 240890, EC 240801, IC 488112, IC 488119, IC 488131, IC 488085, EC 242128, EC 149458, EC 243938, EC 723742, EC 244121, EC 723851, EC 241058, EC 723735-B, IC 488270, IC 488239, IC 488109, EC 244175, EC 724252, EC 723796. EC 723836, EC 244148, EC 723674, EC 23850, EC 240648, IC 397983, EC 240630, EC 240891, EC 100094, EC 240966-A, IC 402125, IC 402103, IC 488195, IC 488146, IC 598466, IC 569092, IC 594504, IC 560928, IC 369857, IC 488246, IC 471387, IC 488171, IC 561238, IC 590841, IC 471435
Dual Purpose (high grain yield and biomass under stress and control)	IC 488095
Grain Type (significantly higher leaf PS-II efficiency under stress and control)	EC 724764-B, IC 560916, IC 548288, EC 240966-A, EC 724905, EC 724484, EC 240989-A, EC 241058, IC 402097 EC 240868, IC 548860, IC 507157,EC 724805 IC 488185, IC 418505, C 402161, EC 723908, IC 402111, IC 554414, EC 24081, IC 58905, IC 488085, IC 488135, EC 97167, EC 723743, EC 240824, IC 554347, IC 420660, IC 471955, EC 149469, IC 397397, EC 243999, EC 724742, IC 401315, IC 548859, EC 240676, EC 240902, IC 488065, EC 240635, EC 724547, IC 402125, IC 488067, IC 426809 IC 472254, EC101775, IC 488264, IC 560917, EC 724872,
Grain Type (significantly higher Pod fluorescence under stress and control)	EC 148709, EC 240900-A, EC 240861, EC 240890 EC 244133, EC 244175, EC 244075, IC 397397, IC 402105 IC 401315, IC 402090, IC 402159, IC 402099, IC 418505 IC 488146, IC 488065, IC 488063, IC 554414, IC 512204

Studies on N-(n-butyl) Thiophosphoric Triamide (NBPT) as a urease inhibitor for improving nitrogen use efficiency in sugarcane cropping systems in India

Sugarcane is one of the most important cash crops in India, contributing 1.1% to India's GDP which is significant considering that the crop is grown only in 2.57% of the gross cropped area. Nitrogen (N) management is one of the critical aspects in sugarcane production, as very low can impact negatively on sucrose production, juice quality and very high can cause lodging, reduced cane quality and increased disease pest infestation. In India, since most of the urea is applied as surface broadcasting, there is a significant loss of N as ammonia volatilization as a result of rapid hydrolysis and an ensuing increase is soil pH in the close proximity of the granule. Since, the hydrolysis of urea is catalyzed by urease enzyme; its regulation can help in reducing the volatilization losses and hence reducing nitrogen footprint through improved nitrogen use efficiency. In this context, the study focused on assessing the effect of adding the urease inhibitor i.e. NBPT (N-(n-butyl) Thiophsphoric Triamide; Trade name: Agrotain), to urea to reduce environmental loss and to improve fertilizer efficiency in sugarcane in vertisol. The experiment was laid out in a randomized block design with five treatments viz., T1: Control (no N); T2: 100% Neem coated urea (NCU); T3: 100% Agrotain incorporated urea (AIU); T4: 80% AIU; T5: 60% AIU with four replications. The results revealed delayed urea hydrolysis in agrotain treated plots as compared to control. The amount of ammonium concentration in 100% AIU plots was double to that of 100% NCU after 10 days of fertilization. Further, highest cane yield was observed in 60% AIU (180 t ha^{-1}) which was comparable to 80% AIU and 18% higher than conventional practice i.e. 100% NCU ($P < 0.05$) (Table 2.3.2). The nitrogen use efficiency and partial factor productivity was higher under 60% AIU followed by 80% AIU (Fig. 2.3.5).

Table 2.3.2: Effect of treatments on sugarcane yield attributes, cane and trash yield

Treatment	Plant height (cm)	Cane girth (cm)	No. of nodes	Inter-node length (cm)	No. of millable canes per stool	Weight of millab le canes m^{-2} (kg)	Cane yield (t ha^{-1})	Trash yield (t ha^{-1})
Control	251.33	9.00	19.32	11.32	8.25	9.45	109.75 c	13.05 c
100% NCU	275.47	9.43	19.44	11.76	9.75	10.53	152.92 b	21.20 b
100% AIU	269.85	9.48	19.77	11.94	9.75	11.79	189.39 a	25.63 a
80% AIU	268.66	9.42	19.79	11.79	8.75	11.63	173.98 ab	21.40 b
60% AIU	265.69	9.40	19.61	11.40	9.75	12.37	180.43 a	16.49 c

Values with different lower case letters are significantly different at p< 0.05.

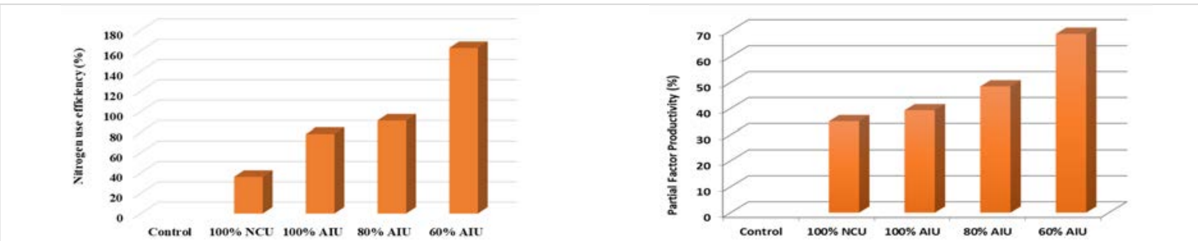


Fig. 2.3.5: Effect of treatments on nitrogen use efficiency and partial factor productivity in sugarcane

Optimising agronomy of quinoa in water scarce regions of India

Alternative crops are adapted to a range of agro-ecologies, are nutrient dense, climate resilient and offer better prospects in abiotic stress areas with low-input agriculture. However, turning the potential of these crops into real benefits requires a systematic approach, multidisciplinary analysis, multi-stakeholder consultation and cross-sectoral coordination. Optimising agronomy of these crops in a new agro-ecological region needs strategies related to sowing time and technique, cropping season, water management, fertilizer management, harvesting, and post-harvest management. In this backdrop, a field experiment was conducted to evaluate the effect of different sowing dates, irrigation techniques and nitrogen doses on quinoa productivity and quality in native murram soil in Rabi 2021-22. The treatments comprised of three factors: a) date of sowing (4 levels): 1st November (D1); 15th November (D2), 1st December (D3), 15th December (D4); b) irrigation (2 levels): irrigation at 80% crop evapotranspiration (ETc) (I1); irrigation at 40% ETc (I2); c) nitrogen doses (3 levels): 100 kg N ha^{-1} (N1); 150 kg N ha^{-1} (N2); 200 kg N ha^{-1} (N3). The experiment was laid out in a strip-strip plot design with date of sowing in vertical and irrigation as horizontal strips in main plots followed by nitrogen dose as vertical strips in sub plots with three replications. Data related to crop morphological (plant height, leaf area, shoot and root weight, shoot: root, days to flowering), physiological (photosynthetic rate) and yield attributes (no. of panicle per plant, panicle height, seed weight per plant, seed yield) were recorded and analysed. It was observed that highest seed yield of 1700 kg ha^{-1} was found in plots sown in 1st November with 80% ETc and 200 kg N ha^{-1}. Similarly maximum water productivity of 1.13 kg m^{-3} was observed in 1st November with 40% ETc and 200 kg N ha^{-1}. Therefore it can be inferred that delay in sowing of quinoa after first November has reduced advantage of water and nitrogen input.

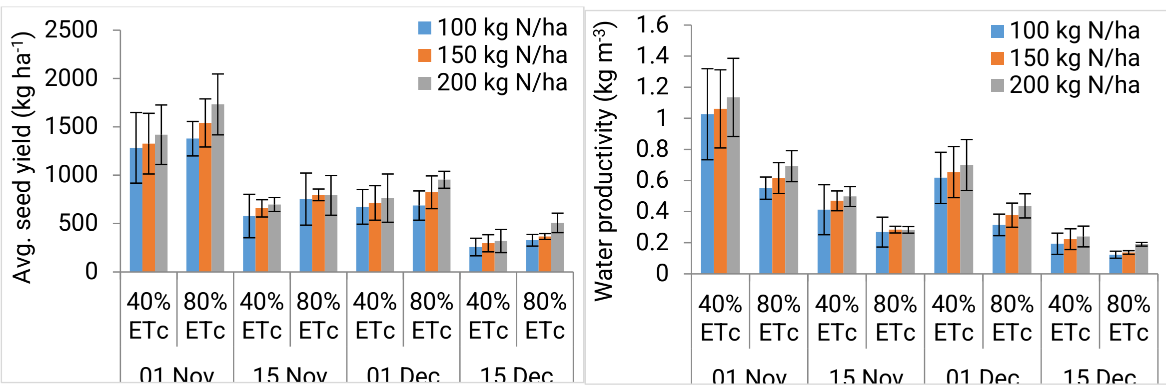


Fig. 2.3.6: Effect of date of sowing, irrigation and nitrogen dose on a) seed yield and b) water productivity of quinoa in native murram soil

Identification of 56 days of climate-smart, high-yielding with drought tolerance Rajmash

The development of early-maturity genotypes helps common bean to improve the speed breeding and extra income within a short duration. A study was therefore undertaken to assess the flowering, pod setting and relationship between grain yield and its attributing traits such as maturity duration under Kharif season. A total of ten promising germplasm determinate lines were evaluated in the Western Zone of the Indian environment (ICAR-NIASM, Pune) during Kharif 2022 (June-September) and also in the Late Kharif 2022 (September-November). Both agronomic and yield-component traits were recorded. The results exhibited that a wide range of genetic variability was observed among germplasm lines and traits correlation coefficients were estimated. This study identified a climate-smart extra early maturing germplasm such as EC 93-2021 which is fully determinate type and matures within 56 days giving a yield of 1251 kg ha^{-1}. The pods look attractive and seeds suitable for vegetable purposes.

Fig. 2.3.7: The germplasm EC-93-2021

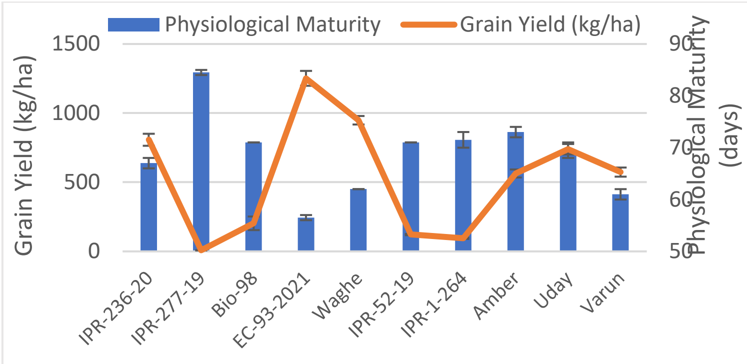


Fig. 2.3.8: The physiological and yield of different Rajmash genotypes studied

Kharif Chickpea: A new introduction to vegetable pulses in Western Maharashtra

Chickpea (*Cicer arietinum* L.) crop is widely cultivated in the arid region of India during the *rabi season* (October-February) and is primarily consumed as "daal" as a protein source. However, it has very good potential for growing in the off-season (June-August) in some parts of India especially Western Maharashtra for vegetable purposes. After preliminary investigations, we identified promising chickpea genotypes which are bold green and shiny seeds and are extra-early maturing in 69-70- and 76-80-days under rainfed and irrigated conditions, respectively. The yield of matured green chickpea plants with pods was between 70-88 and 115 - 176 q ha^{-1} under rainfed and irrigated conditions while that of raw green chickpea pods was between 30-45 and 19-24 q ha^{-1}, respectively. The identified genotypes GG-2 and GNG 2171 showed highest green plant yield with 176 and 87 q ha^{-1} under irrigated and rainfed conditions, respectively. The highest raw green chickpea pod yield was in JG-14 and GNG 2171 with 45 and 24 q ha^{-1} under irrigated and rainfed conditions, respectively. Thus, the introduction of chickpea as a "*Kharif* crop" in the new niche will enhance the farmer's income as well as secure the nutritional requirement.

Fig. 2.3.9: Products of Kharif chickpea; **a**- Green chickpeas plant, **b**- Raw green chickpeas pods, **c**- Raw tender green chickpea of 60 days old

Vegetal protein hydrolysates reduce the yield losses of off-season crops under combined heat and drought stress

Experiments were conducted to evaluate the influence of foliar application of vegetal protein hydrolysate (PHs) based bio-stimulant of different concentrations to reduce the yield losses of off-season crops (soybean and chilli in summer; chickpea in early *Kharif* 2022) under water deficit stress and also on excised leaf water loss. The study revealed that the application of PHs significantly improved the membrane stability index, relative water content, total chlorophyll and proline content of leaves. Consequently, it led to an increase in the number of pods in soybean and chickpea, and fruits in chilli, leading to improved yields when plants were treated with an appropriate amount of PHs. Compared to untreated plants, PHs helped improve the efficiency of PS-II with significantly high photochemical efficiency (QYmax) even at higher excised leaf water loss or reduction in loss of relative water content. This study concluded that foliar application of 4, 2 and 6 ml L^{-1} of PHs can be beneficial for soybean, chickpea and chilli, which exhibited 17, 30 and 25% yield improvement, respectively over untreated plants under water deficit stress. It is suggested that the benefits of PHs can be realized in soybean, chickpea and chilli under environments featured by high temperature and water deficit stress.

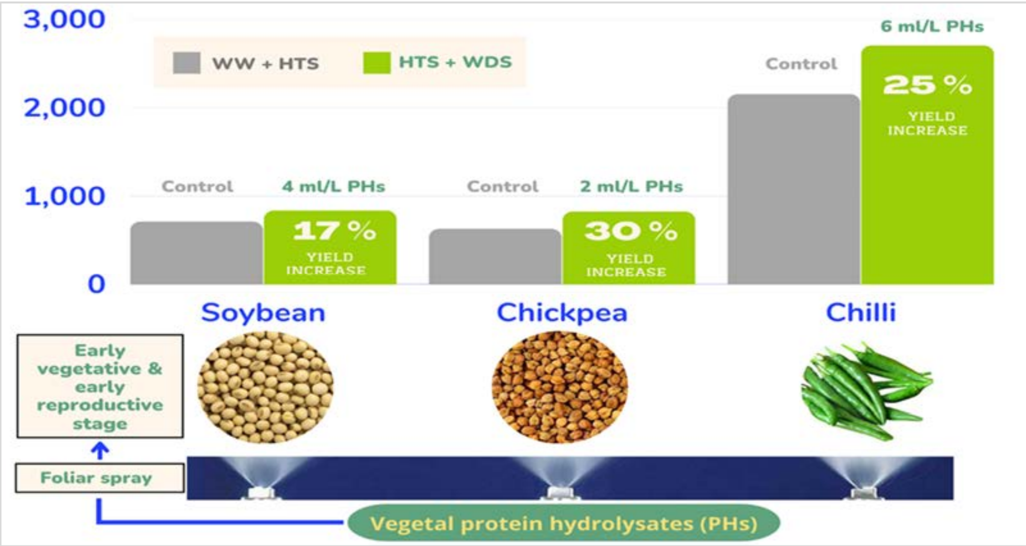


Fig. 2.3.10: Off-season crops yield increase with the application of different concentrations of vegetal PHs under combined HTS and WDS

Identification of photo-thermo-insensitivity and early maturing chickpea genotypes

Growing the same cultivars of chickpeas across different seasons and locations is constrained by their light and heat sensitive behavior. Preliminary experiment on photo-thermo-insensitivity in chickpea genotypes was carried at ICAR-NIASM during the 2021 *Kharif* season, in which 74 chickpea genotypes were evaluated under natural field conditions. Based on the performance of the genotypes, the early maturing genotypes, namely ICE 15654-A, IPC 06-11, JG-14, ICCV 92944, Vishal, Vijay, JG-11 and JG-16, and the photo-thermo-tolerant trait during the late *Kharif* 2021, Rabi 2021-22, summer 2022 and early *Kharif* 2022 were identified.

Table 2.3.3: Cultivation dates and crop duration

Season	Season	Sowing date	Harvesting date	Crop duration (days)
1	Kharif 2021	June 19, 2021	Aug 30, 2021	72
2	Late Kharif 2021	Aug 30, 2021	Nov 22, 2021	83
3	Rabi 2021-22	Nov 17, 2021	Feb 12, 2022	87
4	Summer 2022	Feb 19, 2022	April 26, 2022	66
5	Early Kharif 2022	April 26, 2022	June 17, 2022	54

The maximum temperature and sunshine duration (Fig.) were more than 35°C and 8 hours in summer 2022 and late Kharif 2022, but these genotypes still flowered and set the pods. The late *Kharif* 2021 was not greatly affected. The adverse effects of the summer of 2022 and early Kharif 2022 have been studied. Among them are good results in terms of yield. Therefore, it can be concluded that the chickpea genotypes ICE 15654-A, IPC 06-11, ICCV 92944 and JG-14 can withstand the 40°C under field conditions. The developed donors can be used to develop photo-thermo-insensitive and early maturing genotypes in cultivated chickpea species.

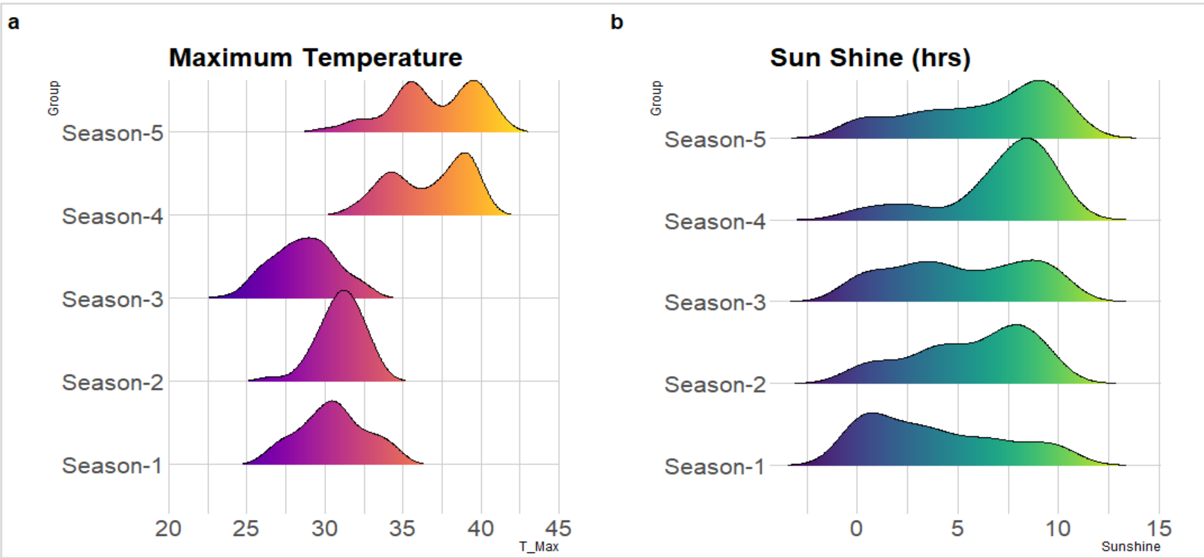


Fig. 2.3.11: Maximum temperature and sunshine hours at experiment location

Fig. 2.3.12: Harvested chickpea genotypes IPC 06-11, ICE15654-A

Special and promising chia mutant plants in M_2 and M_3 generation

The segregating M_2 populations grown during rabi 2021-22 were studied for the spectrum of variability for different traits and frequency of variation deviated from wild type. The mutants with variations were observed in Chia for more than one trait. In some mutant plants variation were observed for four characters and the frequency of mutation ranged from 0.0097 to 0.1065%. Out of three dose of γ-radiation, more mutants were observed in 500 Gy, whereas chlorosis related mortality was more in 600 Gy.

