Annual Report 2021

भाकृअनुप
ICAR

राअस्ट्रैप्रसं
NIASM

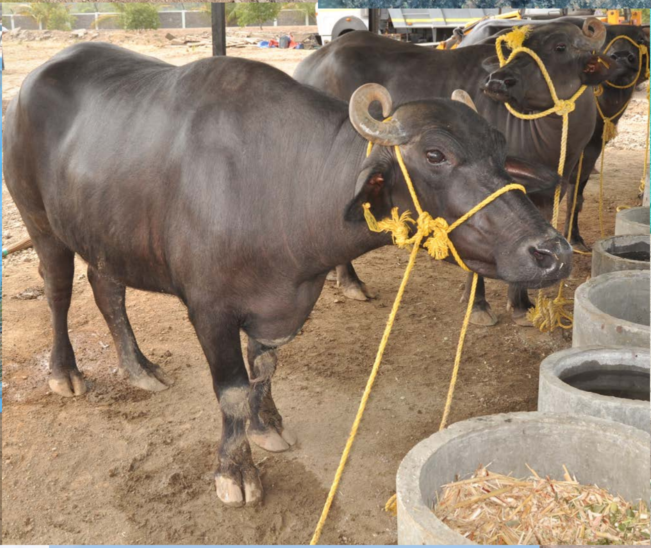
भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

ICAR-National Institute of Abiotic Stress Management











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बारामती, पुणे, महाराष्ट्र ४१३ ११५

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PREFACE

The challenge of multiple environmental stresses in agriculture is aggravating evidently with increased frequency, spatial extent and intensity of the abiotic stresses in the recent decades. The recent projections made by the Inter-Governmental Panel on Climate Change (IPCC, 2021) about the increase in extreme weather events in South Asia, including India, re-emphasised the urgent need for critical outlook and action by all the nations. The basic and strategic investigations have been the key enabler in the human pursuit to restore the environmental balance through realising the decisive framework of adaptation and mitigation strategies. The ICAR-National Institute of Abiotic Stress Management (NIASM), has been striving towards this common pursuit through its incremental scientific explorations aimed at gaining insights and foresights of the processes and devising sustainable management options for crop plants, livestock, fish and poultry sectors. Since its establishment in 2009, the NIASM has complied with the contemporary national and global objectives such as achieving Sustainable Development Goals (SDGs) for the people. The multidisciplinary team of researchers at the institute has the distinct vantage in devising a multi-prong strategy needed to understand the complex scenarios of abiotic stresses and its sustainable management.

This Annual Report has detailed the research investigations and the reach-out activities of the multidisciplinary project teams at NIASM along with the other supporting activities carried out during 2021. Though many instances essentially required the inter-school participation owing to the multidisciplinary project teams, the research findings and the work progress of the projects of NIASM are briefed school-wise under 'Research Highlights' section for simplifying layout and easy comprehension by the readers. The chronological gist of these activities can be readily found on NIASM website in form of our regular publications i.e., monthly Project Coordinator, monthly Farm Coordinator and fortnightly Agro-advisories. The readers interested in the details are encouraged to retrieve these from 43 research papers, 4 review papers, 1 book, 12 technical bulletins, 11 technical/extension folders, 3 training manuals and 48 popular articles given under the publication section. Apart from these publications the research findings have also been presented in several of the national and international fora by the researchers. NIASM hosted one such research fora this year at its campus to encourage the scientific discussions, and also other important activities listed under 'Major Events' section of this Annual Report. The awards and recognition received; external linkages and collaborations developed and all other significant activities have been listed under the pertinent sections of this Annual Report.

I extend my sincere thanks to Dr Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR); Shri Sanjiv Kumar, Additional Secretary (DARE) & Financial Advisor (ICAR); Shri Sanjay Garg, Additional Secretary (DARE) & Secretary (ICAR); Dr Suresh Kumar Chaudhari, DDG, NRM (ICAR); Dr S Bhaskar, ADG, AAF & CC and Dr Adlul Islam, ADG, SWM for their continued support and guidance. Valuable guidance, encouragement and support received from Dr B Venkatswarlu, Chairman and other esteemed members of Research Advisory Committee (RAC); members of Institute Management Committee (IMC) and Institute Research Council (IRC) of the Institute are sincerely acknowledged. I sincerely thank the Heads of the Schools; Scientists; and Technical, Administration and Finance staff of the institute for their whole-hearted efforts and dedication in carrying out the activities of the institute. I appreciate the efforts made by the members of the Publication Committee in compiling this Annual Report. I acknowledge the efforts and commitment of all the staff to serve this national institute.

I sincerely hope that the Annual Report will be useful for the researchers, policy makers, development functionaries, farmers and students and help in promoting sustainable agriculture.

Date: 31-12-2021 (Himanshu Pathak)

ICAR-NIASM, Baramati

ABBREVIATIONS

AHP	Analytic Hierarchy Process
BSF	Black Soldier Fly
CAM	Crassulacean Acid Metabolism
CART	Classification and Regression Trees
CIFS	Climate smart Integrated farming system
CRBD	Completely Randomized Block Design
CV	Coefficient of variation
CWs	Constructed wetland system
DAP	Das after planting
DAS	Days after sowing
EC	Electrical Conductivity
FCR	Feed Conversion Ratio
GEE	Google Earth Engine
GHG	Greenhouse Gases
GIFT	Genetically Improved Farmed Tilapia
GOI	Government of India
HCN	Hydrogen Cyanide
HPLC	High Performance Liquid Chromatography
IAA	Indole-3-Acetic Acid
IBA	Indole butyric acid
ICT	Information and Communication Technologies
IMD	Indian Meteorological Department
IoT	Internet of things
IW:CPE	Irrigation Water: Cumulative Potential Evaporation
LB	Lysogeny Broth
LC50	Lethal Concentration 50

LC-MS	Liquid chromatography–mass spectrometry
NCBI	National Center for Biotechnology Information
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NITI	National Institution for Transforming India
NOAA	National Oceanic and Atmospheric Administration
No./Nos.	Number/Numbers
NUE	Nitrogen Use Efficiency
PCR	Polymerase Chain Reaction
PEG	Polyethylene Glycol
PGPR	Plant growth-promoting rhizobacteria
PGR	Plant Growth Regulators
ppt	Parts per trillion
PS-II	Photosystem-II
RF	Random Forest
RWC	Relative Water Content
SCSP	Scheduled Castes Sub-Plan
SDG	Sustainable Development Goals
SHC	Soil Health Card
SOP	Sulphate of Potash
THI	Thermal Humidity index
TNZ	Thermo- Neutral Zone
TSP	Tribal Sub-Plan
UHPLC	Ultra High Performance Liquid Chromatography
VIIRS	Visible Infrared Imaging Radiometer Suite

EXECUTIVE SUMMARY

1. The framework and databases were developed for a comprehensive, integrated Abiotic Stress Information System (ASIS) capturing soil, water, climate, crop, animal, poultry, fisheries and socio-economic parameters at temporal and spatial scales. The soil nutrient and soil fertility Indices maps at the district level were prepared for the country utilizing more than 16 crore data points.
2. Greenhouse gas (GHG) emissions as well as fodder demand and supply were estimated at the district level using the Tier 1 methodology for India.
3. Digital geo-spatial layers and maps were compiled for India with respect to delineating boundaries, land and water use, socio-economic census, meteorological parameters, soil chemical properties and breeding tracts of livestock.
4. A novel technology to prevent flower and immature fruit drop due to rainfall in dragon fruit was identified and demonstrated. This technology comprises bagging/covering flowers, sheltering plants, and supplementary pollination.
5. For the first time, in dragon fruit, nine different disease-causing pathogens genera were reported, namely, Colletotrichum spp., Fusarium spp., Alternaria spp., *Phoma* spp., *Biopolaris* sp., *Nigrospora* spp., *Neoscystalidium* sp., *Curvularia* spp. and Rhizoctonia spp. NCBI accessions were obtained for the identified pathogens.
6. Pigeon pea genotypes namely ICP-7375, ICP-7076, ICP-7507, ICP-7426 ICP-7314, ICP-6128, ICP-6859, ICP-6815, ICP-7148, ICP-6992, ICP-9414, which exhibited high survival rate, enhanced plant height under stress, and high chlorophyll content and PS-II efficiency as compared to the tolerant checks were identified.
7. Abiotic Stress Gene bank at ICAR-NIASM was established with 1250 crop germplasm collected from several locations.
8. Genotypes JG-16 and BGM 408 were identified as potential source for drought tolerance in chickpea breeding programmes for semi-arid regions.
9. A Climate-smart Integrated Farming System (CIFS) model has been developed in one hectare land at ICAR-NIASM. In the first year, the overall cost of cultivation of different components was Rs 1,61,315, gross income was Rs. 1,91,491 and the B:C ratio was 1.18.
10. Using VIIRS NOAA-20 daily satellite data, fire events for burning sugarcane trash were identified to target preventive technology measures in sugarcane growing areas.
11. A spreadsheet model for spatial assessment of thermal severity for livestock and poultry was developed.
12. The adaptability of goat breeds, namely, Osmanabadi, Sangamneri, Konkan kanyal and Boer, to climatic stress prevalent in the region was assessed. These breeds were found suitable for rearing in similar climatic regions (climate analogues).

13. The Vertical Constructed Wetland Systems (VCWs) have shown higher metal removal capacity compared to horizontal VCWs. The metal removal capacity was found in order for filter materials as Gravel+ Charcoal (GCW) > Gravel (GW) > Gravel+ Brick block (GBW) > Gravel+Coco peat (GPW) > Control (CW) treatments.
14. A UHPLC-based analysis of the exometabolites of halotolerant Rhizobium revealed the presence of putative compounds viz. Gentisic acid, Protocatechuic acid, Gallic acid, Gallic acid derivatives, Vanillin, and Syringic acid derivatives as the active biochemical constituents of the exometabolite pool.
15. An online Cage Culture Directory of India was developed to compile a database on the existing cage culture locations in the country.
16. Turmeric genotypes Allepppy Supreme, followed by Rajendra Sonia, Lackdong, Waygoan, NDH-98, BSR-2 and Roma performed well (based on dry yield per plant) under poor nutrient and shallow soils.
17. Fenugreek varieties Afg-3, Co-2, and Rmt-305 were found tolerant to moisture stress and able to provide higher yield without much reduction in yield due to moisture deficit stress.
18. Isolate 52 extracted from saline habitats from Diveagar area (Raigad district) of Maharashtra exhibited higher siderophore production capability under harsh saline conditions (3.5% NaCl) and is likely a potential microbe for plant growth promotion under saline conditions.
19. A combination of Se-NPs at 0.2 mg kg-1 and EPA+DHA at 0.4 % followed by 0.2% was found to alleviate temperature stress, bacterial infection and arsenic pollution in fish (Pangasianodon hypophthalmus).
20. A Matlab app "Brute force identification of best performing two band spectral Indices" v2.0 was developed to identify two-band indices in hyperspectral spectroscopy studies through corelation analysis.
21. Protocol to identify promising rootstock-scion combinations of tomato for efficient water use using plant phenomics facility was developed.
22. Soybean crops under soybean + maize intercropping exhibited a cooler canopy compared to sole soybean and Soybean + Pigeon pea during flowering, whereas, during pod filling, soybean plants under soybean + Pigeon pea intercropping showed the coolest canopy temperature.
23. Minimum temperature plays a fundamental role in the germination and development of quinoa. Sowing on the second fortnight of December showed better morphological and yield attributes (plant population, panicle height & weight, number of panicles per plant, seed & biomass yield).
24. Exogenous application of PBRs like irradiated chitosan and sea weed extract could effectively improve yield and post-harvest quality of eggplant fruit and showed a major role in alleviating water stress under moderate and severe water deficit conditions.
25. Development Action Plan for Scheduled Castes (DAPSC), implemented by the Institute, helped 1600 beneficiaries and 22 Self Help Groups (SHG's) of 8 Tehsils of Maharashtra through technology demonstration and input distribution. In the Development Action Plan for Scheduled Tribes (DAPST), 288 families were extended support and training.

कार्यकारी सारांश

१. अस्थायी और स्थानिक पैमाने पर मिट्टी, पानी, जलवायु, फसल, पशु, मुर्गी पालन, मत्स्य पालन और सामाजिक-आर्थिक मापदंडों के आधार पर एक व्यापक, एकीकृत अजैविक तनाव सूचना प्रणाली (ASIS) के लिए रूपरेखा और डेटाबेस विकसित किए गए थे। १६ करोड़ से अधिक डेटा बिंदुओं का उपयोग करके देश के लिए जिला स्तर पर मिट्टी के पोषक तत्व और मिट्टी की उर्वरता सूचकांक मानचित्र तैयार किए गया है।

२. ग्रीन हाउस गैस (GHG) उत्सर्जन के साथ-साथ चारे की मांग और आपूर्ति का अनुमान भारत के लिए जिला स्तर पर टियर १ पद्धति का उपयोग करके किया गया है।

३. सीमाओं, भूमि और पानी के उपयोग, सामाजिक-आर्थिक जनगणना, मौसम संबंधी मापदंडों, मृदा रासायनिक गुणों और पशुधन के प्रजनन क्षेत्रों का डिजिटल भू-स्थानिक परतों और मानचित्रों में संकलित किया गया है।

४. ड्रैगन फ्रूट में वर्षा के कारण फूल और अपरिपक्व फलों को गिरने से रोकने के लिए एक नई तकनीक की पहचान की गई और किसानों को उसका प्रदर्शन किया गया, जिसमें फूलों को ढंकना, पौधों को आश्रय देना और पूरक परागण शामिल हैं।

५. ड्रैगन फ्रूट में नौ अलग-अलग रोग पैदा करने वाले रोगजनकों को पहली बार रिपोर्ट किया गया, जिसमे कोलेटोट्रिचम, फुसैरियम, अल्टरनेरिया, फोमा, बायोपोलारिस, निग्रोस्पोरा, नियोसिस्टेलिडियम, कर्वुलरिया और राइजोक्टोनिया प्रजातियाँ शामिल है। इन रोगजनकों एनसीबीआई अंतर्गत पंजीकृत किया गया है।

६. अरहर के जीनोटाइप नामतः ICP-7375, ICP-7076, ICP-7507, ICP-7426, ICP-7314, ICP-6128, ICP-6859, ICP-6815, ICP-7148, ICP-6992, ICP-9414 सहनशील जांचों की तुलना में उच्च उत्तरजीविता दर, तनाव के तहत बढ़ी हुई पौधों की ऊंचाई और उच्च क्लोरोफिल सामग्री और पीएस-II दक्षता का प्रदर्शन किया।

७. भाकृअनुप-एनआईएएसएम में अजैविक तनाव जीन बैंक की स्थापना की गई जिसमे कई स्थानों से एकत्र किए गए १२५० फसल जर्मप्लाज्म शामिल है ।

८. जेनोटाइप जेजी-१६ और बीजीएम ४०८ को सूखा सहनशीलता के संभावित स्रोत के रूप में माना जा सकता है जिसका उपयोग अर्ध-शुष्क क्षेत्रों के लिए चना प्रजनन कार्यक्रमों में किया जा सकता है।

९. एक हेक्टेयर भूमि में एक जलवायु-स्मार्ट एकीकृत कृषि प्रणाली (CISF) मॉडल विकसित किया गया है। इसके पहले वर्ष में, विभिन्न घटकों की खेती की कुल लागत रु १,६१,३१५; सकल आय रु १,९१,४९१ और लाभ लागत अनुपात १.१८ पाया गया।

१०. गन्ना उगाने वाले क्षेत्रों में निवारक उपायों को लक्षित करने के लिए पराली जलाने की घटनाओं के डेटाबेस का संकलन VIIRS NOAA-20 दैनिक उपग्रह के डेटा का उपयोग करके किया गया है।

११. पशुधन और कुक्कुट पालन के लिए थर्मल सेवेरिटी के स्थानिक मूल्यांकन के लिए एक स्प्रेडशीट मॉडल विकसित किया गया है।

१२. उस्मानाबादी, संगमनेरी, कोंकण कन्याल और बोअर नस्ल की बकरियां तनाव युक्त क्षेत्र सहनशील होने के साथ पालन के लिए उपयुक्त हो सकती हैं (जलवायु अनुरूप)।

१३. ऊर्ध्वाधर निर्मित आर्द्रभूमि प्रणालियों (सीडब्ल्यू) ने क्षैतिज सीडब्ल्यू की तुलना में अपेक्षाकृत अधिक धातु हटाने की क्षमता दिखाई है। धातु हटाने की क्षमता फिल्टर सामग्री के लिए बजरी + चारकोल (जीसीडब्ल्यू)> बजरी (जीडब्ल्यू)> बजरी + ईंट ब्लॉक (जीबीडब्ल्यू)> बजरी + कोको पीट (जीपीडब्ल्यू)> नियंत्रण (सीडब्ल्यू) उपचार के रूप में पाई गई है।

१४. हेलोटोलरेंट राइजोबियम के एक्सोमेटाबोलाइट्स के यूएचपीएलसी आधारित विश्लेषण से पुटीय यौगिकों की उपस्थिति का पता चला जैसे की जेंटिसिक एसिड, प्रोटोकैच्यूइक एसिड, गैलिक एसिड, गैलिक एसिड डेरिवेटिव, वैनिलिन और सिरिंगिक एसिड डेरिवेटिव एक्सोमेटाबोलाइट पूल के सक्रिय जैव रासायनिक घटकों के रूप में है।

१५. भारत में मौजूदा मछली पिंजरा संवर्धन स्थानों पर डेटाबेस संकलित करने के लिए भारत की एक ऑनलाइन पिंजरा संस्कृति निर्देशिका विकसित की गई है।

१६. हल्दी जीनोटाइप एलेप्पी सुप्रीम, उसके बाद राजेंद्र सोनिया, लैकडोंग, वेगांव, एनडीएच-९८, बीएसआर-२ और रोमा ने कम पोषक तत्व और उथली मिट्टी में अच्छा प्रदर्शन किया (प्रति पौधे शुष्क उपज के आधार पर)।

१७. मेथी की किस्में Afg-३, Co-२ और Rmt-३०५ नमी की कमी के प्रति सहनशील हैं और नमी की कमी के कारण उपज में अधिक कमी किए बिना उच्च उपज प्रदान करने में सक्षम हैं।

१८. महाराष्ट्र के रायगढ़ जिले के दिवेगर क्षेत्र के खारे आवासों से निकाले गए आइसोलेट ५२ ने कठोर खारा परिस्थितियों (३.५ % NaCl) के तहत उच्च साइडरोफोर उत्पादन क्षमता का प्रदर्शन किया और लवणीय परिस्थितियों में पौधों के विकास को बढ़ावा देने के लिए एक संभावित सूक्ष्म जीव होने की संभावना है।

१९. पंगासियानोडोन हाइपोफथाल्मस मछली को ०.२ मिलीग्राम प्रति किलोग्राम और ईपीए + डीएचए ०.४% पर एसई-एनपी का मिश्रण तथा ०.२% के मिश्रण से तापमान तनाव, जीवाणु संक्रमण और आर्सेनिक प्रदूषण को कम किया जा सकता है।

२०. सह-संबंध विश्लेषण के माध्यम से हाइपरस्पेक्ट्रल स्पेक्ट्रोस्कोपी अध्ययनों में दो बैंड सूचकांकों की पहचान के लिए एक मैटलैब ऐप "सर्वश्रेष्ठ प्रदर्शन करने वाले दो बैंड स्पेक्ट्रल इंडेक्स की ब्रूट फोर्स पहचान" वर्ज़न २.० विकसित किया गया है।

२१. पादप फीनोमिक्स सुविधा का उपयोग करते हुए प्रभावी जल उपयोग के लिए टमाटर के बेहतर रूटस्टॉक-सायन संयोजनों की पहचान करने के लिए प्रोटोकॉल विकसित किया गया है।

२२. सोयाबीन + मक्का अंतर - फसल के तहत सोयाबीन की फसलों में एकमात्र सोयाबीन और सोयाबीन + अरहर की तुलना में फूल आने के दौरान ठंडा कैनोपी का प्रदर्शन किया गया, जबकि फली भरने के दौरान सोयाबीन + अरहर की अंतर - फसल के तहत सोयाबीन के पौधों ने सबसे ठंडा कनोपी तापमान दिखाया है।

२३. न्यूनतम तापमान क्विनोआ के अंकुरण और विकास में एक मौलिक भूमिका निभाता है। दिसंबर के दूसरे पखवाड़े में बुवाई ने बेहतर रूपात्मक और उपज विशेषताओं (पौधे की आबादी, पानिकल की ऊंचाई और वजन, प्रति पौधे की संख्या, बीज और बायोमास उपज) को पाया गया है।

२४. पीबीआर जैसे विकिरणित चिटोसन और सी वीड एक्सट्रक के छिड़काव अनुप्रयोग से बैंगन फल की उपज और कटाई के बाद की गुणवत्ता में प्रभावी रूप से सुधार हो सकता है। इसे मध्यम और गंभीर पानी की कमी की स्थिति में पानी के तनाव को कम करने मे भी इनकी एक प्रमुख भूमिका पाई गई है।

२५. संस्थान द्वारा कार्यान्वित अनुसूचित जातियों के लिए विकास कार्य योजना (DAPSC) के अंतर्गत प्रौद्योगिकी प्रदर्शन और सामग्री वितरण के माध्यम से महाराष्ट्र के ८ तहसीलों के १६०० लाभार्थियों और २२ स्वयं सहायता समूहों (SHG) की मदद की। अनुसूचित जनजातियों के लिए विकास कार्य योजना (DAPST) में २८८ परिवारों को सहायता और प्रशिक्षण दिया गया।

1. INTRODUCTION

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. Moreover, the projected climate change is considered a far greater threat to humanity than COVID-19, because of its irreversible impacts. Many of the effects of these abiotic stresses like drought, heavy precipitation, extreme temperatures (both high and low) are likely to pose a severe threat to the food security of the growing population. Therefore, there is a need for 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. To address these concerns, the ICAR-National Institute of Abiotic Stress Management (ICAR-NIASM) was established on February 21, 2009 as one of the national institutes under Indian Council of Agricultural Research (ICAR). Over the years, the institute has been working diligently in areas of basic and strategic research for the management of abiotic stresses.

The present food security challenge has added dimensions due to the increasing population, with limited scope to overexploit natural resources and with no provision for indiscriminate human intervention into the agro-ecology, particularly when adverse effects of climate change are looming large due to unprecedented carbon load in the atmosphere. Despite the great potential to contribute to food production in the present form, the prevailing management practices need to be tuned to the current trend of weather and agro-ecologies, which are pretty different from the one that existed in the past same season or month. The much-needed resilience in agriculture can only be maintained and enhanced with continued research and extension efforts that are tailored to tackle the dynamic challenging situations arising mainly due to increasing climatic aberrations, shifting seasons and market price fluctuations of agriculture commodities. Considering the magnitude of the problem, ICAR-NIASM has been engaged in further strengthening its reoriented academic, research, and extension initiatives. This should lead to timely management solutions to the country's few anticipated abiotic stress scenarios. Even amidst the COVID-19 issues and challenges, several scientific discussions, stakeholder interactions, farmer awareness and training workshops were organized. The current Annual Report provides a glimpse of the research, teaching and extension work carried out during 2021.

Role of the Institute

The institute has a focus on stresses that are caused by excess or deficit of soil moisture, soil salinity, sodicity, acidity, water logging, declining water quality, heat stress, cold wave, floods, sea water inundation, etc.

through approaches involving conventional as well as novel techniques for crop improvement, resource management and policy development. The institute has implemented important research programmes in a thematic mode through four schools: Atmospheric Stress Management,

Water Stress Management, Soil Stress Management, and Policy Support Research. Furthermore, the institute has plans for strategic human resource development to manage abiotic stresses long-term by networking with national and international institutes. While focusing on abiotic stresses, the institute has been making efforts to complement the ongoing Research and Development under the National Agricultural Research and Education System (NARES). The institute also aims to generate intermediate products for tolerance to multiple stresses such as gene constructs and stress-induced promoters, which other institutes will use to get end products of the crop, livestock, fisheries, etc.

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

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.

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.

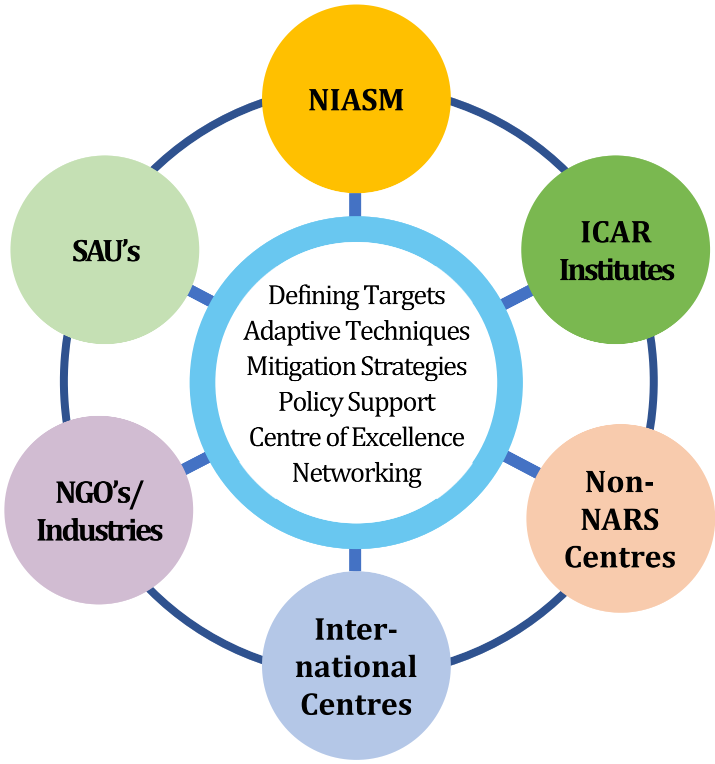


Fig. 1.1. Institute's strategy for achieving the mandate.

Status of the Institute

In the XI 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 newly constructed 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. Presently, the scientific, technical and administrative staff strength is 30, 10 and 4, respectively. Thus, the filled-up cadre strength is 44 against 116 sanctioned posts (Table 1.1). The institute has initiated research through four schools with a multidisciplinary approach (Figure 1.2).

Table 1.1. Cadre strength of the Institute as on December 31, 2021.

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	29	21
Technical	33	10	23
Administrative	32	04	28
Grand Total	116	44	72

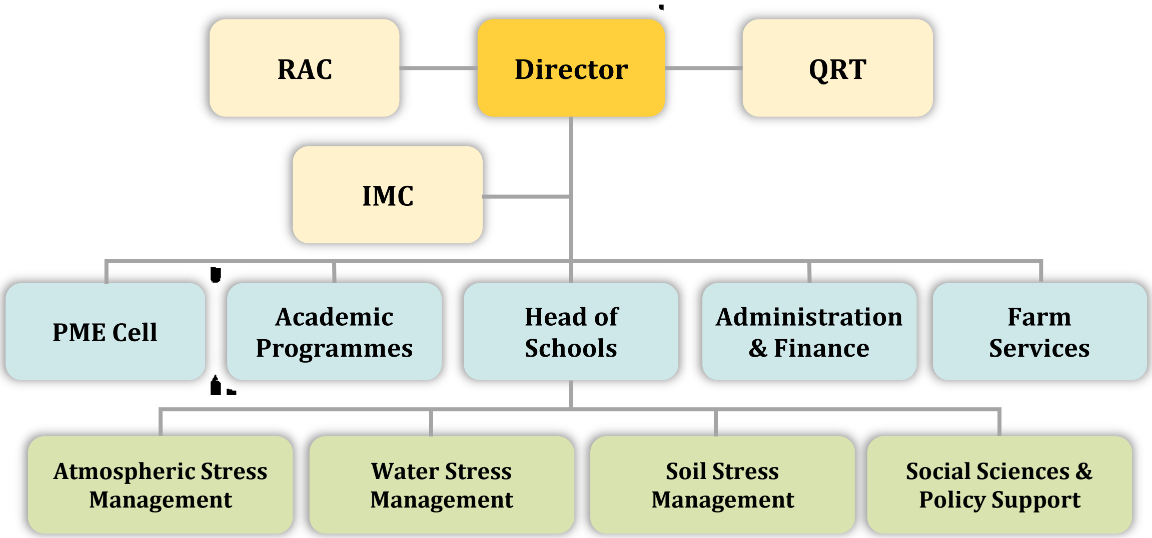


Figure 1.2. Organogram of the Institute.

Objectives of the Schools

School of Atmospheric Stress Management

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

School of 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.

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.

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.

2. WEATHER AT ICAR-NIASM

Weather information is of paramount importance for abiotic stress studies and agriculture in general. Observations of weather parameters are being recorded at institute regularly from January to December 2021, which are described below.

Temperature

The Long Period Average (LPA) of the annual mean temperature of Baramati is 26.3 °C. Figure 2.1 depicts the monthly mean temperature recorded at ICAR-NIASM. The recorded annual mean temperature was 25.6 °C; monthly mean temperatures ranged from 21.5°C (December) to 29.4°C (May). A linear increase in monthly mean temperature was observed from February to May, followed by a reduction during June to September due to monsoon wind's cooling effect, finally, with 21.5°C in December. The monthly maximum temperature was at peak in April (37.5°C) and dipped to 28.2°C in December. May recorded the maximum (22.7°C), and February recorded the minimum (14.0°C) values (Fig. 2.1 and Table 2.1).

Relative humidity

Relative humidity measured at standard hours (0700 LMT) and (1400 LMT) throughout the year was used to compute monthly statistics. The monthly mean relative humidity during different months is depicted in Figure 1. In the morning, relative humidity varied between 63% (March) and 92% (December). Variation in afternoon relative humidity was between 19 % (April) to 68 % (July). The mean morning and afternoon relative humidity was found to decrease from January to April, due to increasing temperature. It reached the highest value during monsoon months and rose again in December due to post-monsoon rains in winter. Annual mean relative humidity averaged over the entire year stood at 63% and ranged between 41-79%. Higher diurnal ranges (more than 45%) in RH were observed in January, February and April. The lowest diurnal range was observed in July (21%) and August (24%) (Fig. 2.2 and Table 2.1).

Rainfall

Long Period Average (LPA) annual total rainfall of Baramati is 576 mm, with an average of 34 rainy days per year. This year, Baramati received about 91% of its average annual rainfall, distributed among 44 meteorological rainy days, which yielded 523 mm of total rainfall. The monthly cumulative rainfall during different months recorded at ICAR-NIASM, Baramati has been given in Figure 2.2. The maximum rainfall was received in October (114.6 mm) during the monsoon season, followed by September, June, and July (Table1). In the monsoon season, there were 31 rainy days with total rainfall of 297 mm, which is 74% of the region's normal rainfall during the monsoon season. The late withdrawal of monsoon resulted in incessant rains during October. In the post-monsoon season, the highest rainfall occurred in October (114.6 mm), and during the summer season, 16 mm of rainfall was received (Fig. 2.2 and Table 2.1).

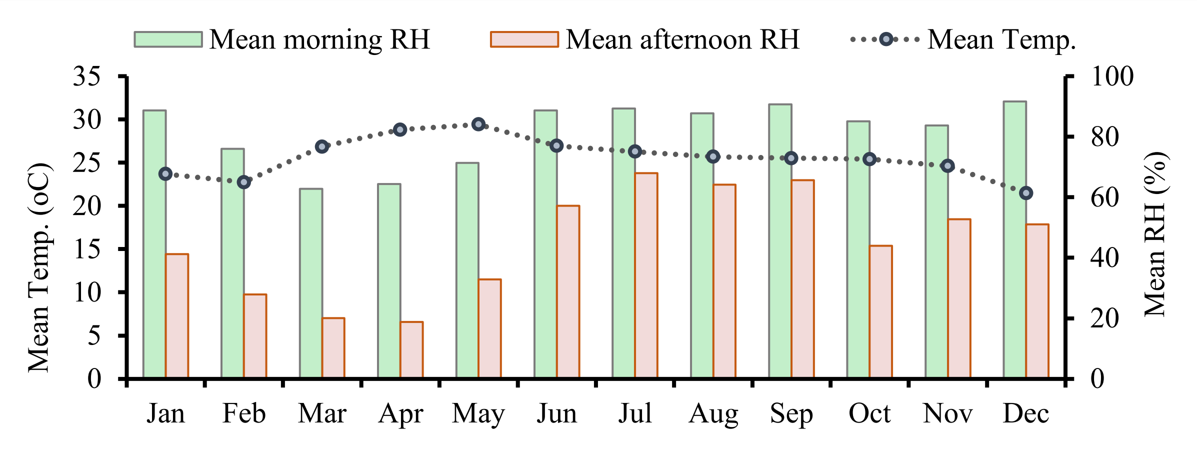


Fig. 2.1. Variations of monthly mean temperature, mean morning and afternoon relative humidity during 2021 at ICAR-NIASM Baramati.

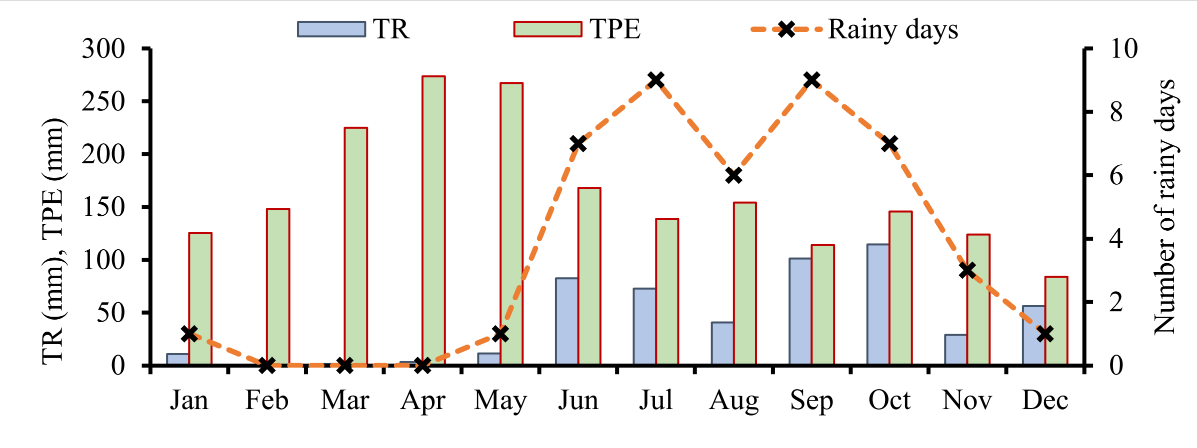


Fig. 2.2. Variations of monthly total rainfall (TR), total pan evaporation (TPE) and number of rainy days during 2021 at ICAR-NIASM Baramati.

Wind speed, Pan Evaporation and Sunshine duration

Monthly averages wind speed, pan evaporation and bright sunshine hours recorded during 2021 are depicted in Fig. 2.3.

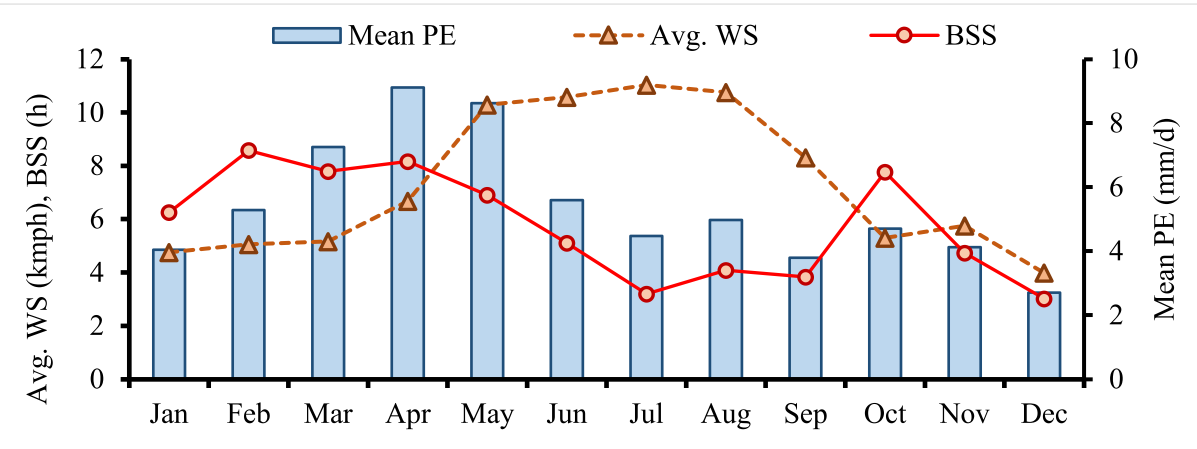


Fig. 2.3. Variations of monthly mean pan evaporation (PE), average wind speed (WS) and mean bright sunshine hours (BSS) during 2021 at ICAR-NIASM Baramati.

Monthly average wind speed varied from 4.0 (December) to 11.0 kmph (July), and the annual average daily wind speed was 7.3 kmph. Wind velocity was higher during May-August (>10.0 kmph) compared to the rest of the months (Table 2.1). Annual total open pan evaporation (TPE) aggregated to 1967 mm, around four times the total rainfall this year. The evaporative demand gradually increased from January and achieved its highest value in April (9.1 mm/d). It declined after that to 5.6 mm/d in June, and from July to December, average daily pan evaporation varied between 2.7 to 5.0 mm/d. The lowest evaporation rate was recorded in December (2.7 mm/d). The annual average of daily PE was 5.3 mm. During the year, the daily average of bright sunshine duration remained 5.8 hrs and monthly average values have been found to vary between 3.0 hrs (December) and 8.6 hrs (February).

