ABSTRACT BOOK

AGMET- 2025

AAU, JORHAT

National Conference

AGMET-2025

Frontier Technologies for Weather and Climate Based Decisions in Agriculture and Allied Sectors

February 13 - 15, 2025

Assam Agricultural University, Jorhat

AGMET-2025

ABSTRACT BOOK

Organised by

Association of Agrometeorologists, Anand &
Assam Agricultural University, Jorhat

In collaboration with

NATIONAL CONFERENCE ON FRONTIER TECHNOLOGIES FOR WEATHER AND CLIMATE BASED DECISIONS IN AGRICULTURE AND ALLIED SECTORS

AGMET-2025

February 13th – 15th, 2025

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Jointly organized by

Association of Agrometeorologists, Anand

&

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Sponsored By

National Conference on Frontier Technologies for Weather and Climate Based Decisions in Agriculture and Allied Sectors

AGMET-2025

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Dr. Bidyut C. Deka
Vice Chancellor

ASSAM AGRICULTURAL UNIVERSITY
JORHAT-785013, ASSAM (INDIA)

(Recipient of Sardar Patel Outstanding Institution Award)

Message

It is a matter of great pride and privilege for Assam Agricultural University (AAU), Jorhat, to host the *National Conference on Frontier Technologies for Weather and Climate-Based Decisions in Agriculture and Allied Sector (AGMET-2025)*, jointly organized with the Association of Agrometeorologists, Anand.

The ever-evolving challenges posed by climate variability, extreme weather events, and their cascading effects on agriculture and allied sectors necessitate the adoption of cutting-edge technologies and scientific innovations. This conference, focusing on themes such as natural resource management, precision agriculture, digital technologies, AI, IoT, crop modelling, and climate-resilient crop improvement, promises to ignite insightful discussions and pave the way for sustainable solutions.

I am delighted that the compendium of abstracts, which serves as the abstract volume for this conference, encapsulates the essence of the research endeavours presented by the participants. This volume not only reflects the depth and diversity of ideas being explored but also acts as a valuable repository of knowledge for the scientific community.

I extend my heartfelt gratitude to the organizers, participants, and contributors for their dedication to this noble cause. I am confident that AGMET-2025, complemented by the insights captured in this abstract volume, will emerge as a milestone in fostering innovation and collaboration in agriculture under changing climatic conditions.

Wishing the conference a grand success.

Vice-Chancellor

Assam Agricultural University, Jorhat

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"Healthy Soils for a healthy life"

Message

The unprecedented behavior in weather and climate extremes brings constant global threat to food security and further possibilities for such challenges in near future. Accurate information on extremes of meteorological variables has a prodigious potential for judicious use of farm input and increasing the farm output. Recently the demand by farmers' and other stakeholders for meteorological services has increased manifold. And thus, the timely weather information service is realized to be one of the tools to meet the challenges of the future particularly with reference to weather extremes.

I am pleased to note that the Association of Agrometeorologists, Anand and Assam Agricultural University, Jorhat are jointly organizing a National Conference on 'Frontier Technologies for Weather and climate Based Decisions in Agriculture and Allied Sectors' from 13th to 15th February, 2025. Considering the profound influence of weather and climate on agricultural production systems and its allied ventures; the seminar will be provide a better platform to exchange their scientific thoughts amongst leading agricultural scientist and young researchers.

I extend my heartfelt thanks to Association of Agrometeorologist (AAM), Anand and AAM, Jorhat Chapter for having agreed to take up the task of organizing the event at Assam Agricultural University, Jorhat. I am sure with their joint concerted efforts, the AGMET-2025 is going to be a grand success. Being the Chairman of the Local Organizing Committee, I also take this opportunity to welcome all the delegates to this wonderful event and wish them fruitful deliberations and discussion. May this conference pave the way for groundbreaking insights and actionable solutions for a sustainable and climate-resilient future in agriculture.

Best wishes for a successful and fruitful conference.

(P. K. Pathak)
Dean, Faculty of Agriculture
AAU, Jorhat

Message

It gives me immense pleasure to extend my warm greetings and best wishes to all the participants of the National Conference **AGMET-2025** on *Frontier Technologies for Weather and Climate-Based Decisions in Agriculture and Allied Sectors,* jointly organized by the Association of Agrometeorologists and Assam Agricultural University, Jorhat.

This conference is a significant platform to address pressing challenges posed by global climate variability and extreme weather events to agriculture and allied sectors. The theme, focusing on frontier technologies such as natural resource management, artificial intelligence, digital tools, IoT, and advanced crop modelling, highlights the transformative potential of technology in ensuring resilience and sustainability in agricultural systems.

The *Abstract Volume* of AGMET-2025 is a testament to the extensive research, innovative ideas, and ground breaking solutions contributed by experts and scholars from across the country. It will serve as a valuable resource, capturing the essence of the deliberations and showcasing the collective expertise of the scientific community.

Since its inception in 1999, the Association of Agrometeorologists has been at the forefront of fostering education, research, and collaboration in agricultural meteorology. With over 1,900 life members, 20 chapters across India, and our flagship *Journal of Agrometeorology,* we have created a robust platform for scientific discourse and innovation.

I extend my heartfelt gratitude to Assam Agricultural University for hosting this event and to all the contributors for enriching this conference with their insights. Let AGMET-2025 inspire collaborative efforts, innovative strategies, and meaningful outcomes to shape a climate-resilient future for agriculture.

Wishing the conference and the publication of the abstract volume great success!

With best wishes!

Dr. K. K. Singh

President
Association of Agrometeorologists, Anand

The Association of Agrometeorologists (AAM), established in 1999, has grown significantly, now exceeding 1,905 life members. It has expanded its reach beyond meteorology and agrometeorology to a wide spectrum of allied scientific fields, including agronomy, soil science, horticulture, entomology, plant pathology, agricultural engineering, plant physiology, ecology, agricultural statistics, environmental sciences, plant breeding, and animal sciences.

AAM operates from its headquarters at the Department of Agricultural Meteorology, Anand Agricultural University, Gujarat, India, with 20 regional chapters across the country, including Hisar, Ludhiana, Pune, Hyderabad, Mohanpur, Pantnagar, Coimbatore, New Delhi, Jammu, Ayodhya, Raipur, Thrissur, Parbhani, Bihar, Bhopal, Meerut, Kashmir, Varanasi, Jorhat, and Jaipur.

The Journal of Agrometeorology (JAM) (ISSN 0972-1665 print, 2583-2980 online) is AAM's official peer-reviewed quarterly publication, released in March, June, September, and December. Initially a half-yearly publication (1999–2016), it features original research articles, full-length papers, short communications, and review articles in English. Indexed in major scientific databases, JAM has shown a consistent increase in impact factor since 2008. SCOPUS Cite Score (2025): 1.8, SJR: 0.64, SNIP: 0.791; Scimago H-Index: 17, IF: 0.915; WOS IF (2021): 0.557; SCOPUS IF (2024): 0.484. All issues are available on the official website: https://journal.agrimetassociation.org.

To promote education and research in agrometeorology, AAM has instituted nine awards, including Best Ph.D. Thesis, Best M.Sc. Thesis, Young Scientist, and Best Paper awards. It also confers Fellowships and Honorary Fellowships to distinguished scientists for lifetime achievements and contributions to agricultural meteorology and allied sciences. Retired agrometeorologists are regularly felicitated for their contributions.

AAM has successfully organized ten national seminars and four international conferences on various contemporary agrometeorological topics across India.

The National Conference AGMET 2025, themed "Frontier Technologies for Weather and Climate-Based Decisions in Agriculture and Allied Sectors", will focus on crop models, remote sensing (RS), and GIS-based agrometeorological interventions. Given the complexities of climate change and the regional variability of its impacts, the conference aims to develop strategic action plans tailored to different agro-climatic zones in India.

I extend my sincere gratitude to the Honorable Vice-Chancellor of Assam Agricultural University, Jorhat, Assam for hosting the seminar and commend the Jorhat Chapter of AAM for taking this initiative. I warmly welcome all delegates and look forward to fruitful deliberations and discussions.

Dr S. B. Yadav, Secretary

Association of Agrometeorologists, Anand

Preface

The National Conference AGMET-2025, themed "Frontier technologies for weather and climate – based decisions in agriculture and allied sectors," aims to gather leading experts to address one of the most pressing challenges of our time – climate change. Given its significant impact on agriculture and related fields, there is demand for innovative, science-driven strategies to ensure food security, sustainable livelihoods, and resilience. AGMET-2025, jointly organized by the Association of Agrometeorologists, Anand, and Assam Agricultural University will be held from 13-15 February 2025 at Jorhat. This conference serves as an excellent platform for researchers, policymakers, and students to share knowledge, discuss breakthroughs, and foster collaborations to address these critical challenges.

The Abstract Volume of AGMET-2025 presents a collection of innovative and cutting-edge research abstracts submitted by participants from across the country. These abstracts showcase advancements in climate-smart agriculture, predictive weather models, decision-support tools, and sustainable practices in agriculture and allied sectors. By sharing this knowledge, the publication will serve as a valuable resource for the global scientific community, inspiring new research directions, fostering innovation, and aiding informed decision-making. It bridges the gap between research and practice, empowering stakeholders to adapt to and mitigate the effects of climate change.

We extend our heartfelt gratitude to Dr. Bidyut C. Deka, Vice-Chancellor of Assam Agricultural University, for his visionary leadership and unwavering support in organizing the conference. We are also deeply grateful to the Register, AAU, Dean, Faculty of Agriculture, Director of Research (Agri), Director of Extension Education, and Director of Postgraduate Studies of AAU, as well as the President, Secretary, and all the members of the Association of Agrometeorologists for their support and encouragement. A special note of thanks goes to the subcommittees of the conference and, in particular, the Abstract Volume Compilation Committee for their meticulous efforts in bringing this publication to fruition. Your collective contributions have made this endeavour a success.

(Rajib Lochan Deka)
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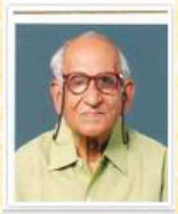

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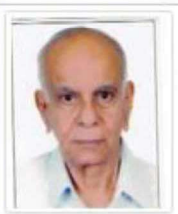

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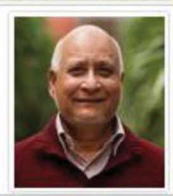

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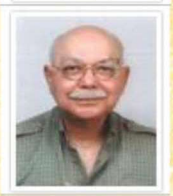

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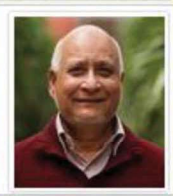

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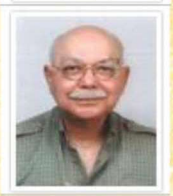

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Plenary-01

LA RAMDAS MEMORIAL LECTURE
"*Contributions and Innovations in Climate-Resilient Agriculture*"

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The legacy of Dr. Lakshminarayanapuram Ananthakrishnan Ramdas, often referred to as the "*Father of Agricultural Meteorology*" in India, provides an invaluable foundation for contemporary agricultural research and climate resilience. His pioneering work in meteorology and agricultural climatology has informed present-day strategies for climate-smart agriculture. The abstract highlights the evolution of agricultural meteorology initiated by Dr. Ramdas, and emerging innovations for breeding climate-resilient crops. His work continues to influence researchers aiming to tackle the complex challenges posed by climate change and variability in agriculture. Key traits for climate-smart crops include heat, drought and flood tolerance varieties, as well as pest and disease resistant varieties. Emerging tools and technologies include genomic selection and genome editing, high-throughput phenotyping, AI and predictive breeding models etc. The efforts on development of drought- and flood-tolerant crop varieties through collaborative research are going on for building climate resilient agriculture. Genetic advancements and marker-assisted selection have also led to the development of pest- and disease-resistant crops, ensuring greater food security. Research in climate-smart breeding now focuses on leveraging machine learning algorithms and high-throughput technologies for rapid genotype assessments. The integration of remote sensing data and climate models has significantly improved predictive capabilities, enabling breeders to anticipate and respond to future climatic challenges. The integration of traditional meteorological insights with modern breeding technologies and data-driven approaches will be critical for ensuring agricultural sustainability and food security in the face of ongoing climate challenges.

***Keywords*:** Agricultural Meteorology; Climate Resilience; Climate-Smart Breeding; Crop Adaptation Strategies

Plenary-02

Frontier Technologies for Weather and Climate Based Decisions in Agricultural Water Management – An Overview

ARJAMADUTTA SARANGI
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Climate and the weather at regional scales play a major role in deciding different agricultural activities for enhancing the livelihood of stakeholders. It is also observed that there was an increase of temperature by 0.7^0C during last 100 years besides prominent spatio-temporal variability of rainfall. In this context, judicious management of irrigation water under changing climate will be required to not only save water but also to bring more area under assured irrigation. In India, the irrigation sector would require 30% more water from

the present level of 588 billion cubic meters to feed the burgeoning population by 2030. Moreover, till 2024, about 50% of the net cropped area (142 Mha) is irrigated and remaining area is not having any irrigation facility. Major source of irrigation is through use of ground water (61%) followed by canal systems (25%). Hence, the changing climate scenarios necessitate implementation of climate resilient water management technologies. Therefore, it is essential to estimate the Actual Evapotranspiration (AET) of different crops and perform water budgeting investigations to ensure availability of water to sustain agricultural productivity in the region. Modern tools and techniques *viz.* AI/ml, big data analysis, remote sensing and GIS applications, IoT enabled integrated soil moisture and water depth sensing systems besides decision support systems (DSS) and mobile applications are being developed to assist in both weather based and soil moisture deficit based irrigation scheduling for different crops. Integration of crop model and climate generator would assist in deciding the future irrigation requirement for sustaining the crop yield under changing climate. Besides this the water footprint estimation at watershed scale can assist in delineation of regions for growing suitable crops to reduce the water footprint and enhance water productivity. Also, the ground water and energy nexus impacting the environment can be reduced by deciding the operation schedule of ground water pumping based on the crop water requirement. Estimation of regional crop coefficients of different crops by using the digital weighing type field lysimeters would assist in computation of irrigation water requirement at regional scale and for water budgeting investigation to save water and enhance crop water productivity.

Nonetheless, inclusion of innovative weather based prediction and analysis protocols using modern tools would assist in implementation of different agricultural water management technologies for enhancing water productivity *viz.* crop water demand based irrigation scheduling; supply of measured quantity of water as required by crop at different growth stages; up-scaling of micro irrigation method; modification in the existing rotational water supply schedule in canal commands based on the crop water demand; development of water foot print based conjunctive water use plan for judicious use of both canal and ground water resources; use of appropriate soil moisture conservation techniques, ground water recharge techniques and planting methods; bio-engineering measures for moisture conservation of rain fed and irrigated ecosystems; implementation of deficit irrigation protocols in the region of less water availability; Direct Seeded Rice (DSR) and System of Rice Intensification (SRI) cultivation methods in place of conventional rice cultivation method; crop diversification and selection of appropriate cropping system based on soil health, water and climate of the region and shifting to integrated farming system models are some of the technologies which need to be up-scaled for saving appreciable quantity of water. Further, development of climate resilient and bio-fortified cultivars would also assist in enhancing the productivity of grain and nutrition status of different ecosystems under changing climate.

Plenary-03

Impact of Climate Change on Horticultural Crops

D. RAJI REDDY

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Significant variation in the mean state of the climate, persisting for an extended period is referred as climate change. Climate plays a significant role in plant growth and productivity. Changing climate brings more significant hazards for agriculture/horticulture, including greater water stress, higher temperature, rainfall extremes and soil degradation that can quickly damage crops and food security. It is estimated that all the

horticulture crops put together occupy cover 11.6 million hectares area with an annual production of 91 million tonnes. Though, horticulture crops occupies 8% of the cropped area in India contribute nearly 30% contribution in agricultural GDP. In India variety of horticultural crops comprising of fruits, vegetables, root and tuber crops, flowers and other ornamentals, medicinal and aromatic plants, spices, condiments, plantation crops and mushrooms are grown due to varied and suitable climate. Several studies indicate that anthropogenic global climate change is strong, and the projected climate change could greatly impact horticultural production at global and national level.

The major impacts of rising temperatures on horticulture crops are many *viz*., changes in ripening, pollination, onset of flowering, irregular flowering, and malformation which will result in a reduction in productivity and quality. Major fruit crops are sensitive to temperature in terms of floral budding, full blooming, fruiting, change in phenology, colour development, and maturity. 75% increase in atmospheric CO_2 concentration (a long-term exposure whereby the concentration of CO_2 increases from 400 ppm to 700 ppm) has increased the number of fruit produced by the trees by 74±9%, the fresh weight of the fruit by 4 ± 2% and the vitamin C concentration of the juice of the fruit by 5±1% (Idso *et al*., 2002). Vegetable are also very sensitive to climate variations like sudden rise in temperature and irregular rainfall resulting in increased pest incidence, decreasing productivity, quality and sometimes entire crop loss.

Several technologies are available for reducing the impact of climate change. Adaptation strategies to climate change include selection of appropriate fruit/vegetable species or varieties to suit to the changed climatic conditions. Adoption of technologies like crop management and input management practices like change in the sowing date, use of efficient technologies like drip irrigation, soil and moisture conservations measures, fertilizers management through fertigation and Integrated Nutrient Management, change of crop, pre and post-harvest management will not only minimize the losses but also increase the positive impacts of climate change. Weather-based agro-advisories, awareness programme, publicity through print and electronic media, training farmers on adopting appropriate technologies, development of new land use patterns, agroforestry, soil health, alternate cropping systems and farming systems, natural resource conservation, well-structured storage facilities for perishable products, precision farming reduce the climate-related stress on crops

Plenary-04

Water Cycle Changes in a Globally Warming Climate

R. KRISHNAN

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Human-induced climate change has warmed the atmosphere, ocean, and land, and is already affecting every region of Earth in multiple ways. The changes we experience will increase with further warming. This talk will provide a brief summary of the key assessments from the IPCC AR6 WG1 report, with special focus on observed and projected changes in water cycle, the regional monsoons, attribution of regional monsoon precipitation changes to different anthropogenic drivers (e.g., greenhouse gases (GHG), aerosols), uncertainties in projections of water cycle and monsoon rainfall changes and related topics. Finally, the implications of water cycle changes for adaptation and mitigation options will be briefly discussed.