Table 2.3.4: The special and promising M_3 mutants in chia

Sl.	Special and promising traits	Mutant lines	Fig. No.
Mutants with special traits			
1.	Multiple and increasing leaf number from basal to top & entire plant chlorosis	400WW 31-1-1 (one plant)	2.3.14 A
2.	Entire plant chlorosis (Yellow plant type)	400WW 31-1-2 to 25 (All 24 plants except one)	2.3.14 C
4.	Half of the plant chlorosis (yellowing)	400WW 74-1-1 to 10 (10 plants)	2.3.13 A
5.	Cup shaped cotyledon and curly leaves with basal leaf chlorosis	400WW 148-1-1 to 15 (15 Plants); 148-2-1 to 1 (12 Plants)	2.3.13 B
6.	Triple leaves and radial branching (Emergence of three leaves and three branches at each node)	400BP 118-1-1 (one plant) 400BP 152-1-1 & 2 (Two plant)	2.3.13 C
7.	Multiple and increasing leaf number from basal to top	400BP 118-1-2 (one plant)	2.3.14 A
8.	Short, round and compact panicle	600WW 80-1-1 to 27 (27 plants), 600WW 81-2-1 to 31 (31 plants), 500WP 204-1-1 to 4 (4 plant), 204-2-1 (one plant)	2.3.13 D
9.	Branching spike	600WW122-1-1&2 (double) 600WW 86-1-1 (double) & 2 (triple)	2.3.13 E
10.	Loose spike with intermittent leafy structures	600WW 75-1 to 20 (20 plants) and 500WP 204-1-5 (One plant)	2.3.14 E
11.	Short and dense spike with large size variegated purple (white patches) florets	500WP 204-1-6 (One plant)	2.3.14 B
Mutants with promising traits			
12.	Purple pigmentation at stem, leaf petiole and florets and bold seeds with only two per flower instead of four in wild type	500BP 94-1-1 to 24 (24 plants); 94-2-1 to 21 (21 plants), 94-3-1 to 18 (18 plants); 500BP 125-1-1 to 22 (22 plants), 125-2-1 to 19 (19 plants), 125-3-1 to 20 (20 plants)	2.3.14 F & G
13.	Early flowering (4-5 days)	400WW:93-1; 106-1; 106-2; 400WP: 57-1; 500WP: 54-1;65-1;65-2;155-1;221-1,2&3; 600WP:18-2	-
14.	Early flowering (6-8 days)	500WP:17-1;65-3; 600WP:27-3 400BP:37-2;127-1; 500BP:6-1;15-1	-
15.	Early flowering (8-10 days)	500BP: 11-1	2.3.14 D
16.	Dark foliage, vigorous, good branching and spike	50-60 mutant lines	-

The M_2 mutant plants with special trait viz., triple radial branching pattern type and ornamental type (variation in foliage color and spike shape and length) and promising mutants with early flowering, compact and longer spike. More than 800 M_2 mutants along with wild types have been sown in progeny (plant) to row method for advancing to M_3 generation and also for conforming the inheritance and stability of traits during rabi 2022-23. Preliminary observation in M_3 generation indicated that some the plants expressed the same traits observed in M_2 generation with segregation indicating penetrance/inheritance of traits. Expression of some of the novel traits like purple pigmented stem, petiole and floret (calyx); two seed with bold size and loose spikelet with intermittent leafy structure etc (Table 2.3.4 and Fig. 2.3.13 & 2.3.14) indicates the variability in expressivity besides possibilities of polygenic and epigenetic inheritance. The special and promising M_3 mutants are listed in Table 2.3.4. Some of these identified mutant lines/plants with special and promising traits have potential to be registered as genetic stocks/ mutant lines, ornamental type and genetic resources (germplasm). Subsequently, such lines will be useful for basic research and breeding programme to develop high yielding varieties with tolerance to abiotic stresses.

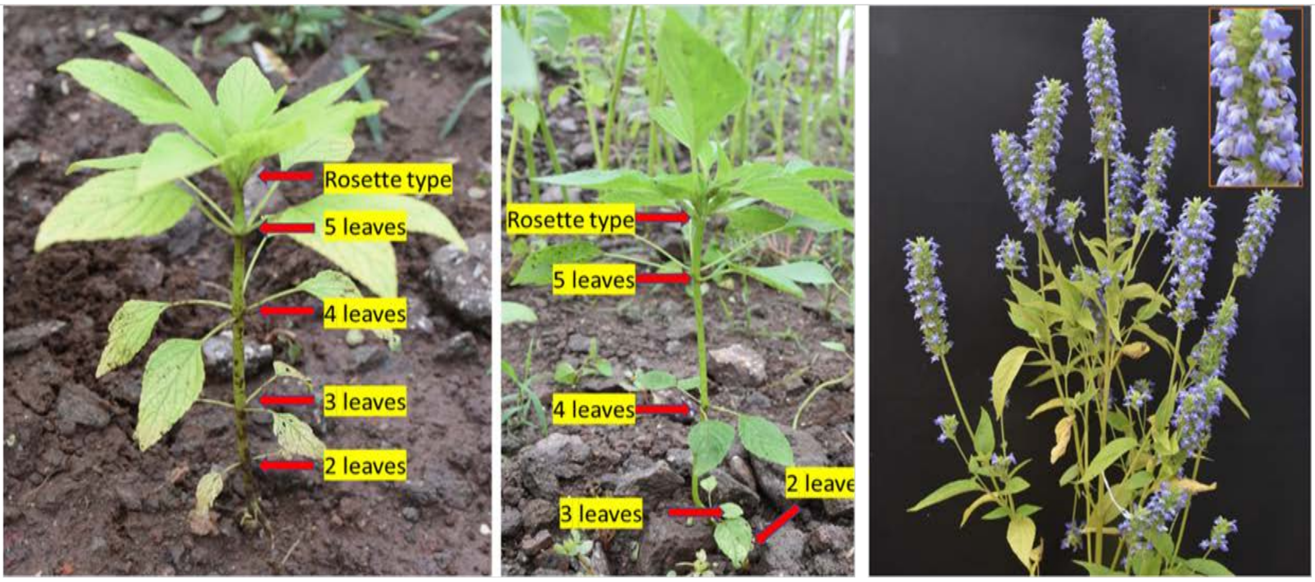
M_2 generation | M_3 generation | M_2 generation | M_3 generation | M_2 generation | M_3 generation

A. Half of the plant chlorosis | B. Cup shaped cotyledon ,curly leaves with chlorosis | C. Triple leaves and radial branching

M_2 generation | M_3 generation | M_2 generation | M_3 generation

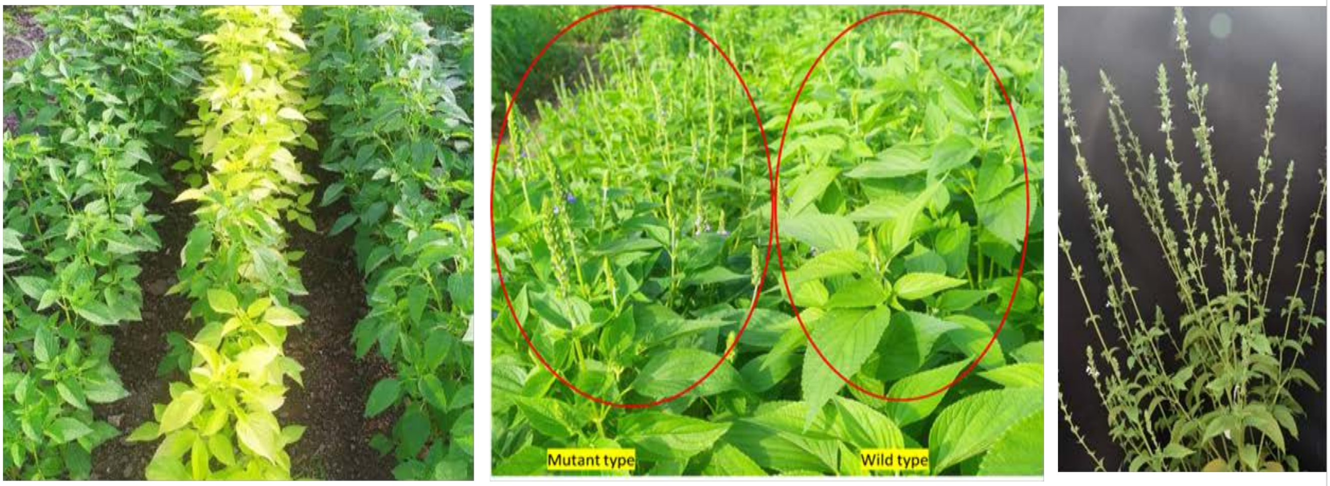
D. Short, round and compact spike | E. Branching pattern in spike

Fig. 2.3.13: Compartive view of expression of special traits at seedling (A, B and C) and flowering (D and E) stages in M_2 and M_3 generation



A. Variation for phyllotaxy in mutants (31-1-1& 118-1-2): Whorled

B. Short and dense spike (204-1-6)



C. Entire plant chlorosis (ornamental yellow plant type)

D. Mutant line (500BP 11-1 & 2) showing 8-10 days early flowering compared to its wild type

E. Long, loose spike with phyllody pattern

F. Purple pigmentation in petiole, stem and calyx (in spike)

G. Variation for size ,color of flower; seed size and number of seed per floret in mutant lines (upper row)

Fig. 2.3.14: Some of the novel traits expressed at different stages in M_3 generation

Study of floral morphology, flowering behavior and pollination process in dragon fruit unraveled cause for low productivity in white dragon fruit variety

In India, during early period of dragon fruit introduction, most of the farmers planted white fleshed regular fruit size variety of *H. undatus* and thus occupied the major area. The observation from dragon fruit orchards of ICAR-NIASM and farmers and data from dragon fruit growers' surveys conducted during 2021 and 2022 in Pune and Solapur districts in Maharashtra showed that the yield of white variety was very low and varied between 7-10 ton ha^{-1} besides poor quality of fruit. The comparative fruiting index and fruit size in the three varieties (regular white, regular red and jumbo red) of dragon fruit indicated that the production of more number of smaller size fruits despite of good flowering and potential to produce bigger size fruits (fruit size varies between 90-450 g) was the major cause reason for low productivity, poor quality and performance of the white variety. In order to identify the cause for production of smaller size fruits, the floral morphology, flowering behavior and pollination mechanisms in the three commercially cultivated varieties of dragon fruit were studied. The study revealed that the floral structural variation in stigma and filament length, temporal variation in flower opening and closing were attributed to delay and partial pollination process in white variety. Thus, consequently smaller fruits with uneven seed distribution and white meshy type pulp were produced owing to fertilization of only few ovules and conversion into seed. A pollination experim ent with three treatments viz., self, cross and natural pollination was therefore conducted to fix the problems associated with white variety. The supplementary hand self and cross pollinations fixed the problem of partial pollination and enhanced fruit size the up to 30 and 82%, with additional yield of 3.0 (33%) and 9.0 tons (100%) $acre^{-1}$, res pectively compared to natural pollination (Table 2.3.5). Hence, supplementary pollination unlocks the potential yield (up to 18 tons $acre^{-1}$) besides enhancing the fruit quality (color, shape, pulp and seed set).

Table 2.3.5: Variation fruit size (weight) in different pollination treatment (N=100)

Treatment	Average (g)	Range	Percent increment	SD
Natural pollination	247.00	98-415	-	79.64
Hand self-pollination	321.00	200-455	30	45.40
Hand cross pollination	452.00	310-654	82	60.50

Identification of best pollen parents for enhancing fruit size and quality in dragon fruit

The selfing and crossing mode of pollination was examined in the collected clones/varieties. It was found that all the clones are self-pollinated and one red/pink fleshed clone (designated as NIASM DFR-1) collected from Andaman showed self-incompatibility. Interestingly the pollen from the same clone enhanced the fruit size of white fleshed clone up to (500-600 g) 100% up on cross pollination. The pollen from another white variety (designated as NIASM DFW-2) also reported to enhance fruit size up to (400-500 g) 80% upon cross pollination.

Demonstration and dissemination of technology on supplementary hand pollination for enhanced productivity in dragon fruit

A technology on supplementary pollination was demonstrated to more than 50 dragon fruit farmers and skilled labours during 2022 by conducting on field hands on trainings at farmers orchards located in Baramati, Bhigwan and Indapur talukas of Pune district. This technology targeted to reduce yield loss occuring due to pollen wash out by rainfall during anthesis and doubling productivity in white variety by enhancing the fruit size and quality. Few farmers have already benefitted by adoption of this technology.

Fig. 2.3.15: Demonstrations on supplementary hand pollination technique in dragon fruit

Identified high nutrient use efficient foxtail millet accessions

Under umbrella project on "Genetic garden and gene bank for abiotic stress tolerant plants, animals and fisheries for food security and sustainability", 118 accessions of foxtail millets were collected from ICRISAT and evaluated for nitrogen use efficiency during 2021 and 2022. Based on physiological (Chlorophyll content and NDVI), growth (plant height, number of variation for chlorosis and NDVI was observed at seedling stage in foxtail millet. leaves, biomass) and yield parameters (productive tillers, seed weight, yield per plant) selected 10 best lines as high nitrogen use efficient lines. Chlorosis was prominent (upper block) under N deficit treatment irrespective of the accessions evaluated. Promising lines for N deficit soils based on yield data of kharif 2021: FXM-10,54, 59,70,74,77,82,87,90,91,97,99,104,110 and 118 (NIASM codes). These selected lines can be evaluated under nutrient poor soils under AICRP trials for confirmation and promising lines will be registered as genetic stock.

Fig. 2.3.16: Variation for chlorosis and NDVI at seedling stage in foxtail millet.

Establishment of crop cafeteria to display important and popular varieties of cereals including small millets, pulses, oil seed and spice crops

As a part umbrella project on "Genetic Garden and gene bank for abiotic stress tolerance" in order to create awareness on biodiversity particularly plant genetic resources and its importance in abiotic stress tolerance management ICAR-NIASM, Baramati establishing crop cafeteria regularly during kharif and rabi seasons. During kharif 2022, important and popular varieties of cereals including six small millets, pulses, oil seed and spices crops have been displayed in crop cafeteria.

Fig. 2.3.17: Field view of crop cafeteria and display of diverse foxtail millet panicles

More than 500 students, farmers, scientist and other faculties and guests visited the crop cafeteria during the season. The sowing of rabi crops (wheat, chickpea, lentil, sunflower, quinoa, fenugreek, coriander etc.) has been planned for rabi season 2022-23

Collection, multiplication and evaluation of the germplasm/ genotypes/ accessions for different abiotic stresses

More than 1600 germplasm/genotypes/ accessions of different crops have been collected from different organizations. The seed/planting materials of collected germplasm is maintained and being utilized for basic research and screening for different abiotic stress tolerance. The details of these collections are given in Table 2.3.6.

Table 2.3.6: Germplasm/genotypes/accessions collected at ICAR-NIASM, Baramati

Sl.	Crops	Varieties/germplasm/ genotypes	Abiotic stress tolerance	Source
1	Safflower	3 varieties	Drought	NARI, Phaltan
2	Sweet Sorghum	3 varieties	Drought	
3	Stylo	2 varieties	Drought	
4	Subabul	2 varieties	-	
5	Wheat	10 breeding lines	Salinity	ICAR-CSSRI, Karnal
		10 promising lines	Drought	ICAR-NIASM
8	Pigeon pea	4 genotypes	Water logging	ICRISAT
9	Soybean	6 genotypes	Drought	ICAR-IISR, Indore
		2 genotypes	Water logging	
10	Quinoa	14 genotypes		MPKV, Rahuri
11	Turmeric	16 genotypes		-
12	Brinjal	14 wild species		IIHR, Bengaluru
		30 local varieties		
12	Fenugreek	17 Genotypes		NRCSS, Ajmer
13	Pigeon pea	141 Accessions		ICRISAT,
14	Groundnut	174 Accessions		Hyderabad
15	Foxtail millet	118 Accessions		
16	Finger millet	77 Accessions	Multiplication and	
17	Cow pea	250 Accessions	evaluation/screening	NBPGR, Delhi
18	Mungbean	296 Accessions	for different abiotic	WVC, Taiwan
19	Tomato	250 Accessions	stresses under	WVC, Taiwan
20	Ajwain	12 genotypes	progress	NRCSS, Ajmer
21	Chickpea	72 genotypes		IIPR, Kanpur
22	Lentil	32 genotypes		IIPR, Kanpur
23	Groundnut	8 varieties		UAS, Raichur & Dharwad
24	Finger millet	35 wild species & varieties		ICAR-IISS, Mau
26	Passion fruit	20 genotypes/ varieties		ICAR Institutes
27	Citrus	30 root stocks/genotypes		IARI, New Delhi
28	Dragon fruit	20 collections, farmers orchards		Pune & Solapur, MS
		Blood Mary, Harpura white & Purple pink	Multiplication under progress	Centre of Excellence (Fruits), Hyderabad
Total		1673		

Identification of extra early-climate smart, drought-tolerant and high-yielding cotton germplasm

With objective of identifying early maturing and drought-tolerant genotypes of cotton to rapidly improve genetics and produce short-duration cotton varieties, a study, including core set of 207 lines selected from 862 *G.hirsutum* cotton accessions maintained at AICRP Cotton, MARS, UAS Raichur was undertaken. These lines were sown in the augmented design along with 5 local checks for the irrigated and drought environment in ICAR-NIASM, Baramati during *Kharif* 2022. Important morphological, physiological and yield traits were recorded. The results exhibited a wide range of genetic variability in terms of drought tolerance and crop maturity among the germplasm lines studied. The study identified RACH-P-18, MIHC-98-4, MIHC-399-5 and RAH-14292 as early, drought tolerant and high-yielding lines which mature in140-145 DAS with the estimated yield of 31.9, 30.0, 33.0 and 30.3 q ha^{-1}, respectively. These lines have superior fiber length and fiber strength, suitable to derive the high-yielding drought-tolerant extra early varieties for rainfed conditions. Similarly, extra early lines which are high yielding and mature in 140-145 DAS under the non-stressed environment viz. RACH-P-12, RAH 18310-5, RAH-1070, RAH-14326 and RAH-14217 with an estimated yield of 38.7, 36.3, 36.7 and 37.0, q ha^{-1}, respectively were identified.

Fig. 2.3.18: Field view of experiment at ICAR-NIASM

Genetic variations in physiological responses to drought in cluster bean (*Cyamopsis tetragonoloba* L.)

The twenty-five-vegetable type cluster bean genotypes including one check variety Phule Guar were evaluated for drought tolerance in greenhouse conditions (Fig. 2.3.19). The water stress was imposed after 40 days of seed sowing by withholding irrigation water for twelve days. Significant changes were observed among the genotypes for various morphological and physiological traits. Among the physiological traits, the maximum PS-II efficiency (0.78) was recorded in the However, it was at par with check Phule Guar (0.77). It was observed that genotypes RHRCB 01, RHRCB 04, RHRCB 11, RHRCB 15, RHRCB 17, RHRCB 23, RHRCB 24, and Phule Guar are relatively tolerant to drought.

Fig. 2.3.19: Cluster bean genotypes evaluated for drought tolerance in greenhouse genotypes RHRCB 15 and RHRCB 23.

Collection, conservation and maintenance of vegetable germplasm

The germplasm of tomato and eggplant was collected from different international and national gene banks and research institutes. In tomato sixty germplasm accessions of *Solanum lycopersicum* and ten accessions of wild species were collected and conserved.

In eggplant, thirty accessions of improved line and local varieties, and wild species are collected and multiplied (Fig. 2.3.20 a, b). Further, these accessions are being maintained and to be used for screening for different abiotic stresses.

Fig. 2.3.20: a. Local and improved eggplant accessions

Fig. 2.3.20: b. Eggplant wild relative species

S. sisymbriifolium and *S. torvum* as the potential rootstocks for drought tolerance in eggplant

Eggplant wild species are potential sources for tolerance to biotic and abiotic stresses. The five wild eggplant wild species (*Solanum gilo, S. indicum, S. macrocarpon, S. sisymbriifolium* and *S. torvum*) were used as a rootstock and the commercial cultivar Suraj (SUR) was used as a scion on these rootstocks. The splice grafting was done in a grafting cum healing chamber under optimal micro-climatic conditions by maintaining 27°C temperature and 90% relative humidity. Following proper healing, it was revealed that cultivated eggplant can be grafted successfully onto the selected wild species with more than 85% success rate and good graft compatibility. Further, these grafted plants were screened under controlled greenhouse conditions (Fig. 2.3.21 & 2.3.22). The grafted plants were allowed to establish properly for thirty-five days and then screened for drought stress by withholding the irrigation water for twenty days, whereas another set of control plants was irrigated at 80% FC throughout the experimental period of sixty days. It was revealed the eggplant grafted on *S. sisymbriifolium* (SUR/SIS) and *S. torvum* (SUR/TOR) rootstocks outperformed other species and non-grafted control plants for the majority of the traits under investigation. These rootstocks had the highest shoot fresh biomass, root dry biomass, and root to shoot ratio even after 20 days of withholding of irrigation water (Fig. 2.3.23 a, b).

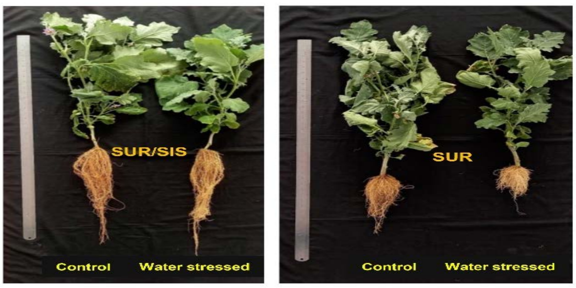
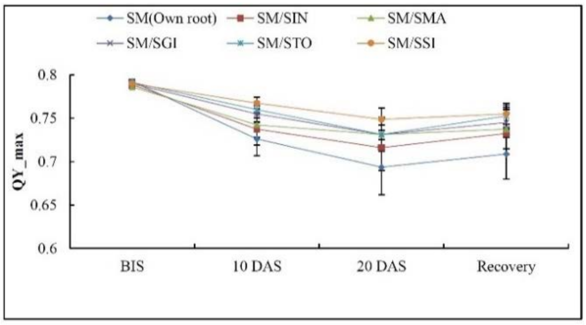


Fig. 2.3.21: Shoot and root biomass of grafted on *S. sisymbriifolium* rootstocks and non-grafted under drought stress

Fig. 2.3.22: Eggplant grafted on wild species rootstocks

Plants grafted on *S. sisymbriifolium* and *S. torvum* rootstocks exhibited better physiological traits such as leaf RWC, PS II efficiency, chlorophyll content, NDVI, and canopy temperature, indicating that these rootstocks are sturdy and tolerant in nature. Thus, grafting on these rootstocks altered the scion variety's physiological response under drought conditions. The same rootstocks were tested in the field during the post-monsoon season under three levels of deficit irrigation (Fig. 2.3.23 a, b). Plants grafted onto *S. sisymbriifolium* yielded 20% more under deficit irrigation (60% ETc) than non-grafted plants. These results clearly show that eggplant grafted onto *S. sisymbriifolium* rootstocks changes scion morphology and physiology under drought stress and increases yield.