Table 2.1. Mean monthly weather parameters recorded in 2021.

Parameter	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmax (°C)	30.7	31.4	36.0	37.5	36.2	31.9	30.5	30.1	30.1	31.9	30.4	28.2
Tmin (°C)	16.7	14.0	17.7	20.2	22.7	22.0	22.0	21.2	21.0	18.9	18.8	14.8
RH I (%)	89	76	63	64	71	89	89	88	91	85	84	92
RH II (%)	41	28	20	19	33	57	68	64	66	44	53	51
Avg. WS (kmph)	4.8	5.1	5.2	6.7	10.3	10.6	11.0	10.8	8.3	5.3	5.8	4.0
BSS (h)	6.3	8.6	7.8	8.2	6.9	5.1	3.2	4.1	3.8	7.8	4.7	3.0
Total rain (mm)	10.6	0.0	1.4	3.2	11.4	82.4	72.8	40.6	101	115	28.8	56.0
Total rainy days	1	0	0	0	1	7	9	6	9	7	3	1
Mean PE (mm/d)	4.0	5.3	7.3	9.1	8.6	5.6	4.5	5.0	3.8	4.7	4.1	2.7

Extreme weather observation recorded in 2021

The warmest and coldest days in the entire year were obtained based on daily mean temperature data, and it was found that 11th and 12th May (31.6°C) and February 9 (19.0°C), were the warmest and coldest days respectively (Table 2). Daily maximum temperature reached up to 39.9°C (May 12), while lowest daily minimum temperature dipped to 8.8 °C (February 9). The warmest and coldest months were calculated based on monthly mean maximum and minimum temperatures, respectively. May (29.4°C) was the warmest and December (21.5°C) was the coldest month during this year (Table 2). The cumulative monthly rainfall was highest in October (114.6 mm). The highest rainfall, pan evaporation and wind speed events were reported on December 2 (49.8 mm), April 2 (13.6 mm/d) and May 16 (20 kmph), respectively.

Table 2.2. Important meteorological events of the year 2021.

Particular of weather parameter	Value	Date
Highest daily mean temperature	31.6 °C	11 & 12 May 2021
Lowest daily mean temperature	19.0 °C	February 9 2021
Highest daily maximum temperature	39.9 °C	May 12 2021
Lowest daily minimum temperature	8.8 °C	February 9 2021
Highest monthly mean temperature	29.4 °C	May 2021
Lowest monthly mean temperature	21.5 °C	December 2021
Highest daily rainfall	49.8 mm	December 2 2021
Highest monthly cumulative rainfall	114.6 mm	October 2021
Highest monthly cumulative PE	273.5 mm	April 2021
Highest rate of daily PE	13.6 mm	April 2 2021
Highest daily wind speed	20.0 kmph	May 16 2021

3.1 Research Programme 1:

Atmospheric Stress Management

The weather aberrations caused primarily due to atmospheric changes has direct impact on production and productivity of crops, livestock and fisheries and also indirectly due to associated population dynamics of biotic factors such as pest and diseases. The research programme on atmospheric stress management has therefore focused its research activities broadly on understanding the effects of atmospheric stress and developing assessment and management strategies in crops, livestock and fisheries using geo-spatial mapping approaches, basic and strategic investigations in areas focusing thermal and salinity stress. This included the compilation of geo-spatial datasets and development of tools pertinent to mapping of abiotic stresses, thermal severity assessment in livestock, investigating thermos-tolerance in goats, studies on salinity environment in fish and exploring insects as novel protein source. The major research findings emerging out and the progress made under this programme during the past one year is summarized below.

Compilation/creation of databases and geospatial mapping of multiple components

The raw datasets of multiple parameters pertinent to Abiotic stress information system viz. delineating boundaries, Land and water use, Socio-economic census, Meteorological parameters, Soil chemical properties and breeding tracts of livestock were sourced from several open access sources and compiled into databases to create respective geospatial layers and maps.

Delineating boundary layers: Several of the geographical delineating boundaries namely, administrative boundaries (village, tehsil/block, district and state boundaries); Agro-climatic zones; Agro-ecological zones; Agro-sub ecological zones; Meteorological Sub Divisions; Basins and Waste lands were collected from different sources, digitized and converted to GIS layers and subsequently maps (Fig. 1.1 a-h).

Land use and land cover: The land use and land cover raster maps for the base year 2005 and 2010 are sourced from GOI sites and to create waste lands map (Fig. 1.1 i).

Inland water bodies: The NDWI derived from multi-temporal sentinel 2A images were used to delineate and aggregate water pixels into water bodies' boundaries vector shapes. The union of generated polygons and point coordinates of reservoirs was used to generate boundary layer of water reservoirs at country level (Fig. 1.1 j).

Meteorological parameters: The gridded dataset Rainfall, Minimum and Maximum temperature datasets of IMD from 1901-2020 at 0.5°x 0.5° and 0.25°x 0.25° resolution were extracted and pre-processed using custom built python libraries. These datasets were used to generate geospatial layers of tehsil/block level layers of minimum, maximum, average temperature and rainfall.

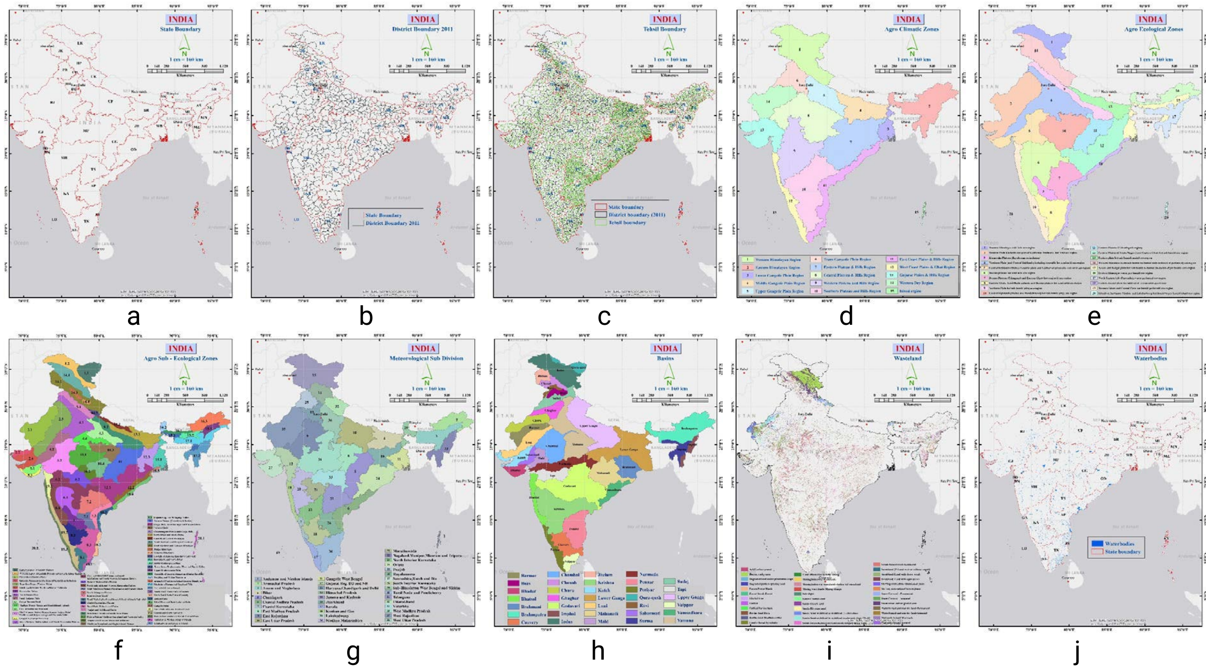


Fig. 1.1: Maps of delineating boundary layers

Soil chemical properties: The village level datasets on high, medium and low levels of soil chemical properties viz. soil organic C; pH; electrical conductivity; and available N, P, K, S, Zn, Fe, Cu, Mn and B were sourced from the Soil Health Card (SHC) programme of the Govt. of India. These datasets were extracted and pre-processed using custom built python codes to prepare database and subsequently maps of respective soil properties (Fig. 1.2).

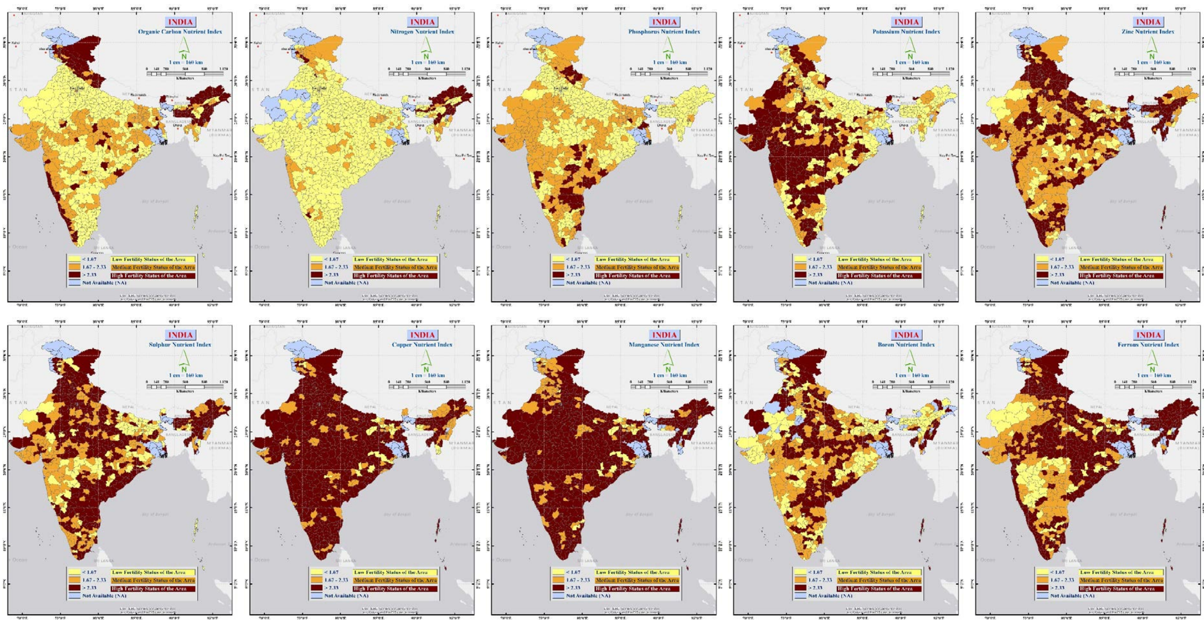


Fig. 1.2: District-wise soil chemical properties of India

Livestock population: The livestock population data was sourced from the 20th livestock census of India and pre-processed to prepare village level geospatial layers of cattle, buffalo, sheep, goat and pig population. These datasets were used to prepare the abiotic stress maps for livestock.

Breeding tracts of livestock: The breeding tracts for cattle buffalo, goat, sheep and poultry were sourced for 752 indigenous species. The dataset was cross checked for anomalies and used to prepare maps of breeding tracts of respective livestock type (Fig.1.3).

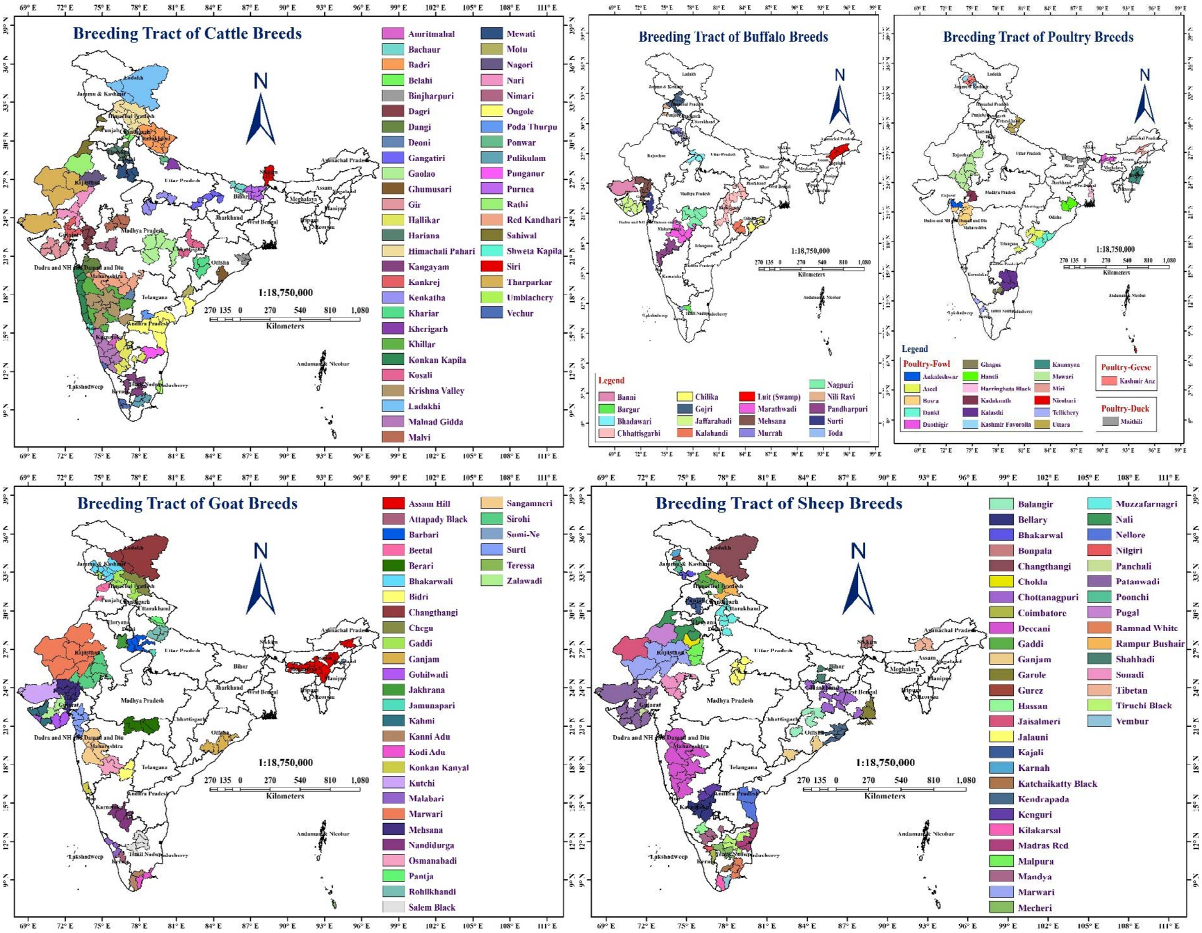


Fig. 1.3: Breeding tracts of Livestock of India

These datasets and maps will be used to prepare the climate analogues of the indigenous species across India to alternatively suggest the possibility of adoption in the abiotically stressed and non-stressed These geospatial layers were used to create the geospatial maps for depiction and interpretation purpose under Abiotic Stress Information System (ASIS) framework. All the compiled datasets will further be 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.

Soil Nutrient and Soil Fertility Index maps of Haryana State

With increasing land-use pressure, intensifying abiotic stresses and plateauing yields, soil fertility assessment is in growing demand. A standard set of procedures to assign a soil fertility index (SFI) would be beneficial for assessing and managing soil health for sustainable crop production. In this study, a framework was developed to determine a SFI using the data on soil organic C; pH; electrical conductivity; and available N, P, K, S, Zn, Fe, Cu, Mn and B. The georeferenced datasets of soil parameters were collected from soil health card (SHC) programme of the Govt. of India for the state of Haryana as model state (84 lakh soil samples across years 2015-2019) and screened for duplicates and out of range values for each individual parameter. The screened dataset was interpolated using inverse distance weighting (IDW) technique to generate geospatial Soil nutrient maps. for each soil parameter (Fig 1.4). The resulting maps were integrated into a weighted sum SFI (Fig 1.4 SFI). The SFI obtained using the method described herein was able to synthesize the complex information contained in large multivariate data-sets, and therefore would be useful for application at regional and also at national scales.

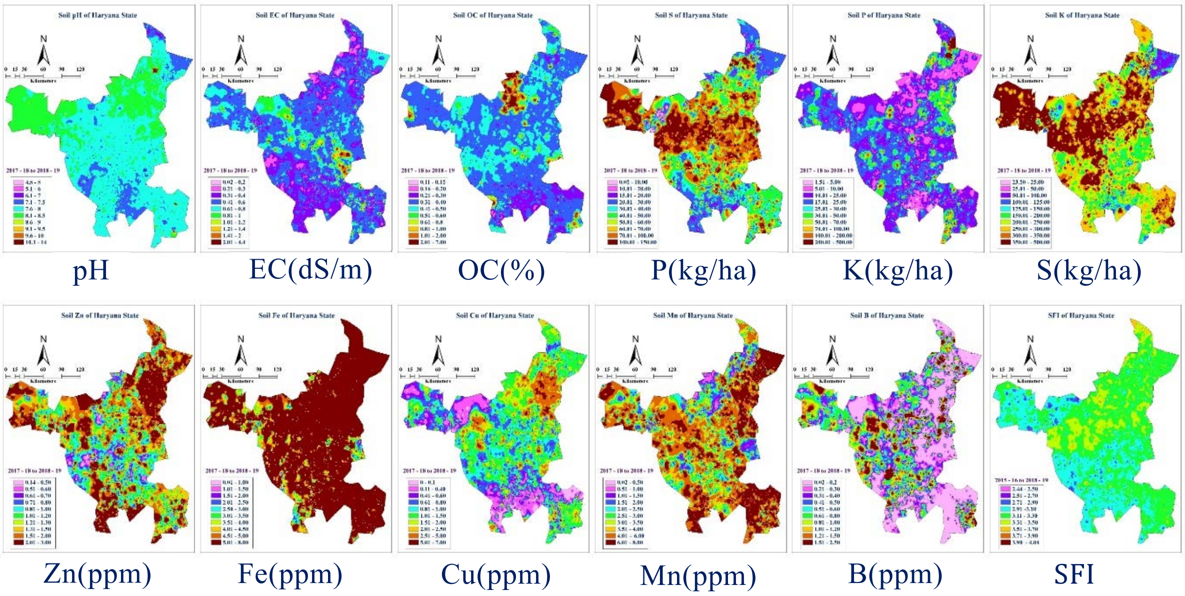


Fig. 1.4: Soil Nutrient and Soil Fertility Index maps for Haryana State

Estimation of GHG emissions and fodder demand-supply for Livestock:

Various factors like human population, livestock population, livestock density, fodder demand, fodder supply, milk production and GHG emissions were considered for the livestock component. To arrive at the final values for each factor, calculation was done as per the protocol described for each of them from different sources. The entire flowchart describing the methodology for each factor was generated (Fig. 1.5). The final data derived for each factor were integrated into the GIS environment and maps were generated for each state at the district level. The district level GHG emission from livestock through enteric fermentation for India is depicted in Fig. 1.6.

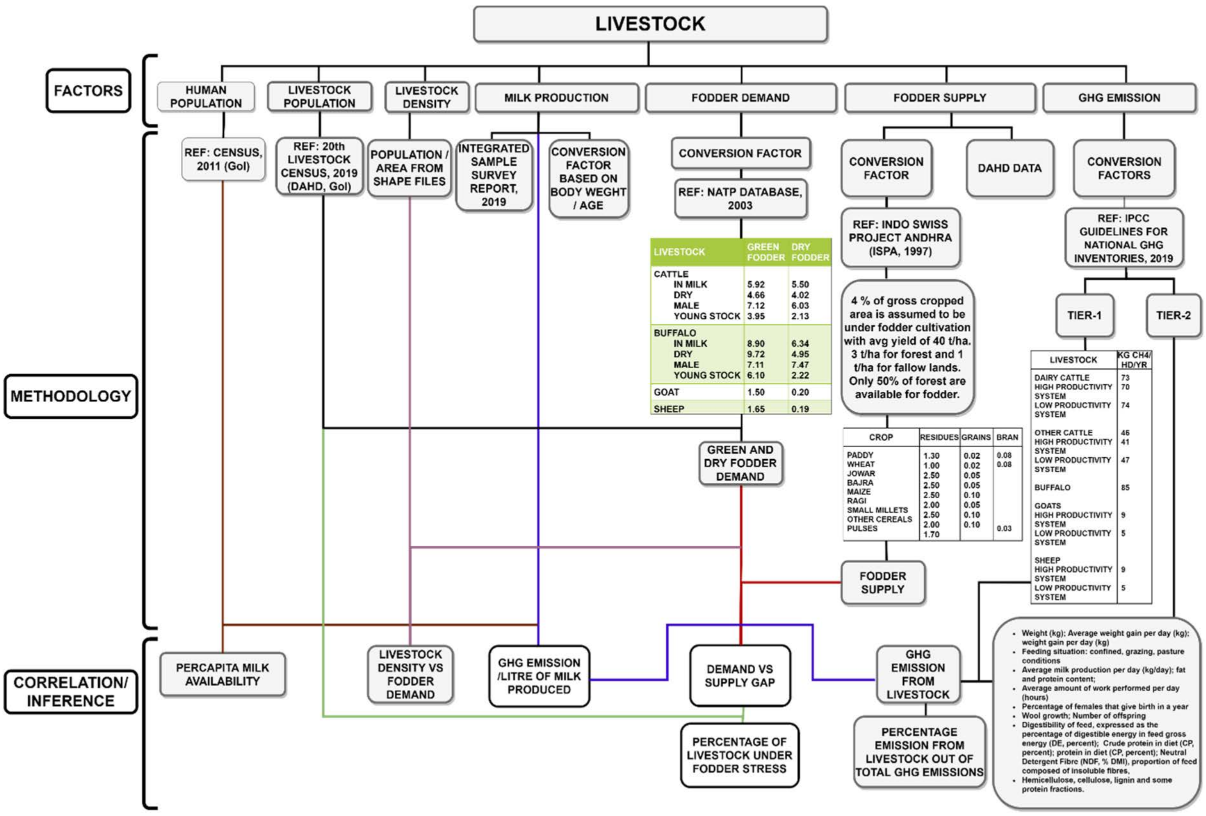


Fig. 1.5: Methodology flowchart for various abiotic factors

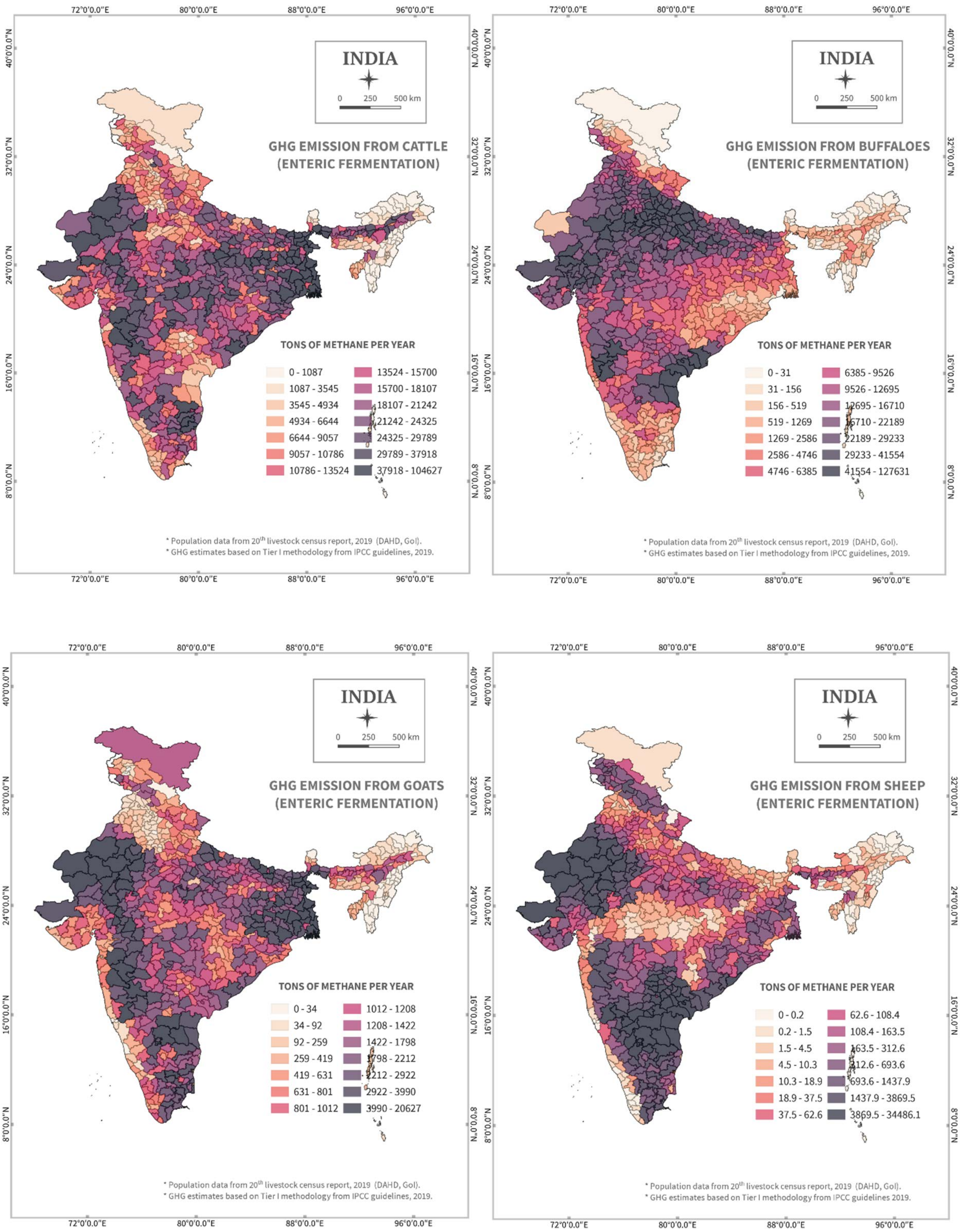


Fig. 1.6: GHG emission from livestock

This data will be subjected to further interpretation and inference for each factor and the inter-relation between the factors will be arrived at.

Thermal stress severity assessment tool for livestock

A spreadsheet model for spatial assessment of thermal severity for livestock and poultry was developed in Microsoft excel. The thermal severity is assessed on the basis of Thermal Humidity Index (THI). The threshold limits of the THI for classification of thermal

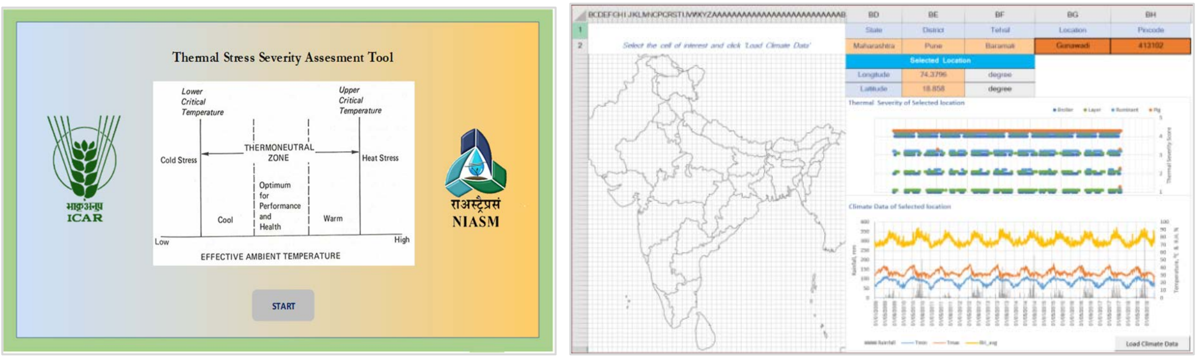


Fig. 1.7: Screenshots of the worksheets of Thermal stress severity assesment tool for livestock

stress into low medium and high categories have been adjudged on the basis of published literature. The geo-location can be selected using either PIN code, name of village or the geo-coordinates of the place to generate the thermal severity of the place based on past decadal meteorological parameters. The anticipated thermal severity for livestock at the selected geo-location is also generated based on the forecasted five-day meteorological parameters sourced form openweather.org. This tool is under further development for generating suggestions on management options suitable to adopt to the anticipated thermal severity for livestock.

Management Adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability.

An experiment was initiated in four breeds of goat viz. Osmanabadi, Sangamneri, Konkan kanyal and Boer to assess comparative performance of these breeds exposed to various climate stressors particularly heat stress during various seasons of year. The monthly average temperature and humidity data and various daily weather parameters such as temperature (max/min), Humidity (max/min) and rainfall during the experimental period were collected from Agromet facility of the Institute. The thermo-neutral zone for goats is between 14 and 24^{0}C.

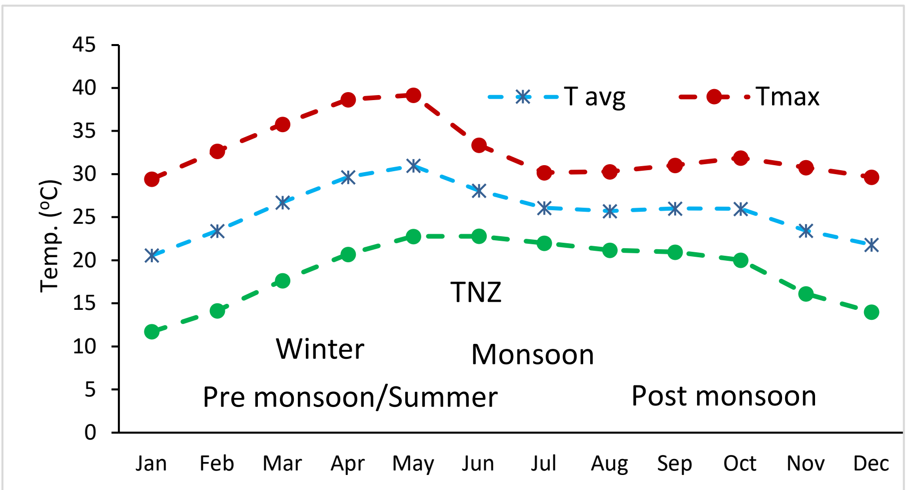


Fig. 1.8: The monthly mean (35 years) maximum (Tmax), minimum (Tmin) and average (Tavg) temperature of study area along with thermo-neutral zone for goats.

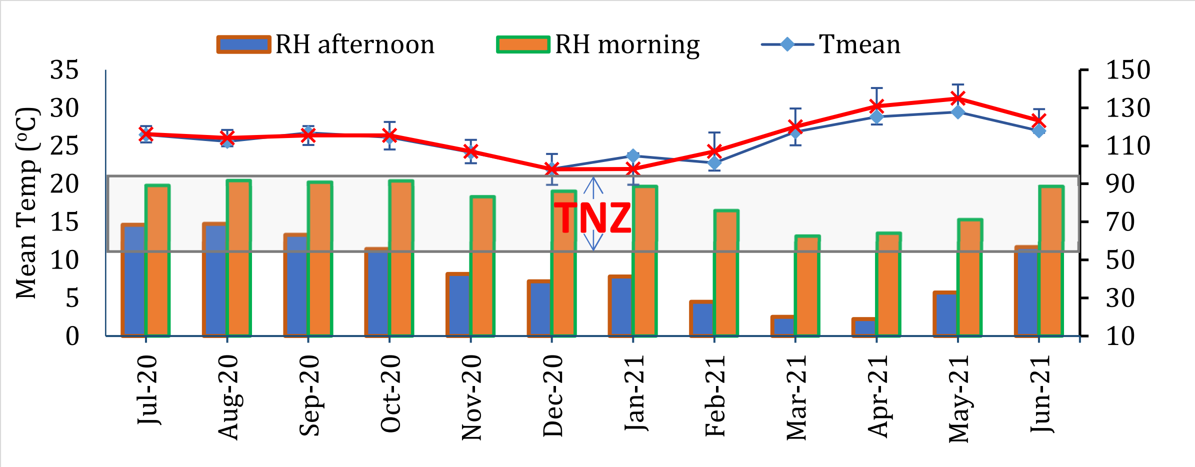


Fig. 1.9: The mean ± standard error monthly average temperature and average monthly temperature during the study period.

Comparative status of growth was assessed by recording weekly body weights of kids of different breeds. Hemato-biochemical and physiological parameters were recorded monthly, in all four goat breeds during July 2020 to till date. The data for kids born in all the groups was also recorded. All the animals were observed regularly for any parasitic infestations. The preliminary assessment of various parameters revealed following facts which need further validation with more number of observations. The monthly average maximum temperature prevailing in the area is higher than thermos-neutral zone of goats during all the months.

The monthly average mean temperature was higher than TNZ during all the months except December and January months. This indicated exposure of goats under experiment to variable degree of 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.

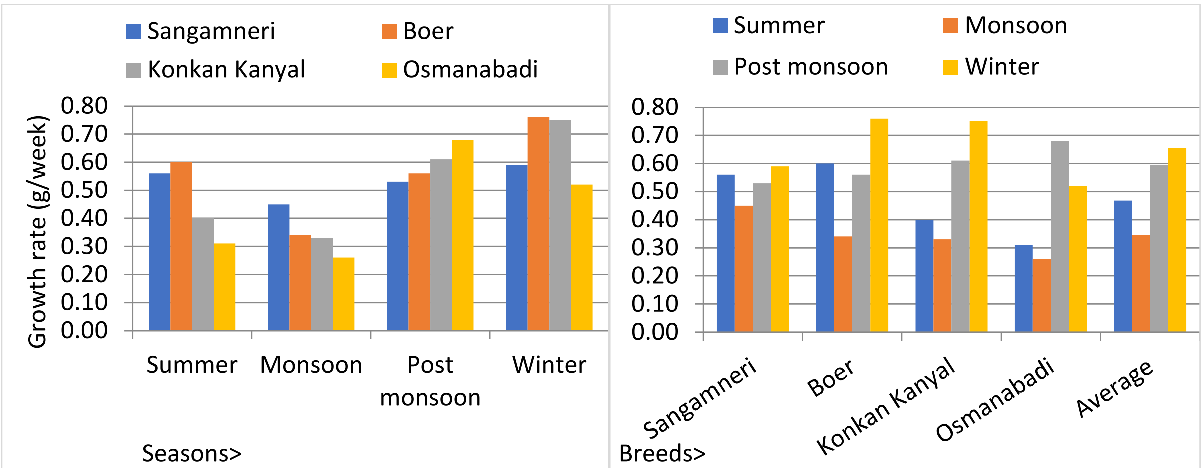


Fig. 1.10: Growth rate (g/week) in different breeds of goats

The overall growth rate, kidding rate was higher for Boer goats. In all the 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 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. However further studies with more number of animals are required for validation of these preliminary observations. In order to study prevalence and pattern of occurrence of anaemia along with its etio-pathology, survey of goat farmers has been planned. A detailed proforma for farmer's profile and goat husbandry practices is prepared. Survey was conducted from Undvadi (Supe) village.

IoT-based system for monitoring abiotic stress in livestock.

A study to develop IoT based monitoring system for abiotic stress in livestock was initiated. Post preliminary survey of literature, procurement of micro-controller and sensor components and its programming was carried out using compatible Arduino libraries. Verification for proper integration of body temperature sensor with the micro-controller unit is being carried out (Fig. 1.11).

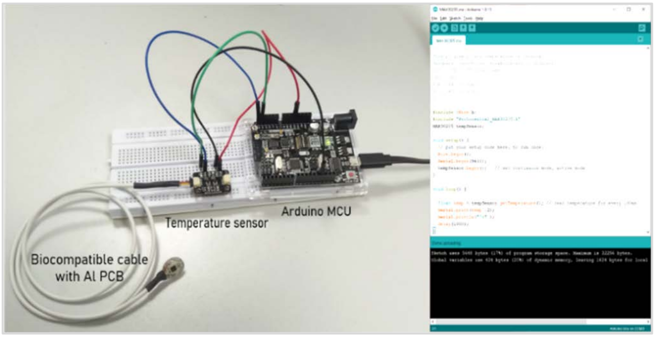


Fig. 1.11: Breadboard testing of IoT system

Response of GIFT Tilapia fish to different salinity stress (inland saline water) exposed to acute and chronic salinity

The study was conducted to assess the effect of salinity stress on growth and hematological composition of GIFT Tilapia strain, Oreochromis niloticus. The effects of 96 h exposure to different salinity levels (0, 11, 6, 9 ppt) were adjudged using LC_{50} values. Based on these LC_{50} three different sub lethal salinities, viz. 0, 5 and 10 ppt were identified to study the long-term effects of salinity stress on O. niloticus for a period of 60 days. The experiments were conducted using Completely Randomized Design with 3 Treatments (T0-0 ppt, T1-5 ppt, T1-10 ppt) and 4 replications (6 fishes in each replication). Inland saline water (18 ppt) brought from nearby farmers field was used to prepare salinity treatments of the experiment and the fingerling O. niloticus (8.93± 0.59 g) were used. Fish were fed with 32 % crude protein (CP) diet upto satiety level on daily basis. Water quality parameters were measured at every 15 days interval. No mortality occurred in any treatment reveling survival tolerance of GIFT tilapia in inland saline water upto 10 ppt salinity. No significant difference was observed at $P>0.05$ in daily weight gain and daily growth index among the fishes exposed to different salinity stress (Table 1.1). Highest value of weight gain (8.7475± 0.94 g), daily weight gain (0.15 ± 0.02 g), and Daily Growth Index (0.93 ± 0.08) were noted in T0 (0 ppt) while lowest values were noted in T2 (10 ppt). However, the total weight gain, specific growth rate and protein efficiency ratio significantly decreased with increased salinity at 5 ppt level.