Plenary-05

Development of climate-smart crops through biotechnological intervention

BIDYUT KUMAR SARMAH
Director, DBT-North East Centre for Agricultural Biotechnology
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Jorhat – 785 013

The big challenge for the plant scientists is how to produce 70% more food to feed an expected 2 billion people by 2050. Furthermore, the climate change multiplies both biotic and abiotic threats to the food crops. The conventional breeding technologies alone cannot help breeders to breed for climate smart crop varieties with more productivity and with resistance against pests and diseases. Modern biotechnological interventions such as genome engineering have made it possible to make varieties with improved traits to confer resistance against biotic and abiotic stresses and with higher production. Research in the area of Genetic engineering for the improvement of grain legumes such as chickpea (*Cicer arietinum* L) has been going on at Assam Agricultural University, Jorhat. Chickpea (*Cicer arietinum*) is the most important pulse crop of India and is one of the major sources of protein for the vegetarian population. Two very serious insect pests of chickpeas are weevils (*Callosobruchus sp.*) and pod borers (*Helicoverpa armigera*). There is little or no natural resistance to these insects in the cultivated varieties which hinders the development of resistant chickpeas using conventional breeding methods. With the development of gene technology, it is now possible to incorporate insect resistance genes from unrelated sources into this important grain legume. We in collaboration with CSIRO Plant Industry, Australia, have transformed chickpeas using a bean á-amylase inhibitor (á-*ai*) gene to confer resistance against the stored grain pests in the *Callosobruchus*group. Transgenic lines were found to protect the seeds from attack of the pest when compared to control seeds. We have also transformed chickpeas using two different Bt genes (*Cry1Ac* and *Cry2Aa*) and developed transgenic lines with complete protection against pod borers (*Helicoverpa armigera*). The transgenic lines were found to be nutritionally similar to the untransformed chickpea. Introgression breeding has been conducted in our collaborating institutions and confined field trials using introgressed lines harbouring Bt-Cry2Aa gene confirmed 25% yield enhancement in comparison to the untransformed chickpea. Currently introgressed lines developed at PAU and UASD are being tested under the Confined Field Trial for event selection. Recently, we have optimized a genome editing protocol in chickpea for the development of herbicide resistant chickpea.Genetically modified crops (Biotech crops) have been accepted worldwide because of their yield advantage. Biotech crops such as soybean, maze, cotton, canola etc., are commercially grown in 71 countries covering 2.7 billion hectares and cultivated by more than 17 million farmers. The deregulation process is very stringent for releasing any GM crop variety in the field, and the regulatory bodies thoroughly verify all biosafety issues in relation to integration of an alien gene into a crop variety. Thus, considering the benefit of our farmers and for the food and nutritional security, we should say "YES" to the genetically engineered crops.

SI/LT-1

Polyhouse based Rain Water Management for Sustainable Agriculture under Climate Change Scenario in Eastern Dry Zone of Karnataka

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The present study analyzed rainfall patterns, rooftop rainwater harvesting (RWH) efficiency and irrigation water use efficiency (WUE) in protected cultivation at AICRP on Dryland Agriculture, UAS, GKVK, Bangalore from 2019 to 2022. Rainfall analysis revealed significant inter-annual variability, with total annual rainfall ranging from 902.0 mm in 2019 to 1477.4 mm in 2022, representing deviations from normal annual rainfall (-1.52% to +61.31%). Several months across the four years exhibited higher-than-normal rainfall, making them suitable for water harvesting. RWH analysis from a rooftop catchment area (1200 m^2 in 2019-2021 and 1500 m^2 in 2022) showed collected rainwater volumes of 774.0 m^3, 1413.74 m^3 and 1928.60 m^3 against estimated volumes of 1416 m^3, 1352.3 m^3 and 2216 m^3, respectively. Rainwater losses averaged 23.58%, lower than typical open-field losses (30-35%). The study also evaluated WUE for broccoli, capsicum, pole beans and cherry tomato under different irrigation regimes (75, 50 and 25%), Available Soil Moisture (ASM) and surface irrigation. Results demonstrated that 75% ASM required the least water and yielded the higher WUE: 84.98 kg $ha^{-1}mm^{-1}$ (broccoli), 102.25 kg $ha^{-1}mm^{-1}$ (capsicum), 114.27 kg ha-mm^{-1} (pole beans) and 88.41 kg $ha^{-1}mm^{-1}$ (cherry tomato), significantly higher than surface irrigation. This study highlights the potential of RWH to supplement water resources and emphasizes the importance of optimized irrigation strategies like 75% ASM for maximizing WUE in agriculture.

Keywords: Available Soil Moisture (ASM), Rooftop Rainwater Harvesting, Water Use Efficiency (WUE), Protected Cultivation and Irrigation Management

SI-O1

Performance of Rice (*Oryza sativa* L.) as Influenced by Low Sunshine Intensity and its Management through Triacontanol

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Rice (*Oryza sativa* L.) is an important cereal cultivated globally as well as in Punjab, India. Solar radiation reaching the earth surface is decreasing at the rate of 2.7% per decade, which can negatively affect the productivity of rice crop.Apart from this, inter and intra seasonal variation in quantity of solar radiation received is also noticed quite frequently, which has a marked impact on rice productivity in Punjab. Therefore, to quantify the impact of reduction in sunlight intensity and the management options under such conditions, a field experiment (factorial RBD) was conducted at Ludhiana (Punjab), India during summer seasons of 2020 using rice variety PR 122. The 30 days old seedlings were transplanted on 22-6-2020 in the puddled field. Fertilizers were applied at the rate of 275 kg Urea, 190 kg SSP and 50 kg of MOP per hectare as per recommendations. Weed control was achieved by applying Rifit Plus 37 EC followed by 2 hand weeding. The experiment involved three levels of reduction (50%) in sunlight intensity [no reduction, reduction during 15-45 (S1) and 46-75 (S2) DAT(days after transplanting)] and three levels of triacontanol [control (T0), triacontanol before radiation stress (T1) and triacontanol midway of radiation stress (T3)]. The reduction in radiation intensity was achieved by covering the plots with the green shade net capable of reducing the incoming radiation by 50%. Tricontanol was applied @ 875 ml/ha of commercial formulation having 0.1% tricontanol. The results indicated that, the reduction in sunlight intensity (S1) caused a significant increase in plant height of rice when measured at harvest. However, tricontanol failed to have any significant effect on plant height of rice. The reduction in radiation (S1) caused a significant reduction in number of effective tillers/$m^2$of rice. Tricontanol (T1) significantly increased the number ofeffective tillers/m^2 of rice as compared to control. The reduction in radiation (S1and S2) caused a significant decrease in weight of grains /panicle. Application of tricontanol (T1) significantly increased the weight of grains /panicle of rice as compared to control. The reduction in radiation (S2) caused a significant decrease in number of filled grains /panicle of rice. Tricontanol (T1) application, significantly increased the number of filled grains /panicle of rice as compared to control. The S1and S2 caused a significant reduction in 1000 grain weight of rice. However, application of Tricontanol failed to have any significant effect on 1000 grain weight of rice. The reduction in sunlight intensity during 15-45 and 45-75 DAT caused 20.6 and 34.1% reduction in grain yield of rice as compared to control, respectively. Application of Tricontanol before radiation stress (T1) caused a significant increase in grain yield by 16.0% as compared to control. However, the application of tricontanol midway of shade stress failed to have any significant effect on grain yield of rice.

SI-O2

Phenology, growth, yield and PAR absorption in potato as influenced by different growing environments and cultivars under north Indian Indo- Gangetic Plains

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A field experiment was conducted during *Rabi* season 2021-22 and 2022-23 at Agricultural Meteorology Research Farm of CCS HAU, Hisar, Haryana (India) to study the effect of different growing environment and varieties on phenology, growth, yield and PAR absorption of potato crop. The experiment was comprised of four growing environment/planting dates (main plot treatments) *viz*. D1-1st week of November, D2-2nd week of November, D3- 3rd week of November and D4- 1st week of December and sub plot treatments comprising three different varieties *viz*. V1- Kufri Bahar, V2- Kufri Pushkar and V3- Kufri Lima during both the crop seasons. The experiment was laid out in split plot design with four replications. Among different growing environments, crop planted on 1st week of November had taken significantly maximum (105) number of days to attain maturity, higher average growing degree days (974.9) while helio-thermal units were maximum (5758.2) under D3 (3rd week of sowing). Leaf area index (3.38) at tuber bulking, chlorophyll content index, tuber yield (368.2 q/ha) and absorbed PAR (169.5 w/m^2) was found grater under crop planted on 2nd week of November in comparison to other dates of sowing. The crop grown under D2 (2nd week of November) environment also had higher average heat use efficiency (40.7) and helio-thermal use efficiency (7.0). Among different varieties, Kufri Lima had taken significantly maximum average days to emergence (24) andmaturity (104) along with higher (160.6 w/m^2) absorption of PAR while leaf area index (3.33), chlorophyll content index and yield (337.1 q/ha) was significantly maximum under Kufri Pushkar. In conclusion, crop sown on 2nd week of November performed better and had higher leaf area index, chlorophyll content index, and utilized PAR more efficiently to produce higher yield. Among varieties, Kufri Pushkar had higher tuber yield and found most stable under different growing environments.

Keywords: Potato, growing environments, cultivars, PAR, tuber yield

SI-O3

Soil physico chemical properties and microbial biomass of land use practices of Annapurna Conservation Area, Central Nepal

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The Annapurna Conservation Area comes under the Chitwan-Annapurna Landscape (CHAL), located in Central Nepal, covered 32090 Km^2, and has enormous potential for agriculture, forestry, and

tourism thereby contributing the overall social and economic development. Maintaining the quality of soil is the major concern for most rural people in the middle mountain region for the sustainability of the mid-hill farming. The study aims to identify the land-use types and depths on soil physicochemical and microbial biomass. The study was conducted at Ghale Gaun area of Lamjung district, the middle mountain regionof Annapurna Conservation Area.A total of 40 soil composite samples (4 land use types - crop land, abandoned land, tea orchard and alder plantation × 5 replications × 2 depth layers: 0-15 cm and 15-30 cm) were collected by stratified random sampling method and analyzed using the standard protocol. The study revealed that soil physical (soil textural fractions, BD), chemical (pH, SOC and its stock, TN, available P and K) and microbial (microbial biomass Carbon and Nitrogen and ratio) properties respond differently with land-use types and soil depths. The soil in the study area was primarily acidic. The textural classes of the soils were observed as loam and sandy loam. SOC, TN, available P, available K, microbial biomass decreased with increasing depth. However, BD and microbial biomass C and N ratio increased with soil depth. The most positive influence of conversion of the crop land was observed in tea orchard, followed by alder plantation, having higher clay content, SOC, TN, available P, available K, and microbial biomass. In both soil depths, sand content, BD, soil pH, SOC, TN, available K and microbial properties were found similar under crop land and abandoned land, indicating that there was no significant improvement in soil properties after 10-15 years of abandoning cultivated land. Good soil quality was found at the surface of 0-15 cm depth under tea orchard and alder plantation sites ($0.6 < SQI < 0.8$), while cropland and abandoned land at 0-15 cm depth and all land use types at 15-30 cm depth were found to have fair soil quality ($0.4 < SQI < 0.6$). A significant correlation was exhibited between microbial biomass to clay, BD, SOC, and TN suggesting that microbial biomass may serve as a suitable indicator of soil quality.

***Keywords*:** Annapurna Conservation Area, Land-use types, Soil Properties, Microbial Biomass

SI-O4

Niger Crop: A Climate-Resilient Source of High-Quality Edible Oil

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Niger crop (*Guizotiaabyssinica*) is a climate-resilient crop valued for its ability to thrive under challenging environmental conditions and its high-quality oil. The deep root system of the crop enables it to access moisture from deeper soil layers, allowing it to survive dry spells and grow with minimal water, making it ideal for regions with erratic or low rainfall. It thrives in degraded, marginal and low-fertility soils with minimal preparation, tolerating acidic to slightly alkaline conditions. The crop withstands high temperatures, thriving in semi-arid and tropical climates without significant yield loss. Requiring little to no fertilizers or pesticides, It is an environmentally sustainable option for resource-limited regions. With a short growing season of 90–120 days, it fits into short cropping windows and adapts to variable growing seasons caused by climate change. As a cover crop, it reduces soil erosion, enhances organic matter, and improves soil fertility by adding biomass and recycling nutrients.Niger is primarily cultivated for its oil, rich in unsaturated fatty acids like linoleic acid (Omega-6) ~65–75% and oleic acid (Omega-9) ~15–25%, with low saturated

fat content (~10–12%), making it heart-healthy. It also contains Vitamin E (tocopherols), which acts as an antioxidant, protecting the oil from rancidity and supporting skin and immune health. Additionally, phytosterols in the oil promote cholesterol lowering properties. Even under harsh conditions, Niger consistently produces yields, ensuring food security and providing a safety net for farmers. Its adaptability to extreme weather, such as heat waves and delayed rainfall, makes it a reliable choice for sustainable agriculture and livelihood enhancement in climate-affected regions.

***Keywords*:** Niger, Climate resilient crop, high quality edible oil

SI-O5

Role of resource intensive irrigated wheat cultivation in enhancing climate change in different regions of Punjab, India

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Wheat is major winter season cereal whose cultivation has increased from 1.4 Mha during 1960's to 3.5 Mha during 2020's in Punjab. This tremendous increase of 150% was enabled by introduction of dwarf wheat varieties and increase in irrigation facilities during the era of *Green Revolution* in Punjab state. Currently the state enjoys the title of "*Food bowl*" as it contributed 51% of wheat towards central food grain pool during 2021-22. The present study was conducted to evaluate the changes in climate during wheat growing season in the state. The data on area under wheat and meteorological data were analyzed for the three representative locations, i.e. Ballowal Saunkhri (north-eastern region), Ludhiana (central region) and Bathinda (south-western region) wherein A-Class Agro-meteorological observatories maintained by Punjab Agricultural University are located. In the north-eastern regions of the state, the area under wheat at Ballowal Saunkhri increased by 30% (from 60 to 78 thousand ha) during past 27 years (1995-96 to 2022-23). In the central regions of the state, there been a slight increase by 3% at Ludhiana and a decrease in south-western region by 10% at Bathinda over the past 53 years (1970-71 to 2022-23). The maximum temperature during the wheat growing season has not registered significant change in the state. On the other hand, the minimum temperature has increased @ 0.03°C/year (R^2= 0.35) at Ballowal Saunkhri, @0.05°C/year (R^2= 0.88) at Ludhiana and @0.03°C/year (R^2= 0.49) at Bathinda. Wheat is irrigated under assured irrigation conditions in the state and consequently the amount of moisture in the ambient atmosphere measured as relative humidity (RH) showed increasing, while the pan evaporation (Epan) a decreasing trend. Consequently, the maximum and minimum relative humidity (RH) at Ballowal Saunkhri has increased @ 0.2%/year (R^2= 0.66) and @ 0.3%/year (R^2= 0.84), respectively, while the Epan has decreased @ 3.8mm/year (R^2= 0.59). However, at Ludhiana and Bathinda the maximum RH did not show significant increase. The minimum RH at Ludhiana has increased @ 0.1%/year (R^2= 0.56) and Epan has decreased @ 2.3mm/year (R^2= 0.38). The south-western regions of Punjab state have a semi-arid type of climate and so both the minimum RH and Epan have increased @ 0.6%/year (R^2= 0.64) and @ 9.1 mm/year (R^2= 0.46), respectively. The rainfall during the wheat growing season in the three distinct regions of the state, i.e. humid (north-eastern) having annual rainfall > 900mm, sub-humid (central) having annual rainfall 600-800mm and semi-arid (south-western) having annual rainfall <250-300mm did not indicate any distinctive change. But the

enhancement in moisture content due to crop cultivation under assured irrigation induced increase in moisture content in ambient atmosphere has been translated into a consistently cloudy atmospheric condition. This type of climate change was indicative with a declining trend in bright sunshine hours (BSS) during wheat growing season. The analysis showed a significant decrease in BSS from >8 hours during the 1970s to 6.3 hours during 2023-24 in the state. Hence, the resource intensive irrigated wheat cultivation has resulted in humid air induced slightly cloudy with warm nights type of climatic changes in the state.

***Keywords*:** Wheat, Climate Change, Temperature, Relative humidity, Rainfall, Sunshine hour, Punjab

SI-O6

Maximizing productivity of Kodo millet through irrigation and nitrogen management in Punjab

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Kodo millet (*Paspalumscro biculatum* L.) is a drought-tolerant crop, can contribute significantly for improving food and nutritional security in semi-arid regions or the regions with scanty and erratic rainfall. The limited productivity and poor economic returns are among the important reasons for the low adoption of millets by cultivators. The efficient irrigation and nitrogen (N) management are critical for maximizing its growth and yield. The field experiment was conducted at Punjab Agricultural University Regional Research Station, Gurdaspur to study the effect of irrigation and nitrogen management on the growth and yield of Kodo millet during the year 2022 and 2023. The experiment comprised two irrigation levels (I1: irrigation at 0.9 IW/CPE and I2: irrigation at 0.75 IW/CPE) and five nitrogen levels (N0: control, N1: 25 kg N ha^{-1}, N2: 50 kg N ha^{-1}, N3: 75 kg N ha^{-1}, and N4: 100 kg N ha^{-1}), arranged in a factorial randomized block design with three replications. The results indicated that irrigation at 0.9 IW/CPE (I1) produced higher plant height, number of tillers, and grain yield compared to irrigation at 0.75 IW/CPE (I2). Among nitrogen treatments, N1 (25 kg N ha^{-1}) produced significantly high plant height and grain yield, followed by N2 (50 kg N ha^{-1}). Higher crop lodging was observed in the treatments with higher N doses, resulting in reduction of yield. The study highlights the importance of optimizing irrigation and nitrogen application for enhancing the productivity of Kodo millet under varying water availability conditions.

Keywords: Kodo millet, Irrigation, Yield, Nitrogen, IW/CPE ratio.