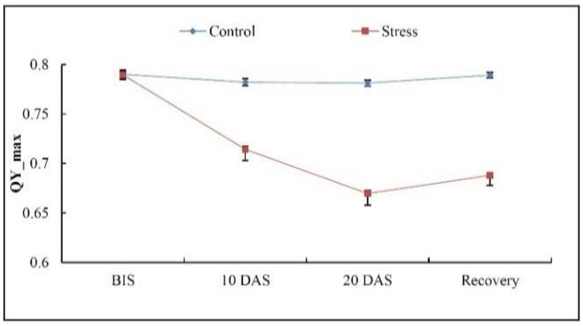


Fig. 2.3.23: a) Photosystem II efficiency (QY_Max) of graft combinations during period of water stress, b) Photosystem II efficiency (QY_Max) of grafted plants in control and water stress

Interactive effect of soil types and biostimulants in grapes cv. Sharad seedless

An experiment on the effects of soil type [native (*Murrum*), black, and mix soil of native and black] and biostimulants (Sea algae, *Ecklonia maxima*, *Ascophyllum nodosum* and Biopolymer) on morphometric, yield, and quality attributes in grape cv. Sharad seedless were conducted after forward pruning from October 2021 to March 2022. The biostimulants were applied as foliar spray during EL-15, EL-23, EL-31, and EL-35 BCCH phenological stages. Biostimulants application improved the morphological (vine length, cane girth, and dry biomass) and physiology status (chlorophyll fluorescence, chlorophyll, and RWC) and yield attributes (number of bunches, bunch weight, berry size, and berry weight) of the vine grown in mixed soil resulted in higher yield. Based on the results obtained it was revealed that in comparison to native soil without biostimulants application (0.48 kg/vine), vines are grown in mixed soil and black soil with sea algae treatment yielded up to 6.46 kg/vine and 6.08 kg/vine respectively.

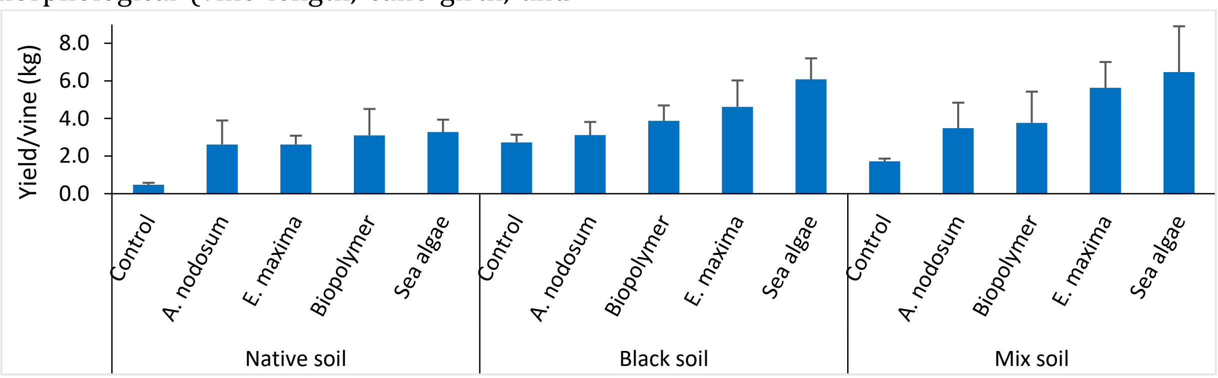


Fig. 2.3.24: Effect of soil types and biostimulants application on yield

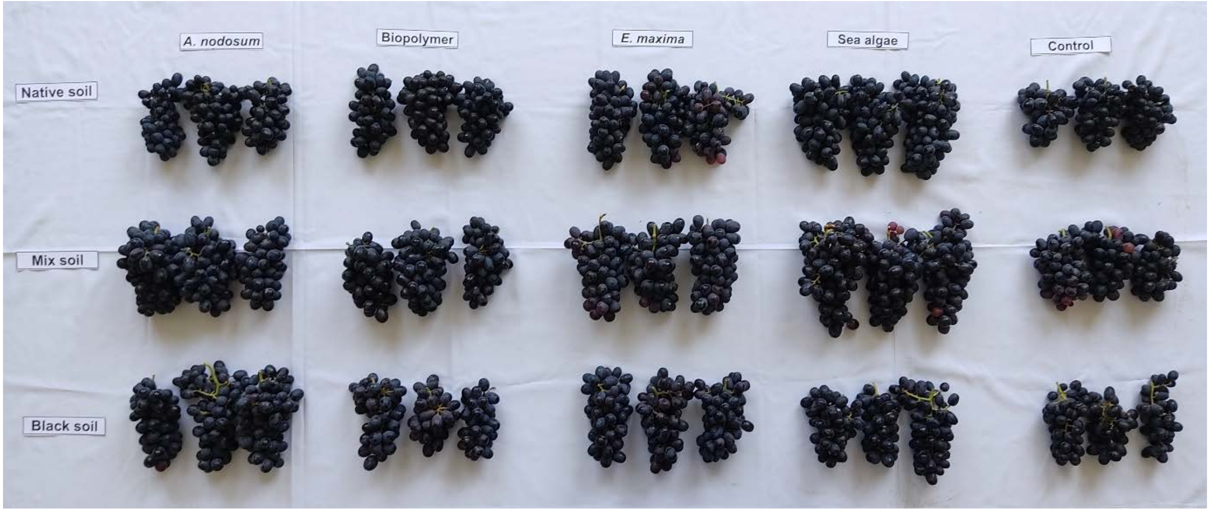


Fig. 2.3.25: Bunch size of cultivar Sharad Seedless grown in soil types with application of biostimulants

Studies on effect of deficit irrigation strategies on water use efficiency, yield and quality of pomegranate (Cv. Bhagwa) in shallow basaltic soils

The study was conducted at ICAR-NIASM experimental block with different deficit irrigation strategies and along with Plant two bio regulators salicylic acid (SA) and Naphthalene Acetic Acid (NAA) on water use and yield and quality of Pomegranate grown on shallow basaltic soils. The highest value of RWC (76.69%, 75.49%, 76.63%, 74.69%) was observed in plants treated with PRD-80+SA+NAA in flower bud initiation, flowering, fruit setting & fruit enlargement stage, respectively. However, the RWC values in all the treatments increased up to the fruit setting stage and decreased at the time of harvest. As RWC is an indicator of water stress, the positive effect of SA as a stress tolerance hormone was observed during the growth stage. The phenological variation of RWC is shown in Fig. 2.3.26.

The Plant yield as affected by different treatments is shown in Table 2.3.7. The Plant yield per plant was found to be more in plants treated with PRD-80+SA+NAA. However, as only irrigation level was concerned, plants with 60% irrigation level produced a lower yield per plant (8.61 kg in PRD-60 +SA, 8.07 kg in DI-60+SA+NAA & 6.7 kg in DI-60+SA) as compared to control plants. No significant difference was observed between plants treated with DI-80 (11.33 kg) & PRD-60+SA+NAA (9.42 kg). The DI and PRD treated plants with 80% irrigation levels coupled with SA+NAA significantly increased the WUE (6.30 & 6.69 kg m^{-3}, respectively). Water use efficiency was more in plants under water deficit conditions, and it increased further with applications of PGRs. PRD-treated plants with a 60% irrigation level coupled with PGRs (4.56-4.99 kg m^{-3}) were found to have higher Water use efficiency than control plants (3.82 kg m^{-3}). The total phenols were found to be significantly more in plants treated with 60% irrigation level irrespective of DI & PRD and the total phenol was found to range between 85.34-205.50 mg GAE/100 ml. However, significantly lower phenolic content among all the treatments was observed in control plants (85.34 mg GAE/100ml) as shown in Table 2.3.7. Flavonoids followed a similar trend like that of phenols and the highest flavonoid content was found in plants treated with PRD-60+SA+NAA (46.3 mg CE/100 ml). The flavonoid content ranged between 19.3-46.3 mg CE/100 ml., DPPH radical scavenging activity was found to be more in plants treated with PRD-60+SA (75.23%). A significant difference was observed in DPPH levels among plants treated with DI-80 (41.98%), PRD-80 (58.72%), & control plants (28.79%)

Fig. 2.3.26: Phenological variation of RWC (%)

Table 2.3.7: Effect of different treatments on total yield, Fruit weight, WUE, TSS and Phenols, Flavonoids, FRAP and DPPH in fruit juice

Treatment details	Plant yield (kg plant^{-1})	Fruit weight(g)	WUE (kgm^{-3})	TSS (^{0}Brix)	Phenols (mg GAE 100 ml^{-1})	Flavonoids (mg CE 100 ml^{-1})	FRAP (mg AAE 100 ml^{-1})	DPPH (%)
DI-80	11.33 ^{de}	285.80 ^{bc}	4.50 $^{d-g}$	15.50 ^{bc}	125.50 ^{c}	21.2 ^{bc}	22.03 ^{de}	41.98 ^{e}
DI-80 + SA	13.93 ^{bc}	317.57 ^{b}	5.53 ^{bcd}	16.50 ^{abc}	128.67 ^{bc}	22.2 ^{bc}	27.26 ^{bcd}	49.77 ^{de}
DI-80+SA+NAA	15.85 ^{ab}	404.10 ^{a}	6.30 ^{ab}	16.50 ^{abc}	137.17 ^{bc}	24.9 ^{bc}	25.29 ^{cd}	56.20 ^{cd}
DI-60 + SA	6.70 ^{g}	207.63 ^{e}	3.55 ^{g}	17.50 ^{ab}	192.83 ^{a}	42.2 ^{a}	35.92 ^{a}	74.31 ^{a}
DI-60+SA+NAA	8.07 ^{fg}	228.53 ^{de}	4.27 ^{efg}	18.50 ^{a}	198.33 ^{a}	38.7 ^{a}	39.15 ^{a}	70.19 ^{ab}
PRD-80	12.30 ^{cd}	290.07 ^{bc}	4.89 $^{c-f}$	15.50 ^{bc}	138.00 ^{bc}	25.3 ^{bc}	26.57 ^{cd}	58.72 ^{bcd}
PRD-80 + SA	14.23 ^{bc}	320.00 ^{b}	5.65 ^{abc}	15.50 ^{bc}	141.17 ^{bc}	26.5 ^{bc}	32.48 ^{abc}	66.74 ^{abc}
PRD-80+SA+NAA	16.86 ^{a}	430.33 ^{a}	6.70 ^{a}	16.50 ^{abc}	150.34 ^{b}	28.6 ^{b}	32.70 ^{abc}	64.80 ^{abc}
PRD-60+SA	8.61 ^{fg}	249.37 ^{cde}	4.56 $^{c-g}$	17.00 ^{ab}	199.50 ^{a}	42.0 ^{a}	35.08 ^{a}	75.23 ^{a}
PRD-60 +SA+NAA	9.42 ^{ef}	268.07 ^{bcd}	4.99 ^{cde}	18.50 ^{a}	205.50 ^{a}	46.3 ^{a}	34.80 ^{ab}	73.40 ^{a}
CONTROL	12.01 ^{cd}	309.63 ^{b}	3.82 ^{fg}	14.50 ^{c}	85.34 ^{d}	18.3 ^{c}	15.44 ^{e}	28.79 ^{f}
CD (P=0.05)	2.58	57.07	1.09	2.32	22.09	9.3	7.77	11.86

Means with similar alphabets show no significant difference at P = 0.05 by DMRT

Mitigating water stress effects in vegetable and orchard crop

The results of the four field/lab experiments performed are summarized as below:

Effect of temperatures and coating materials on enhancing shelf-life of custard apples

The combined effect of four temperatures [4, 8, 16 and ambient conditions (22-28°C)] and four coating materials (1.5% irradiated chitosan, 0.1% mineral oil, 5% biopolymer and control) was studied for improving the shelf-life of custard apple fruits during storage. Among the coating materials, mineral oil (MO) was found effective in minimizing fruit weight losses (7.2%) over control (10.3%). The minimum fruit weight loss (6.2%) was noted at 4°C. However, stone formation owing to chilling injury was noted at 4 and 8°C (Fig. 2.3.27). The complete loss of fruits after 8 day of storage was reported at ambient condition. The coating significantly improved TSS, DM and firmness of custard apple fruits. Overall, fruits coated with MO and stored at 16°C had superior quality.

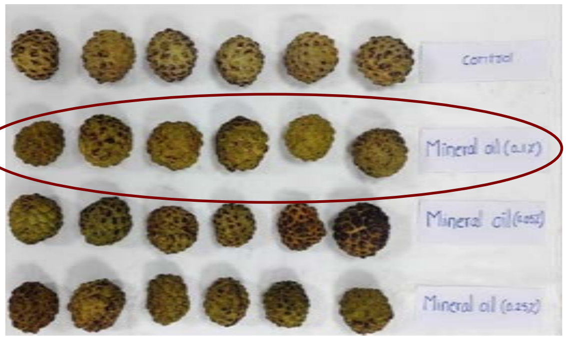


Fig. 2.3.27: Optimizing concentration of mineral oil (MO) at 16ºC in storage

Developing maturity indices for custard apple fruits using non-destructive approach

Custard apple is one of the popular climacteric fruit and determining right stages of maturity/ripeness of a fruit is crucial to the agriculturists and the food processing sectors. An image processing based setup to identify various maturity phases of custard apple was developed (3000 images), which includes affordable handheld instrument. The developed hand held device is cost effective and giving high (99%) accuracy for detecting maturity stages. Further, with slight modification it can be used for classification of custard apple fruits of different varieties based on their maturity for longer storage (Fig. 2.3.28).

Fig. 2.3.28: Prototype Device for detecting custard apple maturity custard apple

Fruit quality and water production functions of the eggplant as affected by grafting of stress tolerant rootstocks

A field study was conducted during year 2021-22 to evaluate the interactive effect of grafting of wild rootstocks viz., Solanum macrocarpon (SM), Solanum gilo (SG), and Solanum torvum (ST) and commercial cultivar (cv. Ajay, AJ) and varied water deficit irrigations levels (100, 75, 50 and 25% ET) applied based on crop evapotranspiration using line source sprinkler system. The preliminary results indicate that maximum total fruit yields (TFY) of 40.6 Mg ha -1 was obtained at 100% ET and declined to 31.6, 20.1 and 9.2 Mg ha -1 at low (75% ET), medium (50% ET) and severe (25% ET) stress conditions, respectively.

The water productivity (WP) improved by 5.8-11.1 kg m^{-3} in grafted treatments under medium and severe water deficits owing to its better growth canopy and physiological traits. This study specified that selection of appropriate grafting combinations viz., AJ/SM and AJ/SG reduces water usage by 26.1-42.2%. The linear functions best defined the relationship between TFY and AW (Fig. 2.3.29), whereas the quadratic functions fitted best define the relationship between WP and AW, indicating that efficient utilization of water stored in the root zone by grafted plants in water deficit conditions due to deeper root systems of wild rootstocks The physiochemical fruit quality traits such as harvest index, mean fruit diameter, mean weight, protein and TSS declined with water deficit stress while these were markedly

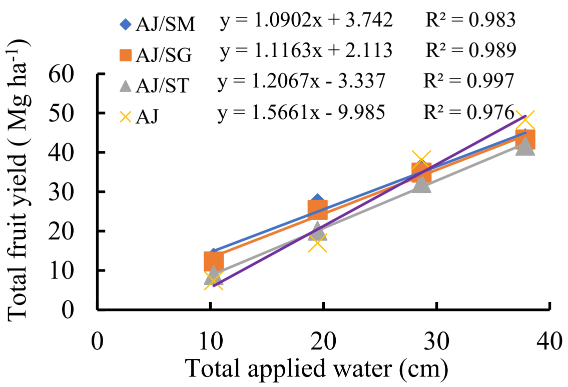


Fig. 2.3.29: Relationship between total fruit yields and total water applied for different grafted and non- grafted eggplant treatments

Similarly, higher accumulation of dry matter, rehydration quality, phenolic and flavonoids compounds in fruits of grafted eggplants under medium water deficits indicating their suitability for transportation, storage and processing purpose

Long term effect of soil filling mixtures on yields, storage shelf-life and profitability of dragon fruit (Hylocereus undatus) in shallow basaltic degraded regions of India

Datasets of last 8 years pertaining to dragon fruit (*Hylocereus undatus*) cultivated in drought prone Deccan Plateau, India under interventions of trench planting and soil filling mixtures were analyzed. (Fig. 2.3.30). The soil filling mixtures in trenches consisted of i) original native soil (*T*-Native), or ii) black soil transported from adjoining fields (*T*-Black) and iii) mixture of the two soils (*T*-mixed soil; 1:1 Black: Native). Pits were filled with native soil, as a common practice adopted by farmers in the regions (control) for comparing with trench soils. Trench planting with mixed (1:1 black clay: native loamy sand with 27% stones) soil improved fruit yields (44%) and marketable quality than conventional pit planting practice. Antioxidant potential and storage quality were retained in trench-mixed soil fruits. Maximum yield losses (12.5%) and inferior storage quality was observed in fruits from pit-native and trench-black soils, respectively. The practice of creating trenches and filling with mixed soil had a B:C ratio of 1.85 and thus could be recommended for degraded land.

Fig. 2.3.30: Experimental layout and performance of soil filling mixtures on dragon fruit

Improving fruit size, uniformity & storage quality of dragon fruit by plant growth regulators grown under varied soil filling practices in semi-arid regions

Lower fruit yield, non-uniform and smaller fruit size are the key constraints which limiting the postharvest quality of Dragon fruit (*Hylocereus undatus).*

Therefore, impact of exogenous plant growth regulator (PGRs) and soil filling mixture on fruit yield and post-harvest quality of dragon fruits during storage was investigated. The treatments combinations included the foliar application of PGRs viz., 25 ppm gibberellic acid (GA3), 20 µM salicylic acid (SA), 600 ppm thiourea (TU) and control (no PGRs) at bud initiation, flowering and fruit development stages and three soil filling mixtures of native(N), mixed (1B:1N) and black (B) soils, respectively. Results revealed that variability in fruit size was significantly reduced with PGRs (CV= 3.7-14.3%) over control (CV=10.7-24.4%). Foliar application of GA3 improved the maximum mean fruit weight by 12.5-20.8% but reported highest physical weight loss (PWL) up to 31.8% during 32 days of storage (Fig. 2.3.31). The fruit firmness measured in terms of the cutting and penetration forces was found better with PGRs. The highest values of cutting force (8041.22 g) and penetration force (637.01g) were observed in fruits treated with TU followed by SA in mixed soils. The superior values of TSS, protein, rehydration quality, phenols and flavonoids were observed in PGRs during storage. Especially, mixed soil with TU could be the possible option for growing of dragon fruit orchards in degraded lands owing to higher fruit yield and superior quality. Overall this study suggest that conjunctive use of PGRs and optimizing regional specific soil filling mixtures could be recommended as efficient strategy for improving fruit yields, sustaining marketable quality and prolong the shelf life of dragon fruit during storage.

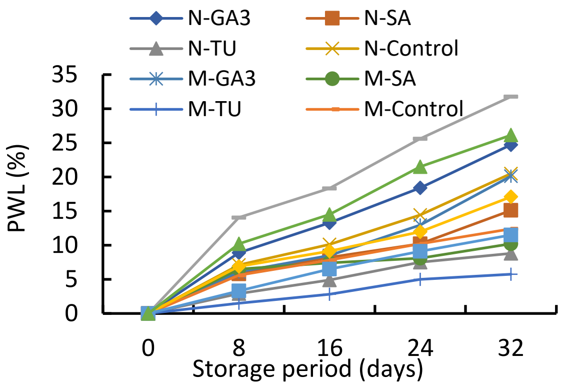


Fig. 2.3.31: Changes in physiological weight loss of dragon fruit grown under varied PGRs and soil filling mixtures practices

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

Research activities conducted under CRPCA project are summarized below

Interactive effect of chickpea genotypes, deficit irrigation and plant growth regulator in CA based sugarcane cropping system

A new experiment on G x M x E was initiated to study the interaction effects of chickpea genotypes (G), plant growth regulators (M) and water stress environments (E) and growth regulators in sugarcane (Variety: Co-86032) cropping system during year 2022. The main treatments included three water deficit treatments viz., I1: 50% DI; I2: 75%DI and I3: 100% (full irrigation) were applied using drip irrigation system. Two soil surface cover management practices *viz.,* S1: Intercrop (8 cultivars of chickpea) residue covering and S2: no residue was accommodated in subplots.

Main crop: Sugarcane; Intercrop : Chickpea

Four PGRs namely thiourea (TU, 1800 ppm), irradiated chitosan (IC, 5 ml/L), nano-urea (4 ml/L), salicylic acid (SA, 25 µM) and no PGRs (control) were applied exogenously with interval of one month after crop establishment (60 DAT) as sub-sub plot treatments. The real time crop-soil-water parameters measurements were measured with interval of 30-45 days interval. Although crop is yet be harvest, the preliminary results of irradiated chitosan and nano-urea seems to promising for enhancing the growth attributes of sugarcane.

Effect of tillage, crop residues and nutrient management practices for enhancing productivity of sugarcane cropping system

During the year 2022, field data of plant and four consequent ratoon crops was analyzed to study the interactive effect of tillage, crop residues and nutrient management practices for enhancing productivity of sugarcane cropping system (Fig. 2.3.32). In plant sugarcane crop, the treatment of reduced tillage with application of 10% of RDF as basal, 40% through band placement and remaining 50% through fertigation improved the cane yields by 11-16.6% over farmer's practices i.e., conventional tillage (CT). In case of ratoon crop reduced tillage with 50% application of RDF as basal with SORF in band placement and remaining 50% RDF through fertigation in standing crop with mulching and non-mulching improved the ratoon cane yields by 30 and 38.5% over farmers practice with mulch (M) and non-mulch (NM), respectively. The enzymatic DHA, APA and BGL activities after harvest of 4th ratoon sugarcane crop in the same treatment with mulching were 11.6, 0.63 and 1.5 times higher than conventional farmer's practice in 0-15 cm soil depth. This trial is monitored for last five years and demonstrated to more than 2500 farmers, students during the year 2022.