Table1.1: Effect of different salinity stress level concentration on growth response of *O. niloticus*.

Parameters	T0 (0 ppt)	T1(5 ppt)	T2 (10 ppt)
Total Weight Gain (g)	8.75± 0.94 ^{a}	6.52 ± 0.92 ^{b}	6.03 ± 1.20 ^{b}
Survival %	100 ± 0.00 ^{a}	100 ± 0.00 ^{a}	100 ± 0.00 ^{a}
Daily Weight Gain	0.15 ± 0.02 ^{a}	0.11 ± 0.02 ^{a}	0.10 ± 0.02 ^{a}
Specific Growth Rate %	1.33 ± 0.05 ^{a}	0.83 ± 0.14 ^{b}	0.82 ± 0.13 ^{b}
Protein Efficiency Ratio	0.82 ± 0.05 ^{a}	0.44 ± 0.10 ^{b}	0.43 ± 0.09 ^{b}
Daily Growth Index	0.93 ± 0.08 ^{a}	0.66 ± 0.11 ^{a}	0.63 ± 0.11 ^{a}

The values are expressed as mean ± Standard Error (± SE). The values in a row with different superscript vary significantly ($p < 0.05$).

Table 1.2: Effect of different water salinity (ppt) concentration on hematological profile of *O. niloticus*.

Parameters	T_0 (Control) n=06	T_1(5 ppt) n=06	T_2 (10 ppt) n=06
WBC (10^3/uL)	174.68 ± 0.37 ^{a}	54.95 ± 21.14 ^{b}	72.33 ± 16.70 ^{b}
RBC (10^6/uL)	1.61 ± 0.001^a	1.03 ± 0.19 ^{b}	0.97 ± 0.18 ^{b}
HGB (g/dL)	11.37 ± 0.03 ^{a}	7.12 ± 1.27 ^{b}	7.53 ± 0.81 ^{b}
HCT (%)	24.15 ± 0.06 ^{a}	15.17 ± 3.10 ^{b}	15.08 ± 2.63 ^{b}
MCV (fL)	150.52 ± 0.09 ^{a}	189.89 ± 25.12 ^{a}	166.14 ± 3.43 ^{a}
MCH (pg)	70.18 ± 0.05 ^{a}	57.43 ± 11.56 ^{a}	86.38 ± 11.16 ^{a}
MCHC (g/dL)	46.63 ± 0.09 ^{a}	38.27 ± 7.67 ^{a}	55.07 ± 6.95 ^{a}
RDW (%)	18.13 ± 0.05 ^{a}	9.92 ± 2.32 ^{a}	25.83 ± 7.41 ^{a}
PLT (10^3/uL)	25.00 ± 0.06 ^{a}	54.17 ± 22.88 ^{a}	93.67 ± 30.53 ^{a}
MPV (fL)	6.63 ± 0.13 ^{a}	6.12 ± 0.38 ^{a}	6.63 ± 0 .25 ^{a}
PDW	21.2 ± 0.07 ^{a}	19.7 ± 0.62 ^{b}	20.58 ± 0.21^{ab}
PCT (%)	0.02 ± 0.00 ^{a}	0.03 ± 0.02 ^{a}	0.06 ± 0.02 ^{a}

The values are expressed as mean ± Standard Error (± SE). The values in a row with different superscript vary significantly ($p < 0.05$).

Further, in order to determine effect of salinity on hematological alteration, the WBC (White blood cells), RBCs (Red blood cells), HGB (Haemoglobin), HCT (Haematocrit), MCV (Mean Corpuscular Volume), MCH (Mean Corpuscular Haemoglobin) and MCHC (Mean Corpuscular Haemoglobin Concentration), RDW (Red Blood Cells Distribution Width), MPV (Mean Platelet Volume), PDW (Platelet Volume Distribution Width) and PCT (Platelet Crit) were analysed by using Blood cell automated analyser. Significant reduction in WBC, RBC, HGB and HCT counts were observed at 5 and 10 ppt salinity compared to control treatment (Table 1.2). However, MCV, MCH, MCHC, RDW, PLT, MPV, PDW and PCT did not significant alter with salinity levels. The results obtained in the study indicated that, salinity above 5 ppt significantly ($p > 0.05$) affects the growth, physiological and haematological responses of O. niloticus at juvenile stage.

Identification of farm ponds and storage water tanks using satellite imagery for targeting farm pond-based aquaculture in rainfed areas of Maharashtra

Limited irrigation is one of the important and critical constraints in agriculture as only 35% of the net sown area in India is under complete irrigation. To overcome irrigation problems as well as to boost the agriculture production, significant efforts were initiated by Government of Maharashtra through schemes popularly known as "Magel Tyala Shet Tale" (Farm pond on Demand) and Jalyukt Shivar (JYS). These farm ponds have scope for aquaculture without affecting the water level in farm pond. 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 has been worked out. The sentinel 2A bands (B3 and B8) were used 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 (Fig. 1.12). These databases are further subjected to deep learning models for identification and localization of farm ponds in image. This methodology will generate the database of farm ponds suited to farm pond aquaculture model in rainfed areas of Maharashtra.

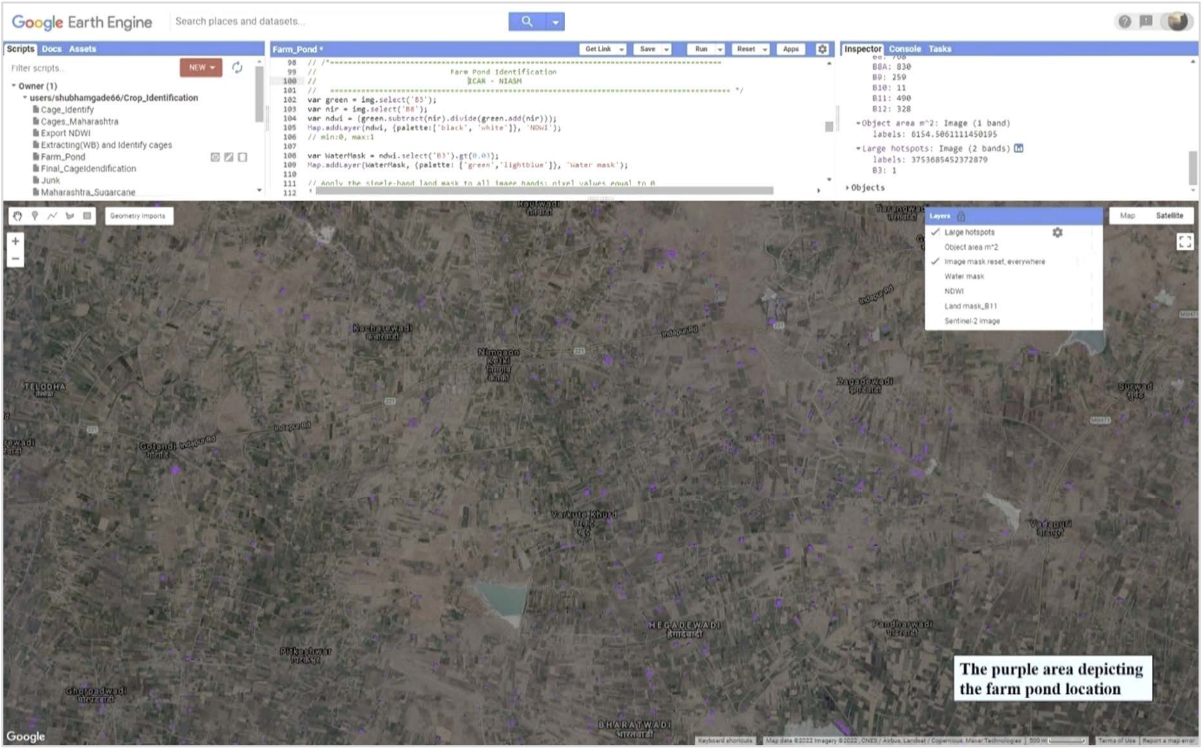


Fig.1.12: Screenshots of the Identified farm ponds and storage water tanks on GEE platform

Software for automating extraction of geo-server tiles using geojson files

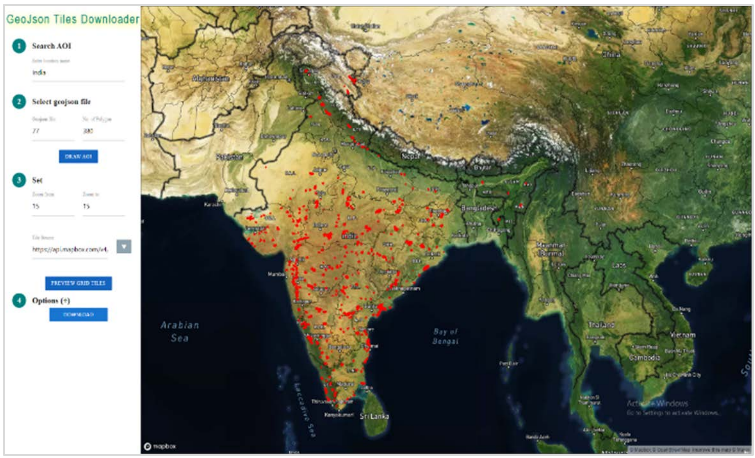


Fig.1.13: Screenshot of the developed software

High resolution satellite imagery is accessible from several of the free geo-servers in form of vector and raster tiles using web browsers. These tiles contain the visual information about the feature of interest and therefore can be subjected to image processing pipelines for generati--ng feature polygons of interest. The dynamic nature of features of interest in agriculture and allied domain require quick spatial and temporal acquisition of the satellite imagery at different spatial resolutions, in order to develop classification or semantic segmentation deep learning models. These models help generate database of the features of interest for consumption in GIS projects like the Abiotic Stress Information System (ASIS) being developed at ICAR-NIASM. However, the downloading and nomenclature of the geo-server tiles is complicated due to web browser bindings on client side and limiting measures imposed on server side. Considering the requirement of geo-server tiles in generating the database needed for GIS projects like ASIS, a software "Geojson Tiles Downloader" was developed to simplify and automate the task of downloading the geo-server tiles within the defined geojson boundary file at predefined zoom level and directory structure. The developed software is forked and modified independently from the open-source projects written in Python, Javascript, CSS and Html. The software requires python 3x and a web browser for its execution.

App for identification of best performing two-band spectral indices

A Matlab app "Brute force identification of best performing two band spectral Indices" v 2.0 has been developed for identification of two band indices in hyperspectral spectroscopy studies through co-relation analysis. The algorithm used has been optimized for recursive calculations, memory allocation and display of two band indices for all combinations of spectral values in user defined range and input parameters using Ratio (RI), Normalized difference (NDI) and pre-defined Transformations (TI). The co-relations between all two band indices (RI, NDI, TI) and Y- parameter values are calculated and compared to find the Maximum R^2 obtained. The app needs installation in Matlab environment as an addon for its use. The steps involved depicted in Fig. 1.14 are:

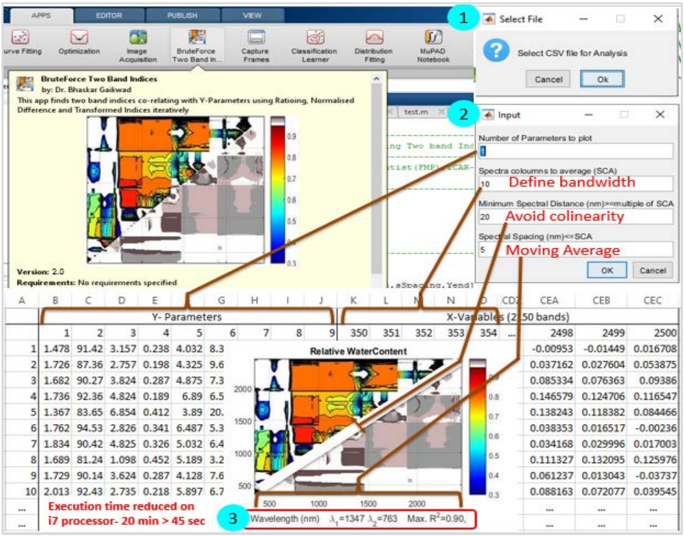


Fig. 1.14: Screenshots of the developed app

Step 1: Select CSV file organized as per defined template of spectra and Y-Parameters;

Step 2: Specify the configuration viz. number of Y parameters to plot, specifying bandwidth for analysis in terms of number of spectra columns to average (SCA), specifying minimum spectral distance as multiple of SCA to avoid collinearity, and specifying spectral spacing (n<=SCA) to perform collinearity calculations only for every n^{th} moving average values.

Step 3: Calculate and display the R^2 contour plot for selection of potential spectral bands in the upper diagonal area and the respective calculation method used (RI/NDI/TI) in the lower diagonal area of the plot.

Establishment of Black Soldier Fly Mass Production Unit

In the recent years, insects have received wide attention as a potential source of protein both for humans and livestock. Insects have high reproductive rate and can be cultured easily, have high feed conversion efficiency and can be reared on bio-wastes. Aquaculture Industry in India is rapidly growing with a target of annual fish production to 15 million tonnes by the year 2020. There is a increase in feed cost ranging from 40-70% has made aquaculture feed a very costly input in fish production system. Insect species can be a source of high protein when replaced fully or partially with the fish meal. The insects have high nutritive quality, are easy to reproduce and culture with higher biomass producers. Black Soldier Fly (BSF), *Hermetia illucens* (Linnaeus, 1758) is an insect belonging to the order of Diptera, family of Stratiomyidae. BSF is a harmless insect with a potential to solve two of modern agriculture's growing problems namely, serve as an alternative protein source for animal feeds

Fig. 1.15: Set-up of Black Soldier Fly Production Unit

(Poultry and Fish) and helpful in converting organic wastes into a fortified, complete manure for agriculture. BSF is a rich source of protein (32-56%), Chitin (8%), Lipids (38%), Crude fibre (20.7%), Ash (9.8%).

Establishment of Butterfly Garden at ICAR-NIASM, Baramati

One of the most beautiful & colourful insects easily observed are the butterflies. Observing butterflies is creatively engaging and enjoyable activity for children and could be a stress buster for adults as well. Butterfly is one of the indicator species indicating health of our surroundings and plays a vital role in food chain & ecosystem. Approximately 1500 species of butterflies are found in India of which about 230 species have been recorded in Maharashtra.Their dwindling numbers on account of rapid loss of their habitat, necessitates an attempt to create awareness for their conservation and therefore a butterfly garden was established at ICAR-NIASM.

The host and nectar plants as listed below were grown in the butterfly garden to allow multiplication and foraging.

Host Plants- Kadipatta (*Murraya koenigii*), Lemon (*Citrus limon*), Bel (*Aegle marmelos*), Panfuti (*Bryophyllum pinnatum*), Mussaenda (*Mussaenda frondosa*, *Mussaenda erythrophylla*) and Halad kunku (*Asclepias curassavica*) are being grown for specific butterfly species to lay eggs and provide host plant leaves as feed to its caterpillar.

Fig. 1.16: The bulterfly garden established at ICAR-NIASM

Nectar Plants- Flowering plants such as Pentas (Pentas lanceolate), Periwinkle (*Vinca rosea*), Jamaican Spike (*Stachytarpheta jamaicensis*), Pink Portweed (Stachytarpheta mutabilis), Lantana (*Lantana camara*) are being grown for butterflies to suck the nectar. Butterflies species have been found to feed on overripe fruits, decomposing meat, plant sap, salt from soil etc. apart from flower nectar.

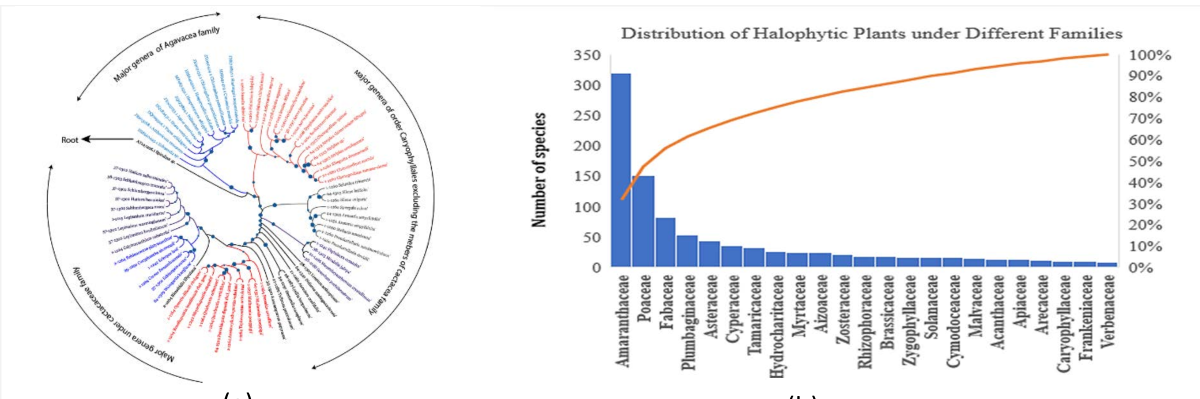
3.2 Research Programme 2: Soil Stress Management

Soil stresses like salinity, mineral toxicity and nutrient deficiency have emerged as major threats to crop production, livestock, fisheries and other commodities. Management of these stresses through advancing basic and strategic research in soil related stresses in crop plants, livestock and fisheries, has been the focus research areas carried under the school of Soil Stress Management. The work in areas of unravelling the mechanism and traits of soil stress response through microbiome-based approach, adaptation strategies through climate resilient integrated farming systems, and mitigation approaches in soil and water pollution have generated substantial basic understanding of the underlying processes. The major research findings emerging out and the progress made under this programme during the past one year is summarized below.

Exploitation of halophytic plants and associated microbiome for amelioration of saline agricultural land of arid & semi-arid regions

The halophytic plants adapted to naturally grow under saline conditions can be exploited for agricultural potential as food/feed/fodder/energy crop and simultaneously ensuring the increased utilization of the saline degraded lands. The microorganisms associated with such halophytic plants have been subjected to the same evolutionary forces as that of the halophytic plants that enabled them to survive under hypersaline conditions as Holobiont (Host + Associated microbes). Studies are being carried to explore the functional role of halophyte-associated microbiome consisting of extremophiles, and extremotolerant microbes (that tolerate higher salt concentration levels toxic to most plants and microorganisms), for imparting agricultural resilience to saline conditions.

Evolution and distribution of halophytes: The phylogenetic relationship among halophytes were inferred using the *rbcL* gene sequences retrieved from NCBI database and a very divergent evolution of halophytes was noted with halophytes occurring in almost all the major families of angiosperms with the maximum number of species falling under Amaranthacea and Poaceae family of angiosperms. The phylogenetic tree also indicated that the peculiar metabolic features like succulence and CAM (Crusselasean Acid Metabolism) may have first originated in members of the Agavaceae family.



(a) (b)

Fig. 2.1: (a) *A rbcL* gene sequence-based phylogenetic tree of prominent genera of Caryophyllales showing the divergent evolution of halophytes covering wide spectrum of angiosperm families b) Species distribution of halophytes with in major angiosperm families showing highest halophytic plants falling under Amaranthacea and Poacea families.

Halophytes associated microbes and their PGPA potential: A Preliminary survey of the coastal saline habitats from Diveagar area of Raigad district (Konkan Region of Maharashtra) was conducted and the samples of mangroves water, mangroves plants, mangroves marshy soil, seawater were collected for isolation of halotolerant and halophilic microbial isolates. The EC (Electrical Conductivity) value of the mangrove marshy soil ranged between 10.37 to 23.4 dS/m whereas the EC of the water from mangroves fields and coastal sea ranged between 74.7-123 dS/m. The pure cultures of microbial isolates have been obtained and glycerol stocks have been preserved. The *in vitro* assays for screening of PGPA traits like IAA production, ability to grow in nitrogen-free conditions, siderophore production, and phosphate solubilization was carried under high salt conditions (3-5% NaCl (w/v). The quantitative estimation of siderophore production was done using a CAS-shuttle assay. Interestingly, out of 26 microbial isolates tested so far, four isolates (Isolates 36, 13, 39, and 16) are found hyper-siderophore producers in the quantitative assay (Fig 2.2a and 2.2b). The siderophore producing ability of isolates was tested at ambient (1% NaCl) and harsh saline conditions 3.5 % NaCl (w/v). Siderophore Production ability decreased under higher salt concentration (3.5% NaCl, w/v) compared to ambient salt concentration**.** However, one Isolate (isolate 52) exhibited higher siderophore production capability under harsh saline conditions (3.5% NaCl) and thus can be a potential candidate for plant growth promotion under saline conditions and further being tested.

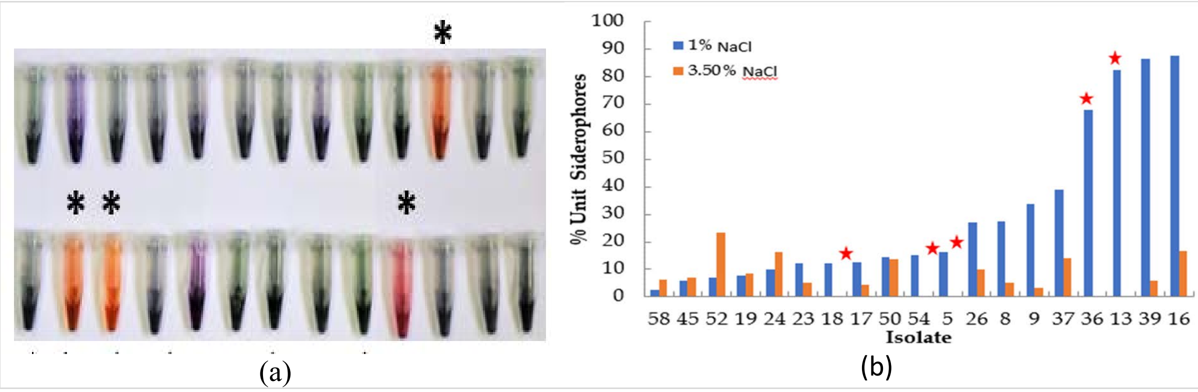


Fig. 2.2: (a) CAS-shuttle Assay: Siderophore-hyper producing isolates marked with (*) The Loss of blue-color and development of orange color in CAS-shuttle Assay is indicative of higher siderophore production. (b) Siderophore producing ability of isolates was tested at ambient and harsh saline conditions, A- 1% NaCl, B- 3.5 % NaCl (w/v)

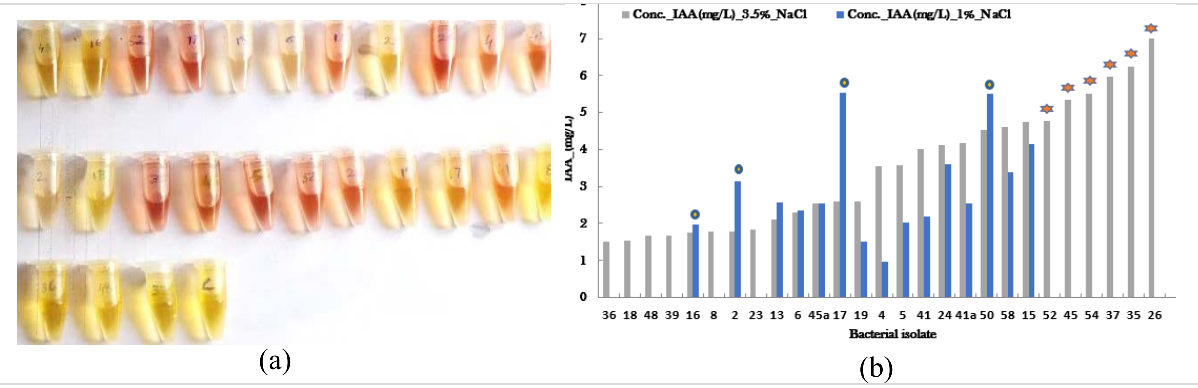


Fig. 2.3: (a) IAA production by microbial isolates as indicated by color development due to Indole-Salkowski reagent reaction. (b) Estimation of IAA production of halophytes associated bacterial isolates under moderate (1% NaCl, w/v and High NaCL (3.5%, w/v). (IAA producers exclusively under high salt conditions 3.5% NaCl indicted with star(✶) symbol.

The screening of halotolerant bacterial isolates for IAA production indicated the biosynthesis of IAA in microbial isolates could be salt-specific. In general, the production of IAA appeared more prevalent at a higher salt concentration (3.5% NaCl), indicating an adaptation of isolates to the surrounding environment (Fig 2.3a, 2.3b). Salt–specific synthesis of IAA within the isolates is certainly an important trait, typically in saline soils; however keen insights into the underlying mechanisms are yet to be generated. Microbial isolates showing the ability to grow in nitrogen source deficient media under high salt conditions (3.5% NaCl) were screened for the presence of *nif*H gene (gene encoding the nitrogenase reductase subunit) using PCR with *nif*H gene primers. Surprisingly, one isolate (09) exhibited a relatively larger PCR amplicon (~500 bp) than the reported length of 360 bp; thus, the isolate is being investigated further employing the sequencing of the corresponding DNA region (Fig-2.4a). A stem endophyte of mangrove showed high pigment and siderophore production. The culture exhibited prominent fluorescence in UV light which very closely resembled that of *P. fluorescence* (Fig. 2.4b). The bacterium has significant plant growth-promoting potential including siderophore production, phosphate solubilization, Indole-3-acetic acid production. Other important characteristics such as exopolysaccharide production, nitrogen fixation, HCN production, and actual in planta performance are under investigation.

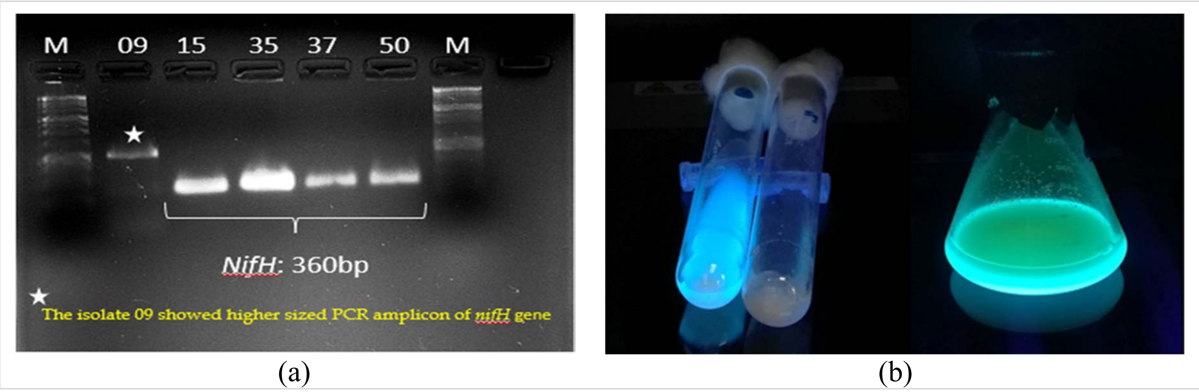


Fig. 2.4: (a) Gel image showing the presence of the *nif*H gene in the bacterial isolates showing ability to grow in nitrgen free media. (b) A stem endophyte of mangrove showing fluorescence under UV light, isolate also displayed significant plant growth promoting potential including Siderophore production, Phosphate solubilization, Indole-3-acetic acid production.

HPLC based detection of active component of the secretome of halotolerant bacterial isolates from coastal mangrove's samples: To resolve the metabolites secreted by a halotolerant microbial isolate of the halophytic origin, the HPLC-based methods are being optimized. Metabolite production was induced for different isolates in LB medium and secreted metabolites were extracted employing the organic solvent extraction method.

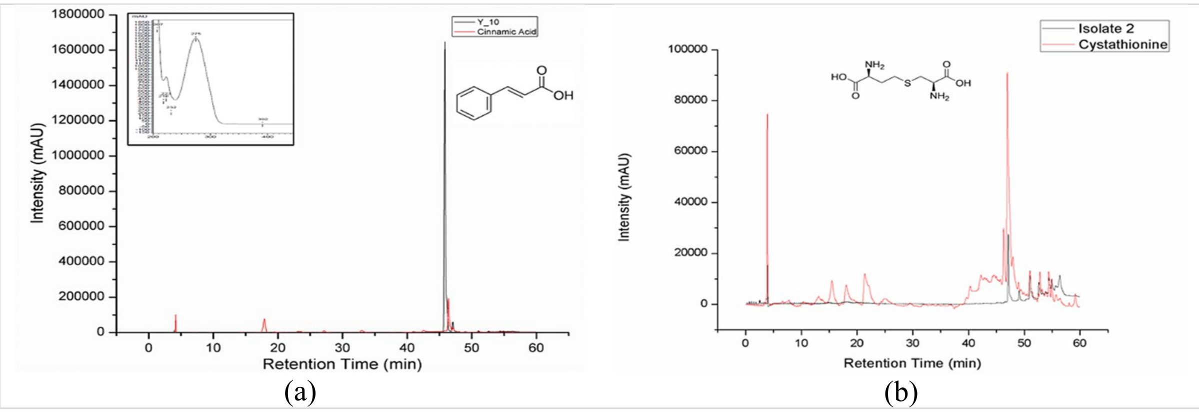


Fig. 2.5: (a) HPLC chromatogram of Cinnamic acid standard compared with that of the halotolerant PGPR isolate Y_10 (b): HPLC chromatogram of cystathionine standard compared with that of the halotolerant PGPR isolate Y_10.

The extracted metabolites were then analyzed through HPLC for the presence of different bioactive compounds using a gradient elution method. Metabolite's chromatogram of 10 halotolerant isolates has been generated so far. Metabolite chromatogram of the isolates was compared with that of standard compounds, and UV-spectrum-based comparison of individual peaks was done for further confirmation of the identity. Finally, based on the literature, the presence of different bioactive compounds within the metabolites pool is to be correlated with the PGPR potential and thus the host-stress tolerance. So far biomolecule like cinnamic acid (Fig. 2.5a) and cystathionine (Fig. 2.5-b) has been detected and identified in the metabolites pool of a halotolerant isolate Y_10 & isolate 2, respectively. The library for reference standards like salicylic acid, GA3, Kinetin, biotin, IBA have been developed for their easy identification in the secretome of the microbial isolates of halophytic origin.

Halotolerant *Rhizobium* and PGPB based biomolecules for mitigation of salinity and drought stress

Efficient management of drought stress in plants is critical to sustaining crop productivity under the current climate change scenario. Microbe-based next-gen strategies are increasingly thought upon particularly due to the exceptional ability of microbes to sustain under a diversity of adverse environmental conditions and even induce the stress tolerance mechanisms in plants. Thus, inoculation of resilient microbes having plant growth-promoting traits in crop plants cultivated in drought-prone areas could induce a general drought tolerance in plants thereby reducing the overall losses. Although this approach appears to be efficient, inoculum failures are frequently complained, which is typically due to the competence of inoculants in differing foreign environmental conditions, and the indigenous microflora. Considering the overall difficulties and constraints, the concept of direct utilization of microbial products has been proposed. Extending the same, we developed a bioformulation containing microbial biomolecules from eight bacterial cultures (Fig. 2.6) and assessed its performance under drought conditions in spinach under greenhouse conditions. The performance of microbial biomolecules-based bioformulation towards mounting drought stress tolerance was evaluated in spinach (*Spinacia oleracea* L.). The spinach seedlings grown for 15 days under normal moisture conditions, were subjected to drought-stress by restricting the irrigation (2:1 irrigations-normal: stress), with the bioformulation applied through the foliar spray at weekly intervals for four weeks. These plants were harvested and analyzed for physicochemical attributes. The results indicated a significant influence of bioformulation application on the overall growth and development of spinach under water deficit conditions.

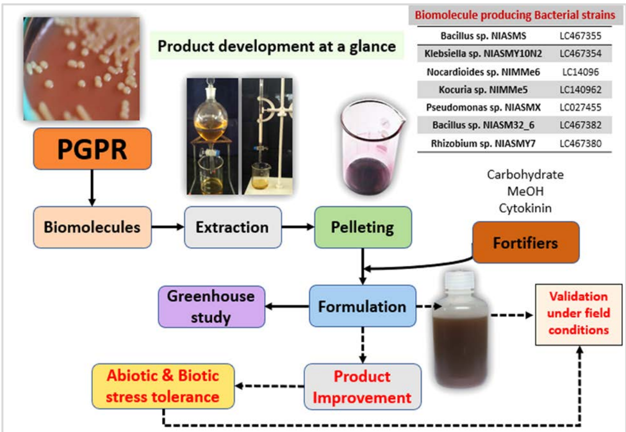


Fig. 2.6: Development process of microbial biomolecule based formulation

An increase in shoot length over the control under the influence of bioformulation treatment signified the relatively sound phenotypic status of the plants. The root length, though was higher in control, it remained statistically insignificant. A comparatively longer root length in control lowered the shoot: root ratio, which could be attributed to the natural strategy of plants to search for water under limiting moisture conditions. In the case of treatment both the root and shoot exhibited parallel development, indicating higher efficiency of the seedlings towards coping up with the induced drought conditions. The canopy temperature is an important indicator of plant responses to drought stress. Not surprisingly, the canopy temperature of the bioformulation-treated spinach seedlings in this experiment also exhibited significant variation over the control. As anticipated, the canopy temperature of untreated (control) seedlings remained higher when exposed to drought conditions. However, the bio formulation treatment appeared successfully reduce the rising canopy temperature of the seedlings even under drought conditions. This indicated a positive influence of the bioformulation application at the physiological level in spinach under drought conditions. Similarly, other physicochemical biomarkers also exhibited significant positive variations in bioformulation-treated seedlings indicating the successful mitigation of drought stress.

To reveal the biochemical basis of the positive influence of bioformulation on the plant growth attributes, the HPLC was employed to identify the abundant active components of the bioformulation. The UHPLC based analysis of the exometabolites in bioformulation revealed the presence of putative compounds viz. Gentisic acid, Protocatechuic acid, Gallic acid, Gallic acid derivatives, Vanillin, and Syringic acid derivatives as the active biochemical constituents of the exometabolite pool as revealed based on their λ_{max} and retention time. The results are also being validated by using the reference standards of putatively identified compounds. Encourage by the results obtained in greenhouse conditions, the formulation is also being tried in Sorghum and Chickpea under field conditions. The effect of the application of bioformulation on the global metabolome profile of leaves and developing grains are being studied employing LC-MS.

Designing the climate-smart integrated farming system (CIFS)

Selection and optimization of the components of one hectare model of CIFS for enhanced productivity, profitability and climate resilience is being carried out from July 2020 at ICAR-NIASM, by integrating abiotic stress farming system components crop, livestock, horticulture, agroforestry and fishery. The methodology used is graphically depicted in Fig. 2.7 .

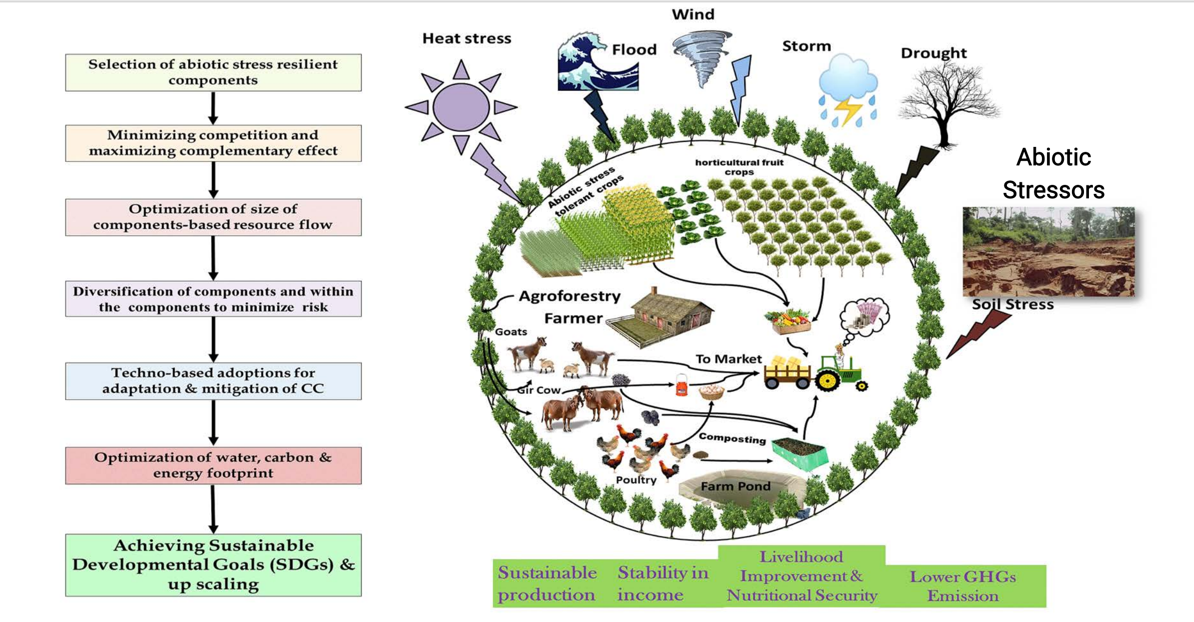


Fig. 2.7: Graphical representation of the design of CIFS

This size of the components is judiciously decided to minimize competition across its components and maximize complementary benefit and their ability to synergistically mitigate the ill effects of climatic vagaries. Selection and implementation of abiotic stress tolerant horticultural crops, agroforestry components for boundaries, crop rotation of climate resilient crops, farm pond & micro-irrigation systems have been carried out. Design and development of structures for multilayer/multitier farming system is completed. Also laying of HDPE sheet in farm pond, rearing of fish in pond, implementation of solar water pump based micro-irrigation facility for crop and horticulture component has been done. The data pertaining to inputs and outputs are being recorded for calculating the water, energy and carbon footprints of the climate-smart IFS. The optimized size of components in the one hectare CIFS model are a) Crop 6250 m^2; Horticulture-3000 m^2; Livestock- Indigenous cow-02, Goats-10, Native poultry birds-50 nos. Fisheries-400 m^2; Apiary-five boxes; Agroforestry boundary plantations). The diversification index of the CIFS Components was calculated as Crop Diversification Index-0.99; Horticulture Diversification Index-0.84; Animal diversity (Simpson's Diversity Index)-0.46. The economics of CIFS components is given in Table 2.1.