SI-O7

Ranking of CMIP6 GCMS for minimum & maximum temperatures over the Periyar River Basin by using MCDM techniques

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The Periyar River Basin (PRB) is the humid tropical basin situated in the Western Ghats, India. It is a complex basin featured by various human-induced constraints. Climatic extremes such as temperature

extremes are susceptible to the impacts of climate change (CLC) warming and these extremes are usually linked with the significant consequences for ecosystems. Therefore, it is essential to study effect of CLC on maximum temperature (Tmax) and minimum temperature (Tmin) of the PRB. Selecting best general circulation models (GCMs) from a given suite through ranking is essential for accurate projection of future climatic parameters. None of the reviewed studies have performed ranking of CMIP6 GCMs for Tmax and Tmin of the PRB. Therefore, in the present study, twenty-seven CMIP6 GCMs are ranked for Tmax and Tmin variables at each grid of PRB by using the performance indicators namely Kling Gupta Efficiency, Nash Sutcliffe Efficiency, Normalized Root Mean Square Error, Correlation Coefficient, entropy technique and two MCDM techniques namely Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) and Compromise Programming (CP). The aggregated ranking of GCMs for the study area corresponding to Tmax and Tmin variables is also carried out by using group decision-making approach (GDMA). The Tmax and Tmin data of 21 grids over the PRB is analysed in the present study, which is having resolution of 0.25° x 0.25°. Top six aggregated ranked GCMs found through GDMA for Tmax are FGOALS-g3, BCC-CSM2-MR, CanESM5, GFDL-CM4-gr2, GISS-E2-1-G and CNRM-CM6-1 corresponding to TOPSIS and CP while that for Tmin are KIOST-ESM, CanESM5, CNRM-CM6-1, INM-CM5-0, INM-CM4-8 and GISS-E2-1-G.

***Keywords*:** Periyar River Basin, Maximum Temperature, Minimum Temperature, Ranking, CP, TOPSIS, CMIP6 GCMs

SI-O8

Timely sowing of wheat (*Triticum aestivum* L.) enhanced the dry matter accumulation and grain yield under rainfed hilly Agro-ecosystem

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An experiment was carried out at Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh during rabi 2023-24, to investigate the effect of sowing dates and genotypes on agronomical and physiological characters of wheat. The experiment was laid out in split-plot design and replicated thrice, wherein main-plot consists of three sowing dates *viz*. timely (4th November), late (25th November) and very-late (16th December), while the sub-plots consist of four wheat genotypes (HD- 2967, HD-3086, HD-3298, HD-3226). Timely sowing significantly increased the post-anthesis dry matter accumulation (DM), dry matter remobilization (DMR), and dry matter remobilization efficiency (DMRE) to the tune of 9.5-54.0%, 11.5-35.9%, and 6.7-45.7% respectively, over late and very-late sown. In contrast, dry matter remobilization contribution to grain (DMRG) was highest in late sowing, with an increment of 4.9-27.2% compared to timely and very late sowing. Further, late and very late sowing reduced the grain filling period by 7 days compared to timely sowing. Similarly, very late sowing reduced the productive tillers by 19.5-20.8% over timely and late sowing. Timely sowing had grain yield advantage of 26.5-34.9% compared to late and very late sown. While, among the genotypes, HD-3086 was superior in grain yield under timely and late sowing, and HD-3226 excelled under very late sowing. Hence, the current study clearly outlined that timely sowing of wheat leads to higher post-anthesis dry matter accumulation and remobilization coupled with extended grain filling duration resulting in enhanced grain yield.

***Keywords*:** Sowing dates, wheat genotypes, grain filling, dry matter accumulation, and grain yield.

SI-O9

On the link of global warming and cloudiness in mid hills of Himachal Himalayas

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The cloud is one of the most obvious, influential features also the most variable components of Earth's climate system. Clouds cover more than two-thirds of Earth at any given moment and play a crucial role in the warming and cooling of the planet by affecting both radiation fluxes and latent heat fluxes. How clouds will perform in a warmed world has some modelers saying they will help cool the planet, while the majority say clouds will further warm it. As the planet warms, clouds have a cooling effect if there are more low-level clouds or fewer high-level clouds, but more warming if the opposite is true. There is a large amount of evidence that the net feedback is positive and will amplify global warming. Changes in cloud cover associated with climate change remain one of the most challenging aspects of predicting future climate change. Climate observations and models suggest that cloud properties have changed and will continue to change in a warming climate. Changes are likely to be seen in cloud amount, height, thickness, geographical distribution and morphology. Trends in cloudiness have been difficult to identify due to lack of reliable long-term cloud records. It is more important to study the surface-observed clouds in terms of inter annual variations or on small scales rather than looking for multi decadal trends on zonal or global scales. The present study investigated the monthly, seasonal, and annual cloud cover variability over two stations located in the mid hills sub-temperate subhumid zone of Himachal Pradesh, by using Pearson's correlation coefficient, Mann-Kendall (MK) test trend and Sen's slope estimator test. Daily data on cloud cover, sunshine hours, maximum and minimum temperature, morning and evening relative humidity, evaporation and rainfall for the period of 23 years (2001–2023) were used in the investigation. In the study, we have tried to analyze the trends in cloud cover and their relationship with bright sunshine, temperature, and other climatic variables under changing climatic scenarios. Both the stations showed an increasing trend in cloudiness, which was increasing at a non-significant rate of 0.01 Okta/year at Solan and 0.30 Okta/year at Kullu. From –0.64 to –0.87, a significant inverse correlation was observed between cloud cover and sunshine hours. It was negatively correlated with maximum temperature and ranged from -0.03 to -0.42 and evaporation with an r value that ranged from -0.08 to -0.44. The minimum temperature showed a significant positive correlation with cloud cover at Kullu but a non-significant positive correlation at Solan. Rainfall showed a negative correlation at Solan whereas a positive correlation was found at Kullu as the total cloudiness and its increasing rate were higher at Kullu. The overall trend in cloud cover in the study area was significantly increasing ($Z = 1.66$) with an upward magnitude ($Q = 0.03$). We tried a case study to work out a local trend in cloud cover, which may be extended over time and space to reach some conclusions.

***Keywords*:** Cloudiness; Weather variables, Correlation; Trend analysis; Himachal Himalayas

SI-O10

Evaluation of Nano-Technology for Improving Rice (*Oryza sativa* L.) Production in Terai Region of West Bengal

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Rice (*Oryza sativa* L.) serves as a vital staple, particularly in India, the country with the largest area dedicated to rice cultivation worldwide. The rice crop necessitates significant amounts of minerals and supplements, along with nitrogen, to thrive. To achieve improved crop yields, farmers often bound to apply large quantities of nitrogenous fertilizers, especially urea granules. This practice leads to unnecessary costs for farmers, as not all the nitrogen is absorbed by the plants, resulting in issues such as nitrate leaching, soil denitrification, and volatilization, which contribute to environmental degradation. Nitrate leaching can contaminate groundwater and other aquatic systems, leading to eutrophication, while the volatilization of nitrogen contributes to global warming by releasing the potent greenhouse gas nitrous oxide (N_2O). Research has demonstrated a direct correlation between cumulative N_2O emissions and the intensity of N_2O based on yield with the rate of nitrogen application. The excessive application of fertilizers, including ammonium salts, urea, and phosphate compounds, adversely affects soil quality, entailing sustainable practices to enhance crop production for an ever-growing population. The only means to do this is to adopt cutting-edge technologies that have not been used in agriculture before. Nano fertilizers, which feature nano-structured compositions, gradually and systematically release nutrients into the soil. These materials, designed through nano-technology, have sizes ranging from 1 to 100 nm. Their small dimensions give nanomaterials a greater surface area relative to their volume compared to conventional forms, enhancing biochemical reactivity and imparting distinctive beneficial properties. Under this context of climate change, a field experiment was conducted in 2021 in Dinhata, Cooch Behar, West Bengal, to assess the performance of two rice varieties (Swarnamahsuri - V_1 and Burdwanmahsuri - V_2) during different planting dates (2^{nd} fortnight of July and 1^{st} fortnight of August) within the kharif season, utilizing three levels of fertilizer: F_1 (Recommended Dose of Fertilizer – N: P_2O_5: K_2O at 80:40:40 kg/ha), F_2 (one liquid nano urea spray @ 4ml/L water combined with 50% of the RDF of N in urea + full RDF of P_2O_5 and K_2O), and F_3 (two nano urea spray @ 4ml/L water along with full RDF of P_2O_5 and K_2O). The experiment followed a Factorial Randomized Block Design with two replications. Results revealed that treatment F_2 yielded the highest output (5.38 t/ha), followed closely by F_1 (5.23 t/ha) and F_3 (5.16 t/ha). The yield of V_1 surpassed that of V_2 (5.35 t/ha vs. 5.16 t/ha), and the first planting date (D_1) out performed the second (D_2) (5.37 t/ha vs. 5.14 t/ha). Agro-meteorological indices, such as Growing Degree Days (GDD), Heliothermal Units (HTU), and Photothermal Units (PTU), exhibited a significant positive correlation with various production components across different growth stages. These results indicate that optimizing fertilizer application with nano urea and adjusting transplanting dates can enhance rice production. On-going studies over multiple years are recommended to refine the findings and increase precision.

Keywords: Agrometeorological indices, Date of sowing, Nano fertilizer, Rice Cultivars, Yield Performance.

SI-O11

Sowing the Seeds of Sustainability : Integrated Farming Systems for Climate-Resilient Agriculture

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Climate change is increasingly recognized as a significant threat to global agriculture, food security, and the livelihoods of millions, particularly in developing countries. The impacts of rising temperatures, water scarcity, erratic rainfall, and the growing intensity of extreme weather events such as floods and droughts underscore the vulnerability of farming systems. Traditional farming methods are ill-equipped to adapt to these challenges, making the development of advanced and sustainable agricultural systems imperative. One such transformative approach is the Integrated Farming System (IFS), which offers a climate-smart, resource-efficient, and eco-friendly solution to these pressing issues. IFS is a mixed farming approach that integrates multiple components, such as crops, livestock, aquaculture, forestry, and horticulture, into a single system. By logically interlinking these components, IFS ensures that the waste from one enterprise becomes a valuable input for another, thus optimizing resource use and enhancing farm productivity. This circular approach minimizes the dependency on external inputs like synthetic fertilizers and pesticides, reducing the environmental footprint and promoting sustainable agricultural practices. One of the key benefits of IFS is its ability to improve soil health and fertility through organic nutrient cycling. Crop rotation and diversification within the system help in controlling pests and weeds, while inter cropping and agroforestry contribute to increased biodiversity and carbon sequestration. Water use efficiency is another critical advantage of IFS, achieved through techniques such as rainwater harvesting, micro-irrigation, and integrated water management practices. These measures not only conserve water but also maintain its quality, making IFS a valuable tool in combating water scarcity. IFS is particularly effective in mitigating greenhouse gas (GHG) emissions. Modules such as rice-fish farming or silvopastoral systems are inherently low emitters of GHGs, while agroforestry components sequester significant amounts of carbon. This makes IFS an emission-negative or low- emission agricultural model, aligning well with global climate goals. In addition to environmental benefits, IFS also provides socio-economic advantages. By diversifying farm activities, it generates multiple income streams, reducing economic risks for small and marginal farmers. Improved income levels lead to better access to education, healthcare, and other social amenities, contributing to overall livelihood security. Despite its potential, widespread adoption of IFS requires robust policy support, capacity-building initiatives, and investment in research and innovation. Tailored IFS models that address regional agro-climatic conditions and farmer needs must be developed to ensure successful implementation. This extended abstract highlights IFS as a holistic, climate-smart agricultural approach that not only mitigates the adverse impacts of climate change but also enhances agricultural sustainability, ecological balance, and rural livelihoods. Through continued research and policy advocacy, IFS can serve as a corner stone for achieving global food security in the face of climate change.

***Keywords*:** Food security, Integrated farming system, carbon sequestration, climate change, eco- friendly

SI-O12

Conservation Agriculture for sustainable production and resource conservation on marginal lands of Chambal ravines in south eastern Rajasthan

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A field experiment was conducted at ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Kota during 2021-22 and 2022-23 to evaluate the effect of different tillage and residue management practices under supplementary irrigation on productivity, economic returns, and resource use efficiency in black gram-mustard cropping system. The experiment was established in split plot design with two supplementary irrigation practices *viz*., border irrigation and mini sprinkler irrigation in main plots; and five tillage and residue management practices i.e. conventional tillage (CT) + residue incorporation, reduced tillage (RT) + partial residue retention on surface, zero tillage (ZT) + residue retention on surface, fresh broad bed and furrow (F-BBF) + residue incorporation, and permanent broad bed and furrow (P-BBF) + residue retention on surface in sub-plots and replicated thrice. The system productivity and net returns were found higher with mini sprinkler irrigation and P-BBF with surface residue incorporation. However, blackgram yield was higher with F-BBF. WUE was recorded higher with mini sprinkler irrigation in mustard and P-BBF with surface residue incorporation in both the crops. Total energy output was also higher with mini sprinkler irrigation and P-BBF with surface residue incorporation. Similarly, soil moisture content at flowering, pod formation and seed formation were higher with mini sprinkler irrigation and P-BBF with surface residue incorporation. Nutrient uptake was higher with mini sprinkler irrigation over border irrigation in both black gram and mustard. Blackgram had higher nutrient uptake with F-BBF while mustard was found to have higher uptake of nutrients under P-BBF. No significant difference was found in weed biomass between the two irrigation methods. However, ZT and P-BBF has higher weed biomass over other practices. In case of enzymatic activity, higher DHA activity was recorded with mini sprinkler irrigation, and ZT and P-BBF.

SI-O13

Performance of Basmati Rice under Diverse Establishment Methods and Irrigation Regimes in Sub-Tropical Inceptisols

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A field experiment was conducted to evaluate the performance of the rice variety Basmati-123 under different rice establishment methods and irrigation regimes at the Research Farm of the Agrometeorological Section, SKUAST-Jammu, Chatha, UT of J&K, India, during two Kharif and two intervening Rabi seasons, starting from Kharif 2021. The experimental site featured sandy loam soil with low organic carbon and available nitrogen but medium phosphorus, potassium, and sulfur content. Three rice establishment methods were tested: Conventional (E1), Direct Seeded Rice (DSR, E2), and System of Rice Intensification (SRI, E3). Subplot treatments included three irrigation regimes: (I1) 7 cm/4 cm irrigation

depth at 8-day intervals during non-rainy periods with half the recommended NPK dose applied *via* FYM, (I2) alternate wetting and drying at 4cm depth with half NPK dose through vermicompost, and (I3) alternate wetting and drying at 4 cm depth with half NPK dose through FYM. The impact of rice establishment method on grain yield, during Kharif 2021, yield obtained in E1 treatment (23.5 q ha^{-1}) was significantly higher than E3 & E2 method whereas mean grain yield obtained in E3 (21.83 q ha^{-1}) was statistically at par but numerically higher than DSR plots (21.08 kg/ha). Among the irrigation regimes treatment, I2 (23.75 q ha^{-1}) recorded the highest mean value of grain yield, followed by I3 (21.83 q ha^{-1}) and I1 (20.83 q ha^{-1}). Water productivity during kharif 2021 in E1 treatment (0.134) was significantly higher than E2 (0.134) plots but at par with E3 (0.142). During kharif 2022 Yield obtained in E2 was significantly lower than SRI plots, the highest mean value of grain yield was recorded in E1 (24.31qha^{-1}) treatment, followed by E3 (22.42 / ha) and E2 (21.24 qha^{-1}). The grain yield in E3 was at par with E2 treatment. Among the irrigation regimes treatment, I2 (23.48 qha^{-1}) recorded the highest mean value of grain yield, followed by I1(22.65 qha^{-1}) and I3(21.83kg/ha). The grain yield in I1 was at par with I2 treatment. The interaction between (E×I) and (I×E) rice establishment methods and irrigation regimes on grain yield was found significant. The highest mean value of water productivity was recorded in E1 (0.166 kg m^{-3}) treatment, followed by E3 (0.165 kg m^{-3}) and E2 (0.132 kg m^{-3}) treatment, respectively. The data showed that E1 was significantly superior over E2 but was at par with E3. Among the irrigation regimes treatment, the highest mean value of water productivity was recorded in I2 (0.167 kg m^{-3}) treatment, followed by I3 (0.155 kg m^{-3}) and I1 (0.14 kg m^{-3}) treatment, respectively. I2 was significant superior over I1 but was at par with I3. The interaction between rice establishment methods (E×I) and irrigation regimes (I×E) on water productivity was recorded significant. It was concluded that conventional and SRI Methods are equally good in terms of water productivity whereas DSR method shows lower water productivity hence Conventional and SRI Methods are recommended over DRS for comparatively high yield with low input of water for water saving under climate change.

Keywords: Conventional, DSR, SRI, FYM, Vermicompost, Water productivity

SI-O14

Assessment of thermal regime and soil moisture to the yield of soybean

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An experiment was conducted at AICRP on Agrometeorology, VNMKV, Parbhani, during *Kharif* 2013 to 2023, in a split plot design with three replications. Treatments comprised of four sowing environment in the main plot treatment *i.e.* D_1 (27^{th} MW), D_2 (28^{th} MW), D_3 (29^{th} MW) and D_4 (30^{th} MW), with three varieties in sub plot *viz*. MAUS-158, MAUS-71 and JS-335. Thresholds of rainfall, maximum & minimum temperature, Bright sunshine hours and percent available moisture, associated with higher productivity, occurring at different phenophases, were determined. The outcomes achieved from the experiment shown that the yield of soybean was significantly highest in D_1-27^{th} MW (1448 kg/ha) and variety MAUS-158 was initiate to be immensely productive. The computed the optimum thermal regime and percent available soil moisture (PASM) for soybean crop at Parbhani using historical data. The results revealed that if rainfall (675 mm) in 35 rainy days, maximum temperature range 29.4-31.6 ^{0}C, mean relative humidity 73-77% , BSS

3.9-4.5 hr/day and soil moisture 28.3-30.6 %, respectively during crop growing season to get more than 1400 kg/ha yield of soybean crop if delayed sowing, this leads to a reduction in grain yield. Correlation coefficient between PASM and yield was positively correlated (0.942**) and R^2 (0.888) respectively. If PASM was available at 35 % to 25 % optimum yields while PASM was available at 65% to more than 65% then only the optimum yield of soybean was recorded. Considering grain yield *vis-à-vis* rainfall & temperature regimes during flowering to pod developement stage the most important recommendation for the farmers of the region would be to finished soybean sowing before 27th SMW in order to enable them to escape terminal heat stress in soybean and thereby realizing higher grain yield.