Fig. 2.3.32: Performance of conservation agriculture over farmers practices

2.4 SCHOOL OF SOCIAL SCIENCE AND POLICY SUPPORT

Identifying and targeting the perspective technologies by understanding the abiotic stress at farm-level and mitigating the over loss in yield and income of the farmers need to be taken up through problem identification and demonstration of suitable technologies. The research programme at the School of Social Science and Policy Support (SSSPS), NIASM, has focused on addressing abiotic stress management by identifying the bio-physical and socio-economic constraints in major production systems. The major activities of the school were farmer-oriented research focusing on abiotic stresses such as demonstration, capacity building, information sharing, and frontline extension activities along with developmental programmes of DAPSC and TSP. The major research and extension activities under the school and the progress made in the research project during 2022 are summarized below.

Survey of dragon fruit farmers from water and soil stressed regions

The rainfed and dryland agro-ecosystem challenged with abiotic stresses particulary of soil and water suffers low crop productivity. The cultivation of dragon fruit which is adaptable to multiple abiotic stresses is a smart option for farmers in such adverse conditions. In recent years there is a steep increase in area of dragon fruit cultivation in Pune, Satara and Solapur districts of western Maharashtra. The SSSPS, NIASM carried out survey of dragon fruit farmers to understand the socio-economic profile and constraints faced in cultivation of dragon fruit. It was found that farmers are earning an average net income of Rs. 3.0-4.0 lakh acre^{-1} year^{-1}. The data regarding farmers cultivation practices, input support, marketing channels and constraints were collected during the survey.

Socio-economic profile and farmers cultivation practices of dragon fruit

A detailed survey carried out in 17 villages of Pune, Satara and Solapur districts of Maharashtra to understand farmers cultivation practices in dragon fruit revealed cultivation of three variants of dragon fruit viz. Red type, *Hylocereus polyrhizus* (pink peel with red pulp); White type, *Hylocereus undatus* (pink peel with white pulp) and Yellow type, *Hylocereus megalanthus* (yellow peel with white pulp). Majority of the farmers (98.11%) have adopted red type variant of dragon fruit for cultivation due to high market demand and consumer preference. The socio-economic profile of the farmers were analysed and it was found that majority of the farmers belonged to middle age group (64.15%) and had more than 10 years of farming experience (66.03%). Farmers land holding was identified as one of the major factors determining the total yield and income of the farmer. Most of the surveyed dragon fruit farmers were marginal landholders with less than two hectares (35.84%) and small land holders (30.18%). 96.22% farmers did not attend any institutional capacity building or training programme on dragon fruit.

Dragon fruit area is increasing in western Maharashtra in recent years and the

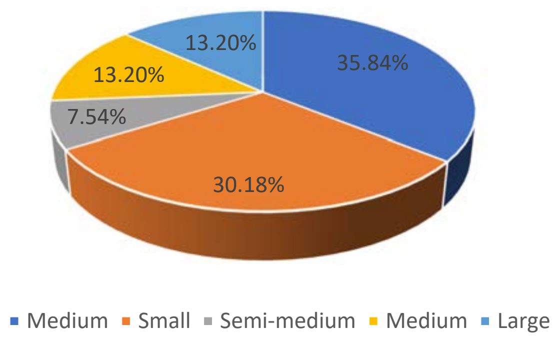


Fig. 2.4.1: Land holding categories

information on agronomic cultural practices and pest management is being disseminated through farmer-to-farmer adoption via social media platforms. To understand detailed cultivation practices in dragon fruit information were collected regarding source of planting material, agronomic practices, pest incidence, yield and marketing channels. 75.47% of farmers were growing dragon fruit in less than 01 hectare of land and the average area under dragon fruit cultivation is 0.85 hectare. Almost all farmers planting 04 stem cutting per post or pole at 4.0 x 2.5 m spacing between rows and poles. Majority of the farmers were using concrete pole and frames (98.11%) as supporting material for branches.

Majority of the farmers reported the incidence of fruit fly (100%) pest and soft rot (77.34%) disease along with sun burning (58.49%). Almost all farmers were following drip irrigation and majority of respondents (98.11%) were following inorganic fertilizer management practices in dragon fruit cultivation. The dragon fruit bears number of flower and fruit flushes in a year and the fruit setting depends on orchard management and prevailing weather conditions. Majority of the farmers (96.22%) were harvesting 3-4 fruit flushes annually followed by pruning of branches in the month of November-December after final flush of fruit harvesting. Most of the pomegranate, sugarcane and grape orchards were shifting to dragon fruit cultivation due to high income and future market demand. The farmers have recorded average yield of 15-18 tonnes ha^{-1}, mostly from third year of the orchard and 11.32% farmers earning additional income through selling stem cutting to farmers. Majority of the farmers (81.13%) perceived that there will be high demand for dragon fruit in future market scenario.

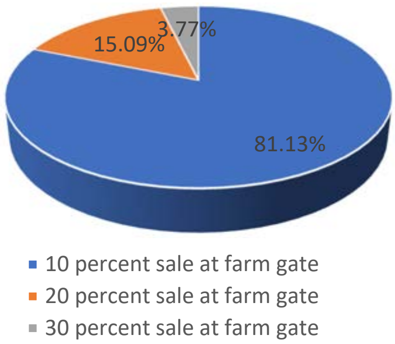


Fig. 2.4.2: Percent of produce sale at farm gate

Constraints in dragon fruit cultivation as perceived by farmers

The constraints faced by dragon fruit farmers were collected and analysed on the scale of very important, medium important and less important categories. Fig.3 shows the constraints perceived by farmers as very important which needs to be addressed to improve yield and income of the farmers. Majority of the farmers perceived high capital cost (76.66%) as major constraints followed by flower drop due to untimely rainfall (63.33%) and poor linkage with agro processing industries (46.66%). The percentage of farmers perceived constraints as very important is shown in the Fig. 3.

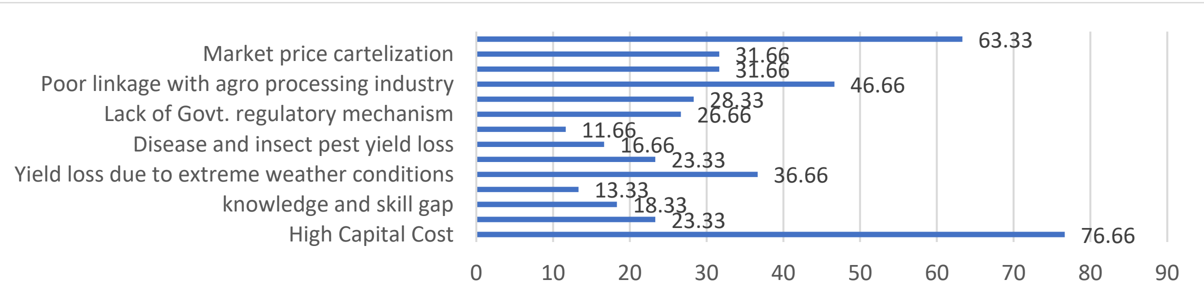


Fig.2.4.3: Constraints perceived by farmers as very important

Methodology for identification of fisheries cage culture in inland open water bodies using deep learning and satellite imagery for monitoring and technology targeting.

Cage culture is an aquaculture method of fish production in which fish are kept in floating net pens. Fish cage culture uses existing water resources but encloses the fish in a cage or basket that allows water to pass freely between the fish and the pond. These floating cages have a specific structure and can be detected from space using satellite images. The methodology for identifying fish cages using India's Google Earth Engine (GEE) platform and Sentinel 2A images was further improved with second-stage verification using deep learning algorithm. In this method of identification of cage culture first the Sentinel 2A imagery of the reservoir boundary (minimum extend) shapefile are downloaded, then super-imposed to calculate the Normalized Difference Water Index (NDWI) for these areas. The NDWI helps in curtailing the area to the reservoir extent. Further training datasets are created using the existing dataset (latitude - longitude) of cage culture sites and used for training machine learning models for accurate classification. Applying the model to reservoir extends, unique objects in water bodies were identified and the area was calculated for each object. Segregation of objects based on the area was done which was categorized as cage and non-cage. The location of predicted cage culture sites was extracted. These locations were further subjected to a second stage verification using Google Earth Imagery at zoom level 17. The deep learning models (Detectron2) were trained and validated for analysis detection. These models classify tiles as cage and non-cage leading further to Instance segmentation of cage and non-cage images.

Cage detection and Instance Segmentation: The benchmark used by Detectron2 is mask R-CNNs. It is implemented in PyTorch and requires CUDA for extensive computations. The potential locations of cage culture (latitude and longitude) were extracted from the GEE. These locations are further processed for the second stage of verification. A tool (GeoJson tile downloader) developed in conjunction with the model development was used for dowlanding the required google earth satellite images of respective locations for varying zoom levels. In the existing study satellite images of 15, 16, and 17 zoom levels were extracted and processed for further object detection. Zoom level 17, performed satisfactorily and outcasted nearly accurate results in object detection. The cages were well-visible, and boundaries were sharply noticeable. Therefore, zoom 17 images were further subjected to object detection and Instance segmentation in the detectron2 algorithm. The downloaded images were classified as cage and non-cage images and the training dataset was created by annotating cages in each image. The CVAT (Computer Vision Annotation Tool) labeling software was used to annotate and create the instance segmentation dataset. It creates a JSON file including the annotation of all cages in a respective image. This training dataset was further incorporated into the detectron2 algorithm. A model was developed for training the annotated images for custom object detection and instance segmentation. The 'MASK_RCNN_R_50_FPN_3x' model was used for training custom datasets due to its reliable speed and accuracy. Images of zoom level 16 with pre-trained model weights were used for model testing. It was observed that detectron2 could identify cages in the images (zoom level=16) with a threshold test value = 0.7.

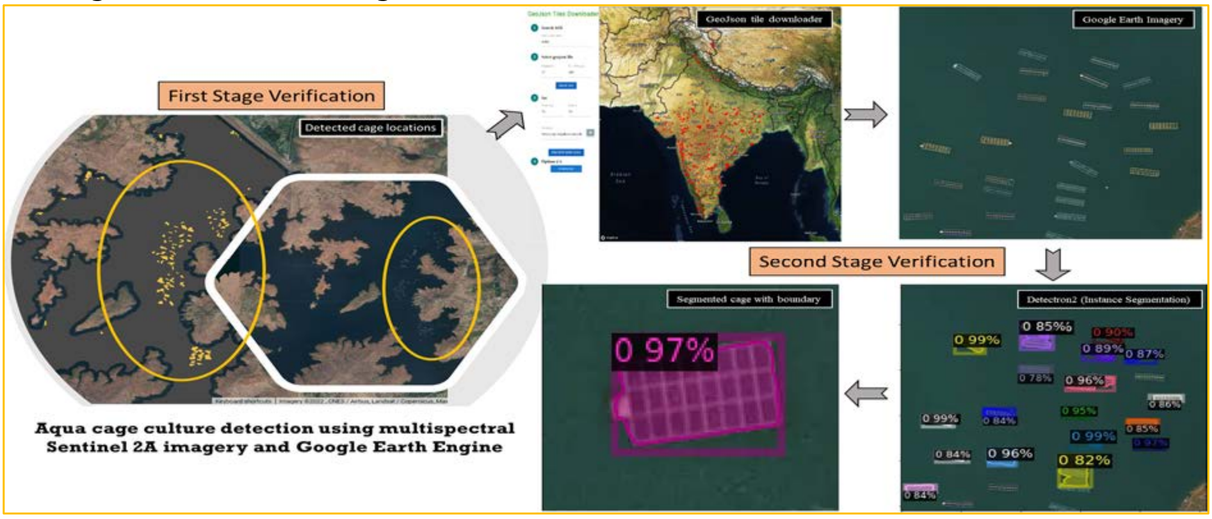


Fig.2.4.5: Graphical abstract of methodolgy for cage culture detection

Hon'ble Prime Minister's virtual address during Agri – Startup Conclave and Kisan Sammelan inaugural programme

On the Occasion of Hon'ble Prime Minister's virtual address during Agri – Startup Conclave and Kisan Sammelan inaugural programme at ICAR-IARI, New Delhi, on 17.10.2022, a live telecast of the programme was organized at ICAR-NIASM, Baramati. Hon'ble Prime Minister Shri. Narendra Modi has Inaugurated the event and addressed the farmers across the nation connected virtually at various ICAR institutes, KVK's and Agricultural Universities. Prime Minister has highlighted about the reforms made in the agricultural sector such as streamlining of the fertilizer production and its supply, introduction of nano urea and strengthening the fertilizer marketing system along with announcement of "Bharat Brand" name tag for all fertilizer products and establishment of 600 Pradhan Mantri Kisan Samridhi Kendra which will act as single window sale point of agricultural inputs at affordable price to farmers. Hon'ble Minister of Agriculture and Farmers Welfare Shri Narendra Singh Tomar and Hon'ble Minister of Chemicals and Fertilizers, Dr Mansukh Mandaviya also addressed the programme. Around 250 farmers, students, institute attended the programme through various social media platform and virtually at ICAR-NIASM, Baramati

Trainings, demonstrations, field visits conducted during 2022

ICAR-National Institute of Abiotic Stress Management as a part of extension activity have coordinated the visits of various stakeholders such as farmers, students, organizations etc. Regarding technologies of the institute such as Horticulture orchards, CIFS model, Medicinal Garden, Phenomics facility along with ATIC museum of the institute.

Sl. No.	Visitors group	No. of Groups	No. of visitors
1	Farmers	14	607
2	Students	30	1736
3	Students (RAWE Programme)	17	255
4	Organizations	14	615
5	KRUSHIK Mela	-	1899
	TOTAL	75	5112

Fig. 2.4.6: Visit of Farmers, students and organisations at ICAR-NIASM

Participation at the horticulture value chain exhibition at VAMNICOM, Pune

ICAR-NIASM, Baramati participated in the Horticulture exhibition organised at VAMNICOM, Pune on 1st November, 2022. The programme was inaugurated by Union Minister of Agriculture and Farmers Welfare Hon'ble Shri. Narendra Singh Tomar along with Minister of Agriculture Shri. Abdul Sattar and Minister of Horticulture Shri. Sandipanrao Bhumare, Govt. of Maharashtra. Hon'ble Ministers along with other dignitaries visited the NIASM institute stall at the exhibition and enquired about the dragon fruit cultivation. ICAR-NIASM stall at exhibition have displayed posters of various abiotic stress management technologies, literatures in the form of technical folders, books and samples to the vistors .

Fig :2.4.7: Visitors at ICAR-NIASM stall

Agricultural Technology Week 2022 at ICAR-NIASM in collaboration with KVK, Baramati

The Krushik: Agricultural Technology Week 2022 was jointly organized by ICAR-National Institute of Abiotic Stress Management, Baramati Pune, Maharashtra and Krishi Vigyan Kendra, Baramati, Maharashtra during 9th to 13th February, 2022. Around 2000 farmers including FPO group, women SHGs, students visited ICAR-NIASM to witness the live demonstrations and the experimental plots during the Krushik Agricultural Technology Week 2022.

Activities under Development Action Plan for Scheduled Castes (DAPSC) programme

Measures to improve the socio-economic conditions of Dalits were introduced in the 1950 Constitution of India which defines the Scheduled Castes (SC) for any State or Union Territory. Out of a total population in Maharashtra, 11.81% belongs to SC. The Development Action Plan for Scheduled Castes (DAPSC) is the GOI schemes to uplift SC community aiming to promote the economic development of SC families living below poverty. The main objective is to enhance income by way of various income-generating schemes, skill development, infrastructure development, etc. so as to reduce poverty among the target population. A multidisciplinary team comprising of Dr Kurade NP (Chairman), Dr Pawar SS (Member Secretary) and the Members namely, Nangare DD, Nirmale AV, Gaikwad BB, Mr Rajkumar, Dr Kakade VD, Dr Aliza Pradhan, Dr Chavan SB and Mr Ravi Kumar K implemented various DAPSC activities in the different districts of Maharashtra under this scheme for the year 2021-22.

One Day Training-cum-Demonstration on "Climate-resilient Backyard Poultry Farming"

A training programme on "Climate-resilient Backyard Poultry Farming" on 19th April 2022 was organized at ICAR-NIASM. Three lectures were delivered during the technical session: 'Management of Backyard Poultry birds', 'Diseases of Poultry, and 'Summer management of Poultry'. The beneficiaries were briefed on how best the benefits of backyard poultry farming can be derived. About 70 beneficiaries were benefitted from the training. Grampanchayat members and social workers also participated in training programme. The training programme was followed by the demonstration of backyard poultry rearing and distribution of Backyard Poultry Cages and Poultry birds to the identified beneficiaries in different villages, namely Gholapwadi, Visapur, Borivel and Baramati.

One Day Training cum Demonstration on "Organic Nutrient Management for Sustainable Crop Production"

ICAR-NIASM organized a training programme on "Organic nutrient management for sustainable crop production" on 23rd April 2022 under DAPSC at: Kadamwadi Village of Malshiras tehsil under Solapur district. Three lectures were delivered during the technical session: 'Vemicomposting for sustainable crop production', 'Compost: a critical component of organic farming' and 'Dragon fruit cultivation and demonstration'. The farmers were demonstrated the use of vermicomposting units for preparation of vermicompost and cultivation of dragon fruit in degraded lands or as backyard activity. About 75 beneficiaries were benefitted from this training programme. A few Grampanchayat members/social workers also participated in the event. The training programme was followed by the distribution of Vemocomposting units, cement poles along with dragon fruit cutting for dragon fruit cultivation to the identified beneficiaries.

One Day Training-cum-Demonstration on "Dragon fruit cultivation in degraded land and kitchen garden"

ICAR-NIASM organized a training-cum-demonstration on "Dragon fruit cultivation in degraded land and kitchen garden" on 30th April 2022 DAPSC at Rakshaswadi Bk Village of Karjat tehsil under Ahmednagar district. Two lectures were delivered during the technical session: 'Dragon fruit cultivation and its demonstration' and 'Tools and implements used in Agriculture' along with demonstration on installing dragon fruit poles, rings, and planting dragon fruit cuttings in degraded lands or as backyard activity. About 100 beneficiaries and farmers were benefitted from this training programme. Sarpanch and other dignitaries from Grampanchayat also participated in the event. The training programme was followed by the distribution of cement poles along with dragon fruit cuttings for dragon fruit cultivation and tool kit for daily use in agriculture to the identified beneficiaries.

Training-cum-Demonstration programme on "Climate Resilient Dairy Production"

ICAR-NIASM organized a training programme on "Climate Resilient Dairy Production" on 6th May 2022 under DAPSC at ICAR-NIASM. Dr Himanshu Pathak, Director ICAR NIASM, in his inaugural address, narrated about implications of climate change in agriculture and importance of continued alliance of beneficiaries with institute for further way outs. Three lectures were delivered during the technical session: 'Nutritional management for climate resilient Dairy animal production', 'Important diseases of dairy animals and its control' and 'Management of Dairy animals under heat stress'. About 75 were beneficiaries benefitted from this training programme. Few Grampanchayat members/social workers also participated in the training programme. The training programme was followed by the distribution of Dairy kit to the identified beneficiaries in different villages, namely Sansar, Gholapwadi, Mankarwadi, Gojibavi, Nirawagaj, Boribel, Baramati, etc.

One day Training programme on "Upliftment of livelihood of SC Beneficiaries"

ICAR-NIASM organized a Training Programme on "Upliftment of livelihood of SC Beneficiaries" on 31st May 2022 under DAPSC at Visapur village of Satara District, Maharashtra. Lectures were delivered on 'Nutritional management in livestock', 'Silage making and importance of backyard poultry' and 'Safety measures to be taken during plant protection operations and Mechanization in agriculture,. About 80 beneficiaries benefitted from this training programme. Grampanchayat sarpanch and the members/social workers from the village actively participated in the training programme. The training programme was followed by the distribution of inputs like sewing machine, domestic flour mill, bicycles, utensil kit and Covid-19 kit to the identified beneficiaries' of Visapur village.

Farmers' Awareness Campaign on Efficient and Balanced Use of Fertilizers

To celebrate 75 years of India's Independence, farmers' awareness campaign on 'Efficient and balanced use of fertilizers' was organized at ICAR-NIASM Baramati on 21st June 2022. Dr Himanshu Pathak, Director was the Chief Guest of the function. Three lectures were organized on the ocassion namely, 'Role of fertilizers in supply of plant nutrients, judicious use of fertilizers using 4R approach and importance of organic fertilizers', "Crop residue management' and 'Trash management and machinery for conservation agriculture in ratoon sugarcane cropping system' On the occasion, agricultural inputs such as drip fertigation system and flour mills were distributed to the farmers under DAPSC scheme (Consortia Platform on Conservation Agriculture).

Field Day cum Farmers Scientists Interaction Meet on "Kharif onion seed production"

ICAR-NIASM, Baramati and Krishi Vigyan Kendra, Baramati jointly organized a Field Day-cum-Farmers'-Scientists'-Interaction Meet on "Kharif onion seed production" under DAPSC 2022-23 at Halgaon of Jamkhed Tehsil and Shinda, Nandgaon of Karjat Tehsil on 27th August 2022. Dr NP Kurade, Chairman DAPSC Implementation Committee, briefed about the DAPSC programme carried out by the Government of India. Dr Aliza Pradhan, Scientist, ICAR-NIASM and Dr Vivek Bhoite, KVK, Baramati briefed the farmers about the package of practices of onion seed production and the benefits related to it. About 35 farmers from Halgaon (Jamkhed) and 93 farmers from Shinde and Nandagaon participated in the interaction meet. Many farmers were enrolled in the onion seed production programme.