Table 2.1: Overall economics of CIFS

	Cost of Cultivation/ rearing (Rs)	Gross Income (Rs)	B:C
Crop	56576	49358	0.87
Livestock	104738	142133	1.35
Overall	161315	191491	1.18

Table 2.2: Component-wise Water Productivity in CIFS

Livestock Components	Water productivity		Rabi Crop	Water productivity
	Rs/m^3	Produce unit / m^3		kg biomass/m^3
Dairy animals	9.62	Milk- 0.29	Chickpea	1.668
Goat	9.11	Meat - 0.027	Sorghum	2.635
Poultry	1.09	Egg- 0.115	Sunflower	0.895
Overall	5.47	-	Safflower	0.723
			Clusterbean	2.549

The overall cost of cultivation of different components of CIFS was Rs. 161315, gross income was Rs. 191491 and the B:C was 1.18 of CIFS in the first year of experiment. 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**.**

Response of turmeric (*Curcuma longa* L) to saline water irrigation on growth, physiology, and antioxidant properties

A pot experiment was conducted to find out the effect of saline water irrigation on growth, physiology, biochemical signal and economic yield in turmeric crop. with five levels of salinity treatments (0, 2, 4, 6 and 8 dSm^{-1}) replicated four times in RCBD. The salinity levels were prepared using NaCl, $CaCl_2$, $MgCl_2$ and $MgSO_4$ to maintain $Cl:SO_4$ ratio in 7:3. Salinity treatments were imposed according to treatment scheduled 30 days after transplanting of seedling and continued till maturity of the crop. The results showed that saline water irrigation induced changes in growth and yield parameters in turmeric crop. Plant height of different levels of salinity stressed was affected significantly with the lowest (37.9 cm) at 8 dS m^{-1} salinity. Slight increase in salinity by 2 dsm^{-1} reduced the growth of turmeric by 15.7 per cent as compared to control. The number of tillers leaves per plant and leaf area were also significantly reduced. Chlorophyll and NDVI of the leaves (Fig. 2.8) also reduced with increase in salinity. The lowest fresh rhizome yield (19.8 g/plant) was recorded at 8 dSm^{-1} that also resulted in the lowest dry yield (2.5 g/plant) and dry recovery (12%). In the present study salinity stress had a major impact on growth through retardation, degradation of photosynthetic pigments, and eventually reduced yield. This study demonstrated that turmeric is sensitive to saline water stress and it reduces the yield drastically if saline water >4 dS m^{-1} is used for irrigation.

Table 2.3: Effect of saline water irrigation on growth and yield parameters of turmeric

Treatments	Plant height (cm)	No. of tillers	No. of leaves	Total leafarea (cm^2/plant)	Fresh rhizome yield (g/plant)	Dry rhizome yield (g/plant)	Dry recovery (%)
0 dSm^{-1}	61.4	1.8	9.4	487.9	55.6	13.5	24.2
2 dSm^{-1}	51.7	1.3	6.8	380.2	40.1	9.3	23.1
4 dSm^{-1}	44.6	1.1	6.3	224.5	29.6	5.8	19.8
6 dSm^{-1}	41.3	1.1	4.8	228.3	23.7	4.2	17.5
8 dSm^{-1}	37.9	1.2	4.2	203.6	19.8	2.5	12.0
SEm±	0.70	0.09	0.43	28.9	2.43	0.60	0.73
LSD (p=0.05)	2.41	0.26	1.26	84.2	7.11	1.76	2.13

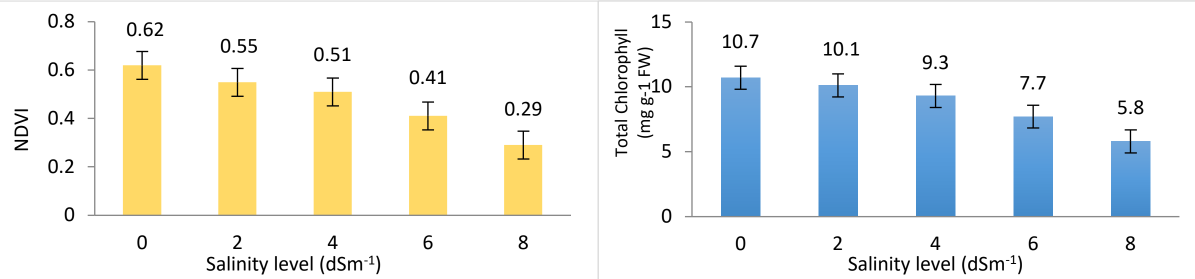


Fig. 2.8: Effect of saline water on Plant NDVI and Total chlorophyll in turmeric

Thus, the use of saline water irrigation must be critically considered to avoid yield loss. Suitable varieties or cultivars tolerant to salinity are required to face the challenge of increasing salinity to make golden spice tolerant to salinity.

Stress tolerance indices for identification of moisture deficit stress tolerant genotypes in fenugreek

Moisture deficit stress tolerance was assessed in fenugreek plant using stress indices. Tolerance to drought is expressed by stress tolerance index (STI) and Stress susceptibility index (SSI). The higher value of STI indicates higher tolerance to stress, while the lower value of SSI (<1) indicates the higher the stress tolerance and vice versa. In the present study, cultivar AFG-3 possessed higher STI (1.17) and lower SSI (0.74) among the genotypes studied. The highest value STI was recorded for Afg-3 (1.17) followed by Rmt-305 (0.84) and Co-2 (0.83). Similarly, highest susceptibility index was recorded in Afg-2 (1.24) and Lam selection-1 (1.23) followed by Hisar sonali (1.15) and GM-1 (1.08) respectively. The higher value of susceptibility index indicates lesser tolerance to stress. It also denotes that Afg-2, Lam selection-1, Hisar sonali and GM-1 are identified as susceptible to deficit moisture stress due to a higher percentage of seed yield reduction under deficit moisture stress conditions. Per cent yield reduction (PYR) indicates stable

Table 2.4: Stress tolerance indices for different genotypes of fenugreek.

Genotypes	STI	TOL	SSI	YSI	YR	PYR	GMP
Hisar Sonali	0.80	0.91	1.15	0.68	0.32	32.35	2.70
Lamselan-1	0.56	0.83	1.23	0.65	0.35	34.54	1.89
Co-2	0.83	0.55	0.74	0.79	0.21	20.68	2.77
RMT-305	0.84	0.69	0.90	0.75	0.25	25.18	2.81
GM-1	0.42	0.60	1.08	0.70	0.30	30.12	1.40
AFG-2	0.66	0.91	1.24	0.65	0.35	34.82	2.23
AFG-3	1.17	0.65	0.74	0.79	0.21	20.76	3.92

performance across conditions. PYR was less in genotypes Co-2 (20.68) and Afg-3 (20.76). Mean productivity is high in Afg-3, Rmt-305 and Co-2 indicate high tolerance towards moisture stress at the flowering stage. This attribute may be due to higher productivity under stress conditions and a narrow reduction in seed yield under stress as compared to non-stress conditions. Moisture deficit tolerance by fenugreek varieties showed that the highest value of stress tolerance index (STI) was recorded in Afg-3 followed by Rmt-305 and Co-2. Similarly, the highest susceptibility index was recorded in Afg-2 and Lam selection-1. Therefore, it is concluded that Afg-3, Co-2, and Rmt-305 are tolerant to moisture stress and able to provide higher yield without much reduction in yield due to moisture deficit stress.

Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics

Constructed wetland system

The pilot scale constructed wetland system (CWs) (Fig. 2.9) established at NIASM for septic tank wasterwater treatment comprised of three parallel units (i) Gravel based Vertical sub-surface flow based CWs (VSSF-CWs) grown with typha (TW), vetiver (VW) along with unplanted (Control-CW) system (ii) Horizontal sub-surface flow based CWs (HSSF-CWs) and (iii) Vertical sub-surface flow based CWs (VSSF-CWs) filled with different growing cum filtration media *viz.* Gravel + Brick block (HGB & VGB-TW), Gravel + Coco peat (HGP & VGP-TW), Gravel + Charcoal (HGC & VGC-TW), Gravel (HG & VG-TW) and along with horizontal media less planted control (HPC), vertical unplanted control (VUC) and Vertical freshwater control (VFC) and grown with commercial floricultural crops.

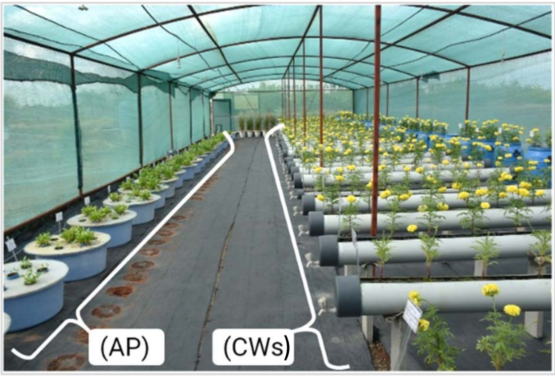


Fig. 2.9: Pilot scale Constructed wetland system (CWs) and Aquaphonics(AP) at

These units were tested for their potential removal of different metallic pollutants as well as flower yield of commercial marigold hybrids : Ashtagandha red and Gold-spot yellow during Jan.–Apr. 2021 and Gold-spot yellow during Sep.-Dec. 2021. These commercial marigold hybrids were selected due to their best performance during earlier screening process. For this metal mixtures of Fe, Mn, Zn, Cu, Cd, Cr, Pb, Ni each with 5.0 mg/l concentrations were prepared by spiking in NIASM wastewater and then fortnightly applied in these systems in three replications planted with Ashtagandha red and Gold-spot yellow (five plant each in horizontal and two plant each in vertical system). Different growing cum filtration media (treatments) has shown average metal removal capacity of 95.09, 92.50, 94.47, 94.89, 94.80 & 96.47% for Zn, Cu, Fe, Mn, Ni and Cd; respectively. The Vertical CWs has shown relatively higher metal removal capacity (96.67, 93.11, 95.06, 95.12, 94.83 & 96.74%) compared to horizontal CWs (93.52, 91.89, 93.88, 94.65, 94.78 & 96.19%) for Zn, Cu, Fe, Mn, Ni and Cd, respectively. The metal removal capacity was found in decreasing order for Gravel+ Charcoal (GCW) > Gravel (GW) > Gravel+ Brick block (GBW) > Gravel+Coco peat (GPW) > Control (CW) treatments.

During Jan.–Apr. 2021, the marigold flower yield was found in decreasing order for
HSSF-CWs : HGP-CW ~ HGC-CW > HG-CW > HGB-CW > HPC and for
VSSF-CWs : VGC-TW > VG-TW > VGP-TW > VGB-TW ~ VFC.

During Sep.–Dec. 2021, the marigold flower yield was found in decreasing order for
HSSF-CWs : HGB-CW ~ HGC-CW > HG-CW ~ HGP-CW > HPC and for
VSSF-CWs : VGC-TW > VGP-TW > VG-TW ~ VGB-TW.

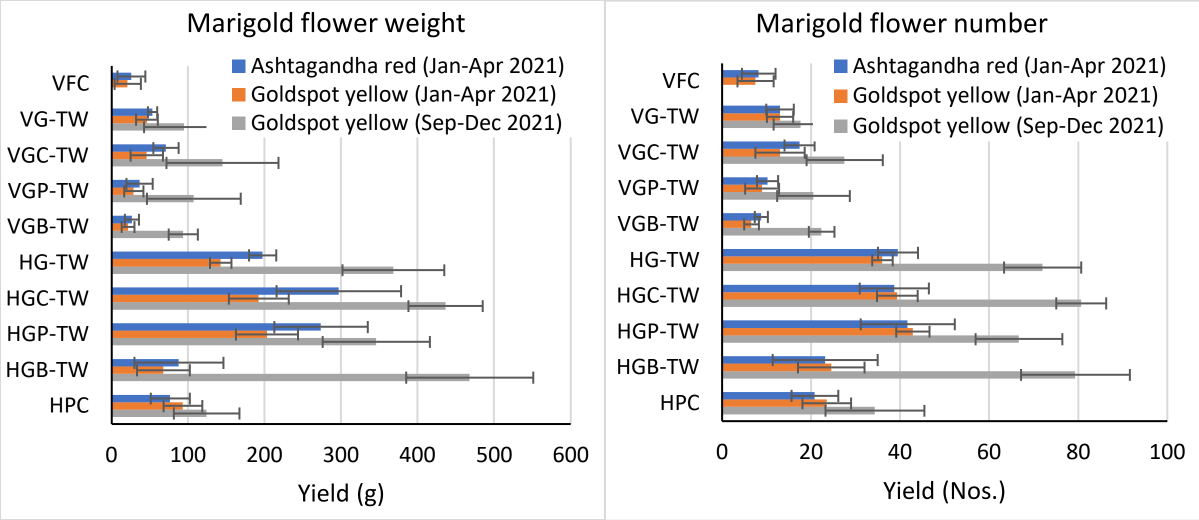


Fig. 2.10: Marigold flower yield in CWs treatments

Aquaponics system

Treated water from all the three systems is collected/stored/fed in aquaponics system under following treatments *viz.* Gravel + Rice hull (GHW), Gravel + Coco peat (GPW), Gravel + Charcoal (GCW), Gravel (GW), Typha treated water (TW), Vetiver treated water (VW) along with Untreated water (UW) and Fresh water (FW) as control. In these aquaponics system without any nutrient addition hydroponically four different vegetable crops were grown *viz.* chilli, cauliflower, cabbage and tomato. Among these vegetable crops yield was found in the order as: Tomato > Cabbage > Cauliflower >> Chilli.

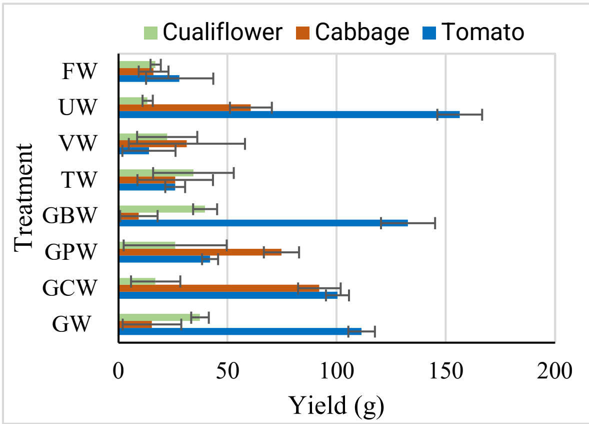


Fig. 2.11: Vegetable yield in aquaponics system

However, among different treatments vegetable yield was found in the order as:

Tomato	: UW > GBW > GW > GCW > GPW > FW > TW> VW
Cauliflower	: GBW > GW > TW > GPW > VW > GCW ~ FW > UW
Cabbage	: GCW > GPW > UW > VW > TW > FW ~ GW > GBW

Vegetables grown in different treatments (other than untreated water) were found safe for consumption with respect to microbial population (*Fecal coliform* and *E.coli*)

During Sept - Dec. 2021 Spinach was grown in these aquaponics system in two different ways (i) hanging pots and (ii) gravel filled columns. From 24 aquaponics systems and 96 columns 3.29 kg spinach leaf and from 72 hanging pots kg spinach leaf was harvested. After analysis the harvested spinach was found safe for consumption.

Flowering crops in field

With these aquaponics treated waters along with fresh water and untreated wastewater six different flowering crops *viz.* chrysanthemum, aster, marigold, gladiolas, Jasmine and tuberose were grown in field in triplicates. Among these flowering crops; from marigold (Gold spot yellow) after planting of 20 plants per plot in three treatments of nine plots about 36.18 kg flower was harvested in three picking. Harvested flower yield was found higher with treated water than untreated and fresh water. Thus, constructed wetland system comprising cultivation of floriculture crops in different composition-based media could prove a sustainable water treatment option that generates additional profit in form of floriculture produce. This option could also supplement in various mitigation strategies to circumvent the global water scarcity.

Fig. 2.12: Treatments imposed in open field

Studies on multiple stresses in *Pangasianodon hypophthalmus*

Mitigating multiple stresses in *Pangasianodon hypophthalmus* with a novel dietary mixture of selenium nanoparticles and Omega-3-Fatty Acid

Effects of a novel dietary mixture of selenium nanoparticles (Se-NPs) and omega-3- fatty acids i.e., Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) on mitigating arsenic pollution, high-temperature stress and bacterial infection were investigated in *Pangasianodon hypophthalmus*. To this aim four isocaloric and iso-nitrogenous diets were prepared: control feed (no supplementation), Se-NPs at 0.2 mg kg^{-1} diet with EPA+DHA at 0.2, 0.4 and 0.6 % as supplemented diets. Fishes were reared under normal condition or concurrent exposure to arsenic (2.65 mg L^{-1}), and temperature (34 °C) (As+T) stress for 105 days with eight treatments in triplicates. Response to various stresses i.e., primary (cortisol), secondary (oxidative stress, immunity, and stress biomarkers) and tertiary stress response (growth performance, bioaccumulation and mortality due to bacterial infection) were determined. Supplementation of dietary Se-NPs at 0.2 mg kg^{-1} diet and EPA+DHA at 0.2 and 0.4 % reduced the primary stress level.

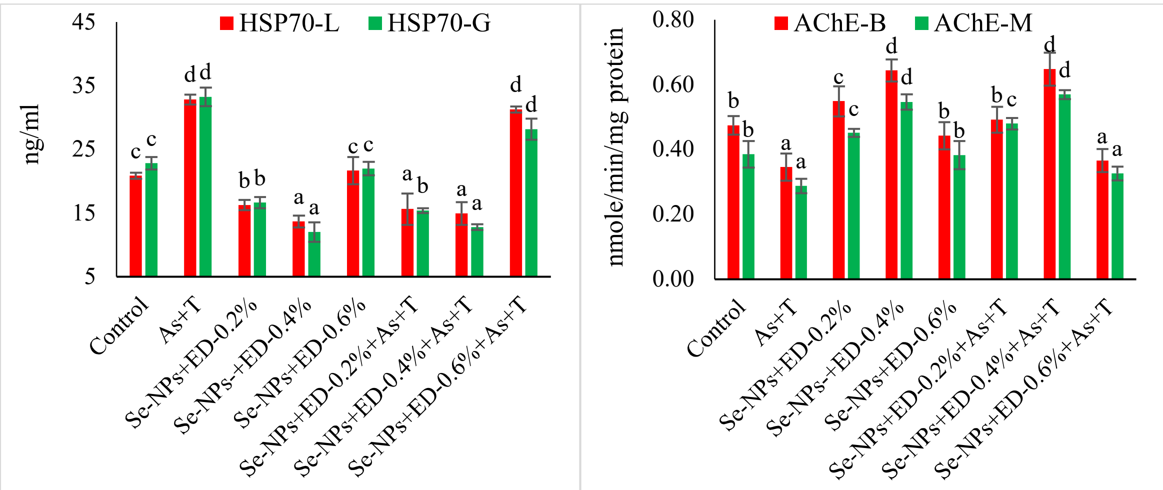


Fig. 2.13: Secodary stress response (HSP70 in liver & gill and AChE in brain & muscle) across treatments

Exposure to arsenic and temperature (As+T) and fed with control diet and EPA+DHA at 0.6 % aggravated the cortisol level. Anti-oxidative enzymes (Catalase, superoxide dismutase, glutathione peroxidase and glutathione-s-transferase) and immunity (Nitroblue tetrazolium, total protein, albumin, globulin, A:G ratio, total immunoglobulin and myeloperoxidase) of the fish were augmented by supplementation of Se-NPs and EPA+DHA at 0.2 and 0.4 %. Neurotransmitter enzyme, HSP 70, Vitamin C were significantly enhanced ($p<0.01$) with supplementation of Se-NPs at 0.2 mg $kg^{-1}$and EPA+DHA at 0.2 and 0.4 %. Whereas total lipid, cholesterol, phospholipid, triglyceride and very low-density lipoprotein (VLDL) were reduced ($p<0.01$) with the supplementation of Se-NPs at 0.2 mg kg^{-1} diet and EPA+DHA at 0.2 and 0.4%. Tertiary stress response viz. growth performance was also significantly enhanced with supplementation of Se-

NPs at 0.2 mg kg^{-1} and EPA+DHA at 0.2 and 0.4 % reared under As+T. Whereas arsenic bioaccumulation in fish tissues was significantly reduced with dietary supplementation of Se-NPs and EPA+DHA. Cumulative mortality and relative percentage survival were reduced with Se-NPs at 0.2 mg kg^{-1} and EPA+DHA at 0.2 and 0.4%. The investigation revealed that a novel combination of Se-NPs at 0.2 mg kg^{-1} and EPA+DHA at 0.4 % followed by 0.2% has the potential to alleviate temperature stress, bacterial infection and arsenic pollution. Whereas diet containing Se-NPs at 0.2 mg kg^{-1} diet and EPA+DHA at 0.6 % noticeably enhanced the stress in *P. hypophthalmus*. (For more information please refer: Scientific Reports (2021) 11:19429)

Omega-3 fatty acids effectively modulate growth performance, immune response, and disease resistance in fish against multiple stresses

Arsenic pollution and climate change are among the major global challenges threatening the aquatic environment. Concerted and accelerated scientific efforts are in progress to restrict the ill- impacts of pollution and climate change in the aquatic ecosystem.

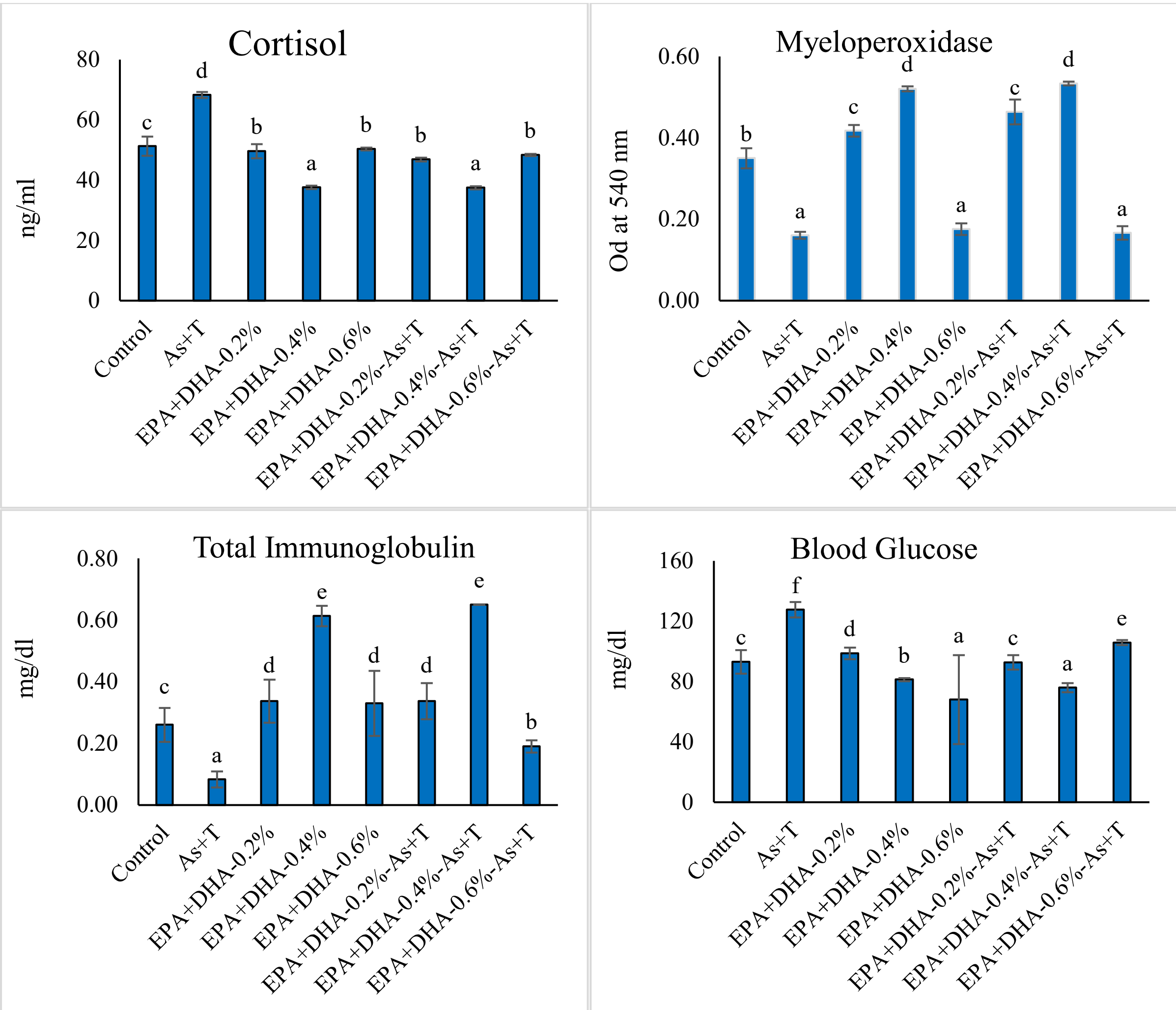


Fig. 2.14: Mitigation of primary and secondary stress response through dieatry supplementation of EPA+DHA fed to *P. hypophthalmus* reared under arsenic and high temperature for 105 days.

In this context, a study was conducted to delineate the effect of omega-3 fatty acids i.e., eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in mitigating arsenic pollution and temperature stress in *Pangasianodon hypophthalmus*. Four isocaloric and iso-nitrogenous diets were prepared viz. control feed (no supplementation), and three treatment groups with combined level of EPA+DHA at 0.2, 0.4 and 0.6 %. Fish were reared under arsenic (2.65 mg L^{-1})

and elevated temperature (34 °C) (As+T) stress for 105 days with eight different treatment groups in triplicates. Growth performance, oxidative stress enzymes, stress biomarkers, immunity, lipid profile, bioaccumulation of the arsenic in fish tissues and bacterial infection in terms of cumulative mortality and relative percent survival were altered on exposure of arsenic and temperature stress. Supplementation of combinatorial mixture of EPA+DHA at the rate of 0.2 and 0.4 % in the diet led to improved growth performance, anti-oxidative status, immunity of the fish and reduced the infection against *Aeromonas hydrophila*. Neurotransmitter enzyme, HSP 70 and Vitamin C were significantly enhanced (p<0.01) with supplementation of EPA+DHA, whereas, total lipid, cholesterol, phospholipid, triglyceride and very low density lipoprotein (VLDL) were reduced (p<0.01) at 0.2 and 0.4% of dietary incorporation of EPA+DHA.

Overall, the present investigation clearly revealed that a novel combination of EPA+DHA at 0.4 % has the potential to mitigate arsenic pollution, temperature stress and protect against bacterial infection in *P. hypophthalmus.* (For more information please refer: Aquaculture 547 (2022):737506)

Dietary riboflavin enhances immunity and anti-oxidative status against arsenic and high temperature in Pangasianodon hypophthalmus

The present study was conducted to delineate the role of dietary riboflavin (RF) on mitigation of abiotic stresses due to low dose of arsenic and high temperature (As+T) on Pangasianodon hypophthalmus. Four diets containing RF at 0, 5, 10 and 15 mg kg^{-1} were fed to fishes reared under low dose of arsenic (2.68 mg L^{-1}) and temperature (34 ◦C) stresses for 90 days. Growth index viz. weight gain percentage, feed conversion ratio, FCR; protein efficiency ratio, PER; and specific growth rate, SGR significantly enhanced (p < 0.01) with supplementation of dietary RF at 10 mg kg− 1 diet, whereas growth index of fish treated under stressors (As+T) and fed with control diet drastically reduced (p < 0.01).

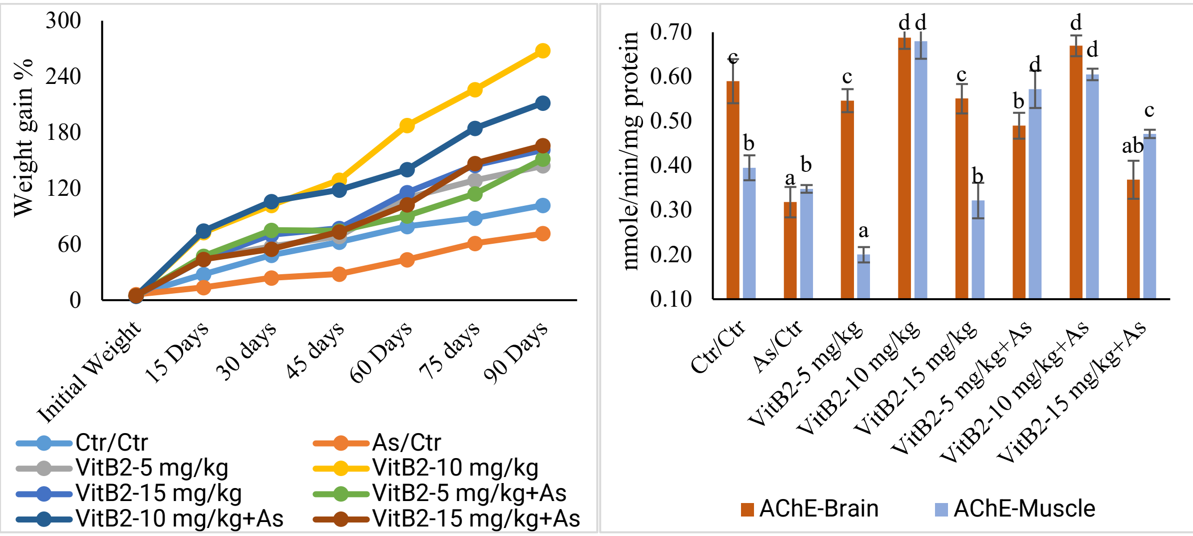


Fig. 2.15: Effect of dietary riboflavin on weight gain % and AChE in brain ad muscle of P. hypophthalmus reared under low dose of arsenic and high temperature for 90 days. Values in the same column with different superscript (a, b, c, d) differ significantly (p < 0.01). Data expressed as Mean ± SE (n=6).

Anti-oxidative status viz. catalase, superoxide dismutase, glutathione-s-transferase and glutathione peroxidase was significantly improved (p < 0.01) with supplementation of dietary RF at 10 mg kg^{-1} diet. Moreover, the immunological status viz. total protein, albumin, globulin, albumin globulin ratio (A:G ratio), respiratory burst activities, myeloperoxidase, total immunoglobulin were significantly improved with supplementation of dietary RF in fish reared under stressors and non-stressors. The biochemical stress markers as blood glucose and HSP 70 was drastically reduced with dietary RF at 10 mg kg^{-1} diet, however, the level of glucose and HSP 70 were elevated with arsenic and high temperature and fed with control diet.

Aeromonas hydrophilla was inducted to fishes to observe the immunological status of fishes fed with dietary RF. The protective role of dietary RF was observed in the histopathological study of liver and gill. Arsenic bioaccumulation in different fish tissues reduced ($p < 0.01$) with dietary supplementation of RF. The study revealed that As pollution and high temperature reduced the growth performance, anti-oxidative status and immunity of the fish but dietary RF mitigated it. (For more information please refer: Aquaculture 533 (2021):736209).

Metal determination and biochemical status in marine fishes facilitates in biomonitoring of marine environmental pollution

This study intended to analyse the bioaccumulation of chromium, manganese, cobalt, copper, zinc, selenium, arsenic, strontium, cadmium, tin, antimony and lead in tissues of 30 different marine fish species collected from New Ferry Whorf, Sassoon dock and Versova fishing harbour. The bioaccumulation patterns of 12 elements were determined to assess the pollution biomarkers based on cellular and oxidative stress. Results revealed that stress biomarkers viz. catalase, superoxide dismutase and glutathione-s-transferase; glycolytic enzymes viz. lactate dehydrogenase, malate dehydrogenase, protein metabolic enzymes viz. aspartate transferase, alanine transferase; and lipid peroxidation were significantly higher in muscle and gill tissues while the neurotransmitter enzyme viz. acetylcholine esterase in muscle and brain were significantly inhibited. Overall results indicated that biochemical attributes such as oxidative stress enzymes, cellular biomarkers, neurotransmitter enzymes and metals and metalloids contamination even at low concentration could be successfully employed as reliable biomarkers for biomonitoring of contaminated marine ecosystems. (For more information please refer: Marine Pollution Bulletin 170 (2021):112682).

Diagnostics of dragon fruit diseases

The farmer's trend towards dragon fruit cultivation has increased in past decade due to its higher market price. However, the climatic uncertainties hamper the quality production of dragon fruit and therefore the profitability as well. Diseases associated with dragon fruit is one of the major issues affecting dragon fruit quality as well as its cultivation in general. Since dragon fruit is relatively a new crop introduced in India, growers are unaware about the associated diseases and its management. The survey done at farmer's field and at NIASM field depicted presence of several pathogenic fungi associated with foliar diseases in dragon fruit. Anthracnose, leaf spot/blight, stem canker, stem rot/soft rot, fruit spot were the common diseases noticed during field survey. Symptomatic samples were collected for laboratory diagnosis which include tissue isolation, culture purification, morphological & microscopic characterization and molecular confirmation. Morphological and microscopic characterization of pure cultures revealed presence of nine different genera viz., *Colletotrichum spp., Fusarium spp., Alternaria spp., Phoma spp., Biopolaris sp., Nigrospora spp., Neoscystalidium sp., Curvularia spp. and Rhizoctonia spp.,* (Fig. 2.16). After microscopic & morphological characterization, selective isolates of leaf spot pathogens were confirmed by molecular characterization i.e., rDNA-ITS gene sequencing with universal primers ITS-1/ITS-4**.** The resulted sequences were submitted to NCBI. Didymella macrostoma Curvularia spicifera, Nigrospora zimmermanii, Alternaria macrospora, Alternaria sp., Curvularia lunata (Cochliobolus lunatus), Alternaria japonica were enlisted among the leaf spot pathogens whereas Colletotrichum truncatum was responsible for anthracnose disease in dragon fruit (Table 2.5).

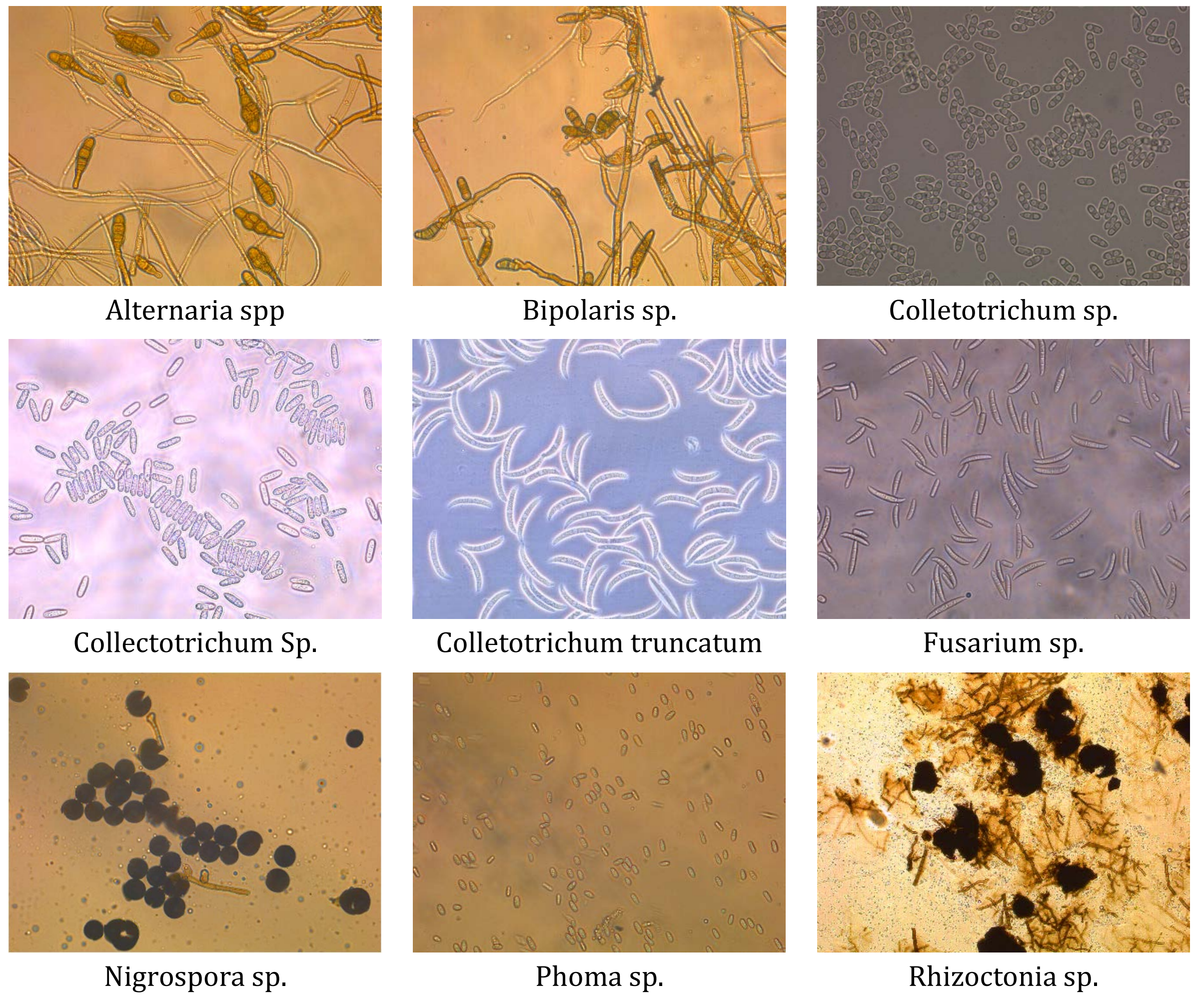


Fig. 2.16: Pathogenic fungal genera associated with foliar diseases in dragon fruit.