***Keywords*:** Date of sowing, PASM, drought, correlation, Thermal regime and yield.

SI-O15

Ascertaining natural resources in watersheds under climate change- AL and Resource Inventory and Hydrological approach

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Watersheds typically rainfed are known for their vulnerability for climate change through socio-economic and livelihood security of the farming community residing in the particular watershed. This highlights the need for interventions *via* research and policymaking. With this view, present study was conducted to estimate the available land and water resources in Narayanaghattahalli sub-watershed, located in Arsikere taluk, Hassan district, Karnataka. While Land Resources Inventory (LRI) targeted detailed documentation of soil (surface soil texture, surface gravel, nutrient status etc.) and site (land use and land cover, slope, erosion and runoff) characters. Hydrological studies targeted to address inflow and outflow of water resources such as rainfall and its distribution, runoff, storage, etc. Collected 320 m grid soil samples, profile studies up to 2m depth (1 profile/31 ha area) revealed a spatial variability of the soil physico-chemical characteristics in the sub-watershed and were classifiable into the four suitability classes IIs, IIIe, IIIes and IIIs. Out of 6375.1 ha of the sub-watershed, 44% of land characterized by the soil depth (100cm to >150 cm) was suitable for cultivation of a range of perennial horticultural and forestry species (Mango, Guava, Pomegranate, Cashew, Glyricidia, Acacia, Sandalwood etc.), and 27.3 % area was suitable for cultivation of annual (Finger millet, Pigeonpea, Maize etc.) sole and their intercropping. It was also found that the soils were depleting the organic carbon deposits, highlighting the need for long term restorations through pulse-based crop rotations (Greengram/ Blackgram/ Sesamum/ Finger millet/ Maize). Relief characteristics (gently sloping and moderately sloping occupied 3-5 and 5-10% area) with 756.38 mm mean annual rainfall with a coefficient of variability 24.03% and Mann-Kendal tau of 0.192 highlighting increasing tendency of rainfall in the region. Of the total annual rainfall, only estimated 11.81% was able recharge the waterbodies and remaining was responsible for moderate erosions across a whopping 1232.8 ha of the sub- watershed, necessitating the need for interventions through tailored soil and water conservation practices like contour bunds, contour trench cum bunds, and graded bunds. Measured impacts through these practices revealed reduction in runoff from 106

mm to 64 mm, with 52 mm of this runoff being harvestable through the construction of check dams and farm ponds. Such interventions craft the examples for need of LRI and hydrological study-based interventions through a comprehensive policymaking in rainfed areas/watersheds for ensuring sustainability of farming.

Keywords: *Climate change, Hydrology, Land resource inventory, Land capability, Crop suitability.*

SI-O16

Enhancing the Quality and Resilience of Naga King Chilli (*Capsicum chinense* Jacq.) through the Application of Metallic Nano particles

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This study examined Enhancing the Quality and Resilience of Naga King Chilli (*Capsicum chinense*Jacq.) through the Application of Different Metallic Nano particles (AgNPs, CuO NPs and ZnO NPs). The experiment was laid out in randomized block design with 10 treatments and three replications. The treatment comprised of : T0 (control), T1 (Metallic Silver NPs @ 10 ppm), T2 (Metallic Silver NPs @ 20 ppm), T3 (Metallic Silver NPs @ 40 ppm), T4 (Metallic Copper NPs @ 10ppm), T5 (Metallic Copper NPs @ 20ppm), T6 (Metallic CopperNPs @ 40ppm), T7 (Metallic Zinc NPs @ 10ppm), T8 (Metallic Zinc NPs @ 20ppm), T9 (Metallic Zinc NPs @ 40ppm). Naga king Chilli seeds were treated before sowing with different metallic nanoparticles suspension at room temperature for 24 hrs. Thereafter, treated seeds were sown in seed tray following the standard protocols. The seeds treated with different metallic nanoparticles concentrations (NPs) among which zinc nanoparticles @ 40 ppm showed the highest performance in respect of quality parameters like vitamin (C147.67 mg/100g pulp)and Carotenoids content (46.06 mg/100g peel) while maximum TSS content (9.74^{0}B) which was found in (Ag NPs @ 20ppm). Findings from this study could provide valuable insights into improve quality of fruits. The findings suggest that optimum dose use can enhance fruit quality, excessive levels may be harmful.

Keywords: Nanoparticles, Naga King Chilli, Quality, TSS, Vitamin C

SI-O17

Spatial and Temporal Trend Analysis of Potential Evapotranspiration under different Agro-Climatic Zones of Maharashtra

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The drivers of the global water cycle are expected to be intensified by the processes of climate change. As ET is a key link between the atmosphere and the soil matrix within the hydrologic cycle, the assessment of ET is important to evaluate the impact of climate change on water resources and agricultural production. Potential Evapotranspiration (PET) is the evapotranspiration that occurs when the ground is

completely covered by actively growing vegetation and there is no limitation of the soil moisture, i.e., there is ample water available for meeting evaporation requirements and it is useful to measure the atmospheric water demand of the region. The accurate estimation of evapotranspiration is beneficial to improve applications in fields, such as drought mitigation strategies, irrigation system performance, optimization of irrigation water use, hydrological modelling, and accurate initialization of climate prediction models, and is also very useful for understanding the global climate change, the local to global energy and water cycles. Thornthwaite's empirical method to estimate PET from mean temperature data was further modified by Thornthwaite & Mather (1955) to enhance its applicability across a wide range of soils and vegetations. This formula is globally optimal for large-scale applications of potential evapotranspiration and aridity assessment across various climates and landscapes, given its lower data requirements compared to other methods. The present study was carried out at Department of Agricultural Meteorology, VNMKV Parbhani, to compute Spatial and temporal trend analysis of evapotranspiration at different location of Maharahtra *viz*. all nine agro- climatic zones. The meteorological data (1990 to 2020) i.e., maximum and minimum temperature was collected from Department of Agricultural Meteorology, Parbhani, India Meteorological Department (official website), and related sites. The Month wise daily potential evapotranspiration had showed highest in May and lowest in January. Kharif had increasing trend of PET at all station with significant increasing trends. For the state of Maharashtra as a whole 4.7 mm/day was found as a normal annual potential evapotranspiration, likewise Season - wise daily normal are 5.0 mm/day in Kharif, 3.0 mm/day in Rabi, 2.4 mm/day in winter, 6.9 mm/day in pre-monsoon, 5.2 mm/day in monsoon and 3.2 mm/day in post-monsoon period on the basis of average of all station under study. Highest (5.7 mm) annual Potential evapotranspiration was found in Central Vidarbha Zone where is lowest (3.7 mm) in Western Maharashtra Plain Transition Zone II.

Keywords: Potential Evapotranspiration, Climate Change, Drought, Trends, Natural Resources

SI-O18

Integrated nutrient Management and mulching effect on yield and growth of Tomato (*Solanum lycopersicum* Mill.)

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Tomato (*Solanum lycopersicum* Mill.) is a herbaceous, annual and perennial. The species of Tomato is originated from Western Southern America. Tomato contains high rate of nutrition and its medicinal value is also high. The productivity is very low despite of its wide range of cultivation. Very less attention is paid to the scientific cultivation of Tomato. So, an experiment was conducted to increase the yield and growth of Tomato. The Integrated Nutrient Management and types of mulching have been used during the cultivation of Tomato. The experiment was held in Zaid season of the year 2021-22 on the Crop Research Farm, Center for Agriculture and Farmer's development, Laxmipur, Sahaspur, Vikasnagar, Dehradun, Uttarakhand, 248197, India. The objective was to find the effect of Integrated Nutrient Management on yield and growth of the crop Tomato. Four Integrated nutrient Management with four types of mulches were paired and applied.16 treatment combinations are made with 3 number of replications. Total number of plots were 16. The morphological data of 30, 60 and 90 days after transplanting of plant are recorded. Days to 50 percent flowering, Plant height (cm), Number of flowers per plant, Fruit weight (g), Days to first harvesting, Days to last harvesting, Number of fruits per plant, and Total yield (q/ha) are recorded. The result is found that the yield and growth are best

found by applying the Integrated Nutrient Management and mulching.The treatment which contain bio- mulch paddy straw (M3) and RDF and vermicompost (D2) results in the highest plant height, maximum gross returns and maximum yield over the rest of the treatments.

Keywords: Tomato, mulching, Vermicompost

SI-O19

Spatio-Temporal Dynamics of Hydro-Climatic Variability and Vegetation Health in Delhi, India: Insights from SPI and MODIS-Derived NDVI"

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This study examines dry and wet spells derived from 0.25° x 0.25° binary gridded rainfall data and explores the interrelationship between the Standardized Precipitation Index (SPI) and the Normalized Difference Vegetation Index (NDVI) across four locations in Central Delhi: Lodhi Road, Safdarjung, Palam, and Ridge. The analysis spans a 30-year period (1992–2022) and focuses on January and July, critical months for rabi and kharif crop seasons, respectively. These months mark the completion of crop germination and the onset of vegetative and flowering stages, enabling effective satellite-based NDVI assessments. The SPI analysis highlights notable weather events, particularly in Lodhi Road and Palam, where maximum SPI values show significant variability. Annual evaluations reveal prolonged dry spells, especially in Lodhi Road and Safdarjung, with SPI values often dropping below zero during critical periods. In January, SPI values display mixed patterns, ranging from peaks of 0.3 to lows of -0.8, reflecting diverse precipitation conditions and their influence on vegetation health. The study identifies strong correlations in precipitation patterns between Lodhi Road and Palam (0.906) and moderate correlations among other locations in Delhi. NDVI analysis from satellite data (2001–2022) shows a gradual improvement in vegetation health, with NDVI values rising from 0.16 in 2001 to 0.3 in 2022. This increase aligns with consistently positive SPI values, indicating above-average rainfall. However, the correlation between NDVI and SPI is weak (-0.0825), suggesting that factors beyond precipitation significantly influence vegetation health. The Mann-Kendall test reveals no significant trends in SPI but identifies a significant upward trend in NDVI, indicating an overall improvement in vegetation conditions. These findings emphasize the complexity of urban vegetation dynamics and highlight the need for integrated strategies in agricultural planning and water resource management to address climate variability in urban areas.

Keywords: SPI, Delhi, NDVI, Dry spell, MODIS

SI-O20

OPTIMIZING SUB SURFACE DRIP FERTIGATION SYSTEM FOR ENHANCED PRODUCTIVITY AND REDUCED WATER FOOTPRINTS OF COTTON IN PUNJAB

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The water footprint (WF) is a consumptive and degradative indicator of the direct and indirect water consumed or polluted during the entire crop season. The *blue* WF (WF_{blue}) is the quantity of surface and groundwater used for irrigation, whereas *green* WF (WF_{green}) is the amount of the rain water consumed. However, the *grey* WF (WF_{grey}) is the amount of fresh water needed to standardize the contaminated water which has been polluted during the production cycle. The sum of WF_{green}, WF_{blue}, and WF_{grey} is termed as the *total* WF (WF_{total}). To evaluate the WF components of cotton, a two-year (2021 and 2022) field study was conducted at PAU, Regional Research Station, Faridkot to optimize lateral depth, emitter spacing and fertigation scheduling of subsurface drip (SSD). Experiment was laid out in a Split-Plot Design with a combination of 2 lateral depths (25 ± 2.5 cm and 30 ± 2.5 cm) and 2 emitter spacings (30 and 40 cm) in main plots, and 4 fertigation schedules [100% N (112.5 kg ha^{-1}) and 125% N in 10 and 14 equal splits in subplots. Two additional control treatments (i) surface flood irrigation with 105 kg N ha^{-1} applied through manual broadcasting-Control1 and (ii) SSDFof 112.5 kg N ha^{-1} at 20±2.5 cm laterals depth, 20cm emitter spacing- Control 2 were also studied. Results elucidated that the SSD laterals placement at 25 ± 2.5 cm and emitter spacing of 30 cm increased seed cotton yield by 15.4 % (in 2021) and 8.7 % (in 2022) over the deeper lateral placement (30 ± 2.5 cm) and wider emitter spacing (40 cm). Among fertigation levels, application of 125% N in 14 equal splits recorded 18.6 % higher seed cotton yield (3432 kg ha^{-1}) over 100% N delivered in 10 equal splits (2895 kg ha^{-1}). Fertigation of 125% RDN with 14 splits recorded lowest WF_{green}(1.21 m^3 kg^{-1} in 2021 and 1.35 m^3 kg^{-1} in 2022), and WF_{blue}(0.53 m^3 kg^{-1} in 2021 and 0.56 m^3 kg^{-1} in 2022). However, fertigation of RD N in 14 equal splits exhibited lowest WF_{grey}. Overall, minimum WF_{total}in 2021 and 2022 was 2.07 and 2.29 m^3 kg^1 through 125 % RDN fertigation in 14 splits and 2.18 and 2.41 m^3 kg^{-1} in 10 equal splits.Though, control 2 recorded maximum WF_{green} and WF_{blue} but, maximum WF_{grey} (0.48 m^3 kg^{-1}, both years) was evident for deeper and wider laterals placement for 125 % RDN fertigation in 10 splits. Nevertheless, surface flood irrigation and manual fertilizer application resulted the highest WF_{total}(3.11 m ^{3} kg^{-1} in 2021 and 3.20 m^3 kg^{-1} in 2022). These findings elucidated that SSD fertigation with lateral placement of 25 cm, emitter spacing of 30 cm, and N fertigation of 125% N (140 kg N ha^{-1}) in 14 equal splits may be a novel and sustainable water-savvy method for better cotton productivity besides WF reduction.

***Keywords*:** Cotton, drip, fertigation, seed cotton yield, water footprint.

SI-O21

Assessment the Impact of Contingent Plan on Resilience to Climate Change towards Prominent Crops of District Morena

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Rain fed agriculture occupies a prominent place in Indian economy and rural livelihoods. At present, about 60% of total net sown area is rain fed, contributing 40% of the total food production. Often due to the late onset of the monsoon, prolonged dry spells of the monsoon, total failure of monsoon leads to failure of crops. The management of the drought primarily involves development of crop management strategies for minimizing the severity of the impact caused by the weather aberrations. The study was based on the data collected from the metrological station Morena. The contingent plan was executed according to the need of hour. Yield under P_2– application of contingent intervention (2069.56 kg/ha) was recorded significantly superior over the farmers practice P_1– farmers practice (1844 kg/ha). The maximum grain yield was recorded in C_2–pearl millet (2122.17 kg/ha) which was significantly superior yield received under C_1- Cluster bean (1929.17 kg/ha) and C_3 (1818.00 kg/ha).

Keywords: Rain fed, crop management, contingent plan, pearl millet, Cluster bean and Pigeon pea

SI-O22

Effect of sowing environments on radiation use efficiency of direct seeded basmati rice varieties under subtropical conditions

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Among the various rice types cultivated in our country aromatic rice is having a unique place because of their characteristic aroma when cooked. Due to the demand and higher price they are gaining popularity over the recent years. The response of a rice variety grown at different transplanting environments can be quite different. Time of transplanting may be one of the agronomic strategies to exploit full potential of a variety and its photoperiod sensitivity so as to harness maximum production with improved quality of grain for high premiums. The response of a rice variety grown at different transplanting environments can be quite different. Selection of proper variety, suitable to the specific ecological situation, may prove to be a boom to the growers. The field experiments were carried out at the Research farm of Agro-meteorological section, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha during the *kharif* season of 2018 and 2019. Three basmati varieties (V1- Pusa 1121, V2- Basmati 370 and V3- SJR-129) direct seeded on different dates (D1- 01st June, D2-16th June and D3- 01st July) in both years.

The experiment was laid out in randomized block design with three replications. The results revealed that the variation in RUE due to the differential dry matter accumulation in various treatments and intercepting different amount of radiation, because of variation in canopy structure and architecture of the canopy, which influenced intercepting of the radiation, photosynthetic efficiency of the leaves in utilizing the intercepted radiation in production of dry matter and loss of various energy under physiological process like respiration, evapotranspiration, metabolic activity etc. Radiation use efficiency (RUE) of the direct sown rice crop under three different environments showed that the RUE was found maximum at 120 days after sowing of the crop and thereafter decreased till the harvesting of crop under all the dates of sowing. The crop sown on 01st June showed highest RUE (0.78 gm/ MJ^{-1}m^{-2}) followed by 16th June (0.74 gm/ MJ^{-1}m^{-2}) and 01st July (0.67 gm MJ^{-1}m^{-2}). Among different varieties, the RUE of variety Basmati 370 was recorded highest (0.81 g MJ^{-1}) followed by variety Pusa 1121 (0.74 g MJ^{-1}) and SRJ 129 (0.65 g MJ^{-1}) at 120 days after sowing, and thereafter it decreased towards maturity of the crop.

Key words: Basmati rice, crop, radiation use efficiency, sowing environments, varieties.

SI-O23

Effect of Crop Microclimates on Growth and Physiological Parameters of Winter Rice (*Oryza sativa* L.) under Medium Land Situation in Assam

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A field experiment was carried out for two years (2016 and 2017) in Golaghat district of Assam with 24 treatment combinations encompassing two crop establishments *viz.* C1: System of Rice Intensification (SRI), C2: Conventional; three transplanting dates *viz*. D1: 26th June, D2: 10th July, D3: 25th July, and four hill densities *viz.* H1: 20 cm x 15 cm (*i.e.* 33 hills m^{-2}); H2: 20 cm x 20 cm (*i.e.* 25 hills m^{-2}); H3: 20 cm x 25 cm (*i.e.* 20 hills m^{-2}); H4 : 25 cm x 25 cm (*i.e.* 16 hills m^{-2}), laid out in a factorial split-plot design and replicated thrice. The findings revealed that among the different growth and physiological parameters *viz.* plant height, tillers m^{-2}, leaf area, dry matter production, leaf area index (LAI), chlorophyll content, crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR); the highest had been recorded by SRI with an exception of lower magnitude of leaf area, LAI and chlorophyll content at the tillering stage. Similar crop responses were also observed in the case of lower hill density exhibiting better growth and physiological parameters. Irrespective of crop establishment technique and hill density, the early transplanting showed significant improvement in growth parameters, however, failed to express any significance with respect to physiological parameters *viz.* CGR, RGR, and NAR.