Farmers Meet and Onion seed distribution at Shinde and Nandgaon villages

Farmers-Scientist-Interaction Meet on Onion seed production along with the distribution of onion seeds (Bhima Shakti) and liquid fertilizer under DAPSC 2022-23 on 27th September 2022 was jointly organized by ICAR-NIASM, Baramati and KVK, Baramati. More than 70 farmers from Shinde and Nandgaon villages participated in the program. Mr Rohit Pawar, a Member of the Legislative Assembly for Karjat tehsil appreciated the work of ICAR-NIASM for the farmers and advised them to use the opportunity to enhance their income. Distribution of 2 kg onion seed/acre and 5 litre liquid fertilizer was carried out to 71 SC beneficiaries. Farmers' meet and seed distribution programme was conducted and coordinated by the DAPSC Implementation Committee members.

Farmers meet and onion seed distribution under DAPSC at Halgaon village

The ICAR-NIASM, Baramati along with KVK, Baramati jointly conducted a farmers-scientist-interaction meet on Onion seed production and distribution of onion seeds (Bhima Shakti) and liquid fertilizer under DAPSC 2022-23 on 4th September 2022 at Halgaon village of Jamkhed Tehsil. More than 60 farmers of Halgaon and Aghi participated in the program. Dr Sangram Chavan, Scientist (Agroforestry) informed the role of ICAR-NIASM under current climate scenarios. The chief guest of the function, Shri Rajendra Pawar, Chairperson of ADT Baramati urged farmers to take advantage of this project for enhancing income. Distribution of 2 kg onion seed/acre and 5lit liquid fertilizer was carried out to 33 SC beneficiaries.

Activities under Tribal Sub-Plan (TSP) programme

TSP implementation and distribution of different agricultural inputs to tribal agricultural beneficiaries was conducted at Nandurbar district on April 18-20, 2022 for implementation of TSP activities, training, demonstration and distribution of various agricultural inputs among farmers at Nandurbar districts. The team has conducted programs in 3 villages which includes framers of twenty-three villages mainly Kadwan, Varda, Nagare, Itwai, Nangipadha, Vadkhut, Anthipadha, Bedki, Pati, Borpadha, Kamod, Khoksa, Karji Budruk, Kotkhamb, Vadphali, Keli, Vavvdhi, Tinmauli, Dapur, Vadsatra, Nagchari, Kakrada and Dhadgaon. We had conducted Farmer Ghosti, input distribution and demonstration on April 18, 2022 at 4 PM at Nanngipadha, and more than eight villages' farmers participated. The work was carried out by team comprising of Dr Kochewad SA, Dr Vanita Salunkhe, Dr Paritosh Kumar, Mr K Ravi Kumar, Mr Rajkumar and Dr Neeraj Kumar.

Table 2.4.1: Details of training, demonstration, field day and Input distribution at Nandurbar district under tribal sub plan

S. No	Activities	Team of the Scientist	Benefic -iaries No.	Date of activities
1	Training and demonstration on Backyard poultry practices for clean milk production and distribution of milk can	Kochewad SA, Paritosh Kumar, Neeraj Kumar	150	18.04.2022
2	Training on Livestock management and distribution of cattle feed, mineral mixture and Chaff Cutter		190	19.04.2022
3	Distribution and demonstration of farm implements (Hand weeder, Power tiller, Spray pump, Solar light trap, Kurapi)		85	19.04.2022
4	Training on Kitchen Gardening and Waste Management for Manure production, Vermicompost, DAP, Biopesticide	Paritosh Kumar, Kochewad SA, Neeraj Kumar	200	19.04.2022
5	Field demonstration for Fish culture including feeding. Distribution of fish feed and ICE Bucket	Neeraj Kumar, Kochewad SA, Paritosh Kumar	110	20.04.2022

6	Field demonstration of pond/soil water analysis through kit, moisture meter, pH reading	Neeraj Kumar, Kochewad SA, Paritosh Kumar	88	20.04.2022
7	Distribution and demonstration of Aata Chakki to Women farmer for Woman empowerment	Kochewad SA, Paritosh Kumar, Neeraj Kumar	64	20.04.2022



Table 2.4.1: Input distribution under Tribal Subplan (TSP) (Jan 2022 to Dec 2022)

S. No	Input	Qty.	Farmer (No.)	S. No	Input	Qty.	Farmer (No.)
1	Plastic container	70 no.	70	20	Hand operated sprayer	14 no.	14
2	Fish Feed (Size 4 mm)	4000 kg	42	21	Tarpaulin sheet	5 no.	5
3	Fish Feed (Size 2 mm)	3000 kg	42	22	Plastic storage bins	50 no.	50
4	Planting Materials Guava	1000 no.	100	23	Tarpaulin sheet (small)	12 no.	12
5	Planting Materials Mango	1000 no.	100	24	Mineral lick	130 no.	65
6	Rice seed	5000 kg	400	25	Shade net (meters)	660 no.	6
7	Maize seed	1000 kg	200	26	Vermicompost unit	50 no.	50
8	Cattle feed	12000kg	240	27	Vegetable crates	200 no.	100
9	Mineral mixture	500 kg	250	28	Poultry feeder	100 no.	100
10	DAP	10000kg	200	29	Fish feed	4.5 ton	42
11	Digital soil moisture meter	2 no.	50	30	Groundnut seed	800 kg	40
12	Temperature correction kit	5 no.	50	31	Ice box	75 no.	75
13	Water analysis kit	1 no.	50	32	Bio-mix	1600 kg	800
14	Soil analysis kit	1 no.	25	33	Flying insect control solar traps	50 no.	50
15	Plastic milk can	60 no.	60	34	Chaffcutter	10 no.	50
16	Pruning shear secateur	60 no.	60	35	Power tiller	1 no.	10
17	Blade pruning secateur	18 no.	18	36	Hand weeder	32 no.	32
18	Khurpi	80 no.	40	37	Multigrain flour grain	25 no.	50
19	Fish fingerlings (*Pangasian odon hypophthalmus*)	100000 no.	42	38	Battery operated manual back carrying sprayer	150 no.	750

3. Training & Capacity Building

Students of ICAR-IARI who completed research work ICAR-NIASM (2021-22)

S N.	Name of student	Roll No.	Discipline	Research Guide	Thesis title	Academic year	NIASM joining year
M.Sc./M.Tech. Research							
1.	Goutam Guruprasad Jena	70001	Soil and Water Conservation Engineering	Nangare DD	Study on the effect of deficit irrigation strategies onwater use efficiency, yield & quality of pomegranate (cv. Bhagwa) in shallow basaltic soils	2020-21	2021
2.	Dharmendra Kumar	70002	Soil and Water Conservation Engineering	Wakchaure GC	Water Production Functions for Stress Tolerant Rootstocks of Eggplant (*Solanum melongena* L.)	2020-21	2021
3.	Siddesh	70003	Environmental Science	H Pathak	Carbon sequestration in Mango, Coconut and Pomegranate orchards in a semi-arid region	2020-21	2021
4.	Sadashiva GN	70004	Environmental Science	Singh AK	Water deficient response of soybean plants differing in ethylene sensitivity	2020-21	2021
5.	A Tamilselvan	70006	Plant Physiology	J Rane	Assessment of efficacy of image-based tools to differentiate drought responses of pulse crops at seedling stage	2020-21	2021
6.	Sagar P	70007	Plant Physiology	J Rane	Evaluation of pod pedicel as a component trait to facilitate photosynthate supply to developing seeds during soil moisture depletion in chickpea (*Cicer arietinum* L.)	2020-21	2021

Students of ICAR-IARI allotted to ICAR-NIASM (2022-23)

SN	Student	Roll No.	Discipline	Guide/ Co-guide	Thesis title	Academic year	NIASM joining
M.Sc. / M. Tech. Research							
1	Ashok Subodhi	70011	Environmental Science	Singh AK	Combined effect of drought and heat stress on quinoa in marginal environments	2021-22	2022
2	N Charishma	70012	Environmental Science	Singh AK	Elevated carbon dioxide responsiveness of soybean genotypes differing in tolerance to soil moisture deficit conditions	2021-22	2022
3	Prerna Kumari	70013	Environmental Science	Singh AK	Pb responsiveness of soybean genotypes differing in tolerance to soil moisture deficit	2021-22	2022
4	Chanmolu Hari Gopala Krishna	70016	Plant Physiology	J Rane	Optimization of phenotyping protocol to assess waterlogging induced roots in cowpea	2021-22	2022
5	Bhavani	70008	Soil & Water Conserve. Eng.	Wakchaure GC	Effect of Deficit Irrigation on Garlic (*Allium sativum L.*) Cultivars in Deccan Plateau of India	2021-22	2022
6	Ganesh Prasad Sahoo	70009	Soil & Water Conserve. Eng.	Nangare DD	Studies on effects of deficit irrigation strategies on water use efficiency, yield and quality of high density planted mango grown in Shallow basaltic soil	2021-22	2022

Students of SAU's joined ICAR-NIASM for research work (2019-23)

SN	Student	Roll No.	Discipline	Guide/Co-guide / SAC member	University	Thesis title	Academic year	NIASM joining
M.Sc. and M. Tech Research								
1	Amol Patil	2021H/05ML	Horticulture	Kakade VD	VNMKV Parbhani	Influence of different shade nets on sunburn and fruiting in Dragon fruit (*Hylocereus spp*)	2021-23	2022
2	Akash Doke	2021H/01ML	Horticulture	Kakade VD	VNMKV Parbhani	Studies in canopy management in Dragon fruit for maximizing productivity	2021- 23	2022
3	Kunal Satav	2021H/37MB	Horticulture	Kakade VD	VNMKV Parbhani	Greenhouse gas budgeting in sweet orange and custard apple in semi-arid region of Maharahstra	2022	2022

SN	Student	Roll No.	Discipline	Guide/Co-guide / SAC member	University	Thesis title	Academic year	NIASM joining
4	Toko Nilly	2021H38MB	Horticulture	Kakade VD	VNMKV Parbhani	Greenhouse gas budgeting in Acid lime and Dragon fruit in semi-arid region of Maharahstra	2022	2022
5	Rituraj Jodave	2021/301	Horticulture	Kakade VD	MPKV Rahuri	Long term effect of planting techniques and filling mixtures in Sapota	2021	2022
6	Lambate Satyajit	2020/300	Horticulture	Kakade VD	MPKV Rahuri	Energy and Greenhouse budgeting of Guava and Pomegranate orchards in semi-arid regions of Maharashtra	2020-22	2022
7	Lahu Chavan	2021H/09ML	Horticulture	Khapte PS	VNMKV Parbhani	Assessing the combined influence of grafting and deficit irrigation on the growth, fruit yield and quality traits of eggplant (*Solanum melongena L.*)	2021-23	2022
8	Sahil Pathan	FDPM-20-84	Forestry	Chavan SB	Dr BSKKV Dapoli	Assessment of structure and function of Betel vine-based agroforestry system in Maharashtra	2020-22	2021
9	Pavan Kumar Mohanty	200112022	Plant Physiology	Gurumurthy S	JNKVV Jabalpur	Phenotyping of chickpea varieties for stem reserve mobilization, yield under Kharif and Rabi sown condition	2021-23	2021
10	Sanjay Umesh Naik	PG21AGR13062	Plant Physiology	Gurumurthy S	UAS Raichur	Morpho-physiological assessment of chickpea genotypes for combined heat and drought tolerance	2021-23	2021
11	Prasad Monohar Naware	20203	Process and Food Engineering	Wakchaure GC	MPKV Rahuri	Thermal imaging and physico-chemical properties based maturity indices for custard apple (*Annona squamosal* L) fruits	2022	2021
12	Kashav Digmabhar Ware	20204	Process and Food Engineering	Wakchaure GC	MPKV Rahuri	Effect of coating materials and storage temperatures on shelf-life of custard apple (*Annona squamosal* L) fruits	2022	2021

13	SS Nale	2020/12	Irrigation and Drainage Engineering	Wakchaure GC	MPKV Rahuri	Effect of Deficit Irrigation and Plant Growth Regulators on Okra	2022	2021
14	Dalavi Deepak Rajendra	2020HT/14M	Horticulture	Khapte PS	VNMKV Parbhani	Studies on graft compatibility of wild Eggplant rootstocks and it's evaluation Under drought stress	2021	2021
15	Mane Mayur Tukaram	2020/311	Horticulture	Khapte PS	MPKV Rahuri	Genetic variations in physiological responses to drought in cluster bean (*Cyamopsis tetragonoloba l.*) Genotypes	2021	2021
PhD research								
1	Priyanka Shivaji Jadhav	2021/60	Horticulture	Boraiah KM	MPKV Rahuri	Floral and pollination biology studies in dragon fruit	2021	2022
2	Priyanka Negi	2021/16	Plant Physiology	J Rane	MPKV Rahuri	Investigation on trait contributing to early crop establishment in direct seeded rice.	2021	2022
3	Ritu Kukde	PhD. AE/2020	Process and Food Engg.	Wakchaure GC	MPKV Rahuri	Optimisation of grading, drying and storage techniques for value addition fruits	2022	2022
4	Senthamil E	PGS21AGR8611	Agronomy	HM Halli	UAS Dharwad	Impact of transient waterlogging stress on the performance of cowpea-maize sequence cropping under semi-arid tropics.	2021-22	2022
5	Vinay M Gangana Gowdra	PAMB 1050	Agronomy	HM Halli	UAS, GKVK Bengaluru	Response of soybean to transient water logging stress and its mitigation strategies under semi-arid tropics	2021-22	2022
6	Suraj Kulkarni	2020/15	Plant Physiology	Boraiah KM	MPKV Rahuri	An insight into pre flowering and post flowering drought tolerance in groundnut genotypes.	2020	2022
7	Vinay Hegde	PHD20PHY2006	Plant Physiology	J Rane	Dr PDKV Akola	Exploring avenues to reduce ecological cost of sugar production	2021	2021
8	Dinesh Yadav	20203286	Forestry	Chavan SB	IGKV Raipur	Influence of variation in free amino acids on efficiency of sandalwood- host relationships under soil moisture depletion	2021-23	2021

9	Subhangi Marskolhe	ADPD/19/0311	Biotechnology	Singh AK	Dr BSKKV Dapoli	Genomics Intervention to Identify Candidate Genes For Salt Tolerance In Rice (*Oryza Sativa L.*).	2019	2020
10	Madhavi Sonone	ADPD/19/0313	Plant Physiology	J Rane	Dr BSKKV Dapoli	Development of phenomics protocol and identification of genetic resources for sodium exclusion in rice (*Oryza Sativa L.*)	2019	2020
11	Dnyanehswar Raut	PHD2019/14	Plant Physiology	J Rane	MPKV Rahuri	Genetic variation in endogenous ascorbic acid accumulation and its influence on physiology and seed yield of chickpea genotypes under wáter stress conditions.	2019	2020
12	Kiran R. Barge	PhD. AE 01/2019	Process and Food Engg.	Wakchaure GC	MPKV Rahuri	Studies on maturity indices and improvement of shelf life of custard apple (*Annona Squamosa* L.) fruit & pulp.	2022	2021
13	AR Jadhav	2019A/29P	Horticulture (fruit Science)	Wakchaure GC	VNMKV Parbhani	Development of improved propagation technique to accelerate establishment of dragon fruit (*Hylocereus undatus*) orchards	2022	2020
14	Channabasava	PHD20AGR10022	Genetics and Plant Breeding	Gurumurthy	UAS Raichur	Marker-trait association studies for yield, yield attributing and fiber quality traits in cotton (*Gossypium hirsutum* L.)	2022	2022

Under Graduate/Post Graduate internship at ICAR-NIASM (2022-23)

SN.	Name of student	Discipline	Guide name	University name	Duration (month)	NIASM joining year	Amount paid (Rs.)
1	Pratik Tanpure	Horticulture	Vanita Salunkhe	LPU Punjab	03 (20 June-20 Sept 2022)	2022	Rs. 20,000/-
2	Deepak Thorat	Horticulture	Vanita Salunkhe	LPU Punjab	03 (20 June-20 Sept 2022)	2022	Rs. 20,000/-
3	Dhanashree D Shinde	B. Tech (Biotechnology)	Sachin S Pawar	VNMKV Parbhani	03 (24th Jan 2022 to 23rd April 2022)	2022	Rs 11,800/-
4	Alok Babar	Engineering	Wakchaure GC	SPPU Pune	01	2022	Rs 10,000/-

Trainings organized by ICAR-NIASM (2022-23)

SN.	Training	Period	Beneficiaries details	Nos.	Organizers	Revenue Generated (Rs.)
1	Unit attachment under STUDENT READY programme SRP-402	19th to 25th Aug. 2022	Students of Sadguru College of Agriculture, Mirajgaon Dist. Pune	12	Rajkumar & Ravikumar	-
2	Abiotic Stresses in Agriculture: An Introduction and Hands-on Training for Skill Development	1st June to 10th July 2022	45 B.Tech (Agricultural Engineering), Masters and PhD students from SAUs, YP and SRF from ICAR-NIASM	45	Wakchaure GC (Course Director) Course Co-Directors: Aliza Pradhan, Gurumurthy, Khapte PS	-
3	Use of Instrumentation in Mitigation and Management of Abiotic Stresses	5th to 7th Sept., 2022	Students and employees from University of Agricultural Science, Raichur, Karnataka	24	Gurumurthy S, Sangram Chavan, Hanamant Halli and Basavaraj PS	-
4	Conservation Agriculture for Improving Water Productivity and Post-harvest Quality of Field Crops under Abiotic Stress Conditions	12th Sept. to 03rd October 2022	Total of 25 students from different institutions namely MPKV Rahuri, BSKKV Dapoli, VNMKV Parbhani, PDKV Akola, and IARI New Delhi	25	Wakchaure GC (Course Director) Courser Co-Directors: Nangare DD, Aliza Pradhan, Paritosh Kumar	-
5	An Overview and Hands-on Instrumentation for Abiotic Stresses in Agriculture	01st to 30th Nov. 2022	Graduate students of B. Tech (Agricultural Engineering) students from SCAE&T, Maldad affiliated to MPKV Rahuri	20	Wakchaure GC (Course Directors) Co-Course Directors: Khapte PS, AS Tayade, Neeraj Kumar	1,00,000/-
6	Unit attachment under STUDENT READY programme	01st to 07th Aug. 2022	VIIth semester students of Dr Sharadchandra Pawar College of Agriculture, Baramati	15	Mr. Rajkumar & Mr. Ravikumar	-
7	NIASM Associate Course on General Agriculture and basics of Abiotic Stress Management in crops and livestock for all the NIASM Associates	1st Aug. to 31st Dec. 2022	ICAR-NIASM	30	Hanamant Halli & Paritosh Kumar	-

4. Awards & Recognition

- Dr Himanshu Pathak, ranked at No. 365 in the world and No. 5 in India in the field of Plant Science and Agronomy by the Research.com.
- Dr Nangare DD, received ISAE Commendation Medal 2022 for his professional achievements in Soil and Water Engineering on November 9, 2022 at TNAU, Coimbatore.
- Dr Wakchaure GC received Best Scientist Award 2022 on 14th Foundation Day (21-22 February 2022).
- Dr Wakchaure GC received Indian Achievers Award 2021-22 in Recognition of Outstanding Professional Achievement & Contribution in Nation Building (23rd Feb 2022), Indian Achievers' Forum & CSR Times, Delhi 110096.
- Dr Wakchaure GC, received ISAE Commendation Medal 2022 for his professional achievements on November 9, 2022 at TNAU, Coimbatore.
- Dr Wakchaure GC, Senior Scientist (AS& PE) received Best Scientist Award for outstanding performance and lasting contribution 14th Foundation Day of ICAR-NIASM, 2022.
- Dr Wakchaure GC, Senior Scientist (AS& PE) received Indian Achievers' Award 2021-22 in Recognition of Outstanding Professional Achievement & Contribution in Nation Building from Indian Achievers Forum , New Delhi (23 Feb 2022).
- Dr Wakchaure GC, Senior Scientist (AS& PE) received ISAE Commendation Award 2022 during 56th Annual Convention of Indian So Dr Wakchaure GC, Senior Scientist (AS& PE) received Outstanding Scientist Award from The Society of Tropical Agriculture during 14th ICAHFS 2022 held at The Exotica Grand Hotel, New Delhi (17-18th December 2022).
- Dr H Halli, received young scientist award at 3 Days International Conference on "Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security" on September 28-30, 2022 at University of Kashmir (J&K) organized by ICAR-IGFRI-RRS, Srinagar, ICAR-NAHEP, BAU, Ranchi & National Agriculture Development Cooperative Ltd. Baramulla, J&K.
- Dr Kochewad SA, received best oral presentation award during 5th National Conference and Webinar on Doubling farmers income for sustainable and harmonious agriculture 'DISHA-2022'on 11 and 12 June organized by KNIPSS, Sultanpur, UP in association with GAPS, Dhanbad, Jharkhand and PKVSS, Patna, Bihar.
- Dr Kochewad SA, received Young Scientist award from Society for Scientific Development in Agriculture and Technology at IVth International Conference on Innovative and current advances in agriculture and allied sciences (ICAAAS 2022) held during 12-

14 June, 2022 at Himachal Pradesh University, Shimla.

- Dr Sangram B. Chavan, Scientist received "Hindi Award-2022" for scientific work during "Hindi Pakhawada 2022" at ICAR-NIASM, Baramati.
- Dr Chavan SB won "Blog Competition Winner" by Korea Forest Service and FAO at XV World Forestry Congress 2-6th May 2022 Seoul Republic of Korea.
- Dr Chavan SB, received "Best Scientist Award-2021 of ICAR-NIASM, Baramati" on NIASM Foundation Day, 2022.
- Dr Chavan SB, received "Best Young Scientist Award-2021" Professionals of Agriculture Technology Society, Sangli.
- Dr Chavan SB, received "Young Scientist Award" for outstanding contribution to the field of Agroforestry during International Conference on Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security during September 28-30, 2022 at University of Kashmir (J&K).
- Dr Chavan SB, Scientist received an International Travel Support grant from SERB India to attend 5th World Agroforestry Congress in Canada.
- Dr Chavan SB, Scientist received Best oral presentation during International Conference on Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security during September 28-30, 2022 at, University of Kashmir (J&K).
- Dr SS Pawar received "Reviewer Excellence Award 2022" by Agricultural Research Communication Center, Karnal, Haryana.
- Dr Kakade VD nominated by Secretary, DARE and DG, ICAR for "New agricultural innovation programme on "Achieving Food Security Using Smart Farming Solutions" -Study Visit, Israel (13th-19th September, 2022).
- Dr Kakade VD, received Tuition Scholarship during "New agricultural innovation programme on "Achieving Food Security Using Smart Farming Solutions" -study visit, Israel (13th-19th September, 2022).
- Dr VN Salunkhe, Chavan SB, SG Lonkar, YS Bhagat, Kakade VD awarded "Best Oral Presentation" at 8th International conference of Indian Phytopathological Society (IPSCONF2022) held during 23rd-26th March, 2022 at SKNAU, Jobner-Jaipur, Rajasthan, India.