Table 2.5: Molecular confirmation of dragon fruit anthracnose and leaf spot pathogens by rDNA-ITS gene sequencing for Dragon fruit as Host

Disease	Pathogen	NCBI Accession no.
Anthracnose	Colletotrichum truncatum	OK639098, OK639099, OK639100
Leaf spot/leaf blight	Didymella macrostoma	OK668225
Leaf spot	Curvularia spicifera	OK668226, OK639092
Leaf spot	Nigrospora zimmermanii	OK668227
Leaf spot	Alternaria macrospora	OK668228, OK639093
Leaf spot	Alternaria sp.	OK668229, OK639095
Leaf spot	Curvularia lunata (Cochliobolus lunatus)	OK668230, OK639094
Leaf spot	Alternaria japonica	OK668231

Vermicomposting for farm waste management

Vermicomposting is one of the major biodegradable waste management ways already working in the nature. An investigation on ways of degrading different types of crop residue and farme waste by vermicomposting was conducted using two earthworm species Red wiggler worm (*Eisenia fetida*) and African night crawlers (*Eudrilus eugenia*) and compared for their nutrient content. The initial enrichment of the vermicomposting unit was done using (IE1)-cow dung based half decomposed FYM and (IE2)-cow dung, for composting wheat husk & farm stubble (weeds) and coconut leaves & farm stubble. The pH and electrical conductivity of the prepared vermicompost was found in the range 7.8-8.0 and 3.4-5.6 dS/m while nutrient content in the range; total organic carbon 13.5-15.4%, nitrogen 0.75-1.3%, phosphorus 0.31-0.51%, potassium 0.92-1.91% and C/N ratio 12-18. In IE1 vermicompost; pH, EC, C-content, N-content, P-content, K-content, C/N ratio was found 7.9, 4.36 dS/m, 13.99%, 0.75%, 0.35%, 1.71%, 18.65; while in IE2, 8.00, 4.66 dS/m, 14.69%, 1.1%, 0.42%, 1.00%, 12.72; respectively.

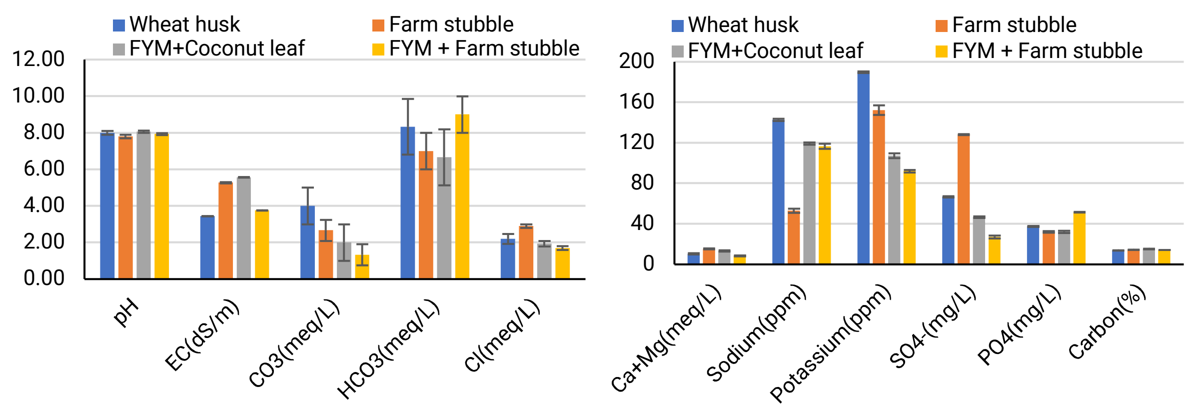


Fig. 2.17: The nutrient parameters measured for vermicompost obtained in the experiment

From eight pits of dimension (5m×1m×1m), with three fourth residue filling and 5kg earthworm loading about 4385 kg of vermi-compost could be harvested after two times residue loading in a year (2020-21). Among different treatments harvested vermicompost was found in the order FYM + Farm stubble (300-350 kg/pit) > Cow dung + Farm stubble ~ Cow dung + Wheat straw (250-300kg/pit) > FYM+ Coconut leaves (200-250 kg/pit).

Potential of sandalwood cultivation under abiotic stressed environment for adaptability & income generation

Fig. 2.18: Nursery raising of Sandalwood seedlings at ICAR-NIASM, Baramati

Indian sandalwood (Santalum album) is a tropical hemi-parasitic tree native to Southern India and Southeast Asia belonging to the family Santalaceae. It has commercial value for its fragrance and; medicinal qualities. The wider distribution of Sandalwood, monopoly in trade & skyrocketing demand have opened up opportunities for upscaling Sandalwood cultivation among farmers. NITI Ayog has brought up recent changes in policy by setting up sandalwood development committee to study the possibilities to remove certain notions on tree plantation, harvesting and marketing through single window approach. However, lack of scientific knowledge on nature of parasitism, choice of host, tree-host ratio, geometry of planting and management practices pose some difficulties during field establishment. Keeping in view the abovesaid constraints, a research trial on sandalwood is planned to get better insight into the host-sandalwood interaction favouring sandalwood plant under water-stress environment; assess impact of planting geometry and host-species on heartwood yield and oil content in sandalwood and assess the current status of heartwood yield and oil content in natural and planted sandalwood. Nursery raising and planting was carried out during 2021. The causality planting of apple ber as host plant was also carried out in the month of August, 2021. Baseline observations in Mango (variety: Keshar) and Apple ber was also carried out at Agroforestry block.

Growth and reproductive parameters of dragon fruit plantation

The growth and reproductive parameter data on plant height, canopy spread, canopy height, and fruit set (%) were recorded. Time required for different sub-principal growth stages of dragon fruit, and yield per plant in dragon fruit planted with different filling mixtures. Highest plant growth, number of fruits, fruit weight, and fruit set and yield was recorded in black soils (Table 2.6). Fruit set and fruit weight decreased with the flowering flushes occurrence, however 'flower and fruit numbers were observed to increase in later flushes (Table 2.7). Meager differences were observed in quality of dragon fruit under different soil types. The time required for different reproductive stages in dragon fruit was quantified as: Bud emergence to flower closing: 20-21 days; Flower closing to Harvesting: 32-33 days; Bud emergence to Harvesting: 52-54 days and no significant differences were observed across soil types.

Table 2.6: Growth and reproductive parameters of Dragon fruit

Soil type	*Plant height (m)	*Canopy height (m)	Canopy spread (m)		#No. of fruits harvested	#Total fruit weight, (Kg)	fruits/pole	Fruit weight /pole (Kg)	Avg. fruit weight, (Kg)	Fruit set (%)
			E-W	N-S						
Native	1.70	0.75	2.14	2.21	1800	519.85	50	10.13	0.231	75.47
Mix (1:1)	1.69	0.70	1.88	1.92	1702	375.66	47	7.97	0.222	82.80
Black	1.69	0.82	2.27	2.32	2276	426.40	63.2	11.88	0.227	86.52

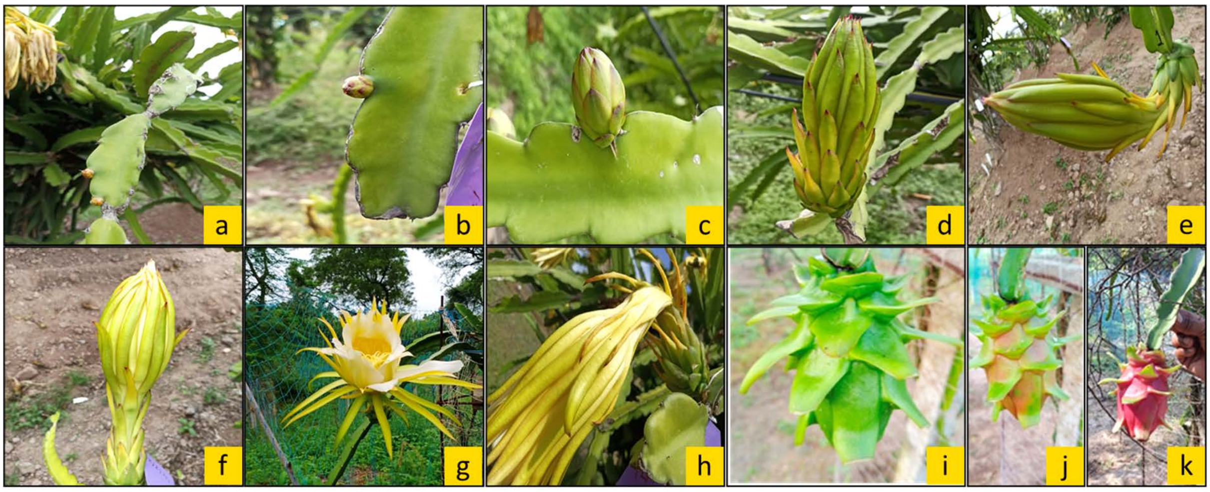
*Plant growth = 25 plants each, #Yield data = 36 plants each in 3 soil types

Table 2.7: Number of fruits and weight under different flushes of dragon fruit

Soil type	Harvesting	I	II	III	IV	V	VI	VII	VII	IX
Native Soil	No. of fruits	79	85	201	24	68	248	326	23	746
	Total weight (kg)	26.36	22.74	63.00	4.93	16.25	33.83	70.80	4.79	122.3
	Avg. fruit weight (g)	333	267	313	205	239	136	217	208	163
Mix Soil	No. of fruits	38	42	125	11	39	193	224	11	519
	Total weight (kg)	13.31	11.84	37.67	1.49	7.40	25.53	57.39	2.43	71.6
	Avg. fruit weight (g)	350	281	301	135	189	132	256	220	137
Black Soil	No. of fruits	136	91	243	28	98	329	522	16	813
	Total weight (kg)	43.37	25.93	76.39	5.74	22.57	44.68	116.7	3.49	87.53
	Avg. fruit weight (g)	318	284	314	204	230	135	223	218	107

Table 2.8: Reproductive growth stages and their duration in dragon fruit

Stage code	Name of stage	Time required (days)
I to II	Emergence of flower bud to Bud elongation	4
II to III	Bud elongation to Petal visibility/ball formation stage	15-16
III to IV	Petal visibility/ball formation stage to Flower opening (anthesis)	1
IV to V	Flower opening (anthesis) to Flower closing	Same day
V to VI	Flower closing to Turning stage	30-31
VI to VII	Turning stage to Harvesting	2



a-b: flower bud emergence; b-d: bud elongation; e: beginning of floral tube elongation; f: petal visibility/ball formation; g: flower opening; h: flower closing; i: fruit growth; j: colour initiation; k: harvesting stage

Fig. 2.19: Growth stages of dragon fruit

Collection and conservation of planting material

"Jumbo" and "C type" variants of Dragon fruit were collected from farmers field of Solapur region (Maharashtra) and replicated at dragon fruit germplasm block at ICAR-NIASM.

Fig: 2.20: Plantation of dragon fruit at ICAR-NIASM germplasm block.

The planting material of different Citrus rootstocks were collected from ICAR-IARI, New Delhi and planted in the nursery at ICAR-NIASM. These rootstocks are Sour Orange, Carrizo Citrange, Jatti Khatti, Cleopatra mandarin, RLC 1, X639, Rough Lemon, Soh Sarkar, Succatan, Pomeroy. They are having tolerance to different abiotic stresses. Thus, collection and conservation of these rootstocks will be helpful in understanding their mechanisms of tolerance and their conservation at ICAR-NIASM.

3.3 Research Programme 3: Water Stress Management

Water stress, is one of the most important abiotic stresses faced in Indian agriculture and its management needs a multipronged approach. The research programme on water stress management has therefore broadly focused its activities to evolve adaptation and mitigation options for management of water related abiotic stresses. These include unravelling the mechanisms and traits contributing to water stress tolerance in plants for generation of climate smart crops; characterization of genes and understanding mechanisms for designing crops for adaptation and mitigation to water stress by utilizing molecular and genomic and physiological tools; optimizing novel genetic improvement approaches for enhancing resilience of crops to water stress, exploring alternative crops suitable for deficit or excess soil moisture situations and aggregating potential collections/species exhibiting abiotic stress tolerance. The major research findings emerging out and the progress made under this programme during the past one year are summarized below.

Evaluation of soybean genotypes for traits associated with drought stress tolerance

A total number of 200 soybean genotypes, along with check varieties i.e., JS-9560, JS-7105, JS-9752 (drought tolerant) and NRC 37 (drought susceptible), were evaluated for drought stress tolerance under greenhouse conditions. Drought stress was imposed by withholding watering for 4 days at flowering stage (R1) stage. Soybean genotypes along with check varieties were evaluated for photosystem II efficiency, canopy coolness and canopy greenness. Genotype TGX-539-2D-7 had higher PS-II efficiency, cooler canopy and canopy greenness under non-stress and also drought stress condition compared to check varieties

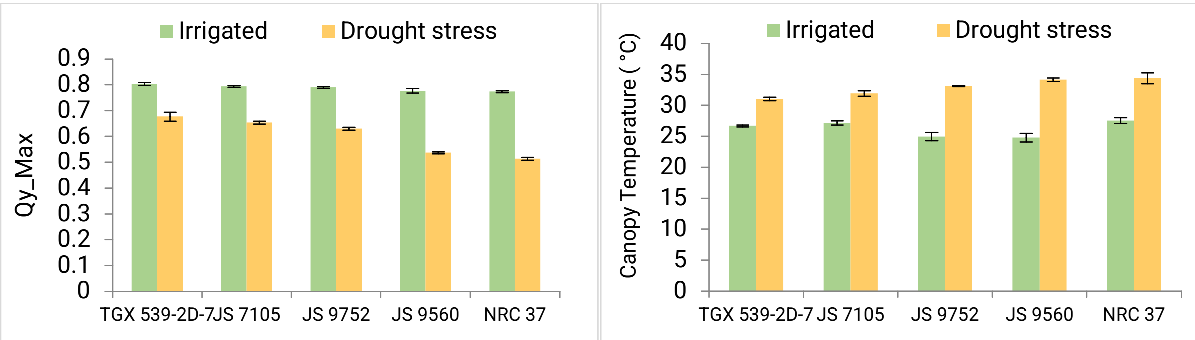


Fig. 3.1: Genetic variability in photosystem II efficiency (Fv/Fm) and canopy temperature under drought and irrigated conditions in soybean genotypes

Screening and identification of waterlogging tolerant pigeonpea genotypes

Waterlogging becoming major production threat in pigeonpea cultivation in *kharif* season; especially in the early phases of crop growth. In order to identify waterlogging tolerant pigeonpea genotypes a set of 50 genotypes from minicore collections along with tolerant checks (ICP-5028, ICP-7035 and MAL 15) and susceptible check (Sips2) were sown in a pot experiment with 3 replications. In each pot 7-8 seeds were sown, 10 days after sowing 5 uniform healthy plants per plot were maintained by removing excess plants from the plants. 20 DAS stress treatment were given to plots by maintaining waterlogging condition (>10mm of water above the soil surface) for 10 days continuously. After 10 days of stress treatment excess water was drained out from the plots and plants were allowed to recover. The traits like survival rate, plant height, chlorophyll content and PS-II efficiency were measured for both control plants and stress treated plants.

Genotypes namely ICP-7375, ICP-7076, ICP-7507, ICP-7426, ICP-7314, ICP-6128, ICP-6859, ICP-6815, ICP-7148, ICP-6992, ICP-9414 exhibited high survival rate, enhanced plant height under stress and high chlorophyll content and PS-II efficiency as compared to tolerant checks. These results need to be validated further for confirmation of tolerance level.

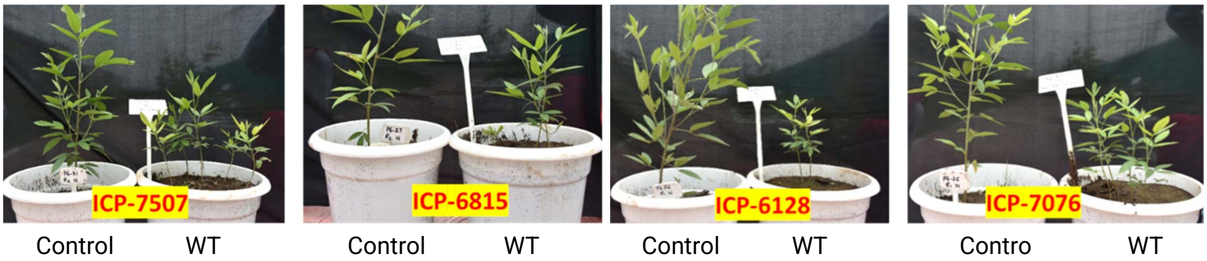


Fig. 3.4: Water logging tolerant genotypes of Pigeonpea

Genetic Variability in root system architecture under *in vitro* conditions in soybean genotypes

Root traits like root length and root biomass are considered useful for improving crop yield. Therefore, root system architecture study is very crucial can be studies through root traits. A total 100 soybean genotypes were evaluated for root traits under *in vitro* conditions. Soybean genotype PLSO-079 had efficient root system in terms of length and biomass compared to check varieties i.e. JS-9752 (drought tolerant), JS-7152 (drought tolerant), JS-9560 (drought susceptible) and NRC-37 (drought susceptible).

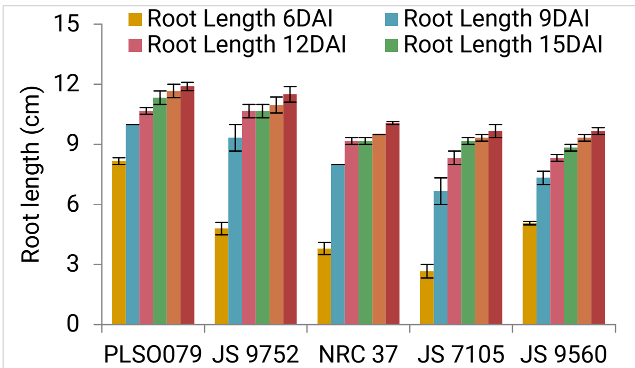


Fig. 3.2: Variation in root length of soybean genotypes under invitro studies

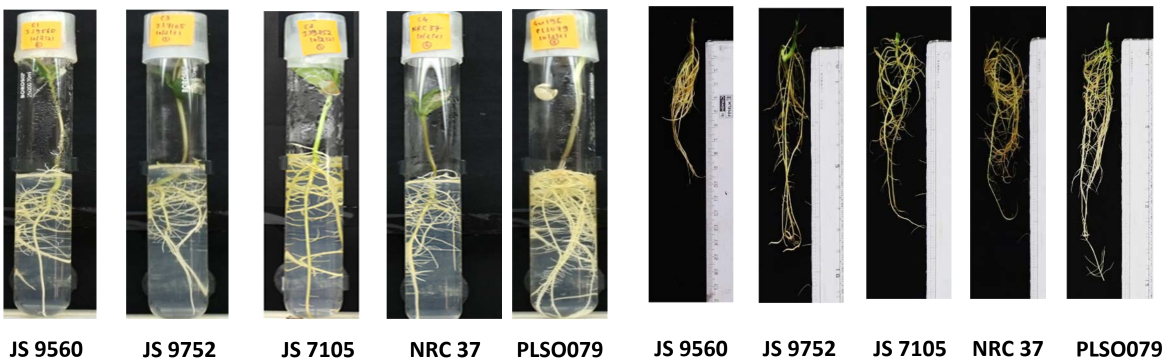


Fig. 3.3: Genetic variability in root system architecture

Phenotyping of Seed Traits in Mungbean Minicore Accessions Using Digital Image Analysis

Phenotyping plays a key role starting form identification of sources for the trait, to selection and advancement of lines, and evaluation of cultivars prior to release. Grain weight and number per pod are the routine post-harvest parameters used by crop scientists for assessing performance of genotypes while other features of grains are often ignored due to constraints in phenotyping. Recent image analysis techniques offer opportunities to bridge this gap. Such techniques need to be optimized for high throughput assessment of individual seed which is practically difficult to do manually for large number of samples. Image-based phenotyping of seed morphological features were therefore carried out. Seeds of 296 accessions of Mungbean obtained from the World Vegetable Centre, Taiwan were subjected to image analysis. For image acquisition, light illuminated setup was used to capture the images of 12192 seeds. Images were analysed by using ImageJ, an open-source software. Different seed parameters *viz.*, Roundness, Feret Y, Feret angle, Feret X, Circularity, Solidity, Raw integrated density, Aspect ratio, Integrated density, Perimeter, Width, Height, and Feret diameter were calculated using inbuilt functions.

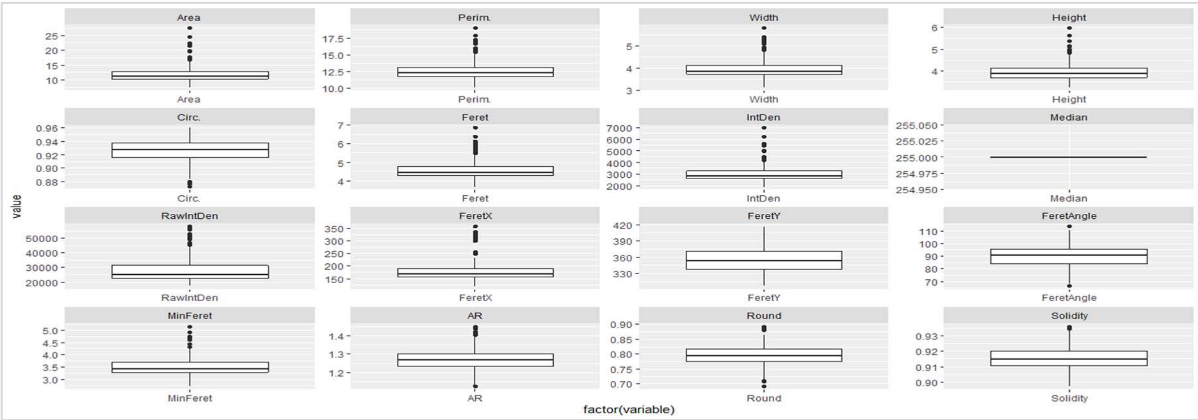


Fig. 3.5: Genetic variation in different seed parameters

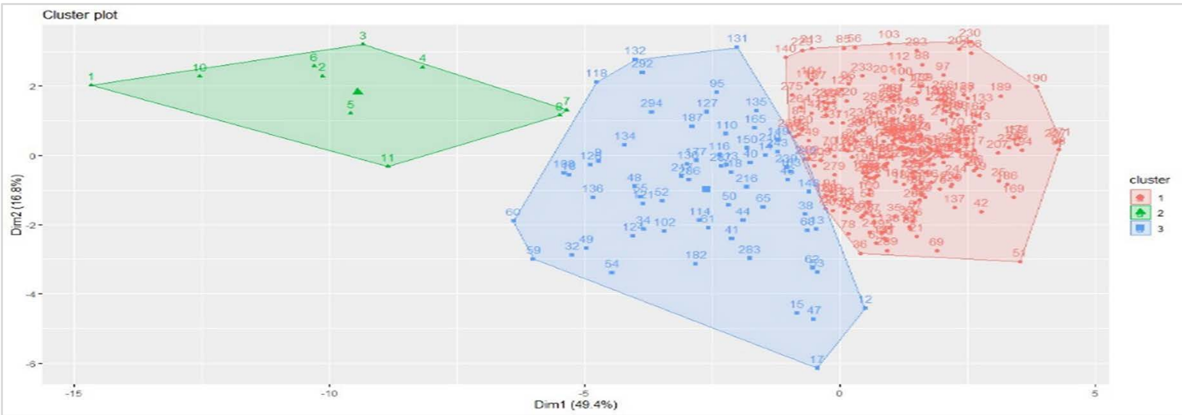


Fig. 3.6: Clustering of 296 Mungbean genotypes based on seed traits derived from digital imaging

These data could differentiate the origin of the seeds as the originating countries could be classified into different clusters. Among the seed parameters, roundness, solidity, feret angle and circularity showed high genotypic variation. Experiments are in progress to establish the relevance of these parameters to grain yield performance under harsh conditions. The present experiment could demonstrate that digital images can facilitate breeders attempt to phenotype large number of seeds in rapid and robust manner. Additionally, results from this experiment could reveal that seeds originating from the cluster of countries like USA, Australia, and Philippines were different from those originated from the Afghanistan, Nigeria, Taiwan and Thailand. Seeds originated from Brazil, France, Kenya, Iran, Iraq, India, Mexico, Netherland, S. Korea, Turkey were grouped in separate cluster. Thus, the image-based protocol developed by us offer potential to provide better insights into the genotypic variation as well as origin of seeds, which needs to be further validated by assessing core collections**.**

Selection and evaluation of M_2 mutant lines of Quinoa and Chia

Selected 400 M_1 quinoa mutants were sown in plant to row method for evaluating M_2 mutants and subsequent selection. Similarly, around 1500 Chia M_1 Quinoa mutants were sown in plant to row for evaluating and further selection of M_2 mutants. Preliminary observation at early seedlings stage in chia confirmed the mutations with respect to chlorophyll and leaf pigmentations. The frequency of chlorophyll mutations increased with increasing dosage. Leaf pigment mutations were observed at all three dosage of gamma radiations (300, 400 and 600 Gy), as a change in cotyledon leaf color from green to yellow, albina spotted and first paired leaf color from green to light green and yellow. Further, cup shaped and multiple cotyledon leaf (three to four) mutations were also observed compared to wild types.

Fig. 3.7a: Mutations in first pair leaf: Different spectrum of chlorosis/ chlorophyll pigment

Fig. 3.7b: Mutations in cotyledon leaf: Albina type, three cotyledon leaf type, cup shaped type

Cause of flower and fruit drop in dragon fruit and cope up strategies

The floral biology study at ICAR-NIASM during fruiting seasons of 2020 and 2021 revealed that the flowering occurs during May to October in five to six cycles of major flushes and few intermediate cycles with fewer flowers. Preliminary observation indicated that flower bud formation coincides with full moon light. A series of experiments were conducted to identify the cause of flower and immature fruit drop and to prevent subsequent yield loss. It is found that the continuous and heavy precipitation during anthesis period causes drastic pollen wash and thus it effects the pollination and consequently the fruit set and development. Even a small amount of rainfall of 3-4 mm during anthesis period caused reduction in fruit size due to insufficient pollination and yield loss up to 70% due to flower and immature fruit drop. A technology has been developed and validated during 2020 and 2021 at ICAR-NIASM, Baramati to prevent flower and immature fruit drop due to rainfall in dragon fruit. This technology comprises three methods such as bagging/covering the flowers, sheltering plants and supplementary pollination to prevent flower and immature fruit drop. This enhanced fruit size and quality upon supplementary pollination particularly cross pollination compared to natural pollinated fruits. Results from experiments at ICAR-NIASM and farmers field revealed that supplementary self-pollination increased the fruit size up to 350 gm (55%) and early maturity/ripening early by 2-3 days. Whereas cross pollination increased fruit size up to 500 gm (120%) and maturity/ripening one week early compared to naturally pollinated fruits (225 gm). In addition, fruit quality in terms of firmness (devoid of spongy flesh), colour and storage also improved. Based on results of farmer's field, this technology doubling the yield and also the income by preventing the yield losses that occurs due to flower and immature fruit drop and improving the fruit size and quality. This technology was disseminated to farmers by conducting hands on training and on field demonstrations.

Fig 3.8a: Cross pollination in dragon fruit

Fig 3.8b: Fruit formation upon cross pollination

Fig 3.8c: Comparison of selfed and cross-pollinated dragon fruits

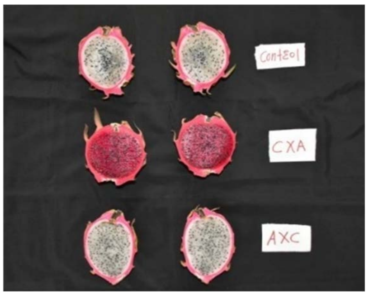


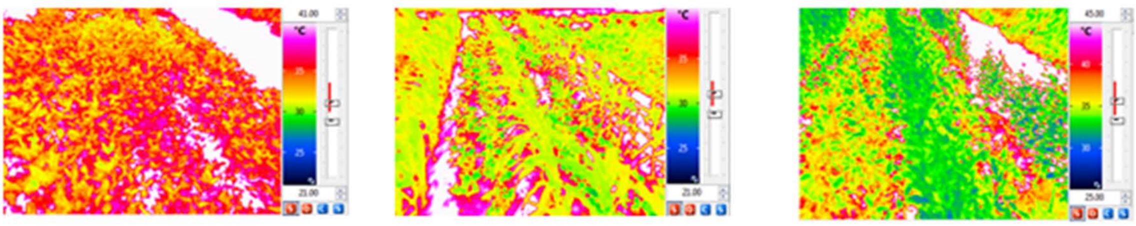
Fig 3.8d: Cross section of naturally self-pollinated, hand cross pollinated dragon fruits

Mode of pollination in *Hylocereus species* of Dragon fruits

A series of experiments on pollination requirement in different species of dragon fruit revealed that the *Hylocereus undatus* (red skin-white flesh) is self-pollinated while *Hylocereus polyrhizus* (red skin- red flesh) is cross pollinated. However, mode of pollination within species may be varying depending on the clonal source and collection.

Soybean based intercropping systems for better productivity and optimum resource use efficiency

Rainfed agriculture in our country is risk prone due to weather aberrations such as delayed onset of monsoon and in-season drought/long dry spells. Therefore, selection of crops and varieties, adoption of intercropping systems based on biophysical environment (rainfall pattern and soil type) of a specific location is essential requisite for drought mitigation and enhanced productivity of rainfed crops.



Sole Soybean | Soybean + Maize | Soybean + Pigeon pea

Fig. 3.9: Canopy temperature of soybean during pod filling under different crop combinations

In order to have a crop combination that is better in mitigating moisture and heat stress compared to other traditional practices, a field experiment on soybean based intercropping systems was carried out in Kharif 2021. Three crop combinations C1 (Sole soybean), C2 (soybean + pigeon pea), C3 (soybean + maize) were established in a randomized block design.

The results showed that soybean crops under soybean + maize intercropping exhibited cooler canopy compared to sole soybean and Soybean + pigeon pea during flowering whereas during pod filling, soybean plants under soybean + pigeon pea intercropping showed the coolest canopy temperature. Further, with respect to crop physiological parameters, yield attributing parameters, soybean equivalent yield and crop water use efficiency, soybean pigeon pea intercropping had significantly higher values than soybean + maize and sole soybean.

Collection, multiplication and evaluation of the germplasm/ genotypes/ accessions of different crops (Genetic garden for abiotic stress tolerance)

Collection, multiplication and evaluation of the germplasm/ genotypes/ accessions of different crops was continued during 2021. In all 141, 118, 77, 174, 250 and 296 accessions of pigeon pea, foxtail millet, finger millet, groundnut, cow pea and mungbean, respectively were collected. With these collections total number of crop germplasm collections /accessions was 1250. The list of collected germplasm/ genotypes/ accessions of different crops is given in Table 3.1.

Table 3.1: The list of collected germplasm/ genotypes/ accessions of different crops

SN	Crops	Germplasm/ genotypes	Stress tolerance	Source
1	Safflower	NARI-6, NARI-96 & GMU-2369	Drought	NARI, Phaltan
2	Sorghum	Madhura-2, Madhura-3 & Revati	Drought	
3	Stylo	Stylo hamata & Stylo sebrana	Drought	
4	Subabul	Wonder graze & Taramba	-	
5	Wheat	KRL 210, KRL 213, KRL 283, KRL 3-4, KRL 99, KRL 19, KRL 1-4 & Karchia 65	Salinity	ICAR-CSSRI, Karnal
		10 promising lines	Drought	ICAR-NIASM
6	Chickpea	72 Genotypes	Under evaluation	IIPR, Kanpur
7	Lentil	32 Genotypes	Under evaluation	IIPR, Kanpur
8	Pigeon pea	4 Genotypes	Water logging	ICRISAT,
9	Soybean	JS-7105, JS-9752, EC-456556, TGX 814-78D, TGX 885-44E, TGX 854-60A	Drought	ICAR-IISR, Indore
		JS-9752, EC-95815	Water logging	
10	Quinoa	14 Genotypes	Under evaluation	MPKV, Rahuri
11	Turmeric	16 Genotypes	Under evaluation	-
12	Brinjal	14 wild species	Under evaluation	IIHR, Bengaluru
13	Fenugreek	17 Genotypes	To be evaluated	NRCSS, Ajmer
14	Pigeon pea	141 Accessions	To be multiplied and evaluated in 2021-22	ICRISAT, Hyderabad
15	Groundnut	174 Accessions		
16	Foxtail millet	118 Accessions		
17	Finger millet	77 Accessions		
18	Cow pea	250 Accessions		NBPGR, New Delhi
19	Mungbean	296 Accessions		WVC, Italy

Evaluation of foxtail millet and finger millet accessions under nutrient poor soil

About 118 and 77 accessions of foxtail millet and finger millet were sown respectively in nutrient poor status soils of genetic garden plots. The foxtail millet with recommended fertilizers of NPK (40: 20: 20) were applied in controlled blocks and no fertilizers applied in treatment blocks. Similarly in finger millet controlled blocks applied with recommended fertilizers of NPK (60:30:30) and no fertilizers in treatment blocks were established. Preliminary observation indicated initial variation in germination, vigor, greenness and chlorophyll content at seedling stage. Irrespective of accessions in both crops the lines with no fertilizer showed slow germination, low vigor, This field experiment was conducted at E_3 plot of Genetic Garden where soil nutrient status is very poor chlorosis and less chlorophyll content.

Fig. 3.10: Variations in seedling emergence and greenness (chlorophyll) in foxtail millet

Differential response of chickpea genotypes under soil moisture stress

An experiment was conducted to identify the plant traits associated with soil moisture stress tolerance and promising genotype for soil moisture stress tolerance. The experiment was conducted using a set of 22 chickpea genotypes and Digvijay as check under two water regimes of well-watered and water deficit. In first experiment plant were grown in pot in natural condition upto 25 DAS after that plant were shifted to plant phenomics facility. For stress treatment with holding of water was done after 30 DAS and optimum water was applied for control in alternative day. For investigation of root traits *in vitro* experiment was conducted by using MS medium and 5 % PEG was used to induce stress. The genotypes were evaluated by using morpho-physiological parameters of canopy such as Chlorophyll content, relative water content (RWC), SPAD chlorophyll meter reading (SCMR), Chlorophyll fluorescence (Fv/Fm), biomass and root traits like root length, root area, number of secondary roots and root biomass.