SI-O24

Frontier Technologies for Weather and Climate-Based Decisionsin Uttarakhand Tea Cultivation

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Tea cultivation in Uttarakhand, a region renowned for its unique agro-climatic conditions, faces mounting challenges due to erratic weather patterns and climate variability.Changes in temperature, precipitation, and the increasing frequencyof extreme weather events significantly impact tea yields and quality. To address these challenges, the integration of frontier technologies such asArtificial Intelligence (AI), Internet of Things (IoT), Remote Sensing, and Geographic Information Systems (GIS) can revolutionize decision-making and ensure the sustainability of tea cultivation in the region. One of the primary applications of these technologies is in weather prediction and monitoring. AI-driven models cananalyze historical weather data along sidereal-time inputs to provide accurate and localized weather forecasts. Such predictive insights allow tea growers to schedule planting, pruning, and harvesting operations optimally. For instance, predicting rainfall can help plan irrigation schedules, reducing water wastage and improving plant health. Moreover, AI algorithms can identify patterns in climatic stressors, enabling early interventions to mitigate their impact. Io T devices further augment these capabilities by providing on-ground, real-time data on critical parameters such as soil moisture, temperature, humidity, and pH levels. Sensors installed across tea plantations can transmit data to centralized systems, allowing farmers to monitor environmental conditions remotely. This enables precise resource management, such as targeted irrigation and fertilization, which reduces input costs while maintaining soil health. IoT solutions also play a vital role in early pest and disease detection, minimizing crop losses through timely intervention. Remote sensing and GIS technologies offer a macro-level perspective essential for long-term planning and risk assessment. High-resolution satellite imagery combined with GIS tools can map plantation areas, monitor vegetation health, and detect anomalies caused by pest infestations or drought stress. These tools also facilitate land suitability analysis, helping identify optimal locations for tea cultivation based on soil characteristics, slope, and climatic conditions. Such insights are invaluable for expanding tea plantations sustainably while preserving the region's fragile ecosystem. The integration of these frontier technologies requires a multi-stakeholder approach. Collaboration between research in stitutions, government agencies, and tea growers is critical for developing user-friendly platforms tailored to local needs. Training programs must be conducted to equip farmers with the knowledge and skills to leverage these technologies effectively. Government policies and subsidies can further incentivize the adoption of advanced tools, ensuring inclusivity across small holder and large-scale farmers. In conclusion, the adoption of frontier technologies in tea cultivation can transform the way Uttarakhand's tea industry responds to weather and climate challenges. By enhancing resilience, optimizing resource use, and ensuring sustainable practices,these innovations hold the potential to secure the livelihoods of tea growers while preserving the region's rich biodiversity. Embracing this technological paradigm is not just a necessity but an opportunity to establish Uttarakhand as a model for sustainable tea cultivation in the face of climate change.

SI-O25

Impact of foliar application of Zn in rice (*Oryza sativa*) under different environmental stress situation

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Availability of nutrients (micro and macro) from soil to plant mainly depends on varying substratum and soil properties including soil moisture content. In calcareous soils, co- precipitation on calcite (ZnCO3) and chemisorption on Fe oxides is significant route for Zn fixation. Water deficit alters physiology of rice crop by interfering with germination, reduces plant height, plant biomass, number of tillers, morphology of root and leaf traits. Pot experiments were conducted to investigate the effect of water regimes and substratum pH on proline, RLWC, seed Zn content, test weight, effective tillers, panicle weight, HI chlorophyll accumulation, Zn content in leaf and grain, ZUE and grain yield and yield components of rice. Two rice genotypes, Aghoni bora and Kabokphao were grown under different water regimes and substratum pH. Zn was applied @ 10ppm ($ZnSO_4.H_2O$) at maximum tillering stage of the crop. There were positive effects of Zn application on both the rice cultivars under normal growth condition. Moreover, application of Zn also reduced the negative impact stress situation in Zn as similation and ZUE of rice crop. Amplification in all the physiological and yield paramaters *viz.* RLWC, proline, seed Zn content, test weight and HI was also noted with application of Zn under water regimes and substratum pH condition in both the cultivars.

Keywords: foliar application Zn, Rice, environmental stress, water regimes, substratum

SI-O26

Effects of natural farming bio-inputs on growth and yield of rice (*Oryza sativa* L)

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A field experiment was conducted during the *kharif* season of 2023-24 at the natural farming block of Instructional-cum- Research farm of Assam Agricultural University, Jorhat to assess the effects bio-inputs of natural farming *viz.,* Ghanajeevamrit (GJM) and Dravajeevamrit (DJM) alone and in combination with biochar on the growth and yield of rice under two methods of establishment. The experiment consisted of two direct seeded rice establishment methods *viz*., manual sowing and drum seeding and seven nutrient management treatments *viz*.,N_O**:** Control; N_1**:**GJM @ 1000 kg/ha;N_2**:** GJM @ 1500 kg/ha; N_3**:**Biochar @ 600 kg/ha+ N_1;N_4**:** Biochar @ 600 kg/ha + N_2;N_5**:** Basal application of DJM @ 2000l/ ha+Foliar application of DJM at 25 DAS, 45 DAS, 55 DAS, 70 DAS @ 500 l/ha in each spray; N_6: Biochar @ 600 kg/ha + N_5. The soil of the experimental site was sandy loam in texture with pH 5.17, organic carbon (0.57 %), available N (228.00kg/ha), available P_2O_5 (25.99 kg/ha) and available K_2O (111.82 kg/ha). The local variety Mahsuri was the test variety. The results revealed that both method of

establishment and nutrient management treatments significantly affected the growth, yield attributes and yield of rice. Among the different bio-input treatments, basal application of biochar @ 600 kg/ha + GJM @ 1500kg/ha (N_4) resulted the highest growth parameters *viz*. plant height (124.16 cm), number of effective tillers/ plant **(**13.71 **)** and grain yield (21.40 q/ha), stover yield (43.18 q/ha). The N_3 treatment also recorded statistically at par results with the N_4 treatment. The manual method of establishment recorded significantly higher grain yield (18.36q/ha) than the drum seeding method of establishment (16.49 q/ha). The interaction effect between the two factors was found non-significant.

***Keywords*:** Ghanajeevamrit, Dravajeevamrit, biochar, natural farming, direct seeded rice

SI-O27

A novel cold reeling technology using herbal formulation to improve seed availability in muga ecosystem

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The availability of quality seeds in muga culture for commercial rearing remains a critical challenge, significantly impacting overall muga silk production. Harsh weather conditions during seed and pre-seed seasons lead to poor cocoon yield, reduced fecundity, low hatching rates, and male sterility, thereby limiting the production of quality Disease-Free Layings (DFLs). Additionally, reelers often purchase muga cocoons at premium prices during off- seasons, reducing their availability for seed production and exacerbating the seed shortage during commercial seasons.This cyclical problem affects farmers'ability to meet seed demand during the commercial season, despite the availability of host plants for rearing. To address this issue, a novel cold reeling procedure using herbal formulation has been developed, enabling reeling of cocoons in water at room temperature without stifling. This process retains live pupae, yielding both reeled silk yarn and live pupae for DFL production. The procedure has been tested successfully at both laboratory andcommercial scales.The reeled silk matches the quality of hot-reeled silk yarn. Effective adoption of this technology by reelers, in coordination with graineurs, can strengthen the muga silk ecosystem.

Keywords: muga, *Antheraea*, silkreeling, DFLs.

SI-O28

Phenology study of *Acacia nilotica* and *Caparis deciduas* in and around university of technology, Jaipur with reference to climate change

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Acacia nilotica (Desi babool) and *Caparisdeciduas* (Kair) are most common species of the arid and semi-arid area of India, both of the species grow naturally in dry area. Understanding the phenology of these two species is of immense importance to observe the climate change effect in the area. As Kair and Kachri (*Cucumis meloagrestis*) are considered as the climate indicators in arid zone. A fully Kair laden with thorn, flowers and fruits indicates drought and high temperature, while in a good season, it bears only average flowers and fruits. In Gujarat state it has been studied that greater blooming deep pink flower in *Caparis deciduas*, there would be less rainfall and high temperature more than 45^{O}C at nearby area (ICAR-CSWRI Avikanagar). Study on climate change reveals that average maximum annual temperature over four decades have risen by 0.80 ^{O}C (between 1977-2016) and on the contrary, average minimum annual temperature dropped down by 1.05 ^{O}C. There has been a steady increase in temperature extremities. As a result, there was a decline in annual rainfall, a high variability in humidityhas also been observed. Owing to such climate changes, phenology of both the species under study has altered. Both the species never become completely leafless, however, annual occurrence of flowering and fruiting occurred two times i.e. in March-April and October-November months rather than once in a year i.e. March to May months. Furthermore, it has been observed that size and maturity of fruits of both species was not usual, taste of the fruit also changed considerably.

***Key Words*:** Phenology, Climate change, Indicators, Flowering, Fruiting

SI-P1

Seasonal Thermal Dynamics and Yield Performance of Bt. Cotton Under Different Sowing Windows

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The research trial was conducted during the *Kharif* season 2021-22 at the experimental farm of the Department of Agricultural Meteorology, COA, VNMKV, Parbhani, Maharashtra, to study the phenology and agro-meteorological thermal indices accumulated growing degree days (GDD), heliothermal units (HTU), photothermal units (PTU), and heat use efficiency (HUE) of Bt. cotton hybrids under different sowing

dates. The experiment employed a split-plot design with three replications and 12 treatments. The treatments included four sowing dates (D1: 25 SMW, D2: 26 SMW, D3: 27 SMW, and D4: 28 SMW) and three Bt. cotton hybrids (V1: Ajeet-155, V2: Ankur, and V3: Mallika) spaced 120 cm x 45 cm. Each of the 36 plots had a net area of 5.4 × 2.4 m² and a gross area of 7.2 × 3.6 m². Sowing was done using the dibbling method.The results showed that thermal indices and phenology of Bt. cotton were significantly influenced by sowing dates. Early sowing (D1) recorded the highest accumulated GDD (4275.3 °C days) compared to later sowing dates, with the lowest GDD observed in the late-sown crop, D4 (3979.0 °C days). Similar trends were observed for HTU and PTU, with D1 exhibiting maximum values (26649.9°Cday hours for HTU and 51304.0°C day hours for PTU) and D4 showing the lowest values (24808.1 °C day hours for HTU and 47758.7 °C day hours for PTU). The decline in thermal indices with delayed sowing can be attributed to shortened crop duration, reduced exposure to optimal temperature regimes, and lower solar radiation during critical phenological stages. Delayed sowing also led to a significant impact on crop phenology, with a reduction in the duration of key growth stages and accelerated maturation. This resulted in decreased heat accumulation, which adversely affected physiological processes like biomass accumulation and flowering, thereby reducing yield. Early-sown crops (D1) exhibited a higher HUE (0.17 kg seed cotton ha^{-1} °$Cday^{1}$) compared to late-sown crops (0.12 kg seed cotton ha^{-1} °C day^{1} for D4), reflecting better utilization of thermal energy. Correspondingly, seed cotton yield and yield- contributing traits such as seed cotton yield per plant, stalk yield, biological yield, and harvest index declined from D1 to D4. Among the evaluated hybrids, Ajeet-155 demonstrated superior performance compared to Ankur and Mallika, achieving higher yields and better yield-contributing traits, while Mallika recorded the lowest values. The findings highlight that early sowing (D1) not only optimized thermal indices but also maximize dthe yield potential of Ajeet-155, establishing it as the most suitable hybrid for attaining higher productivity under the prevailing climatic conditions.

***Keywords*:** sowing dates, thermal indices, GDD, HTU, PTU, HUE, phenology, seed cotton yield.

SI-P2

Effect of Nano fertilizer on sustainable rice (*Oryza sativa* L.) production in Red and Laterite Zone of West Bengal

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To meet demand of exponentially increasing population of our country, farmers have been applying substantial amounts of chemical fertilizers in their fields since the Green Revolution, which has resulted in environmental and ecologica lissues. The over use of chemical fertilizers adversely affects boths oil and plants. Processes such as nitrate leaching, soil denitrification, and volatilization contribute to environmental contamination; nitrogen volatilization also leads to the emission of various greenhouse gases, which play a role in global warming and climate change. Rice (*Oryza sativa* L.) is a crucial staple food, especially in India, which has the largest area dedicated to rice farming worldwide. This crop requires ample amounts of minerals and additional nutrients, particularly nitrogen, to grow effectively. To address these challenges,

it is essential to utilize advanced technologies, including nano technology, to accurately determine the correct nutrient ratios that promote economic advancement while safeguarding environmental health and enhancing nutrient use efficiency. Nanotechnology, exemplified through foliar applications of nano urea, significantly contributes to improving soil health by using nano materials smaller than 100 nm, which have higher absorption rates, better utilization efficiency, and reduced losses, providing concentrated nutrient sources for plants. In this context, a field experiment was carried out during the Kharif season of 2021 in the Sonamukhi block of Bankura, West Bengal, to evaluate the performance and production efficiency of various rice cultivars influenced by different nutrient inputs and plant protection strategies in the Red and Laterite zone of West Bengal. The study also aimed to analyze the relationships among different production factors and agro-meteorological indices at various rice growth stages. The experiment was designed using a Factorial Randomized Block Design with two replications. The treatments involved a combination of two rice varieties (V_1: MTU 7029 and V_2: Nilanjana) and three fertilization rates: F_1 (100% Recommended Dose of Fertilizer, N: P_2O_5: K_2O at 80:40:40 kg ha^{-1}), F_2 (a single nano urea spray @4 ml/L of water combined with 50% RDF of N + full RDF of P_2O_5 & K_2O), and F_3 (Cow dung @15 t ha^{-1}), along with two plant protection measures (P_1: Chlorpyrifos 50% + Cypermethrin 5% EC @2 ml/L of water for controlling rice stem borer, and P_2: Control). The findings indicated that F_2 resulted in the highest number of tillers per plant and spikelets per panicle, followed by F_1 and F_3. The maximum grain yield was recorded in F_2 (4.86 t ha^{-1}) while the minimum yield was observed in F_3 (4.57 t ha^{-1}). Among the two rice varieties, MTU 7029 yielded more (4.79 t ha^{-1}) compared to Nilanjana (4.66 t ha^{-1}). Regarding the different plant protection measures, P_1 resulted in a greater grain yield (4.76 t ha^{-1}) than P_2 (4.45 t ha^{-1}). The results indicated a significant positive correlation between various production components and agro-meteorological indices (GDD, HTU, PTU) at different growth stages of the crop. Further research for more 2-3 consecutive years is required to get the result in finer tuning.

Keywords: Agrometeorological indices, Nano fertilizer, Pesticide, Rice variety, Sustainable production

SI-P3

Inter cropping Paddy Straw Mushroom in Maize: A Microclimate Based Approach as Climate Smart Agriculture

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A comparative study was conducted at Tamil Nadu Agricultural University in 2022 to evaluate the seasonal variability in the performance of paddy straw mushrooms under irrigated maize. Circular PSM beds, placed three days after spawning, were placed between two rows of maize crops at 45 DAS. The findings indicated that the microclimatic conditions under the maize crop during the *kharif* season were more favorable for faster growth (21 days), higher yield (590 g/bed), Land Equivalent Ratio (LER,1.6–1.9) and Crop Equivalent Yield (CEY,10,000 to 11,000 $kgha^{-1}$) and biological efficiency (16- 20), which were higher compared to summer season maize. However, summer maize was also found to be economically

viable. Ideal ranges for successful mushroom cultivation were determined to be morning and afternoon temperatures of 26–29°C and 29–33°C, and relative humidity of 80-98% in the morning and 66–88% in the afternoon. The maize and paddy straw mushroom intercropping system during *kharif* season demonstrated significant productivity advantages and offers small farmers an economically viable, climate-resilient, and sustainable strategy for enhancing productivity while mitigating the adverse impacts of climate change and extreme weather events on agricultural systems.

Keywords: Climate Resilient agriculture; Maize; Microclimate; Intercropping; Paddy straw mushroom; Seasonal variation.

SI-P4

Growth and yield of kharif maize cultivars as affected by different thermal environments in Eastern Uttar Pradesh

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A field experiment was conducted during the Kharif season of 2022-23 at the student's instructional farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. The experiment used a split plot design (SPD) and it was replicated fourtimes withnine treatment combinations.In this experiment used three different growth conditions *viz*. G_1 on June 20th (31.9 ^{o}C), G_2 on July 5th (29.0 ^{o}C) and G_3 on July 20th (31.2 ^{o}C) as well as three different cultivars (C_1-Azad Hybrid-1, C_2 Azad Hybrid-2, and C_3-AQH-04). Results revealed that higher growth and yield was observed when crop was sown on 20th June than that of 5th, July and 20th July, this is likely because crops exposed to abiotic stresses for a longer period of time produced more dry matter, had more leaves, and had other characteristics that are favourable to yield. The varietal performance of 20th June sown crop was found suitable for higher yield followed by 5th July and 20th July. Among the cultivars AQH-04 was recorded higher growth and yield as compared to other varieties due to fulfillment of congenial Temperature.

***Keywords*:** Growth, Yield, kharif Maize, Cultivars, Temperature

SI-P5

Evaluation of Various Aspects of Trends in Regional Streamflow Data of the Cauvery River Basin, India

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This study thoroughly analyses trends in regional streamflow (SF) data over the Cauvery River Basin (CRB) from 1980 to 2011. The aspects of trend, such as magnitude, significance, nature, start point and end point are assessed for annual, monthly and seasonal time scales using various statistical tests. Also,

discrete wavelet transform (DWT) in association with three MK tests is employed to determine the most influential time scale that affects the trend in a given time series. The results indicated that regional SF is decreasing for all temporal scales, with negative SS values, except for the regional post-monsoon SF time series, which showed a positive SS value. Regional monsoon and monthly SF time series exhibit significant trends. The trends started in the 1980s for regional SF time series of monthly, pre-monsoon, post-monsoon, and winter and in 2006 for regional annual and monsoon SF time series. The endpoints of these trends occurred between 1990 and 2010, varying with temporal scales. These trends are driven by short-term periodicities, typically 2 and 4 years for annual and seasonal scales and eight months for the monthly scale.