5. Linkages & Collaborations

Organizations having MOU with ICAR-NIASM

1. Agharkar Research Institute, Pune
2. Agri Tourism Development Corporation, Pune
3. Banaras Hindu University, Banaras
4. Chhattisgarh Kamdhenu Vishwavidayalaya, Chhattisgarh
5. College of Engineering, Malegaon
6. Cytozymes, Mumbai
7. Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli
8. Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola
9. ICAR-Central Arid Zone Research Institute, Jodhpur
10. ICAR-Central Inland Fisheries Research Institute, Kolkata
11. ICAR-Central Institute of Brackishwater Aquaculture, Chennai
12. ICAR-Central Institute of Fisheries Education, Mumbai
13. ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar
14. ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
15. ICAR-Directorate of Onion and Garlic Research, Rajgurunagar
16. ICAR-Indian Agricultural Research Institute, New Delhi
17. ICAR-Indian Grassland and Fodder Research Institute, Jhansi
18. ICAR-Indian Institute of Agricultural Biotechnology, Ranchi
19. ICAR-Indian Institute of Pulses Research, Kanpur
20. ICAR-Indian Institute of Soybean Research, Indore
21. ICAR-Indian Institute of Wheat and Barley Research, Karnal
22. ICAR-National Bureau of Agriculturally Important Microorganisms, Mau Nath Bhanjan
23. ICAR-National Bureau of Plant Genetic Resources, New Delhi
24. ICAR-National Institute of Biotic Stress Management, Raipur
25. ICAR-National Research Center on Pomegranate, Solapur
26. ICAR-National Research Centre for Grapes, Pune

27. iiCARE Foundation, Mumbai
28. Indira Gandhi Krishi Vishwavidyalaya, Raipur
29. International Centre for Agricultural Research in the Dry Areas
30. International Crops Research Institute for the Semi-Arid Tropics, Hyderabad
31. International Rice Research Institute
32. Kamdhenu University, Gandhinagar
33. Maharashtra Animal & Fishery Sciences University, Nagpur
34. Maharashtra Rajya Draksha Bagaitdar Sangh, Pune
35. Mahatma Phule Krishi Vidyapeeth, Rahuri
36. Privi Life science, Pvt Ltd, Mumbai
37. Punjab Agricultural University, Ludhiana
38. Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, J&K
39. Space Applications Centre- ISRO, Ahmedabad
40. Tuljaram Chaturchand College, Baramati
41. University of Agricultural Sciences, Bengaluru
42. University of Agricultural Sciences, Dharwad
43. University of Agricultural Sciences, Raichur
44. University of Delhi, New Delhi
45. University of Horticulture, Bagalkot
46. Vasantdada Sugar Institute, Pune
47. Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani
48. Yara Fertilisers India Pvt. Ltd.

6. Publications

Research Papers

1. Basavaraj PS, Gireesh C, Muralidhara B, Manoj CA, Ishwaryalakhmi LVG, Senguttuvel P, Sundaram RM, Subbarao LV, Anantha MS (2022) Genetic analysis of introgression lines of Oryza rufipogon for improvement of low phosphorous tolerance in indica rice. *Indian Journal of Genetics and Plant Breeding*. 2(2): 135-142. https://doi.org/10.31742/IJGPB.82.2.1
2. Bhendarkar MP, Gaikwad BB, Bhalerao Kamble AL, et al (2022). Impacts of COVID-19 induced Lockdown and Key Reforms in the Indian Fisheries Sector – A Stakeholders' Perspective. *Aquaculture International.* https://doi.org/10.1007/s10499-022-01040-0
3. Boraiah KM, Byregowda M, Keerthi CM, Ramesh S, Singh C, Singh RK, Basavaraj PS (2022) First-second degree statistics-based genetics of powdery mildew and yield attributing traits in blackgram (Vigna mungo). *Indian Journal of Agricultural Sciences.* 92 (1): 105–109. https://doi.org/10.56093/ijas.v92i1.120852
4. Boraiah KM, Gowda GRH, Nagaraja MS, Byregowda M, Keerthi CM, Ramesh S, Basavaraj PS (2022) Breeding Potential of Crosses Derived from Parents Differing in Overall GCA Status for Productivity per se Traits and Powdery Mildew Disease Response in Blackgram [*Vigna mungo* (L.) Hepper]. *Legume Research*. 1-7. https://doi.org/10.18805/LR-4835
5. Chavan SB, Dhillon RS, Rizvi RH, Sirohi C, Handa AK, Bharadwaj KK, Johar V, Kumar T, Singh P, Daneva V, Kumari S (2022) Estimating biomass production and carbon sequestration of poplar-based agroforestry systems in India. *Environment Development and Sustainability.* 24:13493-13521. https://doi.org/10.1007/s10668-021-01996-8
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7. Chavan SB, Uthappa AR, Kumar M, Handa A, Sirohi C, Rawale GB, Sawant AV, Dhoke S (2022) Stalwarts who globally shaped the concept and science called agroforestry. *Indian Journal of Agroforestry.* 24(3): 1-8.
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9. Govindasamy P, Mahawer SK, Mowrer J, Muthukumar B, Prasad M, Ramakrishnan S, Halli HM, Kumar S, Chandra A (2022) Comparison of Low-Cost Methods for Soil Water Holding Capacity. *Communications in Soil Science and Plant Analysis*. 1-10. https://doi.org/10.1080/00103624.2022.2112216
10. Govindasamy P, Mahawer SK, Sarangi D, Halli HM, Das TK, Raj R, Pooniya V, Muralikrishnan L, Kumar S, Chandra A

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11. Govindasamy V, George P, Ramesh SV, Sureshkumar P, J Rane, Minhas PS (2022) Characterization of root-endophytic actinobacteria from cactus (*Opuntia ficus*-indica) for plant growth promoting traits. *Archives of Microbiology*. 204(2): 1-14. https://doi.org/10.1007/s00203-021-02671-2
12. Gurumurthy S, Singh J, Basu PS, Meena SK, J Rane, Singh NP, Hazra KK (2022) Increased significance of chickpea (*Cicer arietinum* L.) senescence trait under water-deficit environment. *Environmental Challenges.* 8: 100565. https://doi.org/10.1016/j.envc.2022.100565
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15. Harisha CB, Basavaraj PS, Boraiah KM, J Rane, Halli HM (2022) Optimization of rapid nursery raising and field establishment protocol in chia (*Salvia hispanica* L.) *Vegetos*. 1-9. https://doi.org/10.1007/s42535-022-00531-y
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backcross populations. *Crop and Pasture science*. CP22105.

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7. Ongoing Projects- 2022

Umbrella Projects

Projects title	PI	Co-PI
Abiotic Stress Information System (ASIS): Geo-spatial digital maps of multiple abiotic stresses, management options and future scenarios (IXX15659)	BB Gaikwad	Amresh Choudhary (on study leave), RN Singh (on study leave), Nangare DD, NP Kurade, SS Pawar, MP Bhendarkar (on study leave), Gopalakrishnan B, H Pathak, SV Potekar, Pravin More (on study leave)
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	Singh AK, Basavaraj PS, Satish Kumar (Upto 30.04.2022), Rajkumar, Karthikeyan N, Paritosh Kumar, Kochewad SA, MP Bhendarkar, Harisha CB, Khapte PS, J Rane, Gurumurthy S, Kakade VD, Hanamant Halli, N Kulshreshta, B Naik, Taware PB, Aniket More, Rushikesh Gophane, Lalitkumar Aher
Model Green Farm (MGF): Environment-friendly, economically viable, state-ofthe-art model farm for abiotic stressed regions (IXX15700)	Nangare DD	H Pathak, Wakchaure GC, BB Gaikwad, VN Salunkhe, Rajkumar, Paritosh Kumar, Aliza Pradhan, Amresh Chaudhary (on study leave), MP Bhendarkar (on study leave), Chavan SB, Kakade VD, Khapte PS, Taware PB, Rushikesh Gophane, Noshin Shaikh, Santosh Pawar, AV Nirmale, Rajagopal V, Hanamant M. Halli
Climate-smart IFS (CIFS): Climate resilient integrated farming system in semi-arid region (IXX15697)	Kochewad SA	Wakchaure GC, VN Salunkhe, Neeraj Kumar, Chavan SB, Kakade VD, Rajkumar, Aliza Pradhan, N Subash, LR Meena, Taware PB, Chahande P, Rajagopal V, Gopalakrishnan B, Halli H

Flagship Projects

Projects title	PI	Co-PI
Adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability (IXX15676)	NP Kurade	SS Pawar, Kochewad SA, BB Gaikwad, Rajkumar, MP Bhendarker (on study leave), RN Singh (on study leave), Nangare DD, AV Nirmale, Gopalakrishnan B, SV Potekar
Augmenting farm income in water scarce regions with alternative crops (IXX15656)	J Rane	Singh AK, Nangare DD, Wakchaure GC, Satish Kumar (Upto 30.04.2022), Karthikeyan N, Boraiah KM, Kochewad SA, Aliza Pradhan, Amresh Chaudhary (on study leave), RN Singh (on study leave), Basavaraj PS, Harisha CB, Halli H
Bio-saline Agriculture: Exploitation of halophytic plant and associated microbiome for amelioration of saline agricultural land of arid & semiarid regions (IXX15657)	Satish Kumar (till 30.04. 2022) & Singh AK (from 01.0 5.2022)	Karthikeyan N, VN Salunkhe, Kochewad SA, Paritosh Kumar, Neeraj Kumar, Amresh Chaudhary (on study leave), H Pathak
Targeting prospective technologies for abiotic stress resilience in rainfed and dryland region (IXX15699)	Nangare DD (till 05.4.202 2) & Ravi Ku mar K (From 06.04.2022)	Nangare DD, SS Pawar, Kochewad SA, BB Gaikwad, Boraiah KM, Karthikeyan N, Rajkumar, MP Bhendarkar (on study leave), H Pathak

Institute Projects

Projects title	PI	Co-PI
Mitigating water stress effects in vegetable and orchard crops (IXX16553)	Wakchaure GC	Nangare DD, Satish Kumar, Aliza Pradhan, K M Boraiah, Khapte PS, J Rane
Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)	Neeraj Kumar	Paritosh Kumar
Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressors (IXX15014)	Neeraj Kumar	Singh AK, Satish Kumar
Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics (IXX14228)	Paritosh Kumar	Neeraj Kumar, Harisha CB
Genomics, genetic and molecular approaches to improve water stress tolerance in soybean and wheat (IXX15660)	Singh AK	J Rane

External Projects

Projects title	PI	Co-PI
Phenotyping of pulses for enhanced tolerance to drought and heat (OXX01737: Funded by ICAR-NICRA).	J Rane	Basavaraj PS, Aliza Pradhan,
Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (OXX03355: Funded by ICAR-CRPCA).	Wakchaure GC	Aliza Pradhan, Amresh Chaudhary, Paritosh Kumar, H Pathak
Evaluation of halotolerant rhizobium and PGPB based biomolecules for alleviation of drought and salt stress ((OXX04473: Funded AMAAS, ICAR-NBAIM, Mau)	Karthikeyan N	Wakchaure GC
Establishment of model herbal garden for medicinal and aromatic plants (OXX4927: Funded by NMPB, New Delhi).	Harisha CB	Nangare DD
Climate smart management practices (OXX4928: Funded by IRRI).	Basavaraj P	J Rane, Himanshu Pathak (Upto 31.07.2022), Hanamant Halli
Studies on N-(n-butyl) Thiophosphoric Triamide (NBPT) as a Urease Inhibitor for Improving Nitrogen Use Efficiency in major cropping systems in India (OXX4926: Funded by CIMMYT).	Aliza Pradhan	Amresh Chaudhary (on study leave), Taware PB, H Pathak, J Rane
Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean (OXX4929: Funded by ICAR-NASF).	A K Singh	J Rane
Development of Nano-based delivery system to mitigates arsenic pollution, ammonia and temperature stress on growth and immune related gene expression in fish (OXX5181: Funded Under LBS Award).	Neeraj Kumar	--
Agri Drone Project (OXX5501: Funded by Central Sector Scheme, Ministry of Agriculture and Farmers Welfare, GOI).	BB Gaikwad	NP Kurade, SS Pawar, Gopalakrishnan B, Rajkumar, S Potekar, Ravi Kumar K, Khapte PS, VN Salunkhe, V Rajagopal, Hanamant Halli, Kakade VD, Chavan SB, Karthikeyan N, Taware PB

Field efficacy of Ortho Silicic Acid (OSA) to alleviate drought stress in wheat crop (OXX5514: Funded by Privi Life Sciences Pvt. Ltd.).	Gurumurthy S	Mahesh Kumar, Aliza Pradhan, Dr J Rane, H Pathak
Bio-efficacy studies of protein hydrolysate based bio-stimulant on cotton, soybean, acid lime, chilli, maize and chickpea crops under drought stress condition (OXX5515: Funded by Green star fertilizers pvt. Ltd.).	Gurumurthy S	N Karthikeyan, Pravin B Taware, Aliza Pradhan, Khapte PS, VS Kakade, J Rane, H Pathak
Efficacy of bio-stimulants in alleviating drought stress in tomato (*Solanum lycopersicum* L.) (OXX5500: Funded by Yara Fertilisers India Pvt. Ltd.)	Khapte PS	J Rane, V Rajagopal

Inter-institutional Project

Project Title	Collaborating Institute Name	Co-PI from ICAR-NIASM
Evaluation of extrinsic and intrinsic parameters for sustainable breeding and culture of *Clarias magur* in captivity	ICAR-Indian Institute of Agricultural Biotechnology (IIAB), Ranchi	Neeraj Kumar
Soybean intercropping with sugarcane in spring season	ICAR-Indian Institute of Soybean Research (IISR), Indore	Hanamant Halli
Depiction of fennel (*Foeniculum vulgare* Mill.) mutant lines for higher yield and moisture stress	ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan	Harisha CB

8. Meetings

10th Research Advisory Committee Meeting

The Research Advisory Committee Meeting was held at ICAR-NIASM on August 17, 2022. Dr B Venkateshwarlu, Chairman, RAC and other distinguished members Dr DK Pal, Dr C Viswanathan and Dr BB Barik attended the meeting physically, whereas Dr SMK Naqvi, Dr PK Ghosh, Director, NIBSM, Raipur and Dr Adlul Islam, ADG (SWM) participated in the meeting online. Dr J Rane, Director (A) briefed about research and development activities during 2021-22. Heads of Schools presented a comprehensive report on the research and achievement. The special invitee Dr Ghosh briefed about the possible research collaboration between NIASM and NIBSM. The Chairman RAC emphasized basic and strategic research on abiotic stress for mechanisms of tolerance, methods and protocols and intermediary products including promising strains and stress alleviation options. All the members of RAC highlighted the need for basic research to bridge the existing knowledge gaps in understanding abiotic stress with enhanced clarity of concepts and strengthened inter-institute collaboration.

12th Institute Research Council (IRC) Meeting

12th IRC meeting of ICAR-NIASM was held on June 15-16, 2022. Dr Himanshu Pathak, Director, NIASM chaired the meeting. Dr M Maheshwari, Former Head, Division of Crop Improvement, ICAR-CRIDA; Dr Pradip Dey, Principal Scientist and PC (STCR), ICAR-IISS, Bhopal; Dr MS Meena, Principal Scientist, ICAR-ATARI, Jodhpur and Dr SK Das, Principal Scientist, ICAR-IVRI participated the meeting as resource persons in different disciplines in person. Dr NP Sahu, Joint Director, CIFE, Mumbai and Dr SR Gadakh, Director Research, MPKV Rahuri participated online. Dr Pathak briefed the achievement of the institute during the year. The action taken report of 11th IRC recommendations was presented by Dr J Rane. The achievements of the Schools were presented by HOS's followed by presentation of Flagship, Umbrella and In-house projects by respective principal investigators. Dr M Maheshwari emphasised and encouraged scientists for advance research for management of abiotic stress in plants and plant field phenomics. A field visit was conducted on June 16, 2022, where all the scientists explained their field research.

ICAR-University-NAAS-Stakeholders Interface Meeting: June 17, 2022

ICAR-NIASM, Baramati conducted ICAR-University-NAAS-Stakeholders Interface Meeting on June 17, 2022. Hon'ble Vice Chancellor Dr VM Bhale, PDKV, Akola and Dr Y S Nerkar, Former Vice Chancellor MPKV Rahuri Co-Chaired the meeting. Dr S D Sawant, Vice chancellor, BSKKV, Dapoli; Dr P K Patil, Vice chancellor, MPKV, Rahuri; all the Director of ICAR Institutes located in Maharashtra and their representatives; progressive farmers; private sectors; NGOs and KVK participated in the meeting. Senior NAAS Fellows and Associates also attended meeting in person or online. Dr Himanshu Pathak Director, NIASM introduced the background and objectives of the meeting. Dr Bhale emphasized the problems Maharashtra agriculture and presented a vision for improvement. Dr Sawant emphasized the improvement of agriculture farming in coastal and inland saline areas. Dr Patil pointed out action points for improvement of agriculture and allied sectors in the state. Progressive farmers and Private highlighted the problems and suggested several measures for adoption of different emerging technologies. On this gracious occasion, a book on 'Abiotic Stress in Agriculture: Impacts and Management' published by ICAR-NIASM and three policy papers published by the Pune Chapter of NAAS were released. Dr Nerkar briefed about the challenges of agriculture and allied sector and focused the need of role of NARES and NAAS in agriculture development in Maharashtra. A Report on 'Reorienting Maharashtra Agriculture' will be prepared and shared with stakeholders to chalk out a program to solve the current and emerging problems.