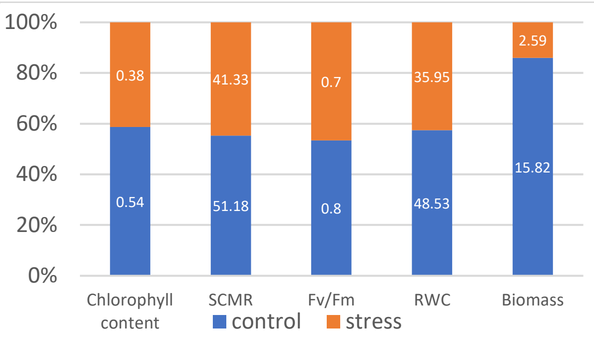


Fig 3.11a: Impact of soil moisture stress on morpho-physiological parameters

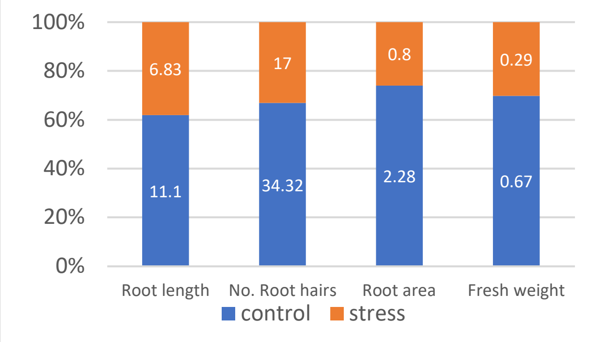


Fig 3.11b: Impact of 5% PEG on root traits

Fig. 3.11a and b indicates that, the physiological parameters like SCMR, chlorophyll fluorescence, total chlorophyll content, relative water content and biomass decreased by 19.24, 10, 30.11, 7.97 and 90.11 % respectively in stressed genotypes as compared to control The root parameters like root length, number of root hairs and root biomass decreased by 38.46, 50.46 and 50.56 % respectively in stressed genotypes as compared to control. JG 16 showed better morpho-physiological parameters and root system than the local check Digvijay and therefore can be used as donor of drought tolerance in chickpea cultivars in breeding program for drought prone areas and also from these experiments. It is concluded that physiological parameters and root traits are reliable parameters in screening the soil moisture stress tolerant chickpea genotypes

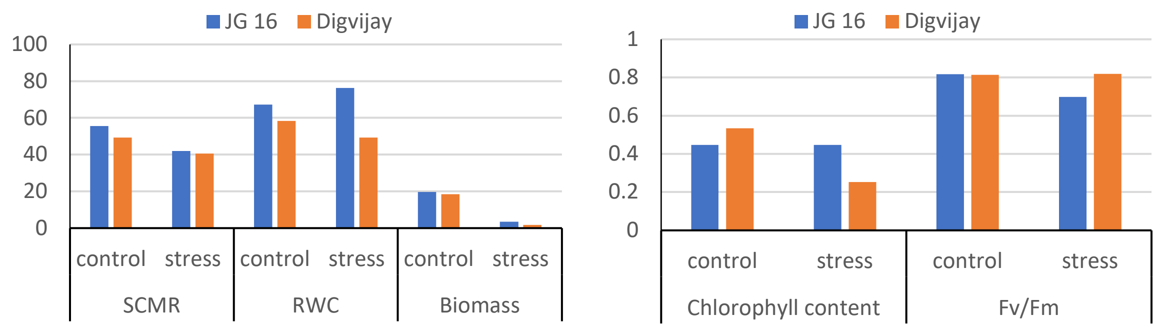


Fig 3.12: Genetic variation in morpho-physiological parameters under stress and control

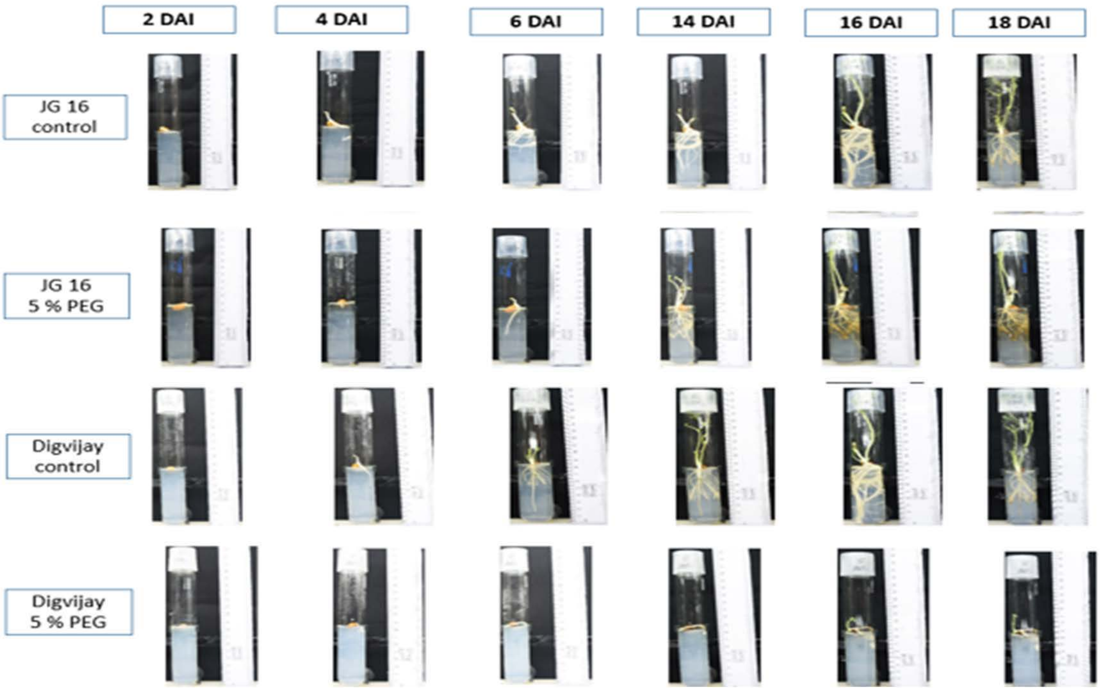


Fig. 3.13: Genotype JG16 and local check Digvijay under control and stress

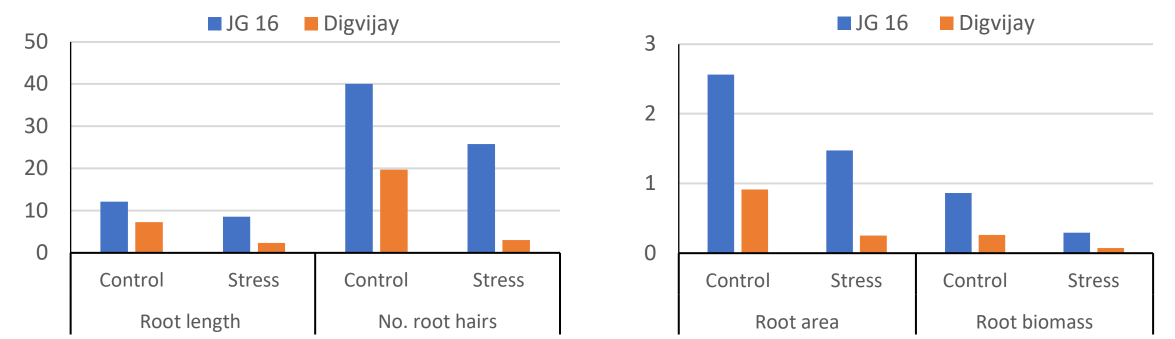


Fig. 3.14: Genetic variation in root traits in 5% PEG and control

Morpho-physio characterization of eggplant species for drought tolerance

Fifteen species of eggplant were planted in field in two replications. Drought like conditions were imposed by withholding irrigation for 4 weeks (One month) after 60 days from planting till maturity (peak fruiting) whereas providing irrigation twice a month. During stress period observation on physiological and morphological traits were recorded and also observed for recovery of stress affected plants seven days after re-watering. It was found that almost all the species recovered from stress. The different species adapted different strategies for avoiding/tolerating the drought condition.

Evaluation and characterisation of turmeric genotypes under nutrient poor and shallow soils

Sixteen genotypes of turmeric were evaluated to know their performance under nutrient poor and shallow soils during rabi 2020-21. It was observed that the variety Allepppy Supreme, followed by Rajendra Sonia, Lackdong, Waygoan, NDH-98, BSR-2 and Roma performed well (based on dry yield per plant) under poor nutrient and shallow soils. However, the varieties Prahba, Sudharshan and lackdong recorded high dry recovery which is positively correlated with piercing force of inner core.

Conventional phenotyping to assess drought responses of chickpea (*Cicer arietinum*, L.) genotypes

An experiment was conducted with 33 chickpea genotypes for depleting soil moisture stress condition with 3 replications. Phenotyping tools such as infra-red thermography, chlorophyll fluorescence imaging system and canopy greenness were employed to assess the differential response of genotypes under stressed condition. Advancement of soil moisture depletion was monitored by gravimetric method. Drought stress was imposed 60 DAS by withholding irrigation. Growth as well as physiological responses of chickpea genotypes to drought was recorded periodically. Results revealed that genotypes – GNG 1958, JG-16, BGM 408 maintained their canopy cooler than check variety under soil moisture stress. Genotypes like Pusa Green 112, BGM 408, GNG 1958 and Digvijay maintained their canopy greenness even under stressful conditions. Genotypes like JG-16, BGD 103, JG-74, PG-5 yield significantly higher than local check variety – Digvijay. However, genotypes like RSG-896, JG-16, BGD-103 produced moderately higher biomass under stressful condition. It could be concluded that genotypesJG-16, BGM 408 can be considered as potential source for drought tolerance in chickpea breeding programs for semi-arid regions.

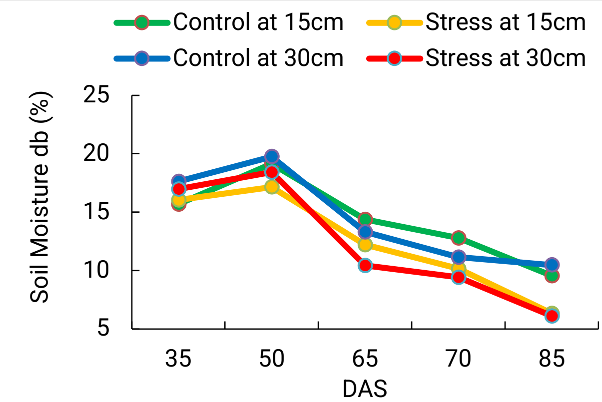


Fig. 3.15a: Advancement of soil moisture depletion over the period

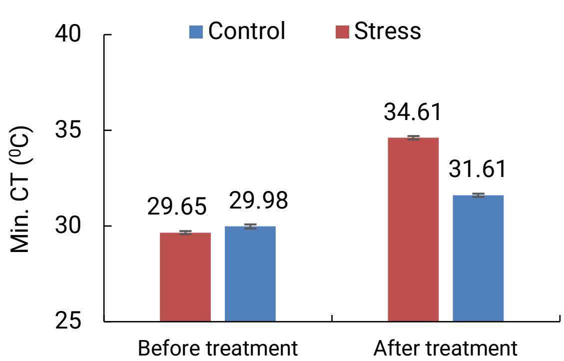


Fig. 3.15b: Effect of irrigation treatment on minimum canopy temperature of plants

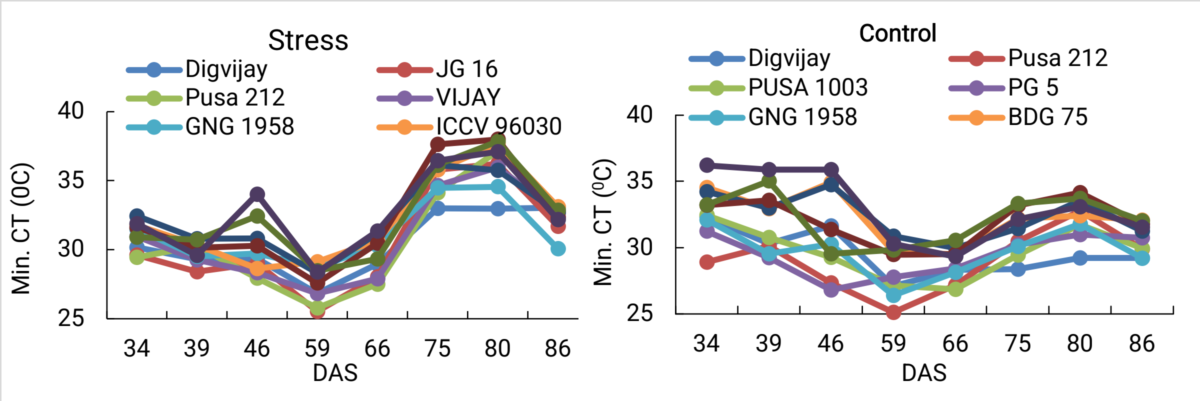


Fig. 3.15c: Genotypic variation with respect to their canopy temperature under control and stress conditions

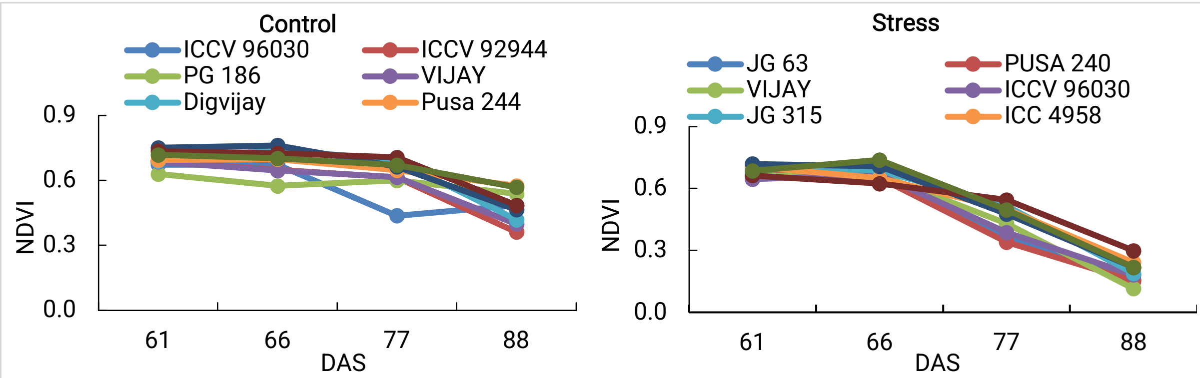


Fig. 3.15d: Genotypic variation with respect to their canopy greenness (NDVI) under control and stress conditions

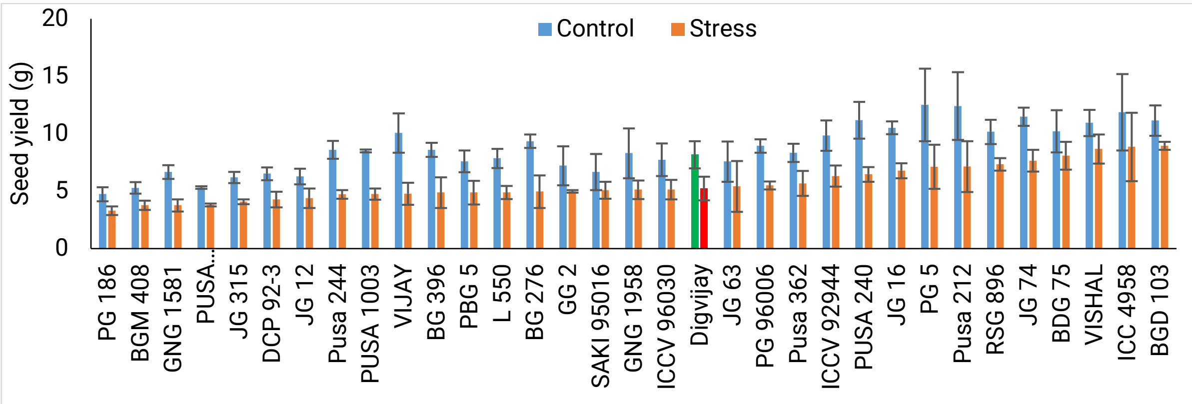


Fig. 3.15e: Genotypic variation with respect to their seed yield (g/plant) under control and stress conditions

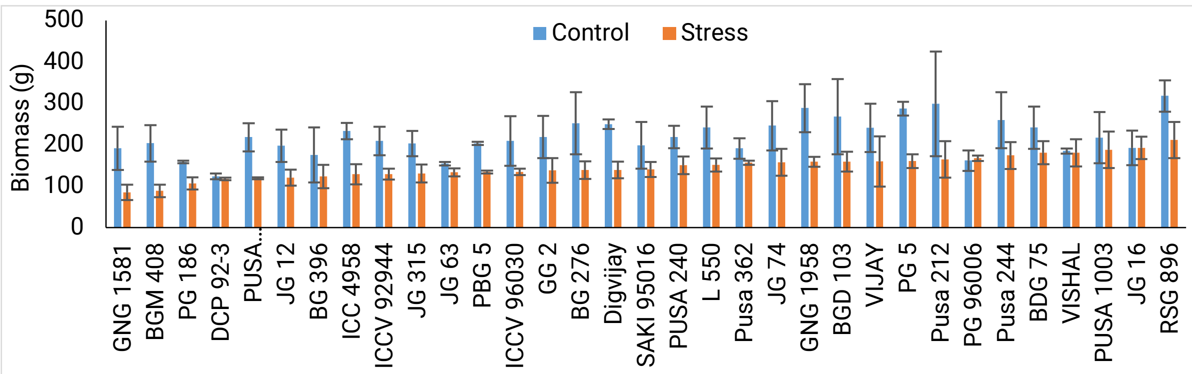


Fig. 3.15f: Genotypic variation with respect to their biomass (g/m^2) under control and stress conditions

Elucidating the influence of rootstocks on drought response of grafted tomato under high through-put phenomics

Tomato is one of the most important vegetable crops due to its many fold uses and high nutritive value. The water shortage during the drought period has significant implications on the production leading up to 50% loss in tomato which makes it imperative to develop strategies to mitigate the adverse effects of drought. The roots are the primary and utmost important part of the plant system which act as a source to maintain soil-water-plant continuum. In the present study, we used a high through-put phenomics facility to assess the efficiency of tomato, grafted on the rootstocks of different genetic backgrounds, at different levels of moisture in the soil (Fig. 3.16). Rootstocks included tomato cultivars and the hybrids, derived from the crosses involving wild relatives as donor parents. Among the rootstocks, an interspecific derivative RF4A was highly efficient in terms of productive use of water. The RF4A rootstock-grafted plants were more conservative in water use with higher plant water status through relatively better stomatal regulation and hence were more efficient in generating more biomass under water stress conditions. These plants could maintain a higher level of PS-II efficiency signifying better photosynthetic efficiency even under water stress. The distinct response of interspecific rootstock, RF4A, to water stress can be attributed to the effective root system acquired from a wild parent (*S. pennellii*), and hence efficient water uptake. Overall, we could demonstrate the efficient use of a phenomics platform and could develop a protocol to identify promising rootstock-scion combinations of tomato for efficient water use.

Fig. 3.16: Grafted tomato plants in plant phenomics facility

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

Nitrogen (N) management is among the most widely and intensively studied topics in contemporary agronomy because of its crucial importance in food production and environment. Majority of cereals are produced using about 50% of synthetic fertilizer-N produced today. However, a larger part of this applied N is lost due to volatilization and leaching. 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 improving nitrogen use efficiency (NUE). Therefore a field experiment was initiated in February 2021-22 to evaluate the role of enhanced urea (urease inhibitor N-(nbutyl) thiophosphoric triamide (NBPT) added to urea for reducing environmental loss and to improving fertilizer efficiency in sugarcane-based cropping system in India. A secondary objective is to determine if at least a 20% reduction in nitrogen fertilizer

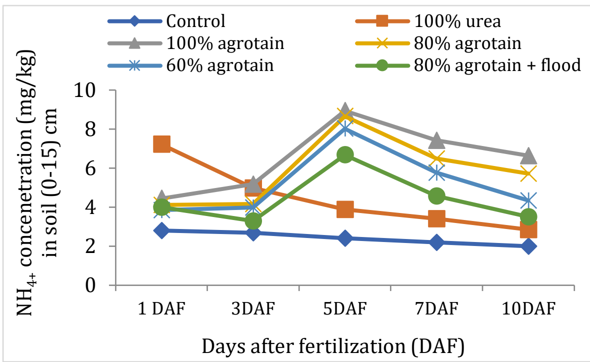


Fig. 3.17: NH_{4+}concenetration (mg kg^{-1}) in soil during pre-growth stage of sugarcane

is feasible without negatively impacting farmer productivity and profit. The experiment was laid out in a randomized complete block design with six treatments and four replications. The size of each plot was 88 m^2 (8 m width x 11 m length). Sugarcane variety Nayana (CO-86032), a recommended drought tolerant variety for the region, was manually planted on 16^{th} February 2021 with spacing of 120 cm x 60 cm under drip irrigation. Basal application of P (140 kg/ha) and K (140 kg/ha) was done. Fertilizer N as urea was applied in three split doses to sugarcane crop at critical growth stages i.e. at Tillering (45 days after planting (DAP)); pre-growth (105 DAP) and grand growth stage (135 DAP). All the recommended package of practices for sugarcane was followed and N- treatments were applied as per the technical programme. Preliminary soil analysis indicated that NBPT urea **(**Agrotain) treated plots had delayed urea hydrolysis at 0-15 cm soil depth.

Effect of sowing date and establishment technique on quinoa growth, development and yield in native murram soil

Achieving SDG's (eradication of poverty, hunger and all forms of malnutrition) require renewed efforts on productivity and income of smallholder farmers while conserving the natural resource base. One such approach is to explore non-conventional pathways such as wider adoption of alternative crops. 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 tangible 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 initiated to assess the effect of sowing date and technique on quinoa germination, development and yield in native murram soil. The first year data revealed that minimum temperature played a fundamental role in germination and development of quinoa. Sowing on second fortnight of December had better morphological and yield attributes (plant population, panicle height & weight, no. of panicles per plant, seed & biomass yield). Both flat bed and ridge and furrow method of sowing had comparable seed yields.

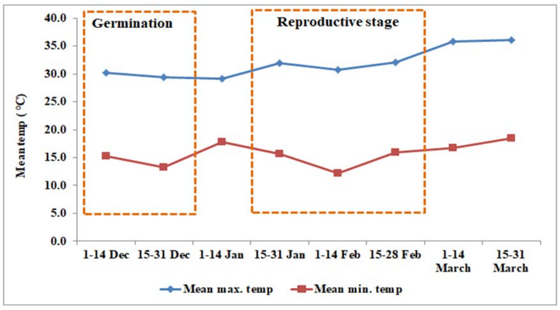


Fig. 3.18: Effect of mean temperature on quinoa germination, growth and

Mitigating water stress effects in vegetable and orchard crop

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

Custard apple responses to plant bio-regulators (PBRs)

A field experiment was initiated to assess the custard apple cultivars responses to PBRs at different growth stages during the year 2021. The experiment was replicated thrice in CRBD with four custard apple cultivars (cv. Balanagar, *cv.* Annona-2, *cv.* NMK-1 (Golden) and *cv.* Hyderabad selection). Four PBR treatments *viz.,* irradiated chitosan (IC, 2ml L^{-1}), seaweed extract (SE, 1.5ml L^{-1}), thiourea (TU, 600 ppm) and control (no PBRs) were foliar sprayed at fruit initiation, development and maturity stages, respectively. The maximum $Qy_{\_max}$ (0.76) was recorded for TU with NMK-1 irrespective to different fruit growth stages (Fig.3.19a and Fig. 3.19b). While RWC continuously declined from fruit initiation to maturity stages i.e. 89.1, 63.4 and 57.4% at fruit initiation, development and maturity stages, respectively. This clearly indicates that foliar use of PBRs have role for maximizing fruit yields in water stress conditions.

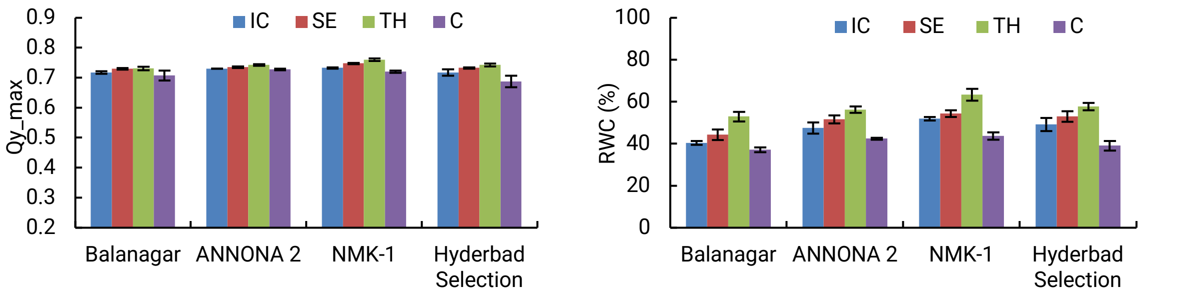


Fig. 3.19: (a) Changes in PS-II (Qy_max) and (b) relative water content (RWC) at fruit development stage of different custard apple cultivars under foliar application of plant growth regulators (PGRs)

Effect of soil mixtures and plant growth regulators (PGRs) on fruit size and storage quality of dragon fruit

The smaller and non-uniform fruit size is one of the major constraints restricting marketable yields of dragon fruit. The key reason would be poor water retentive and fertile soils. Therefore, interactive effect of three soil mixture [native murrum (N), black (B) and mixed (1 B: 1 N)] and four plant growth regulators [25 ppm gibberellic acid (GA3), 20 μM salicylic acid (SA), 600 ppm thio-urea (TU) and Control (no PGRs)] for improving fruit size and storage quality of dragon fruit was studied. These were applied exogenously at bud initiation, after flowering and fruit development stages in standing crop at field conditions.

Fig. 3.20: Storage of dragon fruit

Table 3.2: Interactive effect of soil mixtures and PGR on fresh weight of dragon fruit

Soil type	Treatment	Mean Fruit weight (g)	Std. Dev	CV (%)
Native (N)	GA3	339.6	48.5	14.3
	SA	331.9	36.8	11.1
	TU	338.8	30.4	9.0
	Control	301.9	73.5	24.4
Mixed (1 B: 1 N)	GA3	437.9	16.1	3.7
	SA	394.1	30.8	7.8
	TU	422.5	23.8	5.6
	Control	362.5	39.0	10.7
Black (B)	GA3	364.5	11.9	10.3
	SA	345.3	10.0	9.2
	TU	359.5	8.7	7.7
	Control	303.3	14.4	15.0

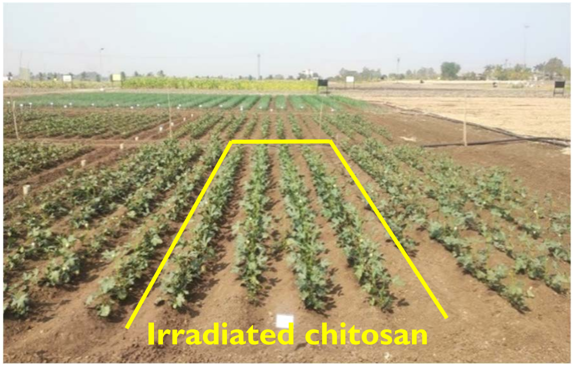
Further matured fruits were stored at standard storage conditions (8ºC and 65 RH) for 32 days (Fig. 3.20). The preliminary results showed that foliar application GA_3 improved the mean fruit weight by 12.5, 20.2 and 20.8% in native, black and mixed soils as compared to control, respectively. Mean fruit weight of dragon fruits treated with GA_3 and TU were almost at par. Irrespective to PGRs, maximum fruit weight was observed in mixed soil than the black and native soils (Table 3.2). Interestingly, variability in mean fruit weight reduced significantly with PBRs (CV= 3.7-14.3%) as compared to control (CV=10.7-24.4%). Total physiological weight loss (PWL) ranged between 3-31.8% for fruits harvested from all PGRs and soils during storage of 32 days. Minimum PWL was observed in fruits harvested from mix soil with TU, whereas maximum PWL found in black and native soil with GA_3 treatment.

Okra (*Cv. Singham*) yield responses to plant bio-regulators (PBRs) for alleviating water stress

A field experiment was conducted during 2021 to evaluate the interactive effect of plant bio-regulators (PBRs) viz., 600 ppm thiourea (TU), 20µM salicylic acid (SA), 100 ml/L biopolymer, 5 ml/L irradiated chitosan (IC), 5ml /L sea weed extract and control (no PBRs) and varied levels of water stress maintained using line source sprinkler system (LSS). The four levels of water stress were applied based on climate meteorological approach i.e., IW: CPE 1.0, 0.75, 0.50 and 0.25, respectively. Preliminarily results revealed that okra pod yield improved by 19.6-26.1% with PBRs. The maximum water productivity (WP) improved by 12.9-13.5 kg/m^3 with PBRs while it was 11 kg/m^3 without PBRs and thereby reduced water usage by 7.9-21.1%. Further highest fruit firmness was obtained at IW: CPE 0.75 with IC. It is concluded that exogenous application of PBRs like IC and SWE could effectively improve yield and post-harvest quality of eggplant fruit and showed a major role for alleviating water stress under moderate and severe water deficit conditions.

Onion responses to sulphar sources for improving yield and storage quality of onion

A field experiment conducted during 2021 reconfirmed that to bulb yield and quality of onion varied with sulphur sources (elemental form) under water stress conditions. Particularly, bensulf (50%) and SOP (50%) minimized physiological weight losses by 18–20.7% during storage. Dry matter, rehydration ratio, TSS, protein content, total phenolics, pyruvic acid and antioxidant enzymes activities increased during storage but in irregular pattern.



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

Research activities conducted under CRPCA project are summarized below

Optimizing planting techniques, micro irrigation and residue management practices for better sugarcane productivity in sugarcane cropping system

During the year 2021, a field experiment was imitated to optimize the effect of zigzag paired row planting, subsurface drip irrigation and intercropping (groundnut-fenugreek) with aim of enhancing productivity of sugarcane cropping system. For this 30 days old seedlings of most popular sugarcane variety Co-86032 were transplanted into eight main plot treatments *viz.,* M1: Zigzag Paired Row (ZPR) (60 cm-plant spacing ,150 cm-row spacing) + Sub-Surface Drip Irrigation (SSDI); M2: ZPR (75 cm, 150 cm) + SSDI; M3: ZPR (60 cm, 210 cm) + SSDI; M4: ZPR (75 cm, 210 cm) + SSDI; M5: ZPR (60 cm, 225 cm) + SSDI; M6: ZPR (75 cm, 225 cm) + SSDI; M7: ZPR (60 cm,180cm) + SSDI; M8: ZPR (75 cm,180 cm) + SSDI. Two soil cover treatments included S1: Groundnut residue + sugarcane trash and S2: without residue were accommodated in sub-plots. An absolute control surface irrigation management practices was also maintained to compare the treatment effects. The preliminary results showed 39.5 and 51.3% improvement in yields of groundnut and fenugreek in M5S1 treatments in comparison to M3S2, respectively indicating possibility of improving productivity sugarcane cropping system using intercrop. The yields responses of sugarcane will be recorded at harvest.

Intercrop 1: groundnut

Soil cover with groundnut residue

Intercrop-2: fenugreek

Fig. 3.21: Overview of experimental plot

Responses of growth regulators, crop residue and micro-irrigation for alleviating water stress in sugarcane

A field experiment is being conducted to study the interactive responses of plant growth regulators (PGRs), crop residues and micro-irrigation for alleviating water in sugarcane (Co-86032). The main treatments consisting of three water stress levels viz., I1: 50% DI; I2: 75%DI and I3: 100% (full irrigation) were applied during cropping period. Two soil surface cover management practices viz., S1: Intercrop (chickpea) residue covering and S2: no residue was accommodated in subplots. 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 are under process.

Sugarcane responses to tillage, crop residues and nutrient management practices

A field trial is being conducted for optimizing the interactive effects of tillage, crop residues and nutrients management's practices in sugarcane (Co-86032) during the year 2021. Three main plot treatments included combination of tillage and nutrient management practices viz., M1: laser land levelling (LLL) + conventional tillage (CT) + 10% of recommended dose of fertilizers (RDF, 500:200:200; N:P:K kg ha-1) applied as basal and remaining 90% doses of fertilizers applied through fertigation; M2: LLL + minimum tillage (MT) + 25% of RDF as basal and 75% through fertigation and M3: LLL + reduced tillage (RT) + 15% of RDF as basal, 20% through band placement and remaining 65% through fertigation. In M3 treatment, 20% of RDF was band placed with MRD machine rather than broadcasting in standing crop at 60 days after planting of sugarcane. The fertigation was done at 15 days interval started at 15 days after planting as per the treatments. Two soil surface cover management practices viz., S1: live trash of sugarcane as mulch and S2: without residue, were accommodated in sub-plots. An absolute control with CT without LLL, recommended nutrient and surface irrigation management practices was also maintained to compare the treatment effects. The real time data of crop growth, soil and water parameters was recorded.

3.4 Research Programme 4: Social Science and Policy Support

The transfer and adoption of technology through supportive policy framework is considered the final step in the process of research and technology development. Therefore, an effective extension system is crucial in the dissemination and successful adoption of technologies among the end-users. 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 and subsequent targeting of the potential technologies to mitigate abiotic induced stress and enhance the farmers' income. The major activities of the school were investigations for targeting technologies and policy suggestions, human resource development, technology transfer and frontline extension along with developmental programs of SCSP and TSP. The major research and extension activities under the school and the progress made in the research project during 2021 are summarized below.

Investigations for geospatial targeting of technologies and policy suggestions

The geospatial targeting of technologies and policies is aimed at identifying the potential areas at regional and national scales for dissemination of pertinent technologies by customizing geospatial tools for collection, depiction and interpretation of datasets from freely accessible data sources. Several of the open source ICT and software tools are used for web scrapping datasets, its compilation into digital databases and statistical analysis for meaningful interpretation and formulation of policies. The identification of areas suitable for technology targeting would be useful in estimating the market and therefore the value of the technology.

Identification of fisheries cage culture in inland open water bodies using sentinel-2A satellite imagery for monitoring and technology targeting.

Fisheries cage culture has boomed in India in the past decade and is becoming a significant source of cultured inland fish for human consumption. However, the perceived and potential environmental effects on and from fisheries aquaculture in form of abiotic and biotic stresses are a primary concern in developing an ecologically responsible industry. The absence of a unified database of cage culture installation sites in India has created a hazy picture of cage culture growth for state and national agencies concerned with monitoring and formulation of policies for aquaculture. Generating the database of cage culture in inland open water bodies of India would be unfeasible by visiting the sites due to the sheer size of its geographical spread and the growth rate of the sector. Therefore, the remote identification of the cage cultures across the large water bodies using the multispectral satellite imagery of Sentinel 2A was explored. The bands (B1 to B12) were examined for their ability to distinguish the cage from non-cage features using Classification and Regression Trees (CART) and Random Forest (RF) classification techniques in the Google Earth Engine (GEE) platform. The sentinel images for Maharashtra state (India) corresponding to the latest google earth imagery were subjected to the image processing pipeline for removing cloud cover; separating water from land; segregating water bodies larger than 1000 ha; generating training and validation datasets; fitting machine learning models and generating model performance metrics. The overall, producer and consumer accuracies obtained using CART model for the validation dataset were 0.92, 0.91, and 0.93, respectively; and 0.95, 0.96, and 0.93, respectively for RF model. RF model performed better than CART in overall, producer and consumer accuracies and therefore could be used to identify cage culture installations regularly to create the database useful for the monitoring agencies and for targeting technology.

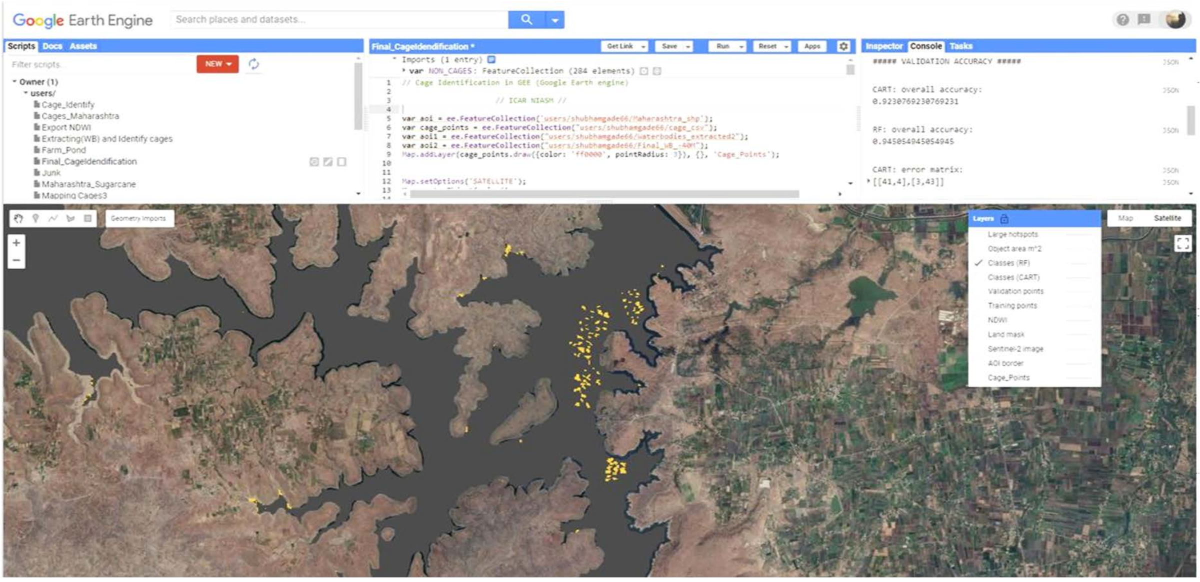


Fig. 4.1: Identification of fisheries cage culture in inland open water using Google Earth Engine

Cage Culture Directory of India

An online Cage Culture directory of India has been developed to compile database on the existing cage culture locations in India based on first hand data collected using open-source Maxar satellite images. This directory provides user with options for searching and sorting cage culture sites state-wise and provides Geo-tagged location, Google Plus Code along with cage type and other additional details available. This directory is first attempt of its type to provide geotagged locations of cage culture locations in India. The cage culture directory can be accessed online on the website link www.niam.res.in/CageCultureDirectoryofIndia.html and is updated on periodic basis.

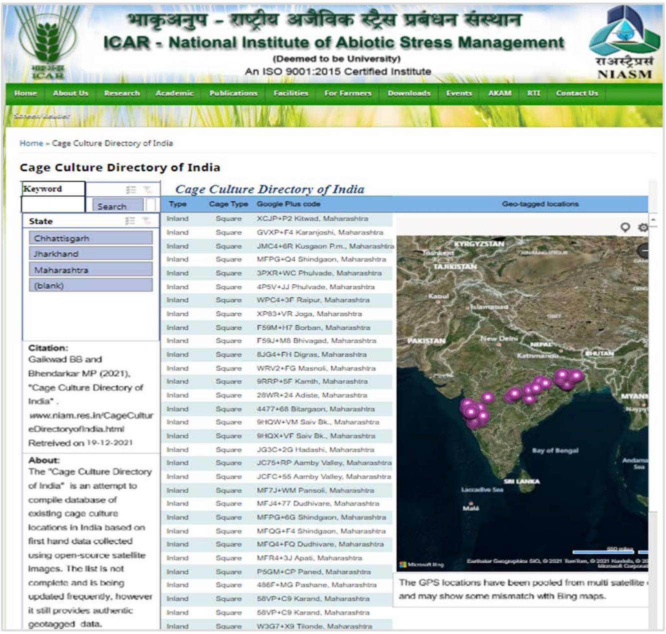


Fig. 4.2: Screenshot of webpage of 'Cage Culture Directory of India'

Prioritization of strategies and policy reforms to support fisheries sector during and post-Covid-lockdowns, using the Multi-Attribute Decision Making (MADM) techniques.