***Keywords*:** Cauvery River Basin; Climate change; Regional streamflow; Trend analysis.

SI-P6

Study the temperature ranges during the seasons at Northern hill zones of Chhattisgarh state

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The patterns of temperature have been analyzed to determine probable changes in temperature at Northern Hill zones. This study was conducted at Department of Agricultural Meteorology, IGKV, Raipur (Chhattisgarh) based on analyzed by 32 years (1991-2023) daily weather data of Sarguja Districts which weather cock software (ICAR, Hyderabad). The analysis showed that the number of days recorded under different ranges of maximum temperature was not in increased in this region. However, number of days recorded under different ranges of minimum temperature during winter season showed in significantly increasing pattern. Number of days with minimum temperature d" 10 °C showed significant increasing pattern in the months of December and January at 1 per cent level. Whereas, January represent the most number of days based on minimum temperature of d" 10°C. Analysis of maximum temperature crossing certain threshold values e" 40 °C, e" 41 °C, e" 42 °C, e" 43 °C & e" 44 it was found that the trends were non- significant, it means number of such days were not increased. But, 11 days were noticed more than 40°C in the March 2011 as an exception.

***Keywords*:** Temperature ranges, Northern Hill zone, Trend, Weather cock, Threshold values.

SI-P7

An Assessment of Agrometeorological Heat Indices for Cotton (*Gossypium hirsutum* L.) Varieties and Sowing Dates

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An experiment was conducted during the *Kharif* season of 2021-22 to investigate the impact of different sowing dates on the agrometeorological indices of *Bt*. cotton at the AICRPAM farm, Department of Agricultural Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The study followed a split-plot design with three replications and 12 treatments, comprising four sowing dates: D1 (25th SMW), D2 (26th SMW), D3 (27th SMW), and D4 (28th SMW), and three *Bt*. cotton varieties: V1 (NHH- 44), V2 (Ajeet-155), and V3 (Mallika). The crop was sown with a spacing of 120 cm × 45 cm. The results revealed that sowing date significantly influenced seed cotton yield and related agrometeorological indices. The highest seed cotton yield was achieved with D1, followed by D2, D3, and D4. The superior performance of D1 was corroborated by thermal indices, including Growing Degree Days (GDD), Heat Units (HTU), and Photo Thermal Units (PTU). D1 recorded the highest accumulated GDD (4233.9 °C day) compared to D2 (4091.3 °C day), D3 (3916.3 °C day), and D4 (3622.1 °C day). Similarly, HTU followed a descending trend from D1 (21900.9 °C day hrs) to D2 (20510.6 °C day hrs), D3 (19541.0 °C day hrs), and D4 (18223.5 °C day hrs). PTU also showed a similar pattern, with D1 accumulating 50806.2 °C day hrs, D2 49095.0 °C day hrs, D3 46995.0 °C day hrs, and D4 43465.2 °C day hrs. The higher thermal indices in D1 were reflected in the Heat Use Efficiency (HUE), where D1 exhibited the highest value (0.16 kg ha^{-1}°C day^{1} hr) compared to D2 (0.12), D3 (0.11), and D4 (0.10 kgha^{-1}°Cday^{1} hr). These findings highlight the critical role of sowing date in optimizing thermal resource utilization for enhanced cotton productivity. The study underscores the importance of timely sowing to harness favorable thermal conditions, maximize heat use efficiency, and achieve higher yields in *Bt*. cotton varieties under the agro-climatic conditions of Parbhani.

***Keywords*:** Cotton, dates of sowing, heat indices, GDD, HTU, PTU, HUE

SI-P8

Liming for higher productivity of potato and managing soil acidity in Bongaigaon district of Assam

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An on farm testing was conducted at the farmers' field during the year 2019-20 and 2020-21 to manage the soil acidity by application of lime for increasing the productivity of potato (*Solanum tuberosum*

L.) in Bongaigaon district of Assam. The trial consists of two treatments (T1: lime @ 2-4 q/ha (based on soil pH) + 50% recommended dose of fertilizers (RDF:N:P_2O_5:K_2O::60:100:100kg/ha) + 1 ton/ha vermicompost and T2: Farmers practice (RDF). Soil samples were collected before commencement of the trial as well as at the end of it. The analysis showed that the soil was moderately acidic (pH 5.41 in 2019-20 and 5.32 in 2020-21). The on farm testing was conducted at five locations in three villages with a total area of 0.66 ha of land. The results of the trial revealed that application of lime @ 2-4q/ha in furrows + 50% recommended dose of fertilizers + 1 ton/ha vermicompost gave significantly higher tuber yield over farmers practice. The tuber yield increased significantly in both the year (307 q/ha in 2019-20 and 299 q/ha in 2020-21) compared to the farmers practice (240 q/ha in 2019-20 and 251 q/ha in 2020-21) with BC ratio of 3.62 and 2.94, respectively. Moreover, improved and higher soil nutrient status was recorded with improvement in soil pH in both the years. So, the integrated use of lime in furrows along with NPK fertilizer can be effectively used for increasing the productivity of potato and maintaining the soil acidity in Assam.

Keywords: potato, lime, RDF, vermicompost, soil acidity and productivity

SI-P9

Sustainable Post harvest Solutions: The Effect of Edible Coatings in Mitigating Climate Change Effects on Assam Lemon Storage

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The Northeast region of India is a rich treasure of different Citrus species. Assam lemon is one of the important Citrus species and it is indigenous to Assam. Climate change causes substantial postharvest losses, shortens shelf life, and speeds up spoiling for fruits like Assam Lemon. Assam lemons are more vulnerable to postharvest illnesses like fungal infections, which accelerate deterioration, as rising temperatures and humidity foster the growth of pathogens. Citrus fruits that are stored may develop rot due to the fungus Penicillium, which further reduces the fruits' shelf life. The use of edible coatings, in particular, has drawn attention as a sustainable postharvest solution that can prolong the freshness and quality of fruit while it is being stored. By slowing down moisture loss, lowering respiration rates, and maintaining flavor and nutritional value, these natural, biodegradable coatings help lessen the negative effects of climate change and provide farmers with an inventive and environmentally responsible way to deal with erratic environmental conditions. Providing non-hazardous edible coating would permit the possibility to reach the distant markets in fresh form. Use of CMC (Carboxy Methyl Cellulose) as exterior coating along with Sodium Benzoate and Bees wax coating can increase the shelf life of Assam Lemon. An investigation was carried out in the Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat with the objective to find out the suitable edible coating treatment for shelf life extension. The fruits were stored in corrugated fibre boxes in ambient condition. Analysis was done at every 5 days interval upto the marketable stage. The observations recorded were TSS (°Brix), juice content (%), physiological loss in weight (%), fruit weight (g). The results of the experiment revealed that the application of treatments had significant effect on various quality parameters of lemon fruitduring storage. The treatment T showed better results in terms of all four parameters during storage. T treatment was superior as an edible coating and retained better quality with extended storage life as compared to all other treatments.

Keywords: Edible coating, Assam lemon, Storage, Juice content, Fruit weight

SI-P10

Effect of varying planting windows on productivity of basmati rice (*Oryza sativa* L.)

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Selecting the right variety and planting technique plays important role in the production of rice crop. Production of the rice is majorly affected by various meteorological parameters such as temperature, humidity, sunlight hours and rainfall. Keeping these points in mind the study was carried out during *kharif* season, 2024-25 on the topic entitled "Effect of varying planting windows on productivity of basmati rice (*Oryza sativa* L.)" at the experimental farm of CSKHPKV, Palampur, Himachal Pradesh. The experiment was laid out in randomized block design. The experiment consisted of nine treatment combinations comprised of three transplanting dates *viz.,* 10th June, 20th June and 30th June and three varieties *viz.*, Basmati-370, Kasturi Basmati and Pusa-1121. The experimental site was silty clay loam in texture, acidic in reaction (pH 5.5) with nitrogen, phosphorus and potassium content in the medium range. The results revealed that significantly higher values of different growth parameters plant *viz.,* height, numberoftillers/m^2 and dry matter accumulation were recorded from the rice crop sown in 10th June with values showing a declining trend with every subsequent transplanting dates of 20th June and 30th June. Among the varieties, Basmati-370 demonstrated superior performance, recorded peak values for all parameters, followed by Pusa-1121. The lowest values were recorded from 30th June transplanting date and Kasturi basmati variety. In conclusion, the transplanting of Basmati-370 variety on 10th June constitutes the most productive treatment combinations.

Keywords: Basmati rice, transplanting dates, growth attributes.

SI-P11

Rainfall analysis for Crop Planning for different types of Rice grown in North Bank Plain Zone of Assam

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This study was undertaken with the objective of analysing rainfall data and crop planning for the North Bank Plain Zone (NBPZ) of Assam. Long-term rainfall data from 1991-2020 across three districts *viz*. Lakhimpur, Biswanath, and Sonitpur of NBPZ were collected from IMD, Pune, and analyzed by computing mean, standard deviation, and coefficient of variation for monthly, seasonal, and annual rainfall.

The long-term trends of annual, seasonal, and monthly rainfall of the study area were determined using the non-parametric Mann Kendall rank test and Sen's slope estimation method. The assured weekly rainfall at 90, 75, and 50 percent probability levels were also calculated using the incomplete gamma distribution module of "weather cock" a software developed by CRIDA-ICAR for the study period. During the study period, the mean annual rainfall of 3209, 1811, and 1828 mm was observed in Lakhimpur, Biswanath, and Sonitpur, respectively. All the districts followed the same seasonal rainfall pattern with 63.2 to 69.9, 21.2 to 26.5 5.7 to 6.6 and 2.7 to 3.0 percent of the annual rainfall during the monsoon, pre-monsoon, post-monsoon, and winter seasons, respectively. A non-significant decreasing trend of annual rainfall was observed in Lakhimpur (2.75 mm year^{-1}) and Sonitpur (8.62 mm year^{-1}), while an increasing trend was observed in Biswanath (8.98 mm year^{-1}). The significant decreasing trend of rainfall was observed only in the winter season in Lakhimpur with a slope magnitude of -3.23 mm/year. The monthly rainfall decreased significantly in January (- 0.77 mm/year) and February (-1.51 mm/year) in Lakhimpur, and increased significantly in July (4.77 mm/year) and September (3.89 mm/year) in Biswanath. In all districts, regardless of probability levels, the maximum and minimum expected rainfall was found between the 26th to 30th and 49th to 2nd SMW, respectively. The expected weekly rainfall during the monsoon season was lower in Biswanath and Sonitpur at all probability levels compared to the Lakhimpur district. Based on the understanding of existing patterns and variability of rainfall, probability of occurrence of rainfall in a specific period, observed rainfall trends, etc.the contingency crop plans for some important field crops, *viz*., Salirice, Ahu rice, Boro rice, rapeseed-mustard, potato and Maize grown in the zone were suggested for NBPZ of Assam.

Keywords: Crop planning, NBPZ, Rainfall trend analysis, Rainfall probability

SI-P12

Impact of Bio-Inputs on the Performance of *Lilium* cv. Eyeliner

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A field study entitled "Impact of Bio-Inputs on the Performance of Lilium *cv*. Eyeliner" was conducted during 2024-2025 at the Research Farm of the Department of Horticulture, School of Agricultural Sciences, Medziphema Campus,Nagaland University. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Data on various growth and flowering parameters were collected, tabulated, and statistically analysed. This study evaluates the effects of various organic treatments on plant growth, bud development, and flower characteristics in Lilium cv. Eyeliner. Seven treatments, including a control (T_1), Bokashi (T_2), Indigenous Microorganisms (T_3), Panchagavya (T_4), Jeevamritha (T_5), Biofertilizer (T_6), and Effective Microorganisms (T_7), were assessed across multiple parameters: plant height, number of leaves, days to bud emergence, number of buds perspike, days to colour break stage, bud length, bud diameter, and flower diameter. The results revealed that T_4 (Panchagavya) and T_7 (Effective Microorganisms) were the most effective treatments, showing significant improvements in plant growth and flower quality parameters. T_4recorded the highest plant height (88.00 cm), number of leaves (86.60), and flower diameter (19.64 mm). T_7recorded the maximum number of buds per spike (5.00) and the largest bud diameter (3.10 mm). The shortest time to bud emergence was observed in T_4(23.40 days), highlighting its potential for early flowering. In contrast, the control treatment (T_1) consistently underperformed, with the lowest values across all parameters.

These findings emphasize the efficacy of organic amendments in enhancing plant growth and floral traits. Panchagavya and Effective Microorganisms emerge as promising alternatives for sustainable and regenerative cultivation practices in Lilium cv. eyeliner.

Keywords: lilium, eyeliner, Regenerative farming, Bio inputs, flower Diameter

SI-P13

Assessment of PAR interception on growth and yield of wet direct seeded *kharif* rice

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A field experiment was carried out at Assam Agricultural University, Jorhat, Assam, during *kharif* season of 2023 to know the effects of the photosynthetically active radiation (PAR) interception in wet direct seeded *kharif* rice variety Ranjit Sub-1 under integrated weed management practices laid out in randomized block design with 14 treatments. The incident PAR (IPAR), reflected PAR (RPAR) and transmitted PAR (TPAR) were measured at 10-day intervals from 30 days after sowing (DAS) during the crop growing period with a line quantum sensor (Model LQM 70-10). The results revealed that Incident PAR (IPAR) above the canopy of wet direct seeded rice during the *kharif* season was found to vary from 777 to 1940 µmol/m^2/s with an average of 1389 µ mol/m^2/s. RPAR varied from 32 to 56 µ mol/m^2/s with an average of 41 µ mol/m^2/s and TPAR ranged between 222 to 778 µ mol/m^2/s with an average of 393 µ mol/m^2/s under different integrated weed management practices. The mean percentage of intercepted PAR (iPAR) varied from 38.59 % to 86.08 %. It was found that at 30 DAS, the percentage of i PAR was lowest (38.6%) and at 90 DAS the highest value (86.1%) was recorded. The leaf area index, dry matter accumulation, SPAD values and yield of wet direct seeded rice were found to be significantly positively correlated with iPAR. The predictive models for estimating grain yield based on intercepted PAR were developed using the stepwise regression method, achieving a coefficient of determination (R^2) of 0.894.

***Keywords*:** PAR, integrated weed management, wet direct seeded rice, intercepted PAR.

SI-P14

Climate Vulnerability in Kerala: A Comprehensive Assessment

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Climate change presents profound challenges to ecosystems, economies and communities worldwide. The increasing frequency and intensity of extreme weather events necessitate evaluating regional climate vulnerabilities to inform mitigation strategies. This study assesses the climate vulnerability of Kerala across 14 districts using the Intergovernmental Panel on Climate Change (IPCC) framework, which evaluates exposure,

sensitivity and adaptive capacity. Exposure was analyzed using weather data from 1983 to 2023 that was collected from weather stations of Kerala Agricultural University and NASA POWER. The exposure indicators included high-temperature events (days with temperatures exceeding 3.5°C above normal), prolonged dry spells (e”9 consecutive days with rainfall<2.5mm) and heavy rainfall events (>64.5mm/day). Sensitivity was assessed using metrics such as the percentage of flood-prone and landslide-prone areas, as well as trends in land-use changes, including cultivable, barren and fallow lands. Adaptive capacity was determined using socio- economic and environmental factors, including percapita income, GDP, literacy rates and Normalized Difference Vegetation Index (NDVI) trends. The findings revealed that Thrissur and Palakkad districts exhibited the highest exposure to climate change induced hazards, while Alappuzha and Ernakulam showed the lowest exposure. In terms of sensitivity, Ernakulam and Thrissur were identified as the most sensitive districts. Adaptive capacity was strongest in Pathanamthitta and Wayanad, attributed to higher literacy rates and NDVI trends, but weakest in Ernakulam due to lower socio-economic indicators. The overall vulnerability assessment highlighted Thrissur as the most vulnerable district to climate change, combining high exposure, high sensitivity and moderate adaptive capacity. Kasargod, on the other hand, was identified as the least vulnerable due to lower exposure and relatively better adaptive capacity. This study emphasizes the urgent need for targeted interventions, particularly in highly vulnerable districts like Thrissur, to address the impacts of climate change. Policymakers should prioritize strategies that enhance adaptive capacity to mitigate exposure and reduce sensitivity to create resilient communities across Kerala.

Keywords: Climate change, Climate vulnerability, Exposure, Sensitivity, Adaptive capacity

SI-P15

Assessing Climate Change Impacts on Direct-seeded Rice Production and Adaptation Strategies for Sustainable Agriculture

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The impact of climate change on rice production is a significant concern, especially for direct-seeded rice in regions like Middle Gujarat. This study evaluates the potential adaptation strategies to mitigate the adverse effects of climate change, focusing on phenology, growth, and yield attributes. Using the InfoCrop model, simulations were run under different climate change scenarios (RCP 4.5 and RCP 8.5) for the period 2025 to 2100. The results demonstrate that climate change significantly reduces rice yields, with yield reductions ranging from 5.95% in 2025 to 2.20% in 2100 under RCP 4.5, and from 4.82% in 2025 to 0.89% in 2100 under RCP 8.5.Several adaptation strategies were evaluated to counter these effects. Shifting the sowing window to the 3rd week of June showed a consistent yield improvement, ranging from 1.11% in 2080 to 3.12% in 2040 under RCP 4.5, and from 0.71% in 2100 to 3.19% in 2025 under RCP 8.5. Changing the variety from Mahisagar to Gurjari resulted in yield increases, with a maximum benefit of 5.95% in 2025 under RCP 4.5 and 4.82% in 2025 under RCP 8.5. Balanced fertilizer application (N:P:K - 120:20:00 kg/ha) also enhanced yields, showing improvements from 0.86% in 2080 to 4.07% in 2040 under RCP 4.5, and from 0.86% in 2100 to 2.99% in 2025 under RCP 8.5. Increasing irrigation by two additional irrigations improved yields by 2.46% in 2025 under RCP 4.5 and 3.01% under RCP 8.5, with lesser benefits in later years.The most effective strategy was the combination of all four measures (changing variety, shifting sowing date, balanced fertilizer application, and additional irrigation), which resulted in a substantial yield improvement,

with a maximum benefit of 6.82% in 2025 under RCP 4.5 and 8.29% under RCP8.5. These finding ssuggest that integrating multiple adaptation strategies can significantly mitigate the effects of climate change and help sustain rice production in Middle Gujarat.