9. Seminar/Workshop/ Symposia/Conference/Trainings attended by Staff

Staff	Title of Seminar/Workshop/ Symposia/Conference/Trainings attended	Venue	Organized by	Dates
Dr K Sammi Reddy	National Seminar on "Harnessing the Potential of Panchabutas (tatvas) for Sustainable Climate Resilient Rainfed Agriculture"	ICAR-CRIDA, Hyderabad	Indian Society of Dryland Agriculture (ISDA)-CRIDA, Hyderabad-Bharatiya Agro-Economic Research centre (BAERC), New Delhi	28-29 September 2022
	First International Conference on "Reimagining Rainfed Agro-Ecosystems: Challenges & Opportunities"	ICAR-CRIDA, Hyderabad	Indian Society of Dryland Agriculture (ISDA), Hyderabad	22-24 December 2022
Dr Nangare DD	Online Training on 'Integrated Watershed Management for Strengthening PMKSY'	Online mode	MANAGE, Hyderabad and ICAR-IISWC, Udhagamandalam	July 11-14, 2022
	56th Annual Convention of Indian Society of Agricultural Engineers on 'Agricultural Engineering innovations on Global food security' and International symposium on 'India@2047: Agricultural Engineering Perspective'	TNAU, Coimbatore	Indian Society of Agricultural Engineers, New Delhi	9-11 November 2022
Dr Pawar SS	International hands-on training on "Advanced Biotechnological Approaches to Augment Productivity in Poultry for Ensuring Food and Nutritional Security"	ICAR-DPR, Hyderabad	International Livestock Research Institute, Kenya & Indian Council of Agricultural Research, New Delhi	20-24 September 2022

Dr Wakchaure GC	International Conference on Advances in Agriculture & Food System Towards Sustainable Development Goals	UAS, Bangalore	UAS, Bangalore	22-24 October 2022
	56th Annual Convention of Indian Society of Agricultural Engineers on Agricultural Engineering Innovation for Global Food Security and International Symposium on India @2047: Agricultural Engineering Perspective	TNAU, Coimbatore	TNAU, Coimbatore	9-11 November 2022
Dr Gaikwad BB	94th IIRS Outreach Programme on "Overview of Geoprocessing using Python" (As Coordinator)	Online & offline mode	Indian Institute of Remote Sensing, Dehradun	17- 28 January 2022
	3rd International Conference on Aquaculture and Marine Biology (Hybrid mode)	Online	Conference Mind	24-25 March, 2022
	National Conference on "Promotion of kisan drones: issues, challenges and way forward.	NASC Complex, New Delhi	Ministry of Agriculture and Farmers Welfare, GOI	2 May, 2022
	International symposium on 'India@2047: Agricultural Engineering Perspective'	TNAU, Coimbatore	Indian Society of Agricultural Engineers, New Delhi	9-11 November 2022
Dr Kochewad SA	5th National Conference and Webinar on Doubling farmers income for sustainable and harmonious agriculture 'DISHA-2022	KNIPSS, Sultanpur	KNIPSS, Sultanpur, UP and GAPS, Dhanbad	11-12 June 2022
	IVth International Conference in Hybrid Mode on Innovative and current advances in agriculture and allied sciences (ICAAAS 2022)	HPU, Summer Hill, Shimla	Society for Scientific Development in Agriculture and technology	12-14 June 2022
Dr Salunkhe VN	On-line training on, "Metagenomic Data Analysis"	IASRI, New Delhi.	IASRI, New Delhi.	19-24 January 2022
	8th International conference (Hybrid mode): Plant Pathology: Retrospect and Prospects	SKNAU, Jobner-Jaipur, Rajasthan	Indian Phytopathological Society (IPS)	23-26 March 2022
Dr Boraiah KM	Virtual training programme on "Plant Taxonomy for Plant	Online mode	ICAR-NBPGR Regional Station,	21-26 March 2022

	Genetic Resources Management”		Thrissur, Kerala.	
	National Symposium on “Self-Reliant Coastal Agriculture”	Online mode	ICAR-Central Coastal Agricultural Research Institute, Goa	11-13 May 2022
	State level seminar on scientific farming in dragon fruit	AAU, Anand	AAU, Anand	18th October 2022
	Online training on Agri-based technologies interventions for entrepreneurship development in semi arid zone	MANAGE, Hyderabad	MANAGE, Hyderabad	22-26 August 2022
Dr Chavan SB	14th Ecocity World Summit (Fully online)	Ecocity 2022 Chair, TU Delft, Netherlands	Ecocity 2022 Chair, TU Delft, Netherlands	22-24 February
	One CGIAR Initiative-Nature+: Nature-positive solutions for shifting Agri-food systems to more resilient and sustainable pathways	Pune, Maharashtra.	BAIF, Pune & IWMI India	2-3 August 2022
	3 Days International Conference on Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security (Through HYBRID MODE)	University of Kashmir (J&K)	ICAR-IGFRI, Regional Research Station, Srinagar, J & K & BAU, Ranchi, & NADCL Baramulla	28-30 September 2022
	Annual group Meet of All-India Co-ordinated Research Project on Agroforestry	ICAR-CAFRI, Jhansi	ICAR-CAFRI, Jhansi	7-9 October 2022
	International training on Diversification of Coastal Agroecosystems for Climate Resilience and Livelihood Security	ICAR-CCARI, Goa	World Agroforestry Centre, New Delhi and ICAR-CCARI, GOA	7 to 11 November 2022
Dr Harisha CB	Training on Analysis of Experimental data	Online mode	ICAR-NAARM, Hyderabad	17-22 January 2022
	2nd Indian Horticulture Summit	Navsari Agricultural University, Navsari, Gujarat	Society for Horticulture Research and Development, Ghaziabad, UP	27-29 April 2022

Dr Gopalakrishnan B	Webinar on Use of ICT in agriculture information access and dissemination	Online mode	CDAC-Noida, BASU- Patna and BAU-Ranchi	14th March 2022
	International Symposium on Psychobiotics and Gut: Potential in Neurological Disorders	Online mode	NDRI- Karnal and DUVASU-Mathura	5-6 December 2022
Dr Halli H	Six-week online course on "Statistical Techniques for Agriculturists"	Online mode	IIT, Kanpur & Commonwealth of Learning, Canada	31st May -26th July 2022
	International Conference on "Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security"	Online mode	ICAR-IGFRI, Regional Research Station, Srinagar, J & K & BAU, Ranchi, & NADCL Baramulla	28-30 September 2022
	Training Workshop on Analysis of Multi-Environment Trials	Online mode	ICAR-NAARM, Hyderabad	3-8 November 2022
	5th International Agronomy Congress on "Agri-Innovations to combat food and nutrition challenges" India, on	PJTSAU, Hyderabad	PJTSAU, Hyderabad	23-27th November, 2021
Dr Aliza Pradhan	Short course training on "Advances in application of phenomics tools for assessment of abiotic stress responses of crop plants"	ICAR-NIASM	ICAR-NIASM, Baramati	28 February – 9 March, 2022
	International workshop on "Climate proofing of watershed development projects with special reference to soil and water conservation technologies"	Online mode	ICAR-Indian Institute of Soil and Water Conservation, Udhagamandalam	02-03 May, 2022
	Global symposium on "soils for nutrition"	Online mode	Food and Agriculture Organization of the United Nations	26-29 July, 2022
	International web conference on "climate smart technology for augmenting water and nutrient use efficiency in paddy eco-system"	Online mode	UAS, Raichur	17-18 August, 2022

	Training workshop on "Analysis of Multi-Environment Trials"	Online mode	ICAR-NAARM, Hyderabad	3-8 November, 2022
	Symposium on "Soils: where food begins"	Online mode	ICAR-IARI, New Delhi & ISSS-Delhi chapter	30 November, 2022
	First International Conference on "Reimagining Rainfed Agro-Ecosystems: Challenges & Opportunities"	ICAR-CRIDA, Hyderabad	Indian Society of Dryland Agriculture (ISDA), Hyderabad	22-24 December 2022
Dr Basavaraj PS	Advanced Statistical Techniques for Data Analysis Using R"	Online mode	ICAR-IIRR and society for advancement of rice research	3rd-15th January, 2022
	Analysis of Experimental Data	Online mode	ICAR-NAARM, Hyderabad	17th - 22nd January, 2022
	Training on "Molecular Biology and Bioinformatics Tools and It's Application in Agriculture & Allied Sciences"	Online mode	Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut – 250110 (U.P.)	8-21 September 2022
	Analysis of Multi-Environment Trials	Online mode	ICAR-NAARM, Hyderabad	3-8 November 2022
	Training on New Crop Breeding Techniques	ICRISAT, Hyderabad	ICRISAT, Hyderabad	21st November - 11th December 2022
Mr Aher L	Training on Computer Applications for technical personnel of ICAR	ICAR-IASRI, New Delhi	ICAR, New Delhi	15-21 December 2022
Mr Potekar S	Analysis of Experimental Data	Online	ICAR-NAARM, Hyderabad	17-22 January 2022
	Data Visualization Using R	Online	ICAR-NAARM, Hyderabad	09-11 March, 2022

१०. राजभाषा अनुभाग

हिंदी दिवस एवं हिन्दी पखवाड़ा समारोह-२०२२

राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने हेतु भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान द्वारा १४ सितम्बर से २८ सितम्बर के दौरान हिंदी पखवाड़ा का आयोजन किया गया। हिन्दी दिवस तथा हिन्दी पखवाड़ा का उद्घाटन संस्थान के निदेशक डा जगदीश राणे जी के मार्गदर्शन में १४ सितम्बर को किया गया। उद्घाटन समारंभ में मुख्य अतिथि के रूप में डा प्रतिभा जावले (सहायक प्राध्यापक, तुलजाराम चतुरचंद महाविद्यालय, बारामती, जिला पुणे) मौजूद रहे। उन्होने भारत में हिन्दी की गति एवं स्थिति के बारे में सभी को अवगत किया। हिन्दी पखवाड़ा में लगातार विविध प्रतियोगिताओंका जैसे की, हिन्दी निबंध लेखन, टिप्पण एवं प्रारूप लेखन, टंकलेखन, स्वरचित काव्यपाठ, वाद-विवाद, आशुभाषण, प्रश्नोत्तरी आदि प्रतियोगिता आयोजित की गयी। जिसमे संस्थान के सभी सदस्यों ने बढ़-चढ़कर हिस्सा लिया और प्रतियोगिताए सफल बनाई।

हिन्दी पखवाड़ा समारोप एवं पुरस्कार वितरण समारंभ का आयोजन २८ सितम्बर को संस्थान के सरदार पटेल सभागार में किया गया। समापन समारोह के मुख्य अतिथि श्री राजेंद्र केसकर (उप-प्रादेशिक, परिवहन अधिकारी, बारामती) ने प्रतियोगिता विजेता को पुरस्कार प्रदान करके सम्मानित किया। मुख्य अतिथि ने राष्ट्रभाषा के रूप मे हिन्दी का महत्व सभी को अवगत किया। राजभाषा कार्यान्वयन समिति के अध्यक्ष डा जगदीश राणे जी ने हिंदी भाषा के रुझान के लिए किए गए उचित प्रयास पर समाधान जताया। डा वनिता सालुंखे (सदस्य सचिव, राजभाषा कार्यान्वयन समिति), डा परितोष कुमार, डा अविनाश निर्मले, डा प्रवीण तावरे, श्री त्रिलोक सैनी आदि ने कार्यक्रम का आयोजन किया एवं कार्यक्रम सफल बनाया।

हिंदी कार्यशाला आयोजन

कार्यशाला १६ सितम्बर, २०२२:

जुलाई से सितंबर 2022 इस तिमाही में संस्थान में हिंदी भाषा के रुझान हेतु 16 सितंबर 2022 को एक दिवसीय कार्यशाला का आयोजन किया गया। राजभाषा कार्यान्वयन समिति के सदस्य सचिव डा. वनिता सालुंखे ने सूत्रसंचालन करते हुए अतिथि तथा उपस्थितों का स्वागत किया। कार्यशाला को आगे बढ़ाते हुए हिंदी भाषा के रुझान के लिए संस्थान से किए जाने वाले प्रयासों का ब्योंरा प्रस्तुत किया। डा. अर्जुन तायडे, प्रमुख, एसएसएसएम, भाकृअनुप-राअस्ट्रेप्रसं, बारामती ने “राजभाषा कार्यान्वयन के लिए संस्थान की पहल” इस विषय पर प्रशिक्षण दिया। उन्होने संस्थान के दैनंदिन कार्यालयीन कामकाज में हिंदी भाषा के प्रचार–प्रसार हेतु भविष्य की योजनाओं को प्रस्तुत किया। राजभाषा कार्यान्वयन समिति के अध्यक्ष और निदेशक डा. जगदीश राणे जी ने अतिथि का स्वागत करते हुए हिंदी भाषा के रुझान के लिए किए गए मार्गदर्शन पर समाधान जताया। उन्होने ने संस्थान के विविध विभागों को दिशा निर्देश देते हुए हिंदी भाषा में अधिक से अधिक कार्य करने का आवाहन किया। इस कार्यशाला का संस्थान के 70 कर्मचारियों ने प्रत्यक्ष रूप से लाभ लिया। कार्यशाला की उपलब्धियों पर चर्चा करते हुए डा. वनिता सालुंखे, सदस्य सचिव, राजभाषा कार्यान्वयन समिति के धन्यवाद ज्ञापन के साथ एक दिवसीय कार्यशाला संपन्न हुई ।

कार्यशाला १९ सितम्बर, २०२२:

संस्थान में हिंदी भाषा के रुझान हेतु 19 सितम्बर, 2022 को हिन्दी कार्यशाला का आयोजन किया गया। राजभाषा कार्यान्वयन समिति के सदस्य डा. वनिता सालूँखे ने सूत्रसंचालन करते हुए उपस्थितों का स्वागत किया।

कार्यशाला को आगे बढ़ाते हुए श्री प्रवीण मोरे (तकनीकी अधिकारी(संगणक)ने 'हिन्दी को गति देने के लिए आधुनिक आईटी उपकरण' इस विषय पर प्रकाश डाला और उपस्थित सभी को इन उपकरणों को लिप्यंतरण, श्रुतलेखन, टंकलेखन तथा अनुवाद में कैसे इस्तेमाल किया जा सकता इसका प्रशिक्षण दिया। उन्होने संस्थान के पत्र व्यवहारों में तथा ई- ऑफिस द्वारा कार्यालयिन कामकाज में हिंदी का आसानी से प्रयोग करने की कई तकनीकियाँ सिखायी।

संस्थागत बैठक

हिन्दी के रुझान हेतु ६ सितम्बर, २०२२ को राजभाषा कार्यान्वयन समिति के सभी सद्यस्यों की उपस्थिती में संस्थागत बैठक का आयोजन किया गया था। जिसमे संस्थान में हिन्दी को बढ़ावा देने के संदर्भ में चर्चा की गई।

उपलब्धि

संस्थान द्वारा प्रकाशित हिन्दी पत्रिका 'सुफलाम' को भारतीय कृषि अनुसंधान परिषद द्वारा गणेश शंकर विद्यार्थी हिन्दी पत्रिका पुरस्कार-२०२१ से सम्मानित किया गया।

राजभाषा कार्यान्वयन समिति के अध्यक्ष और निदेशक डा जगदीश राणे जी ने सबका स्वागत करते हुए हिंदी भाषा के रुझान के लिए किए गए मार्गदर्शन पर समाधान जताया। उन्होने कर्मचारियों को आवाहन किया की इन तकनीकियों का प्रयोग करते हुए हिन्दी में कामकाज को प्राथमिकता दें। इस कार्यशाला का संस्थान के 70 कर्मचारियों ने प्रत्यक्ष रूप से लाभ लिया। कार्यशाला की उपलब्धियों पर चर्चा करते हुए डा. वनिता सालूँखे जी ने धन्यवाद ज्ञापन किया।


भारतीय कृषि अनुसंधान परिषद

प्रशस्ति-पत्र

गणेश शंकर विद्यार्थी हिन्दी पत्रिका पुरस्कार 2021

वर्ष 2021 के दौरान 'क' और 'ख' क्षेत्र में स्थित संस्थानों में भा.कृ.अनु.प.-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान, बारामती, महाराष्ट्र द्वारा प्रकाशित हिन्दी पत्रिका "सुफलाम" को प्रोत्साहन पुरस्कार से सम्मानित किया जाता है।

दिनांक: 16 जुलाई, 2022
नई दिल्ली

(संजय गर्ग)
अपर सचिव (डेयर) एवं सचिव
भा.कृ.अनु.प.

(त्रिलोचन महापात्र)
सचिव (डेयर) एवं महानिदेशक
भा.कृ.अनु.प.

11. Major Events

S.N	Event	Date
1.	Swachhata Pakhwada campaign	15.12.2021-02.01.2022
2.	Farmers training on "Multifunctional Ratoon Drill (MRD) machine for ratoon sugarcane management" at Sangavi village, Phaltan	07.01.2022
3.	Training cum field demonstration to sugarcane progressive farmers of Aurangabad Districts at ICAR-NIASM	20.01.2022
4.	Celebration of 73rd Republic Day	26.01.2022
5.	Visit of Hon'ble Sh. Sharad Pawar, Former Cabinet Minister of Agriculture, GOI and MP, Rajya Sabha to ICAR-NIASM	03.02.2022
6.	Celebration of World Pulse Day	10.02.2022
7.	Agricultural Technology Week celebration in collaboration with KVK Baramati	09.02.2022 - 13.02.2022
8.	Celebration of 14th Foundation Day	21.02.2022
9.	National Science Day Celebration and inauguration of short course on "Advances in application of Phenomics Tools for Assessment of Abiotic Stress Responses of Crop Plants"	28.02.2022
10.	Celebration of International Women's Day	08.03.2022
11.	Exposure visit cum interaction meeting of NABARD officials	11.03.2022
12.	Field visit of students to CRP-CA and demonstration of MRD Machine	15.03.2022
13.	Training-cum-Demonstration on "Climate-resilient Backyard Poultry Farming" and distribution of Backyard Poultry Cages and Birds under DAPSC	19.04.2022
14.	Field Training cum Frontline Demonstration of Intercropping Using MRD Machine in Ratoon Sugarcane	20.04.2022
15.	Training cum Demonstration on "Organic Nutrient Management for Sustainable Crop Production" and distribution of Vermicomposting Units and Cement poles for Dragon fruit cultivation under DAPSC	23.04.2022
16.	Workshop on AGROTAIN Incorporated Urea Produced with N-TEGRATION™ Technology to address fertilizer use efficiency in major cropping systems of India	27.04.2022 - 28.04.2022
17.	Visit of Hon'ble DDG (NRM), ICAR	28.04.2022

18.	Training-cum-Demonstration on “Dragon fruit cultivation in degraded land and kitchen garden” and distribution of inputs for Dragon fruit cultivation under DAPSC	30.04.2022
19.	Training-cum-Demonstration programme on “Climate Resilient Dairy Production” and Distribution and Demonstration of Dairy kits under DAPSC	06.05.2022
20.	Training programme on “Upliftment of livelihood of SC Beneficiaries” and Distribution of inputs under DAPSC	31.05.2022
21.	Short-Term Course on “Abiotic Stresses in Agriculture: An Introduction and Hands-on Training for Skill Development"	01.06.2022 – 10.07.2022
22.	12th Institute Research Council (IRC) meeting	15.06.2022 - 16.06.2022
23.	ICAR-University-NAAS-Stakeholders Interface Meeting	17.06.2022
24.	Awareness Programme on “Protecting Rights in Areas of Farm Innovations, Breeding and Protection of Varieties”	20.06.2022
25.	Farmers’ Awareness Campaign on Efficient and Balanced Use of Fertilizers (including Nano-fertilizers)	21.06.2022
26.	Celebration of International Day of YOGA	21.06.2022
27.	Meeting of ‘Phaltan Forest Conservation Project’	02.07.2022
28.	Valedictory function of Short-Term Course on “Abiotic Stresses in Agriculture: An Introduction and Hands-on Training for Skill Development”	10.07.2022
29.	Developmental Activities and Bhoomipujan at Malad Farm	21.07.2022
30.	Farewell function of Dr Himanshu Pathak	30.07.2022
31.	State-level workshop One CGIAR Initiative-Nature+ at Pune	03.08.2022-04.08.2022
32.	Exposure visit cum Interaction of Bankers Institute of Rural Development (BIRD) trainees	04.08.2022
33.	Har Ghar Tiranga Campaign	13.08.2022 - 15.08.2022
34.	Celebration of Independence Day	15.08.2022
35.	10th Research Advisory Committee (RAC) Meeting	17.08.2022
36.	Guest Lecture on “Applications of Photonics Imaging and its Applications in Abiotic Stress Tolerance"	18.08.2022
37.	Field Day cum Farmers-Scientists Interaction Meet on “Kharif onion seed production”	27.08.2022
38.	ICAR-NIASM scientists visit farmers’ fields to assess the rain induced yield losses in dragon fruit	
39.	Short Term Training on “Use of Instrumentation in Mitigation and Management of Abiotic stresses”	05.09.2022 - 07.09.2022
40.	Short-Term Training Course on “Conservation Agriculture for Improving Water Productivity and Post-Harvest Quality of Field Crops under Abiotic Stress Conditions”	12.09.2022 - 03.10.2022
41.	हिन्दी पखवाड़ा समारोह	14.09.2022 – 28.09.2022

42.	Field visit under One CGIAR Initiative- Nature positive solutions project to Akole cluster of Ahmednagar	15.09.2022
43.	हिंदी कार्यशाला: राजभाषा कार्यान्वयन के लिए संस्थान की पहल	16.09.2022
44.	National Workshop on RKVY-RAFTAAR Agri-Business Incubator	16.09.2022
45.	हिंदी कार्यशाला: हिन्दी को गति देने के लिए आधुनिक आईटी उपकरण	19.09.2022
46.	ICAR NIASM with KVK Baramati, organized "Farmers Meet and Onion seed distribution" under DAPSC at Shinde village (Karjat Tehsil)	27.09.2022
47.	On farm hands on training cum demonstration on supplementary pollination techniques in Dragon fruit at farmers orchards	30.09.2022
48.	"Farmers Meet and Onion seed distribution" under DAPSC at Halgaon village (Jamkhed Tehsil)	04.10.2022
49.	Visit of PI NICRA and Head, Division of Crop Science, CRIDA	11.10.2022
50.	Visit and survey of dragon fruit farmers and nurseries	13.10.2022
51.	Hon'ble Prime Minister address during Agri – Startup Conclave and Kisan Sammelan inaugural programme	17.10.2022
52.	State level seminar on scientific farming in dragon fruit cum famers-scientist meet at AAU, Anand, Gujarat	18.10.2022
53.	On location training program on "Climate resilient agriculture & livelihood for NGOs and FPOs"	31.10.2022-04.11.2022
54.	Observance of Vigilance Awareness Week	31.10.2022 - 06.11.2022
55.	One Month Training on "An Overview and Hands-on Instrumentation for Abiotic Stresses in Agriculture"	01.11.2022-30.11.2022
56.	Horticulture Value chain Function at VAMNICOM, Pune	01.11.2022
57.	NIASM Joins hand with Grape Farmers Association of Maharashtra to Address Abiotic Stress Issues	10.11.2022
58.	ICAR-Zonal sports NRCC, Bikaner	22.11.2022 - 25.11.2022
59.	Celebration of World Soil Day	05.12.2022
60.	Drone demonstration on nano-urea foliar application and farmers sensitization on trash management and enhancing productivity in sugarcane	06.12.2022
61.	Educational tour of agriculture students to ICAR-NIASM	14.12.2022 & 17.12.2022
62.	Hands-on training on "Vegetative propagation techniques for fruits & forest trees" for Social Forestry staff at Dadasaheb Chaudhary Forest Training Academy, Pal (Jalgaon)	15.12.2022-16.12.2022
63.	Swachhata Pledge and Celebration of Kisan Diwas	23.12.2022
64.	Field demonstration on "Recycling of waste water, and its use in agriculture/ horticulture /kitchen gardens/gardening"	27.12.2022
65.	Field demonstration on "Wealth to Waste: Role of insects in organic waste management"	29.12.2022
66.	Valedictory programme of NIASM Associates Course-2 (NAC-2)	30.12.2022

Celebration of New Year

Swachhata Pakhwada campaign

Farmers training on MRD machine

Celebration of 73rd Republic Day

Celebration of World Pulse Day

Agricultural Technology Week 2022

14th Foundation Day Celebration of

Celebration of National Science Day

Celebration of International Women's Day

Interaction meeting of NABARD officials

Field visit of students to CRPCA

Training on Backyard Poultry Farming

Training on Organic Nutrient Management

Workshop on AGROTAIN Incorporated Urea

Training on Dragon fruit cultivation

Training on Climate Resilient Dairy Production

Training on Upliftment of livelihood of SC Beneficiaries

Short Course on Abiotic Stresses in Agriculture

12th Institute Research Council

ICAR-University-NAAS-Stakeholders Interface Meeting

Awareness Programme on Protection of Varieties

Awareness Campaign on Balanced Use of Fertilizers

Celebration of International Day of YOGA

Meeting of Phaltan Forest Conservation Project

Short Course on Abiotic Stresses in Agriculture

Farewell function of Dr Himanshu Pathak

Exposure visit cum Interaction of BIRD trainees

MoU with Yara Fertilisers

Har Ghar Tiranga Campaign

MoU with iiCARE

MoU with UAS, Raichur

Field Day on Kharif onion seed production

MoU with MAFSU, Nagpur

Training on Use of Instrumentation

Training Course on Conservation Agriculture

Field visit under One CGIAR Initiative- Akole cluster

हिन्दी पखवाड़ा समारोह

हिंदी कार्यशाला

National Workshop on Agri-Business Incubator

Farmers Meet and Onion seed distribution


Training Course on Conservation Agriculture


Training on supplementary pollination in dragon fruit


Training on Instrumentation for Abiotic Stresses

Training on Climate resilient agriculture


Participated in VAMNICOM, Pune

Vigilance Awareness Week-2022


NIASM Joins hand with Grape Farmers Association

ICAR-Zonal sports NRCC, Bikaner


Celebration of World Soil Day


Drone demonstration on nano-urea foliar application

Training forestry staff of Maharashtra Forest Dept.