The online snowball sampling done during the Covid-Lockdown period in India, involving 517 respondents revealed the major problems faced by people involved in fisheries as business, viz. lack of transportation facilities, less demand in the market, non-availability of fish seed, non-availability of fish meal & other equipment, unavailability of labour, and technical support. The solutions in form of strategies and reforms, needed to overcome these in the post-covid-lockdown period, were gathered from the respondents/stakeholders, as a bottom-up approach to problem-solving. These were further ranked on a seven scale rating scale by group of 30 experts from the fisheries sector across four attributes of A) Priority of implementation, B) Perceived impact on implementation, C) Ease of implementation, and D) Funding requirement for implementation. A list of strategies and policy reforms to support the fisheries sector in future Covid-lockdowns or similar scenario were also gathered by same fisheries experts and rated on a seven-point scale across four attributes listed above. Out of the responses received, the ratings given by 18 experts were selected based on their completeness, rationality and consistency of ratings among the group. Four weighting methods viz. SWARA (Stepwise Weight Analysis Ratio Assessment), AHP (Analytic Hierarchy Process), MWM (Mean weight method) and EWM (Entropy weight method) were used to assign weight to the attributes which also represented four scenarios as Scenario I) Highest weightage to the priority of implementation as in case of Extended covid lockdowns (represented by SWARA weights); Scenario II) Equal and higher weights assigned to Priority of implementation and Perceived impact on implementation as in case of Intermediate covid lockdowns allowing improvements in subsequent lockdowns (represented by AHP weights); Scenario III) Equal mean weights as in case of covid as new normal (represented by Mean weights) and Scenario IV) Higher weights to funding requirement followed by ease of implementation as in case of Government/stakeholders facing constraints of funds and manpower (represented by higher Entropy weights). Seven Multi-Attribute Decision Making (MADM) methods based on weighted-sum models namely, WSM (Weighted Sum Model) and SAW (Simple Additive Weighting); out-ranking method namely ELECTRE III; and distance-based models namely TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), MABAC (Multi-Attributive Border Approximation Area Comparison), VIKOR (Viekriterijumsko Kompromisno Rangiranje) and GRA (Grey Relational Analysis) were used using the above listed four weighing methods to judge the suitability of these methods in ranking the solutions that allowed explainable rationale of rankings by the analyst. The ranking results under Scenario-I are given in Table 4.1 & 4.2, while those of four scenarios/weighting methods are shown using the colour map in Fig. 4.3 along with the cumulative ratings of all experts and the consistency index which tells about the consistency among expert ratings. The WSM, SAW, TOPSIS, MABAC & ELECTRE3 ranked the strategies and reforms almost similar and were therefore only considered to calculate the final ranking of solutions based on the cumulative ranking scores. However, the VIKOR & GRA ranked only the top & bottom ranks similar to the rest of the methods and deviated a lot for the intermediate rankings.

Table 4.1: Prioritization of strategies under Covid 19/ similar lockdown situation.

Sl. No.	Strategies
1	Creating modernized hygienic fish marketing hubs in potential zones
2	Policy measures to bring aquaculture industry under essential and priority sector (to support transportation of inputs, marketing, processing, import and export activities)
3	Mechanism for doorstep delivery of fisheries input (seed, feed, medicines etc.)
4	Promotion of domestic market by increasing awareness about safety of consumption of fish products (through ICT awareness campaign/KVK/radio talks/ advt. etc.)
5	Value addition: Promoting techniques to enhance the shelf life of fish and fish products
6	Digitized tools for e-governance (licencing of fisheries stakeholders and traceability of produce)
7	Promotion of Biofloc and Recirculatory Aquaculture Systems (RAS) for enhancing resilience
8	Development and promotion of e-commerce platform like eSanta for eliminating middlemen
9	Establishment and strengthening of Fish Farmers Producer Organization (FFPO)
10	Simplified insurance schemes for the fisheries sector
11	Developing fair pricing mechanism for fisheries commodities (similar to MSP in agriculture)

Table 4.2: Prioritization of reforms suggested by the stakeholders in the post-Covid 19 period

Sl. No.	Reforms
1	Appropriate training for resource utilization, fish processing and consumption
2	Transparency in implementation of government fisheries schemes
3	Promotion and development of fish hatcheries at the local level
4	Export promotion
5	Promotion of farm pond based fish farming
6	Proper timely advisory services
7	Financial assistance to the individual fish farmer, fishermen and small traders
8	Simplified credit and subsidy support
9	Financial support mechanism to cope with the losses
10	Minimum support prices and price regulation for assured profitability
11	Extension of lease contracts for reservoirs
12	Hassle-free banking/credit support

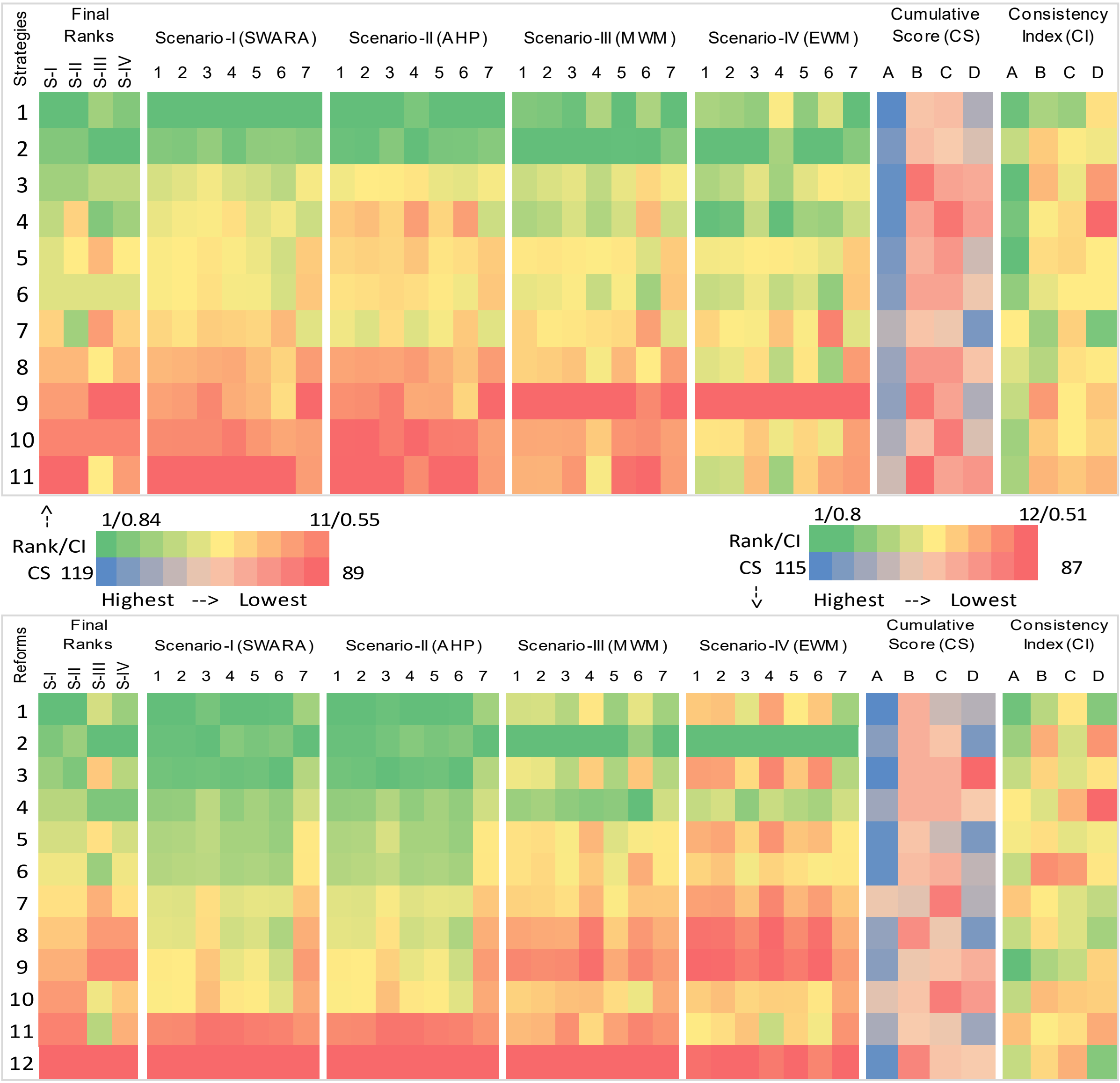


Fig. 4.3: Ranking, Cumulative scores and Consistency Index of strategies and reforms across four scenarios of Covid-19

Compilation of fire events database for targeting preventive measures in sugarcane growing areas.

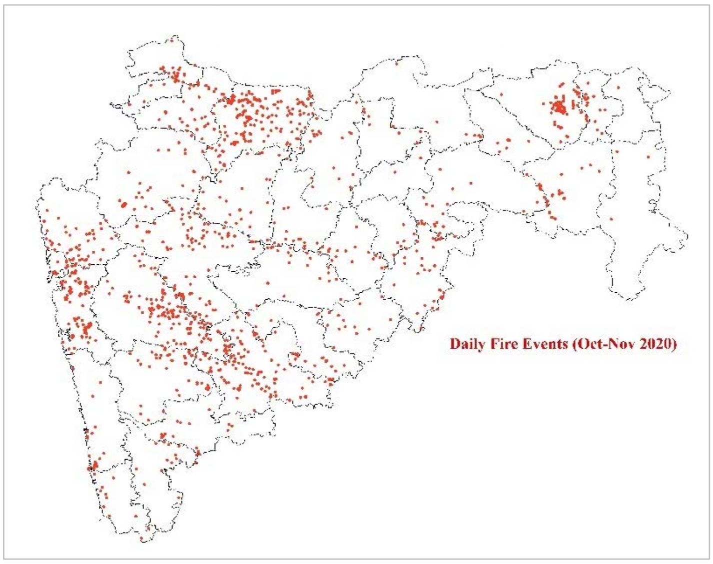


Fig.4.4: Fire events recorded in Maharashtra

The crop biomass burning has gathered significant attention in recent times as event causing air pollution, GHG emissions and adversely impacting soil fertility. Several of the crop residue management solutions in form of in-situ mechanized chopping and microbial decomposition of residues have emerged for crops like paddy as preventive measure. However, such solutions are still limited in crops like sugarcane which generates highest biomass above ground per unit area and is preferably burnt down owing to constraints of knowhow, affordability, availability and accessibility of preventive measures by farmers. The lack of established methodology that would allow monitoring of fire events is one such constraint, overcoming which would allow targeting the preventive measures in such areas by sugarcane factories, custom hiring centres and local government for suitable monetary support. A methodology to gather the fire events using the VIIRS NOAA-20 375 m daily satellite data available from January 2020, was developed to compile fire coordinates from October 2020 to May 2021 coinciding with the harvesting period of sugarcane in Maharashtra. In all 57,321 fire events were recorded during the duration in area of study. The sugarcane crop mask based on NDVI profile is being created to classify the fire event as sugarcane residue burned areas. These targeted areas will be used for estimating the GHG emissions due to sugarcane residue burning and for formulating strategy and policy suggestions for dissemination of preventive measures for sugarcane crop residue burning.

Bio-physical constraints and Socio-economic profile datasets of farmers of rainfed and dryland regions of Maharashtra

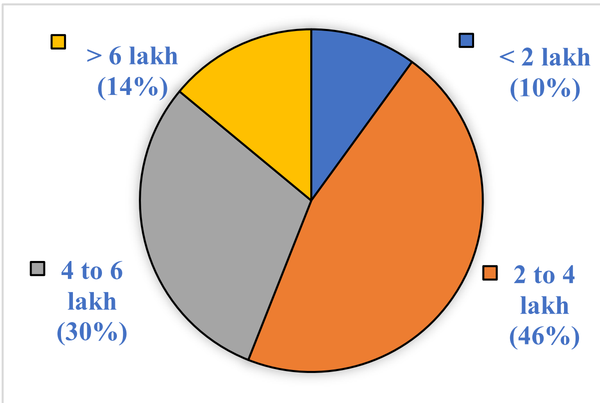


Fig. 4.5: Annual Income of Farmers (Lakh Rs.)

A survey was carried to identify the bio-physical and socio-economic constraints of farmers. The survey was conducted in Pune and Satara districts of Maharashtra to obtain information on abiotic stress in agriculture and the management practices to mitigate them. Well-designed questionnaire with a random sampling technique of data collection was followed with interview and group discussion tools.

The finding of the socio-economic profile shows that the majority of the farmers belonged to the medium age group (48%) followed by the old (30%) and young age group (22%). Majority also had upper secondary education (40%) and were small category farmers with 1.00 ha. to 2.00 ha. of agricultural land (56%) while 20% owned land less than 1 ha. 56% of the farmers stated agriculture as the primary profession along with secondary occupations such as dairy, poultry, etc. Whereas 44% of the respondents stated agriculture alone as the primary occupation. Majority of the farmers had more than 15 years of experience (60%) followed by 18% having 05-10 years of experience of agriculture. Majority has annual income ranging from Rs. 2-4 lakh per year (46%), while 30% reported earnings between Rs. 4-6 lakhs annually (Fig. 4.5). The frequency of contact and usage of information sources data were collected and the finding shows that Television (48%), Mobile (56%) was used most often or contacted as information source whereas agriculture officer (26%) was rarely contacted by the respondents.

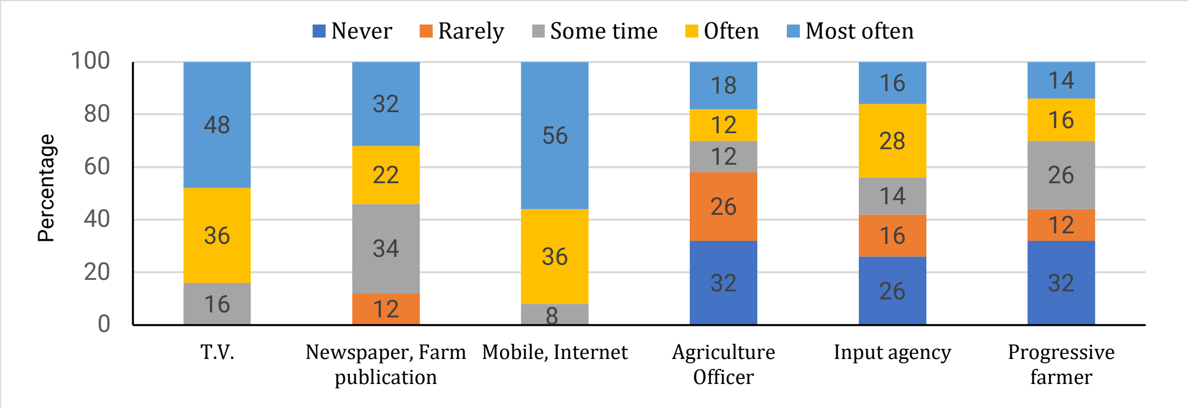


Fig. 4.6: The frequency of contact and usage of information sources

Bio-physical and socio-economic constraints faced by the farmers

The information on bio-physical and socio-economic constraints has shown that most of the farmers experienced drought in the alternate year and heavy rainfall occasionally (Fig. 4.7) which caused 42% & 46% loss in yield loss, respectively. 74% of farmers reported that uneven rainfall occured regularly, while 82% farmers responded to the regular occurrence of mid-season dry spells.

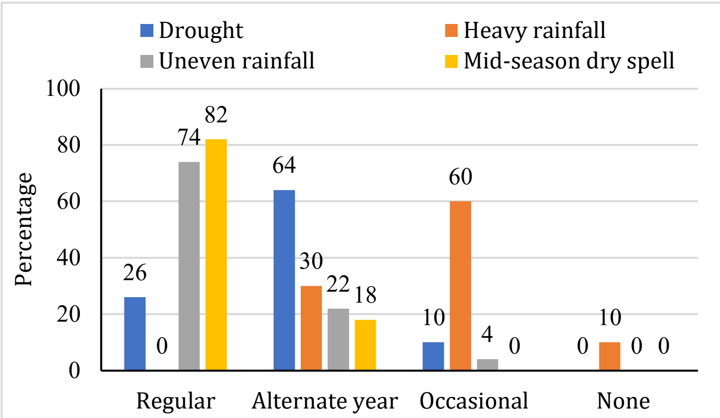


Fig. 4.7: Abiotic stress weather Events

Constraints faced by the Farmers

The farmers reported low market price (84%), high input cost (74%) and credit inadequacy (70%) as the major economic constraints, whereas the irregular supply of canal water (68%) and soil salinity (58%) as the major bio-physical constraints. Most of the farmers also reported the extension gap with the agriculture department (78%) and labour unavailability (66%) as other constraints faced by the farmers.

Fig. 4.9: Farmer Field survey

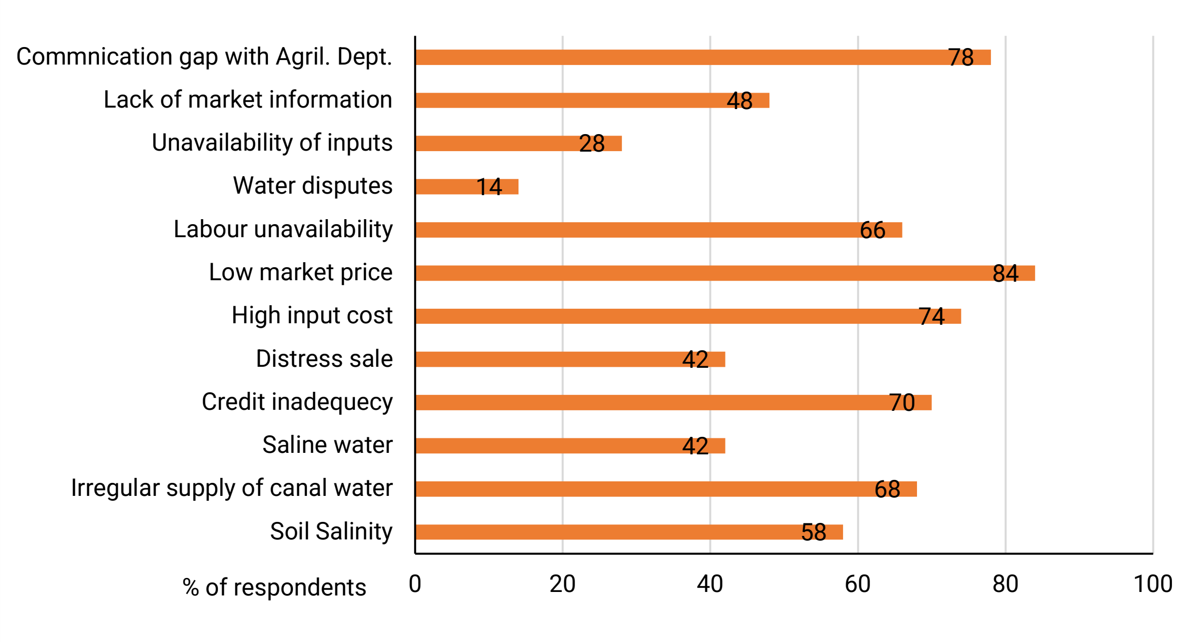


Fig. 4.8: Socio-economic and biophysical constraints faced by farmers

The correlation analysis of selected socio-economic variables with the adoption of conservation agriculture practices was carried out. The results as shown in Table 4.3.

Table 4.3: Correlation analysis

Sl. No.	Socio-economic variables	r value
1	Age	-0.1759
2	Education level	0.0711
3	Occupation level	0.0456
4	Farming experience	-0.2598
5	Land holding	0.4688
6	Annual income	0.2006
7	Extension contacts	0.4884

The frequent extension contacts, facilitate the information on technologies reaching stakeholders and encorage the adoption of conservation technologies. Therefore, there is a need to strengthen the extension network through informal education, skilled training and the use of ICT in the dissemination of technologies.

Compilation of socio-economic databases (Census 2011)

The raw datasets of Socio-economic parameters for level as (No of household, Total population, Total male population, Total female Population, Population of SC, Population of ST, Population of literate-illeterate, Total working male-female, Primary schools, drinking water facility, Tap water, well water, Tank water, tubewell, handpump, River water, canals, lakes, land under forest, Government canal, well (with and without electricity, basin, sub basin, Settlement extent from nearest town etc.) Number of households, Irrigation facility (Well, tank, Tubewell, River, Lake); Unirrigated Area, etc. of Census 2011 were sourced from several open access sources and compiled into database to create respective geospatial layers. This data will be used for targeting technology in abiotic stressed areas.

Scheduled Castes Sub Plan activities

Measures to improve the socio-economic conditions of Dalits were introduced in the 1950 Constitution of India which defines the Scheduled Castes (SC) and Scheduled Tribes (ST) for any State or Union Territory. Out of a total population in Maharashtra, 11.81% SC and 9.35% ST. The Scheduled Caste Sub Plan (SCSP) and Tribal Sub Plan (TSP) are the GOI schemes to uplift SCs and STs communities 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 and infrastructure development so as to reduce poverty among the target population. A multidisciplinary team comprising of Dr NP Kurade (Chairman), Dr SS Pawar (Member Secretary) and Members namely, Dr DD Nangare, Dr AV Nirmale, Dr BB Gaikwad, Mr Rajkumar, Mr MP Bhendarkar, Dr Aliza Pradhan and Dr K Ravi implemented the SCSP scheme in different districts for the year 2020-21.

Distribution of inputs to SCSP beneficiaries.

The SCSP activities were carried in four districts of Maharashtra, Pune, Ahmednagar, Solapur and Satara. Two types of interventions were carried out involving individual beneficiaries' and self-help groups (SHGs). A preliminary survey defining livelihood profile was carried out to prepare a list of beneficiaries and plan suitable intervention. The selection of beneficiaries was based on SC caste certificate, Aadhar card and ration card (either yellow or saffron). Most of the beneficiaries were landless casual labourers. Some of them owned livestock (dairy animals, small ruminants and poultry). The interventions planned included crops, orchards, livestock, fisheries, improving living standards, promoting health, etc. A sum total of 1619 farmers and 22 self-help groups (SHG) from 63 villages of 8 tehsils, namely, Baramati, Daund, Purandar, Indapur, Malashiras, Karjat, Jamkhed and Phaltan were included based on the survey (Table 4.4 and Fig. 4.10).

Table 4.4: Details of inputs provided under SCSP and the number of beneficiaries/SHGs

Sl. No.	Inputs Provided	Beneficiaries
1	Seeds (Jowar, wheat and chick pea) and fertilizers (Urea, SSP and MOP)	82 nos.
2	Goats	300 nos.
3	Poultry cages	150 nos.
4	Water filter	90 nos.
5	Sewing machines	40 nos.
6	Flour mills	100 nos.
7	Dairy Kits (milk can, bucket, milk measure, baskets, mineral mixture, deworming tablets)	300 nos.
8	Tool kits (khurpi, sickle, koyta, pick axe with chisel and spade + dragon fruit/light trap)	300 nos.
9	Battery operated sprayers	100 nos.
10	Bicycles	60 nos.
11	Bamboo's with koyata	55 nos.
12	COVID kits	1000 nos.
13	Tractors	2 SHG's
14	Power tiller with trolly	1 SHG's
15	Refrigerated cooling van	1 SHG's
16	Chilli powder making machines	4 SHG's
17	Fish seeds, feed and training	4 SHG's
18	Support for food stalls during Agri-exhibition	10 SHG's

Fig. 4.10: Various activities carried out under SCSP Scheme (2020-21)

Organization of Training/Field Day for skill development under SCSP

Skill development is essential in creating trained human resources to initiate revenue generation activities for individuals/SHGs. Aiming this, various training programmes and Field Days were organized under SCSP Scheme for the beneficiaries. The details are described below.

1. Field day programme on 'Better Management Practices in Aquaculture' on 23rd March 2021

A one-day field day program on 'Better Management Practices in Aquaculture"' was organized at Kambaleswar village and Malegaon (Kh) village Dist- Pune on 23rd March 2021. The programme was organized on the farmer's field at Kambaleswar village. SCSP beneficiaries from two villages participated in the program. Mr Mukesh Bhendarkar, Scientist (FRM) and Programme Coordinator, guided the farmers on various topics such as acclimatizing the fish to pass fish with the minimum stresses possible during seed stocking. All the Scheduled Caste Sub-Plan 2020-21 Committee members participated in the event. Mr Mukesh Bhendarkar, Dr Bhaskar Gaikwad and Dr Sachin Pawar coordinated the program.



2. Training Programme on 'Farm pond based Aquaculture Model' on 24th March 2021

A one-day training program on "Farm pond based Aquaculture Model" was organized at ICAR-NIASM, Baramati, on 24th March 2021. At the onset, Dr Himanshu Pathak, Director, ICAR-NIASM and Chief Guest, briefed the farmers about institute activities and emphasized the importance of the fish farming business and the need to learn newer technologies in fish farming. Dr Sharad Surnar, Aquaculture Expert, Pune, guided about artificial feed management and Pradhan Mantri Matsya-Sampada Yojana. Mr Mukesh Bhendarkar, the Training Coordinator, advised the farmers on commercially important fish species, freshwater aquaculture, management methods for modern aquaculture, GIFT tilapia. Dr Nitin Kurade, Chairman SCSP, briefed about SCSP program. A Technical Bulletin "मत्स्य संवर्धन मार्गदर्शिका" was released on occasion. The fish seeds and fish feed was distributed to all the beneficiary trainees. All SCSP Committee members participated in the event. Dr DD Nangre proposed vote of thanks. The training programme was coordinated by Mr Mukesh Bhendarkar, Dr Bhaskar Gaikwad and Dr Sachin Pawar.



3. Training on 'Farm pond based Aquaculture: A Business Opportunity' on 27th March 2021

A one-day training program on "Farm pond based Aquaculture: A Business Opportunity" was organized on 27th March 2021 at Jamkhed Dist- Ahmednagar. Dr Himanshu Pathak, Director, ICAR-NIASM and Chief Guest, briefed the farmers about institute activities and the importance of fish farming business with the adaptation of newer technologies. Dr Sharad Surnar, Aquaculture Expert, Pune provided guidance on artificial feed management and Pradhan Mantri Matsya-Sampada Yojana. Mr Mukesh Bhendarkar, the Training Coordinator, guided the farmers on various topics such as commercially important fish species, freshwater aquaculture, management methods for modern aquaculture, GIFT tilapia. Mr Mukesh Bhendarkar, Dr Bhaskar Gaikwad and Dr Sachin Pawar coordinated the programme.



Tribal Sub Plan activities

TSP team has conducted farmers interaction meeting (Kisan Gosti) in several villages such as Vadadha, Mothekadwan, Karnji Budruk, Vavdhi, Nanagipadha, Vadhkhut, Khokasa, Paati of Nandurbar district during 26.12.2021 to 29.12.2021. During training and interaction meetings (Kisan Gosti) with tribal farmers, they got acquainted with the improved technologies in livestock, fishery, horticulture, agro-processing, etc. The team emphasized the adoption of the holistic approach (Integrated farming system) in agriculture for the nutritional and livelihood security of tribal farmers in changing climatic conditions. We have also visited the field plots, livestock farms and farm ponds of some of the farmers for further planning of horticulture, livestock and fishery activities. Demands were received from farmers for the improved varieties of seeds of several crops such as groundnut, wheat, onion seed, fodder crops etc. Fish farmers also demanded for fishing nets for harvesting of the fish.

Table 4.5: Details of the training, demonstration and field days at Nandurbar under Tribal Sub plan

Sl. No.	Trainings/Field demonstration	Team of the Scientist	No. of Beneficiaries	Date of activities
1	Agri-Aquaculture integrated farming (Fish Cum Duck Cum Poultry Cum Animal)	S A Kochewad, Paritosh Kumar and Neeraj Kumar	53	27.12.2021
2	Backyard poultry practices	S A Kochewad, Paritosh Kumar and Neeraj Kumar	56	27.12.2021
3	Livestock management	S A Kochewad, Paritosh Kumar and Neeraj Kumar	49	27.12.2021
4	Kitchen Gardening and Waste Management for Manure production	Paritosh Kumar, SA Kochewad, Neeraj Kumar	42	28.12.2021
5	Field demonstration for Fish culture including feeding	Neeraj Kumar, SA Kochewad, Paritosh Kumar	40	28.12.2021
6	Culture of carp in small pond area	Neeraj Kumar, SA Kochewad, Paritosh Kumar	48	28.12.2021

The team has interacted with 21 Women SHG viz. Santosh Mata SHG Groups, Vaishani Mata SHG Groups, Ujjawala SHG Groups, Aarov SHG Groups, Jijmata SHG Groups, Biswash SHG Groups, Mahila SHG Groups, Shri Swam Sahayata SHG Groups, Radha Swayam SHG Groups, Aarti SHG Groups, Nihal SHG Groups, Pragati SHG Groups, Tulsamata SHG Groups, Piyu SHG Groups, Devmogra SHG Groups, Jyoti SHG Groups, Savitribai SHG Groups, Sumit SHG Group,Suhani SHG Groups, Parvati SHG Groups, Priti SHG for women empowerment through agro-processing entrepreneurship activities. The team also disseminated the NIASM technologies among the tribal farmers.

Fig. 4.11: Training being imparted under TSP programme at Nandurbar district

Agriculture Technology Week 18th-24th January, 2021

The Technology Week was jointly organized by the Krishi Vigyan Kendra, Baramati, Maharashtra and ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra. The KRUSHIK - Technology Week had focus on live demonstrations of agricultural technologies and machineries for farm mechanization, bullock-operated machineries, demonstration of millets, value-addition in pulses and oil seeds, use of hydro gel technology for maize, hydroponic and vertical farming, innovations hub, etc. at KVK and live demonstration of dragon fruit technology, technology for establishing orchards of all fruit crops on shallow basaltic terrain, Climate smart integrated farming system, Conservation agriculture and SORF machine for sugarcane, Livestock and fishery experimental ponds and fish museum, Medicinal and herbal garden, Genetic stock garden, etc. at NIASM. More than 3000 farmers visited ICAR-NIASM to witness the live demonstrations and the experimental plots during the technology week.

Fig. 4.12: Glimpses of Agriculture Technology Week held at ICAR-NIASM.

4. ITMU

Institute Technology Management Unit (ITMU) during the year 2021 processed two new patent applications (Table 4.1) and identified seventeen potential technologies (Table 4.2) developed by ICAR-NIASM. It also registered institute publications under ISSN and ISBN for broader publicity. The institute publications registered under ISBN, are 'Alternative crops for augmenting farmers' income in abiotic stress regions'; 'Conservation Agriculture for Enhancing Productivity, Resource Use Efficiency' & 'Environmental Quality of Sugarcane Cropping' details of which are mentioned in Table 4.1. The ITMU also obtained the RNI reference number (1347075) for ICAR-NIASM, from the RNI office. The ITMU staff also attended the conference relevant to IPR processing.

Table 4.1. IPRs of ICAR-NIASM.

IPRs	Name of Innovation/ Technology/ Product/ Variety (Application/ Registration No.)	Date of Filing/ Registration	Progress
Patent	Process for one step synthesis of bactericidal silver nano-particles from tissue extracts of Labeorohita. (3255/MUM/2012)	09.11.2012	Registered**
	A process for the development of nano-scaled metallic formulations for aquaculture. (202121041218)	14.09.2021	Under Screening & Classification
	Novel Micro-stimulant and Stress Alleviator for Aquaculture. (202121048471)	25.10.2021	Application not yet published
RNI registration for Title Verification of Publications	Abiotic Stress Management News (Print media)	14.06.2019	In Process
	Annual Report (Print media)	14.06.2019	In Process
	Krishi Stress Patrika (Print media)	18.6.2019	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

Table 4.2. Potential Technologies of ICAR-NIASM

SN.	Name of technology (Inventors)	Technology ID (Krishi portal)	Year of Release
1.	***Micro-blasting and soil-mix technique for sapota cultivation in abiotic-stressed basaltic terrain.*** DD Nangare, VD Kakade, PB Taware, P Suresh Kumar, Y Singh, PS Minhas, H Pathak	201628669987978	2020
2.	***Dragon fruit: wonder crop for rocky barren lands and water scarce areas.*** DD Nangare, Mahesh Kumar, PB Taware, VD Kakade	201628672037221	2018
3.	***Deficit irrigation management with plastic mulch in pomegranate orchard in abiotic-stressed basaltic terrain.*** DD Nangare, PB, Mahesh Kumar, Y Singh, PS Minhas, VD Kakade, H Pathak	201628674653663	2019
4.	***Deficit irrigation management in grape orchard in abiotic-stressed basaltic terrain.*** DD Nangare, PB Taware, Mahesh Kumar, Y Singh, PS Minhas, P Suresh Kumar, H Pathak	201628678020305	2018
5.	***Micro-blasting and soil-mix technique for pomegranate cultivation in abiotic-stressed basaltic terrain.*** PB Taware, DD Nangare, Mahesh Kumar, H Pathak	201628730570552	2021
6.	***Cultivating medicinal and aromatic plants in shallow basaltic soil.*** Harisha CB, DD Nangare, PB Taware	201629540781386	2021
7.	***High-density planting in mango for enhancing yield and resource use efficiency under abiotic stress conditions.*** VD Kakade, DD Nangare, PB Taware, SB Chavan, RajKumar, H Pathak	201629534409748	2021
8.	***Micro-blasting and soil-mix technique for guava cultivation in abiotic-stressed basaltic terrain.*** VD Kakade, Y Singh, DD Nangare, Minhas, PS, P Suresh Kumar, PB Taware, SB Chavan, H Pathak	201629536617536	2021
9.	***Rehabilitation of abiotic-stressed basaltic terrain with aonla (emblica officinalis).*** SB Chavan, DD Nangare, PB Taware, Aliza Pradhan, P Suresh Kumar, VD Kakade, RS Gophane, H Pathak	201633497056286	2021
10.	***Preparation of dragon fruit saplings.*** GC Wakchaure, AR Jadhav, DD Nangare, VD Kakade, J Rane, H Pathak	201633501439931	2021

5. हिंदी सेल

हिंदी दिवस एवं हिन्दी पखवाड़ा समारोह

भारत की संविधान सभा ने १४ सितंबर १९४९ को हिन्दी को राजभाषा का दर्जा प्रदान किया। इस पावन दिवस की स्मृति में प्रतिवर्ष १४ सितंबर को 'हिन्दी दिवस' के रूप में मनाया जाता है। राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने हेतु भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान, बारामती द्वारा १४ सितम्बर से २८ सितम्बर,२०२१ के दौरान "हिंदी पखवाड़ा" का आयोजन किया गया। हिन्दी दिवस तथा हिन्दी पखवाड़ा का उद्घाटन १४ सितम्बर,२०२१ को किया गया। राजभाषा कार्यान्वयन समिति के अध्यक्ष एवं संस्थान के निदेशक डॉ हिमांशु पाठक ने हिन्दी को बढ़ावा देने हेतु उचित प्रयास का आग्रह किया। कार्यक्रम के शुरुआत में संस्थान के निदेशक महोदय ने 'राजभाषा प्रतिज्ञा' दिलायी। उद्घाटन समारंभ में मुख्य अतिथि के रूप में डॉ सविता नाईक-निंबालकर (सहयोगी प्राध्यापक, मुधोजी महाविद्यालय, फलटण जिला सातारा) मौजूद रहे। उन्होने हिन्दी साहित्य का उदय एवं विकास के बारे में सभी को अवगत किया। हिन्दी पखवाड़ा में लगातार विविध प्रतियोगिताओंका जैसे की, निबंध लेखन (हिन्दी भाषियोंके लिए/अहिन्दी भाषियोंके लिए), टिप्पण लेखन, टंकलेखन, काव्यवाचन, हिन्दी अनुवाद, तत्काल भाषण, प्रश्नोत्तरी आदि प्रतियोगिता आयोजित की गई। 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 ता का सूर्यवंशी (पूर्व प्रधानाचार्य, राजमाता सुमित्राराजे भोसले विद्यालय, सातारा) ने प्रतियोगिता विजेता को पुरस्कार प्रदान करके सम्मानित किया। मुख्य अतिथि ने राष्ट्रभाषा के रूप मे हिन्दी का महत्व सभी को अवगत किया। कार्यक्रम की अध्यक्षता संस्थान के निदेशक डॉ हिमांशु पाठक जी ने की। संस्थान के चार प्रभागों के प्रमुखों ने अलग अलग विषयों पर सम्बोधन किया। डॉ वनिता सालुंखे (सदस्य सचिव, राजभाषा कार्यान्वयन समिति), डॉ संग्राम चव्हाण, डॉ विजयसिंह काकड़े, डॉ प्रवीण तावरे, डॉ अविनाश निर्मले, डॉ परितोष कुमार आदि ने कार्यक्रम का आयोजन किया एवं कार्यक्रम सफल बनाया।