Keywords: Climate change, Adaptation strategies, Direct-seeded rice, InfoCrop model and Yield improvement

SI-P16

Impact of modified Microclimate on the performance of Greengram under different Planting Systems in Jorhat condition of Assam

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The problem of deficit or excess moisture in successful cultivation of mun gbean in Assam receiving high rainfall with uneven distribution pattern can be addressed by modifying microclimate in the crop fields by growing the crop in different planting systems. Therefore, a field experiment was conducted in the Instructional Cum Research farm of Assam Agricultural University, Jorhat during the summer, 2021 to study the impact of modified microclimates on growth and yield of greengram under different planting systems. The variety SGC-16 was grown in a split-plot design with 3 dates of sowing i.e., 20th February (D1), 6th March (D2) and 20th March (D3) in main plots and three planting systems i.e., ridge and furrow (P1), raised bed with two rows in bed (P2) and flatbed (P3) in sub-plots, with three replications following recommended agronomic practices. Agro-climatic indices viz., growing degree day (GDD), heliothermal unit (HTU), phenothermal index (PTI), and heat use efficiency (HUE) for biomass and seed yield were computed following standard procedures. The crop took 4 to 11 days, 28 to 35 days, 34 to 43 days, 39 to 50 days, and 62 to 75 days to attain the different phenological events, such as emergence, bud formation, flowering, pod initiation, and physiological maturity, respectively under different sowing dates and planting systems. Irrespective of sowing dates mean maximum leaf area index was recorded in P1 (2.06), followed by P2 (1.91) and P3 (1.77). The biomass production at maturity was highest in D3 (15.6 g plant^{-1}), which decreased in earlier dates of sowing, while it was highest under P1 (14.6 g plant-1), followed by P2 (13.4 gplant-1) and P3 (11.6 g plant^{-1}), irrespective of sowing dates. The seed yield of green gram cultivar SGC-16 sown under different sowing dates and planting systems ranged from 286.3 to 681 kg ha^{-1} with an overall mean of 509.8 kg ha^{-1}. Irrespective of sowing dates, the highest GDD accumulation in the entire growth period was recorded under the P1 (1010°C day) system, followed by P2 (973°C day) and P3 (930°C day). The accumulation pattern of PTU by the crops under different treatments was similar to that of GDD. HUE for total biomass production and seed yield ranged from 2.61 to 4.01 kg ha^{-1}°C^{-1} and 0.38 to 0.65 kg ha^{-1} °C^{-1}, respectively. Regression studies showed that there were linear significant relationships between total biomass, seed yield, and max LAI with iPAR. Correlation studies between seed yield, and thermal indices confirmed the existence of a significant and positive correlation between them.

Keywords: Green gram, SGC-16, microclimate, planting system, GDD

SI-P17

Temperatures and Rainfall Trends in Central Zone of India

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Climate change is one of the most important global environmental challenges faced by human beings, and its affects food production, property, natural ecosystem, fresh water supply and health sector. The potential fall outs of this phenomenon have been identified to include rise in temperature, much more erratic rainfall regimes, increased frequency and intensity of extreme weather events, and general unpredictability of agricultural operations among other effects. Changes in temperature and precipitation patterns together with occurrence of extreme events are major threat to future food security due to climate change. Present study was taken in to consideration after collection and analyzing of historical data for different locations of Madhya Pradesh i.e. Jabalpur, Indore and Gwalior.Climatic characterization was done for long-term trends and occurrence of extreme events for precipitation and temperatures were studied in relation to crop growth phases as climate change related occurrence of these extreme events can have serious consequences for agricultural production. Long term trends in weekly temperatures revealed that a cooling trend at Gwalior whereas at Indore temperatures showed a warming trends. At Jabalpur there is a decreasing trend for minimum temperature during *rabi* season which can have real serious repercussion for the seasonal crops. It has been generally observed that low night temperatures during grain filling stage improve crop productivity, particularly for late sown crops.Changes in rainfall pattern are evident at three locations; at Jabalpur rainfall shows an increasing trend where as the other two locations display a decreasing trend. Jabalpur is in high rainfall zone whereas Gwalior and Indore are at low rainfall zones comparatively. Continuous decrease in number of rainy days and abrupt rainfall pattern at the locations studied causing of limit the production potential of major crops.

SI-P18

Modification of Surface Energy Balance for enhancing the growth of Tomato crop in Assam

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An experiment was conducted during *rabi,* 2021-22 in Assam Agricultural University, Jorhat to identify the most suitable strategies for combating the ill effects of low minimum temperature and low as well as fluctuating soil moisture during active crop growth period of tomato in the state through the modification of soil microclimate. The tomato cultivar *Arka Rakshak* was grown in factorial RBD with two row orientations (East-West and North-South) and four mulching treatments, *viz.,* no-mulch, Straw mulch, Transparent polythene mulch and Black polythene mulch with three replications following the recommended agronomic practices. The study revealed that there was increase in weekly minimum soil temperature by 1.3

ºC to 3.0 ºC, 0.8 ºC to 2.4 ºC and 0.1 to 1.8 ºC under black, transparent and straw mulch as compared to non-mulch treatment while the increase in weekly maximum soil temperatures recorded under transparent and black mulch was up to 5.1°C and 4.5°C, respectively, whereas the decrease in under straw mulch was up to 2.3°C. The study also showed that the cultivar took the least time under transparent mulch treatment to attain most of the phenological events. The leaf area index and biomass production were the highest and lowest under transparent and non-mulch treatment respectively. The highest fruit yield was obtained under transparent mulch (374.9q/ha) while the lowest was under non-mulch treatment (249.5 q ha^{-1}). The prediction models developed indicated that fruit yield is positively and significantly correlated at 1% level (r=0.92**) with the average soil moisture in the upper 30 cm soil layer during the vegetative stage. The reason behind highest fruit yield under transparent mulch can be attributed to the better soil hydrothermal regime and thus better growth of the crop under the microclimate.

***Keywords*:** Tomato, *Arka Rakshak*, microclimate, mulching, minimum temperature

SI-P19

Potential of Soil less Agriculture in the Face of Climate Change

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The climate change is threatening the planet's natural resources and disrupting ecosystems. Rising global temperatures, erratic weather patterns, and extreme events like wildfires, floods, and droughts are accelerating the depletion of critical resources such as water, fertile land, and biodiversity. These changes are undermining food security, challenging energy production, and impacting livelihoods, especially for communities most vulnerable to these shifts. Traditional agricultural practices relies on large tracts of fertile soil and significant water input, which is becoming unsustainable in this changing climate. Soilless farming methods, such as hydroponics, aeroponics, and aquaponics, offer aviable alternative to address these issues. These systems use substantially less water up to 90% less than conventional farming and require far less space, making them especially suited for urban areas and regions with limited resources. Additionally, crops grown in soilless systems benefit from faster growth cycles and consistent, year-round yields due to their controlled environments, which also protect them from climate-related risks such as droughts, floods, and soil degradation. The waste water generated from conventional farming practices, particularly from livestock rearing as well as urban sewage, can emit the greenhouse gases and their improper disposal can limit the supply of fresh water. Recent researches suggest that hydroponics can be used to manage waste water for pollutant removal and food production. Hydroponicscan also be used to optimise the rate of photosynthesis which depends on the availability of different factors as: light, nutrients, water, CO_2, in closed greenhouse system and other similar structures. In addition to the maintain the external temperature soilless cultivation enable sustomaintain the temperature evenat the root zone itself which enables us to control the growth of some pathogens and also increase the growth of plant. The pathogens require suitable temperature and humidity to complete their life cycle. Studies have shown that heating the nutrient solution to 20–22°C effectively addressed root death in tomatoes caused by *Pythium* spp. In aeroponic systems, using heated nutrient solutions also sped uproot developmenting in gerplants and resulted in slightly higher fresh rhizome yields compared to plants grown in the same medium without bottom heating. A recent study revealed that weak electric fields can be used effectively in significantly reducing pathogenic zoospore attachment to roots in hydroponic systems, particularly in *Arabidopsis thaliana*. By leveraging these technologies, soilless agriculture not only enhances resource efficiency but also provides a climate-resilient pathway to feed a growing global population. This paper explores

the role of soilless farming inadapting to the challenges of climate change while minimizing environmental impacts.

Keywords: Climate change; soilless farming; hydroponics; aeroponics; root zone temperature; agricultural innovation

SI-P20

Response of black gram (*Vigna mungo* L. Hepper) to organic and natural farming practices under mid-hill conditions of Jammu

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Field experiment was conducted during *kharif* season of 2023 at Regional Agricultural Research Station, Rajouri of Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu to evaluate the response of black gram (*Vigna mungo* L. Hepper) to organic and natural farming practices under mid- hill conditions of Jammu with the objectives to find out the response of organic and natural farming practices on growth, yield, nutrient uptake, soil properties and relative economics of black gram. The experiment was laid out in randomized block design with 11 treatments comprising either sole or a combination of organic and natural farming components (Vermicompost, FYM, Beejamit and Jeevamit) replicated thrice. The soil of the experimental field was silty clay in texture, near to neutral in reaction, medium in organic carbon, available phosphorus, potassium and low in available nitrogen. The results revealed that treatment T11 (100% RDN through Vermicompost + Beejamrit + Jeevamrit) recorded significantly highest seed yield (1183.00 kg ha^{-1}) of black gram. Application of treatment T10 (100% RDN through FYM + Beejamrit + Jeevamrit) was registered 2^{nd} best seed yield (1068 kg ha^{-1}) which was statistically at par with treatment T9 (100% RDN through Vermicompost + Jeevamrit) with seed yield (986.00 kg ha^{-1}) respectively. Treatment T1- control (check), registered lowest seed yield of 508 kg ha^{-1}. However, T11 (100% RDN through Vermicompost + Beejamrit + Jeevamrit also recorded significantly highest gross returns, net returns and B: C ratio. Based on one year of study, it can be inferred that organic and natural farming practices have a positive influence on growth and yield attributes on black gram. Integrated application of organic and natural farming practices positively influenced all the growth and yield parameters of black gram under mid-hill conditions of Jammu.

***Keywords*:** Black gram, beejamrit, jeevamrit and natural farming

SI-P21

An overview on Climate-Smart Agriculture and Soil Health

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Climate-smart agriculture (CSA) represents a holistic approach to transforming agricultural practices to effectively address the impacts of climate change, enhance food security, and promote environmental

sustainability. Recent findings from the latest climate change reports, including data from the Intergovernmental Panel on Climate Change (IPCC) and the Food and Agriculture Organization (FAO), to under score the urgency of adopting CS Astrategies. The data indicate that agriculture is a significant contributor to global greenhouse gas emissions, accounting for approximately 23% of total emissions, with land-use changes further exacerbating the issue. By 2050, it is predicted that approximately 9 billion people worldwide will live in harsher conditions. The overview emphasizes the role of climate resilience in agriculture, particularly in regions most vulnerable to climate variability. For instance, climate change reports project that crop yields may decline by upto 30% in some areas by 2050 due to increased temperatures and altered precipitation patterns. CSA practices can enhance resilience by improving soil structure, increasing water retention, and diversifying cropping systems. Furthermore, the socio-economic dimensions of CSA are explored, highlighting the need for supportive policies, investments, and capacity-building initiatives. Stakeholder engagement, particularly involving smallholder farmers, is crucial for successful implementation.

***Keywords*:** Climate smart, food security, climate change, Green hose gas, vulnerable.

SI-P22

Effect of sowing window on growth and yield of foxtail millet (*Setaria italica*) in the Inceptisol of Assam

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A field experiment entitled "Effect of sowing window on growth and yield of foxtail millet (*Setariaitalica*) in the Inceptisol of Assam" was carried out during rabi season of 2024 at the Post-graduate experimental plot, Department of Agronomy, BNCA, AAU, Biswanath. The objectives of the experiment were to find out the optimum time of sowing of foxtail millet, and evaluate suitable varieties of foxtail millet under varied sowing environment. The experiment was laid out in factorial randomized block design and replicated thrice with ten treatment combinations of two factors *viz.* two varieties (V1: AAU-GSG-Cawn 1 and V2: SiA 3156) and five different dates of sowing (D1: 08th January, D2: 23rd January, D3: 07th February, D4: 22nd February and D5: 08th March). The soil of the experimental area was sandy loam, acidic in reaction, in organic carbon, medium in available N, and low in available P_2O_5 and low in available K_2O. Total rainfall received during the crop growth period was 619.70 mm and distributed in 49 rainy days. Among two varieties results showed that SiA 3156 recorded significantly higher plant height at 50 % flowering and harvest; tillers plant^{-1}, LAI, and chlorophyll content at panicle emergence; and total dry weight plant^{-1}, grain yield (13.75 q ha^{-1}) and harvest index (35.85 %), straw yield. Irrespective of the varieties, 23rd sown crop recorded significantly higher growth parameters, grain yield (14.62 q ha^{-1}) with a higher percent of harvest index (38.95 %). Though the 1st sown crop (8th January) recorded the highest straw yield, however, found statistically at par with the 2nd sowing.

Keywords: LAI, HI, Plant height, Grain and straw yield

SI-P23

Effect of variable thermal regime on yield and yield attributes of *Kharif* Green Gram (*Vigna radiata* L.) cultivars

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A field experiment was conducted during *kharif* season of 2022-23 on the entitled "study on heat unit and heat use efficiency of kharif green gram (*vigna radiata* L.) grown under variable thermal regime" in sandy loam soil of A. N. D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The experiment was conducted in Split Plot Design (S.P.D.) and comprises three thermal regimes/temperatures *viz.* 5th July (G1) (32^{o}C), 15th July (G2) (31.5^{o}C), 25th July (G3) (30.5^{o}C) and three cultivars *i.e.* Pusa Baisakhi (C1), Narendra moong-1 on 15th July and SML-668 on. Results revealed that maximum plant height, number of branches, days taken to attain maturity, dry matter, test weight, leaf area index,number of pod per plant and grains per pod obtained in Pusa Baisakhi cultivar on 1st date of sowing (5th July) followed by Narendra moong-1 on 15th July and SML-668 on 25th July. Additionally, the research underscores that the higher grain yield, Stover yield, biological yield and harvest index observed in Pusa Baisakhi cultivar on first date of sowing.

Keywords: Thermal regime, accumulated heat unit, heat use efficiency, Split Plot Design.

SI-P24

Harnessing Strigolactones for Enhanced Plant Stress Resilience and Productivity

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Strigolactones (SLs) are a class of carotenoid-derived phytohormones that play significant roles in plant growth, development, and stress responses. SLs are recognized for their involvement in regulating key processes such as seed germination, root development, shoot branching, and leaf senescence. Synthesized primarily in the roots and released into the rhizosphere, SLs are essential for plant survival under abiotic stress conditions such as drought, salt, temperature fluctuations, nutrient deficiencies, and heavy metal toxicity. These hormones are involved in oxidative responses and promote osmolyte production to maintain cellular homeostasis during environmental stress. Recent studies have also highlighted the interplay between SLs and other phytohormones like abscisic acid (ABA), auxins, cytokinins, and jasmonic acid, particularly in response to abiotic stressors. This cross talk allows SLs to function as a

key component in regulatory networks that govern plant adaptation to challenging environments. Additionally, exogenous application of SL analogs, such as GR24, has been shown to enhance SL biosynthesis and improve stress resistance. Strigolactones also contribute to plant resilience by supporting photosynthesis, enhancing antioxidant activity, and fostering symbiotic relationships with arbuscular mycorrhiza (AM). While the mechanisms of SL action are complex and involve multiple signaling pathways, current research suggests that manipulating SL biosynthesis and signaling could be a promising strategy for improving plant tolerance to various stresses. It presents an overview of SL biosynthesis, signaling, and their critical roles in stress resistance, highlighting the need for further exploration of SL-based applications in sustainable agriculture and plant protection.

***Keywords*:** Strigolactones, phytohormones, abiotic stress, plant growth, cross talk, environmental stress, sustainable agriculture

SI-P25

Dry Matter Production and Economics of Rice Cultivation with different Rice Residue Management Practices and Fertilizer Levels

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A field experiment titled "Dry Matter Production and Economics of Rice Cultivation with Different Rice Residue Management Practices and Fertilizer Levels" was conducted at the Agricultural College Farm in Bapatla during the kharif season of 2021. The experimental soil was characterized as clay loam with a neutral pH of 7.66 and non-saline electrical conductivity of 0.55 dS m^{-1}. The soil had low organic carbon content (0.43%), low available nitrogen (226 kg ha^{-1}), medium levels of available phosphorus (52.5 kg P Oha^{-1}) and potassium (325 kg KO ha^{-1}), sufficient sulfur (16 ppm), and adequate divalent cationic micronutrients (Fe, Mn, Zn, and Cu). The experiment was structured using a split plot design, with rice residue management practices assigned to the main plots and different fertilizer levels to subplots. The main plots included four rice residue management practices: straw burning (M1), straw incorporation (M2), straw incorporation combined with farmyard manure (FYM) at 5.0 t ha^{-1} (M3), and straw incorporation with decomposing inoculum (DI, ANGRAU) and FYM at 5 t ha^{-1} (M4). Fertilizer levels included 75% recommended dose of fertilizer (RDF) (S1), 100% RDF (S2), and 125% RDF (S3). Significant improvements were observed in plant growth, dry matter, grain, and straw yields with the incorporation of rice straw combined with DI and FYM at 5 t ha^{-1}. Among the fertilizer levels, 125% RDF was found to be superior. The integration of rice straw with ANGRAU-DI and FYM at 5 t ha^{-1} enhanced soil health and yields, particularly when combined with 100% RDF. The highest benefit-cost (B:C) ratio of 1.24 was achieved with the integration of 75% RDF. In contrast, straw burning or straw incorporation alone, even at a higher fertilizer level of 125% RDF, did not yield comparable results. Straw incorporation + DI + FYM @ 5 t ha^{-1} was observed to be the best rice residue management technology for sustaining soil health and crop productivity of dry direct seeded rice economizing 25% of RDF thus showing a higher BC ratio of 1.24. This sustainable practice offers an effective alternative to straw burning, contributing to improved agricultural outcomes and environmental health.