Celebration of KISAN DIWAS

Educational tour of agriculture students

Review visit of the Consortium Leader-CRPCA

Valedictory programme of NIASM Associate Course

Swachhata Pakhwada

12. Distinguished Visitors

Visit of Hon'ble Sharad Pawar, Former Cabinet Minister of Agriculture, Govt. of India and MP, Rajya Sabha

Hon'ble Sharad Pawar, Former Cabinet Minister of Agriculture, Govt of India and currently Member of Parliament, Rajya Sabha visited the Institute on February 3, 2022. Dr Himanshu Pathak, Director, ICAR-NIASM welcomed him and the other distinguished guests. Dr Pathak highlighted the achievements of Indian agriculture over the years and the role of abiotic stress management for sustainable agriculture. He also presented the achievements of ICAR-NIASM in the areas of research, teaching and extension. Sh Pawar appreciated the activities of the Institute and gave his suggestions and blessings for the future activities of ICAR-NIASM.

Visit of Hon'ble Deputy Director General, Natural Resource management

Hon'ble DDG (NRM), ICAR, Dr SK Chaudhari visited ICAR-National Institute of Abiotic Stress Management, Baramti on April 28, 2022. Dr. Himanshu Pathak, Director, ICAR-NIASM welcomed him along with other dignitaries; Dr ML Jat, Dr DS Rana from CIMMYT; Dr HS Jat, ICAR-CSSRI, Karnal and other distinguished scientists from ICAR institutes (IISS, Bhopal & IIWM, Bhubaneshwar), BISA (Ludhiana and Samastipur), PJTSAU, Hyderabad. The program began with a visit to NIASM fields and institute facilities and infrastructures followed by an interaction meeting with all the NIASM staff. The Director, Dr Himanshu Pathak updated Hon'ble DDG (NRM) about recent achievements and the ongoing research, academic and extension activities of the institute. Dr SK Chaudhari also participated in distributing inputs to some SC beneficiaries under DAPSC programme of the institute. The DDG (NRM) took a note of various vacant positions under different cadre of the institute; appreciated the ongoing activities of the institute in the area of abiotic stress management and wished a long success ahead.

13. Personnel

Staff of ICAR-NIASM

Director	
Dr K Sammi Reddy, Director	
SCIENTIFIC STAFF	
School of Atmospheric Stress Management	
1.	Dr Nitin P Kurade, I/c Head & Principal Scientist (Veterinary Pathology)
2.	Dr Sachinkumar S Pawar, Senior Scientist (Animal Biotechnology)
3.	Dr Bhaskar B Gaikwad, Senior Scientist (Farm Machinery and Power)
4.	Dr Gopalakrishnan B, Scientist (Environmental Science)
5.	Mr Rajkumar, Scientist (Agricultural Entomology)
6.	Mr Mukesh P Bendarkar, Scientist (Fisheries Resource Mgmt.) (On study leave)
7.	Mr Ram Narayan Singh, Scientist (Agricultural Meteorology) (On study leave)
School of Water Stress Management	
1.	Dr J Rane, I/c Head & Principal Scientist (Plant Physiology)
2.	Dr Ajay Kumar Singh, Principal Scientist (Agricultural Biotechnology)
3.	Dr Dhananjay D Nangare, Principal Scientist (Soil & Water Cons. Eng.)
4.	Dr Goraksha C Wakchaure, Senior Scientist (Agricultural Structure & Process Eng.)
5.	Dr Boraiah KM, Scientist (Genetics and Plant Breeding)
6.	Dr Gurumurthy S, Scientist (Plant Physiology)
7.	Dr Pratapsingh Suresh Khapte, Scientist (Vegetable Science)
8.	Dr Aliza Pradhan, Scientist (Agronomy)
9.	Dr Basavaraj PS, Scientist (Genetic & Plant Breeding)
School of Soil Stress Management	
1.	Dr Arjun S Tayade, I/c Head & Principal Scientist (Agronomy)
2.	Dr Sanjivkumar A Kochewad, Senior Scientist (Livestock Production Management)
3.	Dr Vanita N Salunkhe, Senior Scientist (Plant Pathology)
4.	Mr Rajagopal V, Scientist (Soil Chemistry/Fertility/Microbiology)
5.	Dr Sangram Bhanudas Chavan, Scientist (Agroforestry)
6.	Mr Karthikeyan N, Scientist (Agricultural Microbiology)

7.	Mr Harisha CB, Scientist (Spices, plantation, medicinal & aromatic plants)
8.	Dr Neeraj Kumar, Scientist (Fish Nutrition)
9.	Dr Vijaysinha D Kakade, Scientist (Fruit Science)
10.	Dr Paritosh Kumar, Scientist (Environmental Science)
11.	Dr Hanamant M. Halli, Scientist (Agronomy)
12.	Mr Amresh Chaudhary, Scientist (Soil Science) (On study leave)
School of Social Science and Policy Support	
1.	Dr Dhananjay D Nangare, I/c Head & Principal Scientist (Soil & Water Conserv. Eng.)
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)
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)
ADMINISTRATIVE STAFF	
1.	Mr Charles Ekka, Chief Administrative Officer
2.	Dr Sunil Kumar Das, Chief Finance & Accounts Officer
3.	Mrs Purnima S Ghadge, Assistant Administrative Officer
4.	Mr Dayanand P Kharat, Assistant Administrative Officer
5.	Mr Girish V Kulkarni, Assistant Administrative Officer
6.	Mr Trilok Saini, Assistant Administrative Officer

Joining, Transfer and Promotion of Staff

Name of the staff	Date	Previous Institute
Joining		
Dr K Sammi Reddy, Director	09.12.2022	ICAR-CRIDA, Hyderabad
Dr AS Tayade, Principal Scientist	11.08.2022	ICAR-SBI, Coimbatore.
Mr Charles Ekka, CAO	21.05.2022	ICAR-CRIDA, Hyderabad
Dr Sunil Kumar Das, SFAO	14.11.2022	ICAR-NRRI, Cuttack
Mr Trilok Saini, AAO (Deputation)	13.04.2022	ICAR-IASRI, New Delhi
Selection/Transfer		
Dr Himashu Pathak	30.07.2022	Selected as Secretary DARE & DG ICAR
Dr Satish Kumar	30.04.2022	ICAR-DOGR, Pune
Mr Anil Kumar Sidharth	02.07.2022	ICAR-IARI, New Delhi
Promotion		
Dr Sachinkumar S. Pawar Senior Scientist (Animal Biotechnology)	28.08.2020	Promotion to next higher grade of PB-4 (Rs 37400-67000+ RGP 9000) (Pay Level-13A) as Senior Scientist
Dr Goraksha C. Wakchaure Senior Scientist (Agricultural Structure & Process Eng.)	10.02.2021	Promotion to next higher grade of PB-4 (Rs 37400-67000+ RGP 9000) (Pay Level-13A) as Senior Scientist
Dr Bhaskar B. Gaikwad Scientist (Farm Machinery & Power)	17.04.2019	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP 8000) (Pay Level-12) as Senior Scientist
Dr Sanjeev A. Kochewad Scientist (Livestock Production & Management)	23.06.2019	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP 8000) (Pay Level-12) as Senior Scientist
Dr Mahesh Kumar Scientist (Plant Physiology)	27.04.2020	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP 8000) (Pay Level-12) as Senior Scientist
Dr Vanita N. Salunkhe Scientist (Plant Pathology)	27.04.2020	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP 8000) (Pay Level-12) as Senior Scientist
Dr Satish Kumar Scientist (Plant Biochemistry)	15.09.2021	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP 8000) (Pay Level-12) as Senior Scientist
Dr Gopalakrishnan B Scientist (Environmental Science)	01.01.2019	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP of Rs 7000) (Pay Level-11)

Dr Paritosh Kumar Scientist (Environmental Science)	01.01.2020	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP of Rs 7000) (Pay Level-11)
Mr Rajkumar Scientist (Agricultural Entomology)	01.01.2021	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP of Rs 7000) (Pay Level-11)
Mr M. P. Bhendarkar Scientist (Fisheries Resource Management)	01.01.2021	Promotion to next higher grade of PB-3 (Rs. 15,600-39,100 + RGP of Rs 7000) (Pay Level-11)
Mr Lalitkumar B Aher Senior Technical Assistant (T-4)	14.07.2021	Promotion to next higher grade of 7 (Rs.44,900-1,42,400) as Technical officer (T-5)
Mr Sunil V. Potekar Senior Technical Assistant (T-4)	28.07.2021	Promotion to next higher grade of 7 (Rs.44,900-1,42,400) as Technical officer (T-5)
Mr Patwaru R. Chahande Senior Technical Assistant (T-4)	16.09.2021	Promotion to next higher grade of 7 (Rs.44,900-1,42,400) as Technical officer (T-5)

14. Major Committees

Research Advisory Committee (RAC)

1. **Dr B Venkateswarlu**, Chairman RAC & Ex- Vice Chancellor, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra
2. **Dr SMK Naqvi**, Former Director, ICAR- Central Sheep and Wool Research Institute, Avikanagar, Rajasthan
3. **Dr N Sarangi**, Former Director, ICAR- Central Institute of Freshwater Aquaculture, Bhubaneswar, Orissa
4. **Dr DK Pal**, Former Principal Scientist, ICAR- National Bureau of Soil Survey and Land Use planning, Nagpur, Maharashtra
5. **Dr C Viswanathan**, Head, Plant Physiology, ICAR- Indian Agricultural Research Institute, New Delhi
6. **Dr BB Barik**, Former Director, Vaikunth Mehta National Institute of Co-operative Management, Pune, Maharashtra and Former Principal, BVRI, Bichpuri, Agra, Uttar Pradesh
7. **Dr Adlul Islam**, ADG (S&WM), NRM Division, KAB-II, Pusa, New Delhi
8. **Dr J Rane**, Head of School, SWSM, ICAR- National Institute of Abiotic Stress Management, Baramati, Maharashtra (Member Secretary)

Institute Management Committee (IMC)

1. **Dr K Sammi Reddy**, Chairman IMC & Director, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra
2. **ADG (S&WM)**, NRM Division, ICAR Hqrs. New Delhi
3. **Commissioner of Agriculture**, Govt. of Madhya Pradesh, Bhopal
4. **Dr Sachin Nalawade**, Head, Dept. of Farm Machinery & Power Eng., Mahatma Phule Krishi, Vidyapeeth, Rahuri
5. **Dr Naresh Kumar**, Professor & Principal Scientist, Centre for Environment Science and Climate Resilient Agriculture, ICAR-Indian Agricultural Research Institute, New Delhi
6. **Dr M Prabhakar**, Principal Scientist & Project Investigator, NICRA, ICAR-Central Research Institute on Dryland Agriculture, Hyderabad
7. **Dr RM Sundaram**, Principal Scientist, ICAR-Indian Institute of Rice Research, Hyderabad
8. **Shri Aniruddha Vasant Pujari**, Pujari Farm, Solapur, Maharashtra
9. **Dr J Rane**, Head of School, SWSM, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra
10. **Smt Purnima S Ghadge**, Asst. Administrative Officer, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra (Member Secretary)

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 Girish V Kulkarni	Member	Chief Administrative Officer	Member
Technical	Sh Santosh Pawar	Secretary IJSC	Chief Finance & Accounts Officer	Member
	Sh Pravin More	Member	Smt. Purnima Ghadge, AAO (Establishment)	Member Secretary

15. Research Team

Research Project Output	Research Team
• α-version Atmospheric Stress Information System	Gaikwad BB, Kurade NP, H Pathak, Pawar SS, Gopalakrishnan B, Nangare DD
• α-version Soil Information System	Gaikwad BB, H Pathak, Kurade NP, Pawar SS, Gopalakrishnan B, Nangare DD
• α-version Abiotic Stress Information System (ASIS)	Gaikwad BB, H Pathak, Kurade NP, Pawar SS, Gopalakrishnan B, Nangare DD
• Databases for geospatial mapping of multiple components under Abiotic Stress Information System	Gaikwad BB, H Pathak, Kurade NP, Pawar SS, Gopalakrishnan B, Nangare DD
• Investigations on suitable day hours available for RPAS applications in Indian agriculture as impacted by local weather parameters	Gaikwad BB
• APY interactive web-maps for selected crops of India	Gaikwad BB
• GHG emission maps from livestock based on Tier I and Tier II Protocol (IPCC)	Gopalakrishnan B, Gaikwad BB, Pawar SS, Kurade NP, Rajkumar V, Nirmale AV
• Prototype of Animal Monitor (V1.0)	Gopalakrishnan B, Pawar SS, Kurade NP, Gaikwad BB, Rajkumar V, Nirmale AV
• Establishment and monitoring of alternate fodder unit	Gopalakrishnan B, Rajkumar V, Pawar SS, Kurade NP, Gaikwad BB, Nirmale AV
• Spatial modelling of time required for advancement of chickpea generations in India	Gaikwad BB, Gurumurty N
• Identification of farm ponds and storage water tanks using satellite imagery and deep learning	Gaikwad BB
• Assessment of seasonal variations in physiological, haematological and growth parameters in different breeds of goats	Kurade NP, Pawar SS, Nirmale AV
• Modulation of Heat Shock Protein 70 (HSP70) gene expression in chickens under heat stress	Pawar SS, Kurade NP, Nirmale AV
• Black soldier Fly (BSF); Hermetia illucens as a novel source of protein	Rajkumar V, Kurade NP, Pawar SS, Gopalakrishnan B, Gaikwad BB, Nirmale AV

• Exploitation of halophytic plant and associated microbiome for amelioration of saline agricultural land of arid & semiarid regions	Singh AK, Kochewad SA, Vanitha Salunkhe, Neeraj Kumar, Karthikeyan N, Paritosh Kumar
• Response of bacterial biomolecules, bioformulation and biopolymer on growth and development of mung bean under field condition	Karthikeyan N, Wakchaure GC
• Climate-smart integrated farming system (CIFS) model for semi-arid region	Kochewad SA, Wakchaure GC, VN Salunkhe, Neeraj Kumar, Chavan SB, Kakade VD, Rajkumar, Aliza Pradhan, Subash N, Meena LR, Taware PB, Chahande P, Rajagopal V, Gopalakrishnan B, Halli H
• Quantification of carbon footprints for major rainfed cropping system in the central Deccan plateau region	Rajagopal V, Kochewad SA
• Effect of deficit irrigation and chia based intercropping systems on seed yield of chia and competition indices	Harisha CB, J Rane, Basavaraj PS, Boraiah KM
• Soil property profile of the research fields of Malad farm	V Rajagopal
• Effect of fruit species introduction on soil properties of gravelly barren land	V Rajagopal, K Sammi Reddy, Chavan SB, H Halli, Nangare DD
• Detection, etiology and phylogenetic analysis of stem canker (Neoscytalidium dimidiatum) in dragon fruit	Vanita Salunkhe
• Detection, etiology and phylogenetic analysis of anthracnose (Colletotrichum truncatum) in dragon fruit	Vanita Salunkhe
• Studies on horticulture crops	Kakade VD, Nangare DD, Chavan SB, Vanita Salunkhe
• Carbon sequestration in mango, coconut and pomegranate orchards in semi-arid region	Chavan SB, Kakade VD, Nangare DD, V Rajagopal
• Biomass equation & Carbon storage in Melia dubia from farmers field	Chavan SB, Kakade VD, Nangare DD
• Nano-copper enhances thermal efficiency and stimulates gene expression in response to multiple stresses in Pangasianodon hypophthalmus (Striped catfish)	Neeraj Kumar
• Exploring mitigating role of zinc nanoparticles on arsenic, ammonia and temperature stress using molecular signature in fish	Neeraj Kumar
• Multi-biomarker approach to assess chromium, pH and temperature toxicity in fish	Neeraj Kumar
• Identification of promising soybean genotypes based on drought adaptive traits and drought responsive GmEIN2 gene	Singh AK, Mahesh Kumar, J Rane
• Genetic variations in physiological response of GmEIN2, GmFnsl and GmWRKY-silenced	Singh AK, Mahesh Kumar, J Rane

soybean plants under no stress (irrigated) and drought stress conditions	
• Screening and identification of waterlogging tolerant pigeonpea genotypes	Basavaraj PS, Boraiah KM, J Rane and Harisha CB
• Identification of High temperature stress tolerant cowpea genotypes	Basavaraj PS, Boraiah KM, J Rane and Harisha CB
• Studies on N-(n-butyl) Thiophosphoric Triamide (NBPT) as a urease inhibitor for improving nitrogen use efficiency in sugarcane cropping systems in India	Aliza Pradhan
• Optimising agronomy of quinoa in water scarce regions of India	Aliza Pradhan
• Identification of 56 days of climate-smart, high-yielding with drought tolerance Rajmash	Gurumurthy S
• Kharif Chickpea: A new introduction to vegetable pulses in Western Maharashtra	Gurumurthy S
• Vegetal protein hydrolysates reduce the yield losses of off-season crops under combined heat and drought stress	Gurumurthy S
• Identification of photo-thermo-insensitivity and early maturing chickpea genotypes	Gurumurthy S
• Special and promising chia mutant plants in M2 and M3 generation	Boraiah KM, Basavaraj PS, Harisha CB and J Rane
• Study of floral morphology, flowering behavior and pollination process in dragon fruit unraveled cause for low productivity in white dragon fruit variety	Boraiah KM, Basavaraj PS, Harisha CB and J Rane
• Demonstration and dissemination of technology on supplementary hand pollination for enhanced productivity in dragon fruit	Boraiah KM, Basavaraj PS, Harisha CB and Vijay Kakade
• Identified high nutrient use efficient foxtail millet accessions	Boraiah KM, Basavaraj PS, Harisha CB
• Establishment of crop cafeteria to display important and popular varieties of cereals including small millets, pulses, oil seed and spice crops	Boraiah KM, Basavaraj PS, Harisha CB
• Collection, multiplication and evaluation of the germplasm/ genotypes/ accessions for different abiotic stresses	Boraiah KM, Basavaraj PS, Harisha CB
• Identification of extra early-climate smart, drought-tolerant and high-yielding cotton germplasm	Gurumurthy S
• Genetic variations in physiological responses to drought in cluster bean (Cyamopsis tetragonoloba L.)	Khapte PS, Boraiah KM
• Collection, conservation and maintenance of vegetable germplasm	Khapte PS

• S. sisymbriifolium and S. torvum as the potential rootstocks for drought tolerance in eggplant	Khapte PS, Wakchaure GC
• Interactive effect of soil types and biostimulants in grapes cv. Sharad seedless	Khapte PS, Nangare DD
• Studies on effect of deficit irrigation strategies on water use efficiency, yield and quality of pomegranate (Cv. Bhagwa) in shallow basaltic soils	Nangare DD, Kakade VD
• Mitigating water stress effects in vegetable and orchard crop	Wakchaure GC
• Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system	Wakchaure GC
• Survey of dragon fruit farmers from water and soil stressed regions	Ravi Kumar K, Boraiah KM, Kakade VD
• Constraints in dragon fruit cultivation as perceived by farmers	Ravi Kumar K, Boraiah KM, Kakade VD
• Methodology for identification of fisheries cage culture in inland open water bodies using deep learning and satellite imagery for monitoring and technology targeting	Gaikwad BB, Bhendarkar MP
• Trainings, demonstrations, field visits conducted during 2022	B Ravi Kumar K, Rajkumar B, Nangare DD
• Activities under Development Action Plan for Scheduled Castes programme	Kurade NP, Pawar SS, Nangare DD, Nirmale AV, Gaikwad BB, Rajkumar, Kakade VD, Aliza Pradhan, Chavan SB, Ravi Kumar K
• Activities under Tribal Sub Plan programme	Kochewad SA, VN Salunkhe, Neeraj Kumar, Paritosh Kumar, Rajkumar B, Ravi Kumar K, Halli H

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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भारतीय कृषि अनुसंधान परिषद

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ICAR-National Institute of Abiotic Stress Management

(समतुल्य विश्वविद्यालय)

बारामती, पुणे, महाराष्ट्र ४१३ ११५

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