हिन्दी कार्यशाला आयोजन

अक्तूबर से दिसम्बर २०२१ इस तिमाही में संस्थान में हिंदी भाषा के रुझान हेतु १८ दिसम्बर २०२१ को एक दिवसीय कार्यशाला का आयोजन किया गया। राजभाषा कार्यान्वयन समिति के सदस्य डा .प्रवीण तावरे 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। श्रीराजेंद्र प्रसाद वर्मा, सहायक निदेशक, हिन्दी शिक्षण योजना, पुणे राजभाषा विभाग, गृह मंत्रालय, भारत सरकार ने "सूचना प्रोद्योगिकी द्वारा कम्प्युटर और मोबाइल के माध्यम से भारतीय भाषाओं में लिप्यंतरण, श्रुतलेखन, टंकलेखन तथा अनुवाद इस विषय पर 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। राजभाषा कार्यान्वयन समिति के अध्यक्ष और निदेशक हिमांशु पाठक जी ने अतिथि का 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 ५६ कर्मचारियों ने प्रत्यक्ष रूप से लाभ लिया। कार्यशाला की उपलब्धियों पर चर्चा करते हुए डाकाकडे जी ने धन्यवाद ज्ञापन किया ।

कार्यशाला १५ जून २०२१

विषय -'योग और रोग प्रतिकारकता' और 'भगवद्गीता के माध्यम से योग दर्शन' आज के वातावरण में कैसे जरूरी है। इस कार्यशाला के प्रमुख अथिति प्रोफेसर के एन धूमाळ, पूर्व प्राध्यापक, वनस्पति विज्ञान, सावित्रीबाई फुले पुणे विश्वविद्यालय ने योग के माध्यम से रोग प्रतिकरकता कैसे बढ़ाएँ इस पर विवेछा कि। इसी कार्यशाला के दूसरे वक्ता श्री कृष्ण कुमार जांगिड़, अनुसंधान सहयोगी, नियासम ने गीता में योग का दर्शन कैसे किया जा सकता है इस विषय पर प्रकाश डाला। समापन टिप्पणी में डॉ .हिमांशु पाठक, निदेशक ने श्रोताओं को जागरूक किया की हिन्दी हमारी राजभाषा है और उसे बढ़ावा देने हेतु अलग अलग कार्यक्रमोंका आयोजन किया जाता है। हिन्दी कार्यशाला उसमें से एक है। हिन्दी कार्यशाला में सिर्फ हिन्दी से संबंधी तकनीक को समझना काफी नहीं। हिन्दी में रुचि बढ़ाने हेतु दूसरे विषयो पर या उस माध्यम से विज्ञान के समझना जरूरी है। योग हमारे संस्कृति का प्राचीन विज्ञान है। कुछ दिन बाद योग दिवस भी मनाया जाएगा। इस उपलक्ष्य में हिन्दी कार्यशाला के तहत योग विज्ञान को जानना एक अच्छी पहल है।

संस्थागत बैठक

हिन्दी के रुझान हेतु हर तिमाही में संस्थागत बैठके ०१.०२.२०२१, ३०.०६.२०२१, ३०.०७.२०२१, १५.११.२०२१ को आयोजित की गई।

बैठक में निम्नावत बिन्दुओं पर निर्णय लिए गए :

1. संस्थान के तिमाही रिपोर्ट के समीक्षा को देखते हुए यह तय किया गया कि पत्राचार एवं कार्यशाला आयोजन पर उचित ध्यान दिया जाएँ । नगर राजभाषा कार्यान्वयन समिति से संपर्क करते हुए कार्यशालाएँ आयोजन में सहयोग प्राप्त करें।
2. ई-ऑफिस के माध्यम से काम करते हुए आनेवाली दिक्कतों को देखते हुए इस विषय पर कार्यशाला के माध्यम से तथा वैयक्तिक रूप से प्रशिक्षण दिया जाएँ। 'आम प्रयोग में आनेवाले पदबन्धों' की संशोधित सूची सभी कर्मचारियों को अनुस्मारक के रूप में परिचालित की जाएँ ।
3. ई-ऑफिस में प्रस्ताव से ही हिन्दी का प्रयोग शुरू किया जाए तथा टिप्पणी को भी हिन्दी में लिखने का प्रयास किया जाए। इसीके साथ ही अंतर-कार्यालय संचार में हिंदी भाषा का भी उपयोग करे।
4. सप्ताह के शब्द या पदबंध जो सूचना पटल पर लिखे जाते है उसमें विशेष रूप से कार्यालयिन कामकाज में उपयुक्त शब्दों का समावेश करें।
5. राजभाषा अधिनियम की धारा ३(३) के अंतर्गत आनेवाले कागजातों को अनिवार्य रूप से द्विभाषी रूप में जारी किया जाएँ। तकनीकी जानकारी भी हिन्दी पृष्टपत्र के साथ संलग्न करें। ईमेल द्वारा किए जाने वाले पत्राचार में अंत में लिखी जानेवाली वैयक्तिक जानकारी हिन्दी या द्विभाषी रखें।
6. संस्थान के चनयित प्रकाशनों का आउटसौर्स माध्यम से भाषांतरण करने का प्रयास करें। जो भी 'औडियो बूक' बनाए जा रहे है वह विशेष रूप से हिन्दी में बनाए जाएँ और उन्हे संस्थान के 'क्यूआर-नियासम' ऐप के जरिए उपलब्ध कराएँ।
7. 'क्यूआर-नियासम' के डेटाबेस हेतु तकनीकी जानकारी मराठी, हिन्दी और अंग्रेजी इन तीनों भाषा में बनाना जारी रखें तथा उसमें जरूरत के अनुसार संशोधन करें। ऐप के सुचारु इस्तेमाल हेतु २-मिनट का विडियो हिन्दी में या द्विभाषी रूप में बनाया जाएँ।
8. हिन्दी 'स्ट्रैस पत्रिका' का संकलन पूरा करते हुए प्रकाशन के लिए जल्द तैयार करें। (द्वारा-संस्थान की प्रकाशन समिति)
9. संस्थान के कर्मचारियों के हिन्दी की जानकारी के बारे में सूची तैयार करें और जरूरत के अनुसार कार्यसाधक ज्ञान उपलब्द कराने का प्रयास करें । (द्वारा-राजभाषा कार्यान्वयन समिति)

वर्ष 2021 के दौरान विशिष्ट उपलब्धियां

1. 'नियासम गीत' में सुधार तथा चलचित्र का निर्माण: 'नियासम गीत' को औडियो रूप में निर्माण और स्वीकृत किया गया था। इसमें अंतिम सुधार करते हुए उसे चलचित्र के रूप में फरवरी २१, २०२१ को जारी किया गया।
2. 'फार्म कोऑर्डीनेटर' को आंशिक रूप से द्विभाषी बनाया: 'फार्म कोऑर्डीनेटर' जो की संस्थान के प्रक्षेत्र में चल रही गतिविधियों का लेखा-जोखा न्यूज़लेटर के रूप में हर महीने प्रस्तुत करता है, उसे आंशिक रूप से द्विभाषी बनाया। हिन्दी में इसका नाम 'कृषि तकनीकी समन्वय पत्र' रखते हुए, यह आंशिक रूप से हिन्दी में लाया जा रहा है ।
3. "क्यूआर-नियासम' ऐप द्वारा हिन्दी में जानकारी: जनवरी १, २०२१ को संस्थान ने 'क्यूआर-नियासम' ऐप जारी किया, जिससे परिसर में उपलब्ध सुविधाओं और गतिविधियों को आसानी से समन्वेषित किया जा सकता है। यह ऐप अपने आप में अनूठा है, जो एंडरोइड स्मार्ट फोन द्वारा परिसर को समझने के लिए व्यक्तिगत मार्गदर्शक का काम करता है। परिसर का राउंड लेते समय, क्षेत्र की संरचनाओं, अनुसंधान परियोजनाओं या सुविधाओं के बारे में जानने की उत्सुकता हो सकती है। इस ऐप के होने पर कोई जानकारी पाने के लिए अब किसी के सहायता की जरूरत नहीं होगी। पास के डिस्प्ले बोर्ड पर लगे 'क्यूआर कोड' को स्कैन करने मात्र उपयोग कर्ता को ऑडियो प्रारूप में, मराठी, हिंदी और अंग्रेजी भाषाओं में सभी जानकारी प्राप्त होगी।
4. हिन्दी औडियो बूक का निर्माण: आईसीएआर -नियासम ने अपना पहला औडियो बूक हिन्दी में प्रकाशित किया, जिसका शीर्षक है 'कमलम् अर्थात ड्रैगन फ्रूट'। यह तथा आगे प्रस्तावित औडियो बूक 'क्यूआर_नियासम' ऐप द्वारा भी जारी किए जाएंगे ताकि किसानों तक उनकी पहुँच आसानी से हो सकें ।
5. नियासम की पारिभाषिक शब्दावली- 'सार्थक' का प्रकाशन किया । इसमें शब्द संकलन हेतु कार्यशाला का आयोजन करते हुए सभिका सहयोग लिया गया तथा इसमें संशोधन जारी रहेगा ।
6. राष्ट्रीय संगोष्ठी में सहभाग : "आत्मनिर्भर भारत: लोकल से वोकल" मार्च १६-१७, २०२१ इस संगोष्ठी के लिए दो शोध सारांश भेजें तथा उसमें ऑनलाइन सहभाग लिया ।

6. MEETINGS

10th Institute Management Committee (IMC) Meeting

The 10th meeting of the Institute Management Committee of ICAR-NIASM was held on February 17, 2021, through online mode. The meeting was attended by: Dr Himanshu Pathak, Chairman of IMC & Director, ICAR-NIASM; Dr S Naresh Kumar, Professor & Principal Scientist, ICAR-IARI, New Delhi; Dr M Prabhakar, Principal Scientist & Project Investigator, NICRA, ICAR-CRIDA, Hyderabad; Dr RM Sundaram, Principal Scientist, ICAR-IIRI, Hyderabad; Dr Jagadish Rane, Principal Scientist, ICAR-NIASM and Shri B K Sinha, Member Secretary & CAO, ICAR-NIASM. Chairman welcomed the members and presented scientific achievements, ongoing research, future plan of the institute, account of physical infrastructural facilities and the academic programme commencing from the current academic year. The Member Secretary presented current staff position and utilization of fund. The Scientist members, namely, Dr S Naresh Kumar, Dr M Prabhakar, Dr RM Sundaram and Dr Jagadish Rane, gave suggestions on the futuristic role of the institute with regard to basic and strategic research in abiotic stress management as well as the academic programmes. The meeting concluded with a vote of thanks.

11th Pre-Institute Research Council (Pre-IRC) Meeting

The 11th Pre-Institute Research Council (Pre-IRC) meeting of ICAR-NIASM was held on April 08-13, 2021. Dr Himanshu Pathak, Director ICAR-NIASM, chaired the meeting. All the I/c Heads, Scientists of schools, and the institute's senior technical staff attended the meeting through physical and video conferencing hybrid mode. The meeting included brief presentations by I/c PME, I/c Head of Schools and Scientist of SASM, SWSM, SSSM, and SSPR followed by discussions on the research highlights presented. Director, ICAR-NIASM also presented his activities and achievements during 2020-2021 and the pipeline targets. The scientific staff participating in the meeting were given the opportunity to provide their comments and suggestion.

11th Institute Research Meeting (IRC) Meeting

11th Institute Research Council (IRC) meeting of ICAR-NIASM was held on June 22, 2021, through a web conferencing system. The meeting was chaired by Dr Himanshu Pathak, Director, ICAR-NIASM. Dr SR Gadakh, Director Research, MPKV Rahuri; Dr M Maheshwari, Former Head, Division of Crop Improvement, ICAR-CRIDA; Dr KN Bhilegaonkar, Principal Scientist and Station In-charge ICAR-IVRI, Pune; Dr Pradip Dey, Principal Scientist and PC (STCR), ICAR-IISS, Bhopal and Dr M S Meena, Principal Scientist, ICAR-ATARI, Jodhpur participated in the meeting as resource persons. Dr Pathak briefed Institute’s achievements. Heads of the Schools presented respective school research programmes and Institute Flagship projects. Principal Investigators presented the progress and targets of the Umbrella projects and In-house projects. The Chairman invited suggestions from resource persons to further improvement. Dr Neeraj proposed vote of thanks.

9th Research Advisory Committee (RAC) Meeting

The 9th Research Advisory Committee (RAC) Meeting of ICAR-NIASM was held on July 03, 2021. Dr Himanshu Pathak, Director, ICAR-NIASM, extended a warm welcome to Dr B. Venkateshwarlu, Chairman of the 9th RAC, and the other distinguished members. Dr SMK Naqvi, Dr N Sarangi, Dr DK Pal, Dr C Viswanathan, Dr BB Barik, Dr PK Ghosh, Director, NIBSM, Raipur (special invitee) and Dr Jagadish Rane (Member Secretary) attended the meeting. A comprehensive report about the overall research and development activities during 2020-21 was presented by Dr Pathak. This was followed by the presentation of the Action Taken Report by Dr Rane. The Heads of the Schools comprehensively presented the achievements and targets of the respective Schools. Dr Ghosh highlighted the scope for collaboration between NIASM and NIBSM. Dr Pathak expressed his gratitude to all the members of RAC for their suggestions and guidance. The meeting ended with the vote of thanks by Dr Rane, Member Secretary, RAC.

7. AWARDS & RECOGNITION

- Dr Himanshu Pathak, Director, ICAR-NIASM received the prestigious "Dr NS Randhawa Memorial Award (2019-20)" of National Academy of Agricultural Sciences, New Delhi on November 13, 2021.
- Dr Himanshu Pathak, Director, ICAR-NIASM was included in the Reuters top 1,000 global climate scientists who had significant impacts on the climate change research and development.
- Dr Himanshu Pathak, Director, ICAR-NIASM delivered the "Dr RV Tamhane Memorial Award Lecture" of Indian Society of Soil Science on November 17, 2021.
- Dr AK Singh, Principal Scientist received Best Scientist Award by ICAR-NIASM on the foundation day.
- Dr BB Gaikwad, Scientist, recognized as university teacher and research guide of MPKV, Rahuri for M.Tech/PhD in the discipline of Farm Machinery and Power.
- Dr Boraiah KM, Scientist received "Young Plant Breeder Award-2021" in International Conference on "Advances in Agriculture, Environmental and Biosciences for Sustainable Development (AAEBSD-2021)" held on August 05-07, 2021.
- Dr Boraiah KM, Scientist received Life Membership in Agro Environmental Development Society.
- Dr GC Wakchaure, Senior Scientist recognized as expert member of Consultative Group by Ld. Registrar, Geographical Indications Registry, Ministry of Commerce and Industries, Govt. of India
- Dr GC Wakchaure, Senior Scientist recognized as Faculty and research guide of IARI, New Delhi (Discipline: Agricultural Engineering) and also as teacher/ research guide of MPKV, Rahuri for M.Tech/PhD in the discipline of Agricultural Structure and Process Engineering and Irrigation and Drainage Engineering.
- Dr Pratapsingh Khapte received "Young Scientist Award-2021" by Indian Society of Plant Physiology at National Conference of Plant Physiology organized by the society in collaboration with ICAR-NIASM, Baramati, Pune from 9-11 December, 2021.
- Dr SA Kochewad, Scientist recognized as Editor for Agri Journal World a monthly e-newsletter and also as Subject Specialist Editor for Agriallis a monthly e-newsletter for the year 2021.
- Dr SB Chavhan, Scientist recognized as Editor for forestry and agroforestry in Agri-science journal.
- Dr SB Chavhan, Scientist recognized as Faulty for Dr BSKKV Dapoli & IARI, New Delhi.
- Dr SB Chavhan, Scientist, Elected as Member of Indian Society of Agroforestry Jhansi for 2021 to 2022.

- Dr SS Pawar received "Young Scientist Award" by Society for Scientific Development in Agriculture and Technology (SSDAT) during VIth International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2021), Bikaner from December 13-15, 2021.
- Dr VD Kakade, Scientist was identified as committee member (state level) for deciding guidelines of dragon fruit cultivation in Maharashtra by Maharashtra State Horticulture & Medicinal Plant Board (MSHMPB), Pune.
- Mr Harisha CB, Scientist awarded Young Horticulturist Award-2021 by Agro Environmental Development Society (AEDS) during International Conference on "Advances in Agriculture, Environmental and Biosciences for Sustainable Development (AAEBSD-2021)" held on August 05-07, 2021.
- Mr MP Bhendarkar, Scientist, received the Best Oral Presentation at 4th International Conference, Global Approaches in Natural Resource Management for Climate Smart Agriculture (GNRSA-2020) during Pandemic Era of COVID-19 from February 26-28, 2021.
- Raj Kumar, Dinesh Ginger, Vijay Kakade, Dhakshanamoorthy, Dinesh, Gaurav Singh and Sneha Dobhal (2021), Best Paper Award in International Web-Conference on Smart Agriculture for Resource Conservation and Ecological Stability organized online on October 29-31, 2021.

Organizations having MOU with ICAR-NIASM

S.N.	Organization
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-Indian Institute of Pulses Research, Kanpur
10.	ICAR-National Bureau of Agriculturally Important Microorganisms, Mau Nath Bhanjan
11.	ICAR-Central Arid Zone Research Institute, Jodhpur
12.	ICAR-Central Arid Zone Research Institute, Jodhpur
13.	ICAR-Central Inland Fisheries Research Institute, Kolkata
14.	ICAR-Central Institute of Brackishwater Aquaculture, Chennai
15.	ICAR-Central Institute of Fisheries Education, Mumbai
16.	ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar
17.	ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
18.	ICAR-Directorate Of Onion And Garlic Research, Rajgurunagar
19.	ICAR-Indian Agricultural Research Institute, New Delhi
20.	ICAR-Indian Grassland and Fodder Research Institute, Jhansi
21.	ICAR-Indian Institute of Agricultural Biotechnology, Ranchi
22.	ICAR-Indian Institute of Soybean Research, Indore
23.	ICAR-Indian Institute of Wheat and Barley Research, Karnal
24.	ICAR-National Bureau of Plant Genetic Resources, New Delhi
25.	ICAR-National Institute of Biotic Stress Management, Raipur
26.	ICAR-National Research Center on Pomegranate, Solapur
27.	ICAR-National Research Centre for Grapes, Pune
28.	Indira Gandhi Krishi Vishwavidyalaya, Raipur
29.	International Center for Agricultural Research in the Dry Areas
30.	International Crops Research Institute for the Semi-Arid Tropics, Hyderabad
31.	International Rice Research Institute
32.	Maharashtra Rajya Draksha Bagaitdar Sangh, Pune
33.	Mahatma Phule Krishi Vidyapeeth, Rahuri
34.	Privi Life science, Pvt Ltd, Mumbai
35.	Punjab Agricultural University, Ludhiana
36.	Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Kashmir
37.	Space Applications Centre- ISRO, Ahmedabad
38.	Tuljaram Chaturchand College, Baramati
39.	University of Agricultural Sciences, Bengaluru
40.	University of Agricultural Sciences, Dharwad
41.	University of Agricultural Sciences, Raichur
42.	University of Delhi, New Delhi
43.	University of Horticulture, Bagalkot
44.	Vasanth Dada Sugar Institute, Pune
45.	Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

9. PUBLICATIONS

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10. MAJOR EVENTS

S.N.	Event	Date
1.	ICAR-NIASM launched QR-NIASM Application	01.01.2021
2.	Drought Action Network (DAN) Meeting	18.01.2021
3.	KRUSHIK - Technology Week - 2021	18.01.2021
4.	Celebration of 72nd Republic Day	26.01.2021
5.	Institute Management Committee (IMC) Meeting	17.02.2021
6.	2nd Foundation Day lecture and Panel discussion of NIASM-NAAS Pune Chapter	20.02.2021
7.	Celebration of 13th Foundation Day	21.02.2021
8.	Celebration International Women's Day	08.03.2021
9.	11th Pre-IRC Meeting	08 to 13.04.2021
10.	Celebration of World Environment Day-2021	05.06.2021
11.	11th IRC Meeting	22.06.2021
12.	9th Research Advisory Committee	03.07.2021
13.	Initiation of 'NIASM Associate Course'	15.07.2021
14.	Establishment of the Naxatra Udyan	16.07.2021
15.	Celebration of 75th Independence Day	15.08.2021
16.	Celebration of Azadi Ka Amrit Mahotsav	26.08.2021
17.	हिंदी दिवस एवं हिन्दी पखवाड़ा	14 to 28.09.2021
18.	Germplasm Awareness Programme and Germplasm Field Day (Kharif 2021)	06.10.2021
19.	Celebration of Rashtriya Ekata Divas:	31.10.2021
20.	Special Swachhta Campaign	02 to 31.10.2021
21.	Field day on "Management strategies for Bacterial blight and Wilt in pomegranate"	21.10.2021
22.	Observance of Vigilance Awareness Week	26.10.2021 to 01.11.2021
23.	Celebration of World Soil Day 2021	04.12.2021
24.	National Conference of Plant Physiology-2021	09 to 11.11.2021
25.	Hon'ble Prime Minister's address during the Conclave on Natural Farming.	16.12.2021
26.	हिन्दी कार्यशाला	18.12.2021
27.	Field Day-cum-COVID 19 Awareness Programme under Scheduled Caste Sub Plan	28.12.2021
28.	Swachhata Pakhwada 16-31 December 2021.	16 to 31-12-2021

11. JOINING/TRANSFER/PROMOTION

Joining of New Staff at ICAR-NIASM

Name of the staff	Date	Previous Institute
Dr Hanamant M Halli Scientist, Agronomy	29.11.2021	ICAR-IGFRI, Jhansi

Transfer of Staff from ICAR-NIASM

Name of the staff	Date	Transfer Institute
Dr Mahesh Kumar	24.12.2021	ICAR-IARI, New Delhi
Shri BK Sinha	17.07.2021	ICAR-CIFA, Bhubaneswar

Promotion of Staff at ICAR-NIASM

Name of the staff	Date	Promoted Post
Dr Pravin B Taware	03.09.2019	Assistant CTO (T7/8)
Mrs Noshin Shaikh	13.07.2020	Technical Officer (T5)
Mr Santosh Pawar	16.07.2020	Technical Officer (T5)
Mr Pravin More	17.09.2020	Technical Officer (T5)
Mr Rushikesh Gophane	30.06.2021	Technical Officer (T5)
Mr Aniket More	01.03.2021	Technical Assistant (T3)
Mr Dayanand P Kharat	23.06.2021	AAO
Mr Girish V Kulkarni	18.09.2021	AAO

12. BUDGET UTILIZATION

Head/Sub-head	Allocation	Expenditure
Grants in aid-Capital	66.12	
Works		0.00
Equipment		41.39
Information Technology		19.71
Library		0.00
Furniture and Fixtures		5.02
Vehicles and Vessels		0.00
Livestock		0.00
Sub Total-1	**66.12**	**66.12**
Grants in aid-Salary		
a) Establishment Charges	620.86	620.85
Sub Total-2	**620.86**	**620.85**
Grants in aid-General		
Pension and other retirement Benefits	4.85	4.85
Travelling allowance	618.41	2.20
Research and Operational Expenses		186.10
Administrative Expenses		424.40
Miscellaneous Expenses		5.71
Sub Total-3	**623.26**	**623.26**
Tribal Sub-Plan		
Grants in aid-Capital	8.87	8.87
Grants in aid-General	29.53	29.53
Sub Total-4	**38.40**	**38.40**
Scheduled Castes Sub-Plan		
Grants in aid-Capital	82.06	82.05
Grants in aid-General	45.40	45.40
Sub Total-5	**127.46**	**127.45**
Grand Total	**1476.10**	**1476.08**

(Financial Year 2020-21)

13. RESEARCH PROJECTS

UMBRELLA PROJECTS

S.N.	Project Name	PI	Co-PI
UP1	Abiotic Stress Information System (ASIS): Geo-spatial digital maps of multiple abiotic stresses, management options and future scenarios (IXX15659)	BB Gaikwad	Himanshu Pathak, DD Nangare, NP Kurade, SS Pawar, Gopalakrishnan B, MP Bhendarkar, SV Potekar, Pravin More
UP2	Germplasm Conservation and Management (GCM): Genetic garden and gene bank for abiotic stress tolerant plants, animals and fisheries for food security and sustainability (IXX15674)	KM Boraiah	AK Singh, Basavaraj PS, Mahesh Kumar, Satish Kumar, Rajkumar, Karthikeyan N, Paritosh Kumar, SA Kochewad, MP Bhendarkar, Harisha CB, PS Khapte, J Rane, Neeraj K, PB Taware, Aniket More, Rushikesh Gophane, Lalitkumar Aher
UP3	Model Green Farm (MGF): Environment-friendly, economically viable, state-of the-art model farm for abiotic stressed regions (IXX15700)	DD Nangare	Himanshu Pathak, GC Wakchaure, BB Gaikwad, Vanita Salunkhe, Rajkumar, Paritosh Kumar, Aliza Pradhan, Amresh Chaudhary, MP Bhendarkar, SB Chavan, VD Kakade, PS Khapte, PB Taware, Rushikesh Gophane, Noshin Shaikh, Santosh Pawar, AV Nirmale
UP4	Climate-smart IFS (CIFS): Climate resilient integrated farming system in semiarid region (IXX15697)	SA Kochewad	GC Wakchaure, Vanita Salunkhe, Rajkumar, MP Bhendarkar, Aliza Pradhan, SB Chavan, VD Kakade, N Subash, Laxman Meena, PB Taware, P Chahande

FLAGSHIP PROJECTS

S.N.	Project Name	PI	Co-PI
FP1	Adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability (IXX15676)	NP Kurade	SS Pawar, BB Gaikwad, SA Kochewad, Gopalakrishnan B, Rajkumar, MP Bhendarkar, RN Singh, DD Nangre, AV Nirmale, SV Potekar

FP2	New Crops: Exploiting under-utilised crops (ex. quinoa) for augmenting income in water scarce regions (IXX15656)	J Rane	AK Singh, DD Nangare, GC Wackchaure, Mahesh Kumar, Satish Kumar, Karthikeyan N, Boraiah KM, SA Kochewad, Aliza Pradhan, Amresh Chaudhary, RN Singh, Basavaraj P, Harisha CB
FP3	Bio-saline Agriculture: Exploitation of halophytic plant and associated microbiome for amelioration of saline agricultural land of arid & semiarid regions (IXX15657)	Satish Kumar	AK Singh, Vanita Salunkhe, SA Kochewad, Mahesh Kumar, Paritosh Kumar, Neeraj Kumar, Aliza Pradhan, Amresh Chaudhary, Kartikeyan N, Himanshu Pathak
FP4	Targeting prospective technologies for abiotic stress resilience in rainfed and dryland region (IXX15699)	DD Nangare	SS Pawar, BB Gaikwad, SA Kochewad, Boraiha K M, Kartikeyan N, Rajkumar, MP Bhendarkar, Himanshu Pathak

EXTERNALLY FUNDED PROJECTS

S.N.	Project Name	PI	Co-PI
EAP1	Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean (OXX4929) (Funded by: ICAR-NASF)	A K Singh	Mahesh Kumar, J Rane
EAP2	Phenotyping of pulses for enhanced tolerance to drought and heat (Funded by ICAR-NICRA)	J Rane	Mahesh Kumar
EAP3	Climate smart management practices (OXX4928) (Funded by: IRRI)	Mahesh Kumar	J Rane, Amresh Chaudhary, Himanshu Pathak
EAP4	Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (Funded by: CA Platform ICAR)	GC Wakchaure	Aliza Pradhan, Amresh Chaudhary, Paritosh Kumar, Himanshu Pathak
EAP5	Establishment of model herbal garden for medicinal and aromatic plants (OXX4927) (Funded by: NMPB, New Delhi)	Harisha CB	DD Nangare
EAP6	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	-
EAP7	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, Himanshu Pathak, J Rane
EAP8	Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing (OXX3595) (Funded by: DST)	BB Gaikwad	-

IN-HOUSE PROJECTS

S.N.	Project Name	PI	Co-PI
1.	Mitigating water stress effects in vegetable and orchard crops (IXX14250)	GC Wakchaure	DD Nangare, Satish Kumar, Aliza Pradhan, K M Boraiah, PS Khapte, J Rane
2.	Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)	Neeraj Kumar	Paritosh Kumar
3.	Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressors (IXX15014)	Neeraj Kumar	AK Singh, Satish Kumar
4.	Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics (IXX14228)	Paritosh Kumar	Neeraj Kumar, Harisha CB
5.	Genomics, genetic and molecular approaches to improve water stress tolerance in soybean and wheat (IXX15660)	AK Singh	J Rane, Mahesh Kumar
6.	Spectral delineation of moisture and nutrient stresses in vineyards through hyperspectral spectroscopy (IXX14265)	BB Gaikwad	DD Nangare

INTER-INSTITUTIONAL PROJECT

S.N.	Project Title	PI	Co-PI
1.	Evaluation of extrinsic and intrinsic parameters for sustainable breeding and culture of *Clarias magur* in captivity. *(Collaboration with ICAR-Indian Institute of Agricultural Biotechnology, Ranchi)*	Neeraj Kumar	--

14. PERSONNEL

SCIENTIFIC STAFF

Dr Himanshu Pathak, Director

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, 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 Management)
7. Mr Ram Narayan Singh, Scientist (Agricultural Meteorology) (Study leave)

SCHOOL OF WATER STRESS MANAGEMENT

1. Dr Jagadish 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. Engg.)
4. Dr Goraksha C Wakchaure, Senior Scientist (Agricultural Structure & Process Engg.)
5. Dr Boraiah KM, Scientist (Genetics and Plant Breeding)
6. Dr Aliza Pradhan, Scientist (Agronomy)
7. Dr Pratapsingh Suresh Khapte, Scientist (Vegetable Science)
8. Dr Basavaraj PS, Scientist (Genetic & Plant Breeding)
9. Dr Gurumurthy S, Scientist (Plant Physiology)

SCHOOL OF SOIL STRESS MANAGEMENT

1. Dr Sanjivkumar A Kochewad, I/c Head & Scientist (Livestock Production Management)
2. Dr Vanita N Salunkhe, Scientist (Plant Pathology)
3. Mr Rajagopal V, Scientist (Soil Chemistry/Fertility/Microbiology)
4. Mr Satish Kumar, Scientist (Plant Biochemistry)
5. Mr Karthikeyan N, Scientist (Agricultural Microbiology)
6. Dr Neeraj Kumar, Scientist (Fish Nutrition)
7. Dr Paritosh Kumar, Scientist (Environmental Science)
8. Mr Harisha CB, Scientist (Spices, plantation, medicinal & aromatic plants)
9. Mr Amresh Chaudhary, Scientist (Soil Science) (Study leave)
10. Dr Vijaysinha D Kakade, Scientist (Fruit Science)
11. Dr Sangram Bhanudas Chavan, Scientist (Agroforestry)
12. Dr Hanamant M. Halli, Scientist (Agronomy)

SCHOOL OF SOCIAL SCIENCE AND POLICY SUPPORT

1. Dr Dhananjay D Nangare, I/c Head &Principal Scientist (Soil & Water Conservation Engg.)
2. Dr Sachinkumar S Pawar, Senior Scientist (Animal Biotechnology)
3. Dr Sanjivkumar A Kochewad, Scientist (Livestock Production Management)
4. Dr Bhaskar B Gaikwad, Scientist (Farm Machinery and Power)
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 Ainash 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, Senior Technical Assistant (Agriculture)
10. Mr Aniket More, Technical Assistant (T3) (Farm)

ADMINISTRATIVE STAFF

1. Shri Anil Kumar Sidharth, Finance & Accounts officer
2. Smt Purnima S Ghadge, Assistant Administrative Officer
3. Mr Dayanand P Kharat, Assistant Administrative Officer
4. Mr Girish V Kulkarni, Assistant Administrative Officer

APPENDIX - I

Institute Management Committee

1. Dr Himanshu Pathak, Chairman IMC & Director, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra.
2. Dr RM Sundaram, Director, ICAR-Indian Institute of Rice Research, Hyderabad, Telangana.
3. Dr S Naresh Kumar, Professor & Principal Scientist, Centre for Environment Science and Climate Resilient Agriculture, ICAR-Indian Agricultural Research Institute, New Delhi.
4. Dr M Prabhakar, Principal Scientist & Project Investigator, NICRA, ICAR-Central Research Institute on Dryland Agriculture, Hyderabad
5. Dr Jagadish Rane, Head, SW SM, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra.
6. Smt. Purnima S Ghatge, Asstt. Administrative Officer, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra (Member Secretary).

Research Advisory Committee

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 Jagadish Rane, Head, SWSM, ICAR- National Institute of Abiotic Stress Management, Baramati, Maharashtra (Member Secretary).

APPENDIX - II

Research Output	Team
• Management adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability.	NP Kurade, SS Pawar
• Response of GIFT Tilapia fish, to different salinity stress (inland saline water) exposed to acute and chronic salinity stress.	MP Bhendarkar
• Compilation/creation of databases and geospatial mapping of multiple components.	BB Gaikwad, NP Kurade, SS Pawar, Gopalakrishnan B, MP Bhendarkar, DD Nangare
• Soil nutrient and soil fertility index maps for Haryana State.	BB Gaikwad, H Pathak
• Identification of farm ponds and storage water tanks using satellite imagery for targeting farm pond-based aquaculture in rainfed areas of Maharashtra.	BB Gaikwad, MP Bhendarkar
• Thermal stress severity assessment tool for livestock.	BB Gaikwad, SS Pawar, NP Kurade
• Software for automating extraction of geo-server tiles using geojson files.	BB Gaikwad
• App for identification of best performing two band spectral indices.	BB Gaikwad
• IoT based system for monitoring abiotic stress in livestock.	Gopalakrishnan B
• Studies on Black Soldier Fly Mass Production Unit.	Rajkumar
• Establishment of Butterfly Garden at ICAR-NIASM, Baramati.	Rajkumar
• Exploitation of halophytic plants and associated microbiome for amelioration of saline agricultural land of arid & semi-arid regions.	Satish Kumar
• Evaluation of halotolerant Rhizobium and PGPB based biomolecules for mitigation of salinity and drought stress.	Satish Kumar
• Methodology for designing climate-smart integrated farming system (CIFS).	SA Kochewad
• Response of turmeric (Curcuma longa L) to saline water irrigation on growth, physiology, and antioxidant properties.	CB Harisha
• Stress tolerance indices for identification of moisture deficit stress tolerant genotypes in fenugreek.	CB Harisha
• Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics.	Paritosh Kumar
• Studies on multiple stresses in *Pangasianodon hypophthalmus*.	Neeraj Kumar
• Diagnostics of dragon fruit diseases.	VN Salunkhe

Research Output	Team
• Metal determination and biochemical status in marine fishes facilitates in biomonitoring of marine environmental pollution.	Neeraj Kumar
• Vermicomposting for farm waste management.	Paritosh Kumar
• Assessing the potential of sandalwood cultivation under abiotic stressed environment for adaptability & income generation.	SB Chavan
• Studies on growth and reproductive parameters of dragon fruit plantation.	VD Kakade
• Collection and conservation of planting material.	VD Kakade
• Evaluation of soybean genotypes for traits associated with drought stress tolerance.	AK Singh
• Genetic Variability in root system architecture under in vitro conditions in soybean genotypes.	AK Singh
• Screening and identification of waterlogging tolerant Pigeon pea genotypes.	Basavaraj PS
• Phenotyping of Seed Traits in Mungbean Minicore Accessions Using Digital Image Analysis.	Basavaraj PS
• Selection and evaluation of M2 mutant lines of Quinoa and Chia.	KM Boraiah
• Cause of flower and fruit drop in dragon fruit and cope up strategies.	KM Boraiah
• Soybean based intercropping systems for better productivity and optimum resource use efficiency.	Aliza Pradhan
• Collection, multiplication and evaluation of the germplasm/ genotypes/accessions of different crops (Genetic garden for abiotic stress tolerance).	KM Boraiah
• Morpho-physio characterization of eggplant species for drought tolerance.	PS Khapte
• Evaluation and characterisation of turmeric genotypes under nutrient poor and shallow soils.	CB Harisha
• Conventional phenotyping to assess drought responses of chickpea (Cicer arietinum, L.) genotypes.	Mahesh Kumar
• Elucidating the influence of rootstocks on drought response of grafted tomato under high through-put phenomics.	PS Khapte
• Studies on NBPT as a Urease Inhibitor for Improving Nitrogen Use Efficiency in sugarcane cropping systems in India.	A Pradhan
• Effect of sowing date and establishment technique on quinoa growth, development and yield in native murram soil.	A Pradhan, J Rane
• Mitigating water stress effects in vegetable and orchard crop.	GC Wakchaure
• Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system.	GC Wakchaure
• Identification of fisheries cage culture in inland open water bodies using sentinel-2A satellite imagery for monitoring and technology targeting.	BB Gaikwad, MP Bhendarkar
• Cage Culture Directory of India.	BB Gaikwad, MP Bhendarkar
• Prioritization of strategies and policy reforms to support fisheries sector during and post-Covid-lockdowns, using the Multi-Attribute Decision Making (MADM) techniques.	BB Gaikwad, MP Bhendarkar
• Compilation of fire events database for targeting preventive measures in sugarcane growing areas.	BB Gaikwad, DD Nangare, Ravi Kure, SS Pawar
• Bio-physical constraints and Socio-economic profile datasets of farmers of rainfed and dryland regions of Maharashtra.	Ravi Kure
• Compilation of socio-economic databases (Census 2011).	BB Gaikwad, Ravi Kure

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 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.

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.

राअस्ट्रैप्रसं

NIASM

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.

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.

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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ICAR-National Institute of Abiotic Stress Management

(समतुल्य विश्वविद्यालय)

बारामती, पुणे, महाराष्ट्र ४१३ ११५

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