SI-P26

Thermal indices of foxtail millet under different sowing environments in North Bank Plain Zone of Assam

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A field experiment entitled "Thermal indices of foxtail millet under different sowing environments in North Bank Plain Zone of Assam" was carried out during rabi season of 2024 at the Post-graduate experimental plot, Department of Agronomy, BNCA, AAU, Biswanath. The objectives of the experiment were to find out the effect of thermal indices on yield of the foxtail millet varities and to find out the optimum sowing time of foxtail millet. The experiment was laid out in factorial randomized block design and replicated thrice with ten treatment combinations of two factors *viz.* two varieties (V_1: AAU-GSG-Cawn 1 and V_2: SiA 3156) and five different dates of sowing (D_1: 08th January, D_2: 23rd January, D_3: 07th February, D_4: 22nd February and D_5: 08th March). The soil of the experimental area was sandy loam, acidic in reaction, medium in organic carbon, medium in available N, and low in available P_2O_5 and medium in available K_2O. The total rainfall received during the crop growth period was 619.70 mm mm and distributed in 49 rainy days. Among two varieties results showed that SiA 3156 recorded significantly higher grain yield (13.75 q ha^{-1}) and harvest index (35.85 %), however, with lower straw yield. SiA 3156 came out as more efficient in terms of HUE (1.07 kg ha^{-1} ^{0}d) despite possessing lower magnitude of accumulated GDD, HTU, PTU throughout the crop growth period. Irrespective of the varieties, 23rd sown crop recorded significantly higher grain yield (14.62 qha^{-1}) with a higher percent of harvest index (38.95%). Though the 1st sown crop (8th January) recorded the highest straw yield, however, found statistically at par with the 2nd sowing. More accumulation of GDD, HTU, PTU throughout the crop growth was observed in delayed sown crops whereas the early sown crop had higher HUE, the maximum magnitude was recorded in the 23rd January sown crop.

Keywords: GDD, PTU, HTU, HUE

SI-P27

Radiation studies on soybean (Glycine max.) crop under different environment

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The present investigation entitled, "Radiation studies on soybean (Glycine max.) crop under different environment"was carried out at Research Farm, Department of Agricultural Meteorology, Marathwada Agricultural University Parbhani (M.S.) During Kharif season 2024. In order to determine the energy balance in several soybean cultivars, the experiment was setup in a split-plot design with three replications and two

factors the date of sowing D1 (MW25), D2 (MW26), D3 (MW27), and D4 (MW28), as well as cultivars V1 (MAUS-158), V2 (MAUS-612), and V3 (JS-335). Line quantum sensors are used to measure photosynthetically active radiation (PAR). The incident radiation reading is dependent on the day's weather. It is within the 820–980 ìmol/m^2/srange. Crop growth affects the reflected radiation value, which rose as the number of leaves increased. V(I) {MAUS-158} had the most reflected radiation (10.92-12.25) µmol/m^2/s), while V (3) {js-335} had the lowest (8.31-8.48 ìmol/m^2/s). As crop development rose, transmitted radiation decreased, and at the maturity stage, it increased.V(1) {MAUS-158}had the most transmitted radiation (550.8µmol/m^2/s), whereas V{3} (JS- 335) had the lowest (4893 ìmol/m^2/s). From the branches to the dough stage (P4 to P7), the mean absorbed PAR percentage and light utilization efficiency rose; at the maturity stage (P8), they fell. V{2} (MAUS-158) had the highest absorbed PAR percentage (39.77%) and light use efficiency (1.5 g $MJ^{-1}S^{-2}$) while V {1} (MAUS-158) had the lowest absorbed PAR percentage (38.29%) and light use efficiency (1.48 gMJ^{-1} S^{-2}). V {1} (MAUS-158) had the mean maximum dry matter (582.82gm^{-2}), while V{3} (JS-335) had the mean lowest (465.69g m^{-2}). For different cultivars, the relationship between cumulative absorbed radiation and leaf area index at different phenophase stages showed that cumulative absorbed radiation rose as the leaf area index increased up to the dough stage (P7) and then fell at the maturity stage (P8) as a result of leaf senescence. D{1} (MW-25) date of sowing and cultivar V {1} (MAUS-158) showed the highet variety growth characteristics, such as emergence and final plant count, number of functional leaves, number of branches, number of pods, and grain yield. Conversely, cultivar V{3} (JS-335) and sowing date D{4} (MW-28) had the lowest yield.

SI-P28

Effect of Integrated Nutrient Management on the Growth and Yield of China Aster (*Callistephus chinensis* (L.) Nees)

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The present investigation entitled "Effect of Integrated Nutrient Management on the Growth and Yield of China Aster (*Callistephus chinensis* (L.) Nees)" was carried out at Horticulture farm, Department of Horticulture, SAS, Nagaland University, Medziphema campus during 2024. The experiment was laid out in randomized block design (RBD) and comprised of Eight treatments were assessed, including a control, 100% recommended dose of fertilizers (RDF), and combinations of 50% RDF with various organic amendments such as farmyard manure (FYM), vermicompost, forest litter, poultry manure, pig manure and goat manure. Half dose of nitrogen and whole of the phosphorus and potassium were incorporated in soil one week before planting according to the treatments. The remaining half dose of nitrogen was applied after 40 days of planting. Significant differences were observed across treatments in terms of plant growth, flowering parameters, and flower quality. Among the treatments, the combination of RDF (50%) + pig manure (2.5 t/ha) resulted in the maximum *viz*, plant height (46.50 cm), plant spread (16.13 cm), number of primary branches (16.50) and No of flowers per plant (31.67), flower diameter (5.35 cm), stalk length (19.08 cm), weight of single flower (5.33 g) and earliest bud initiation (40.50 days), followed by RDF (50%) + goat manure (2.5 t/ha). Other treatments, including RDF (50%) combined with poultry manure, vermicompost, FYM and forest litter, also demonstrated improved plant growth and flower yield, though to varying degrees. In contrast, the control and 100% RDF treatments exhibited comparatively lower

performance in all parameters, with the control treatment showing the least plant height (31.83 cm), flower diameter (3.00 cm), and number of flowers per plant (4.00). The study concludes that integrated nutrient management, particularly the use of RDF in combination with pig and goat manure, significantly enhances the growth and flower yield of China aster, highlighting its potential for promoting sustainable cultivation practices.

***Keywords*:** China aster, integrated nutrient management, Organic Manures, flower quality, fertilizer management, sustainable practices.

SI-P29

Optimising water management in low cost polyhouse through gravity based drip irrigation

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Climate change has made open field cultivation highly challenging, paving the way for protected cultivation as a sustainable and adaptive solution. A field study was conducted during 2023-2024 at the AICRPIWM, Instructional-cum-Research Farm, Assam Agricultural University, to optimize water requirements for cucumber (variety Glossy) and tomato (variety Anup). The experiment was set up in a 100 m^2 polyhouse, employing drip irrigation at 100% crop evapotranspiration (ETc) and fertigation using a 19:19:19 water-soluble fertilizer. The polyhouse was equipped with various sensors, including a maximum and minimum thermometer, pan evaporimeter, digital moisture meter, infrared thermometer, and thermohygrograph, to monitor daily weather conditions. Meteorological parameters such as mean, minimum and maximum temperatures, relative humidity, wind speed, sunshine hours, and rainfall were recorded and analyzed using the FAO Penman-Monteith method in CROPWAT 8 software to estimate reference evapotranspiration and irrigation requirements. Water budgeting was conducted by assessing inflows, including monthly rainfall and harvested rainwater, against outflows such as crop water requirements to determine water surplus or deficit. Water Use Efficiency (WUE) was calculated as the ratio of crop yield to the total volume of water applied. Rainwater harvesting was implemented using a 1000-liter storage tank to conserve excess water, providing a supplemental irrigation source during dry periods to prevent moisture stress. The study highlights the effectiveness of integrating drip irrigation, fertigation, and rainwater harvesting for efficient water management in protected cultivation systems. These practices not only optimize water use but also mitigate water scarcity, enhancing productivity and sustainability for cucumber and tomato cultivation in controlled environments.

Keywords: Drip irrigation, crop evapotranspiration, irrigation requirement, water budgeting, WUE.

SI-P30

Influence of Agroclimatic indices and Photosynthetically Active Radiation (PAR) in Finger millet Yield under the Agroclimate of Jorhat

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Finger millet (*Eleusine coracana*) is a highly nutritious and stress tolerant cereal crop that is widely grown in 1.2 million hectare area with 2.2 million tons of production in India. In Assam too, the average yield of millet crop is about 664 kg/ha and Dhubri is the leading producer of millet crops. During kharif 2023–2024, a field experiment was carried out at the Instructional Cum Research Farm, Assam Agricultural University, Jorhat, using a split-split plot design with two varieties (Gossaigaon Marua dhan and FMAVT 4001), three sowing dates (31st July, 15th August, and 30th August 2023), and two spacing configurations (25 cm × 15 cm and 20 cm × 10 cm). Plant spacing and sowing dates have a significant impact on growth, development and yield of finger millet crop. Plant density at its optimal level ensures proper growth of plants, making better use of sunlight and soil nutrients. Agroclimatic indices, specifically growing degree days (GDD), photothermal units (PTU), and helio thermal units (HTU), were calculated for each distinct phenological phase of the crop. Concurrently, incident, reflected, and transmitted photosynthetically active radiation (PAR) were measured weekly throughout the crop's lifecycle, enabling the subsequent determination of intercepted PAR. Agroclimatic indices, including growing degree days (GDD) and photo thermal units (PTU), demonstrated a negative correlation with delay sowing. Specifically, accumulated GDD (AGDD) decreased progressively from 1896 °C in the early-sown treatment to 1737°C in the late-sown treatment. Conversely, the late-sown treatment exhibited the highest accumulated helio thermal units (AHTU) of 11320 °C hours, while the early-sown treatment recorded the highest accumulated pho tothermal units (APTU) of 22951°C hours across the entire crop growth period. Across the evaluated treatments, the Gossaigaon Maruadhan variety demonstrated the highest intercepted photosynthetically active radiation (iPAR), achieving 76.27 percent at a spacing of 25 cm x 15 cm and 78.06 percent at 20 cm x 10 cm. Conversely, the FMAVT 4001 variety exhibited the lowest iPAR, registering 74.13 percent and 76.10 percent at the respective spacing treatments. Considering sowing time, the early-sown crop under closer spacing exhibited the highest PAR interception rate (78.06 percent), followed by the mid-sown crop and the late-sown crop. The early-sown Gossaigaon maruadhan variety at a spacing of 25 cm x 15 cm exhibited the highest grain yield and associated yield attributes. However, the highest straw yield was observed in the early-sown Gossaigaon maruadhan variety at the 20 cm x 10 cm spacing, that was due to the highest interception of photosynthetically active radiation.

Keywords: Spacing, sowing dates, intercepted PAR, growing degree days, photothermal unit

SI-P31

Yield performance of blackgram (*Vigna mungo* L) var. *Saonia mah* in natural farming

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An observation trial was conducted during the *kharif* season of 2023-24 at the natural farming block of Instructional-cum- Research farm of Assam Agricultural University, Jorhat to evaluate the effects of Ghanajeevamrit (GJM) and Dravajeevamrit (DJM) on the growth and yield of blackgram cultivar *Saonia mah*. The trial consisted of four treatments *viz*.,N_0: Control, N_1**:** GJM@ 300kg/ha + foliar application of DJM at 10, 20, 30 and 40 DAS. N_2**:**GJM @ 500 kg/ha + foliar application of DJ Mat 10, 20, 30 and 40 DAS. N_3: GJM @ 1000kg/ha + foliar application of DJM at 10, 20, 30 and 40 DAS. The plot size was 10m x 10m. The seeds were treated with Beejamrit @ 200 ml/kg of seed. The soil of the experimental site was sandy loam in texture with pH 5.17, organic carbon (0.57%), available N (228.00 kg/ha), available P_2O_5 (25.99 kg/ha) and available K_2O (111.82 kg/ha). The yield recorded in various treatments were N_0 (control) : 267 kg/ha,N_1:410 kg/ha,N_2: 623 kg/ha and N_3: 710 kg/ha. The highest B:C (1: 1.7) was recorded with the N_3 treatment.

Keywords: Ghanajeevamrit, Dravajeevamrit, blackgram, yield, B:C

SI-P32

Evaluating radiation use efficiency and growth-yield dynamics of wheat under different temperature regimes in central Punjab

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The field experiment was conducted during *rabi* 2017-18 and 2018-19 at Research farm, School of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana to assess the radiation use efficiency (RUE) under three sowing dates i.e. D1(25th October), D2 (15th November) and D3 (5th December), and three cultivars (V1- WH1105, V2- UNNAT PBW 550 andV3- PBW590) in main plots and two irrigation treatments (I1 Recommended and I2 Recommended ± weather forecast based) in sub plots. The cultivar PBW 550 sown on November 15 had higher radiation use efficiency (RUE) as compared to other treatments which may be attributed to the more leaf area index (LAI) and intercepted photo synthetically active radiation (IPAR), which resulted in better dry matter production and grain yield. The low RUE in wheat crop under delayed sowing i.e., on 5th December and cultivar PBW 590 lead to reduction in grain yield. The regression relationship of RUE with LAI, total dry matter production and grain yield were linear and positive.

SI-P33

Assessing the Risks and Opportunities in Maize Production through Agricultural Meteorology in India

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Maize (*Zea mays* L.) is the third most important cereal crop in India and plays a vital role in food security and the economy. It is grown across diverse agro-climatic zones, with an estimated production of 28 million metric tons in the 2023-24, achieving a productivity of 3 metric tons per hectare. During the 2023-24, maize is sown on approximately 108.87 lakh hectares. It serves as a staple food and livestock feed, while also being used in industrial products such as food sweeteners and starch. Climate variability presents significant challenges to maize production. Rising temperatures, altered rainfall patterns, and extreme weather events affect maize yields, particularly in regions like the Mid Indo-Gangetic Plains (MIGP), where noted that increases in temperature reduced yields. In Bihar, identified heat stress during the *rabi* season and erratic rainfall in the *kharif* season as key risks to maize production. Rising temperatures are projected to reduce maize yields, especially in regions like the Southern Plateau and MIGP. predicted yield declines of 16%-46% under moderate climate scenarios and 21%-80% under high emissions scenarios, with emphasizing the negative impact of higher temperatures during the monsoon season. In Bihar, highlighted how changing rainfall and rising temperatures affect crop water requirements. Erratic rainfall and high temperatures cause water stress during the *kharif* season, while rising minimum temperatures worsen heat stress in the *rabi* season, further threatening maize yields. Despite these challenges, maize shows resilience to climate variability, particularly in regions like the Upper Indo-Gangetic Plains (UIGP), where moderate temperature increases have minimal impact on yields. Maize shorter growing season and adaptability to varying conditions makes it a promising crop for climate resilience. Maize's ability to tolerate heat and moderate drought, combined with its quick growing cycle, provides it with an advantage in many regions facing shifting climates. Adaptation strategies such as delayed sowing, increased fertilizer use, and supplemental irrigation have proven effective in maintaining yields. (Rao *et al.*, 2022) and (Tesfaye *et al.,* 2017) highlighted the importance of improving crop management practices and water use efficiency. Developing drought- and heat-resistant maize varieties has also been considered key to adapting to future climate challenges. These measures have allowed farmers to better cope with unpredictable weather patterns and maintain maize production levels. In conclusion, despite the challenges posed by climate change, maize remains are silient and productive crop in India.

***Keywords*:** Maize, Agricultural Meteorology, Climate Change, Temperature Fluctuations, Precipitation variability, Climate-Resilient Crop, Varieties.

SI-P34

Effect of growing environment on growth, development and yield of Lentil under the Jorhat condition of Assam

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A field experiment was conducted in the Instructional-Cum Research (ICR) Farm of Assam Agricultural University, Jorhat with an objective to study the effect of weather and hydrothermal regimes on the performance of two Lentil (*Lens culinaris*) varieties *viz*., PL-9 and IPL-220 sown under three different microclimatic regimes i.e., 6 November (D_1), 13 November (D_2) and 19 November (D_3) adopting factorial Randomised Block Design (RBD) during *Rabi*, 2023-24. In the case of the present investigation, mean number of days required to attain 50% flowering and 50% podding tends to decrease by 5 and 10 days i.e., from 64 (D_1) to 59 (D_3) days and 94 (D_1) to 84 (D_3) days, respectively. The mean soil moisture corresponding to the pre- budding, 50% flowering and 50% podding phase was found to be varied from 10.1 to 17.8% (±0.13 to ±0.37), 8.9 to 19.5% (±0.14 to ±0.38) and 10.1 to 20.1% (±0.13 to ±0.46), respectively. Irrespective of the varieties, the mean chlorophyll content varied from 36.3 to 40.8 µ mol/m^2, 34.2 to39.1µmol/m^2and33.5to38.3µmol/m^2 with standard deviation ± 0.28 to ±1.93, ±0.06 to±2.12 and ±0.58 to ±2.87, respectively corresponding to the crop sown under D_1, $D_2$and D_3. Likewise, irrespective of the varieties, the mean iPAR was found to be varied from 51.03 to 71.2%, 50.5 to 70.4% and 49.3 to 70.0% when sown under early (D_1), mid (D_2) and late (D_3) sowing condition; with standard deviation ±0.09 to ±6.3, ±1.0 to ±6.2 and ±0.36 to ±6.03, respectively. Overall, the mean intercepted PAR was found maximum in IPL-220, and among the different phases, iPAR was maximum during the budding stage of the crop (66.04%), when compared with 50% flowering (56.6%) and 50% podding (62.4%) phase of lentil crop. Irrespective of the sowing dates, the mean seed yield was found maximum in PL-9, which was found to be varied between 730 to 801 kg/ha. The highest seed yield of PL-9 might be attributed to more number of filled pods per plant (43.9 to 58.93) and more number of mean seeds per pod 1.21 to 1.42. Overall, the crop performance was found best under early sowing condition; which might be attributed to prevailing mean maximum and minimum temperature of 25.5°C (17.5-31.0°C) and 11.6 °C (6.7-18.5°C); with mean bright sunshine hours of 5.6 and mean accumulated rainfall below 90mm.

Keywords: Chlorophyll content, iPAR, seed yield and soil moisture

SII/LT-1

Extreme Weather Events and Agricultural Productivity: A Growing Challenge for Agrometeorologists

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Extreme weather events, such as droughts, floods, hailstorms, and heat/cold waves, have become increasingly frequent and severe due to climate change. These events pose significant challenges to agricultural productivity, threatening global food security and economic stability. This abstract examines the impact of extreme weather on agriculture, explores adaptive strategies, and highlights the importance of policy interventions to mitigate risks. Extreme weather conditions disrupt crop yields, soil fertility, and water availability, leading to reduced agricultural output and economic losses for farmers. Droughts, for example, diminish water resources essential for irrigation, while floods and cyclones cause soil erosion, crop destruction, and infrastructure damage. Heatwaves can impair photosynthesis and increase plant stress, reducing overall productivity. Livestock farming is also affected, as heat stress leads to lower milk production, reduced fertility, and increased mortality rates. Beyond direct impacts, extreme weather events contribute to increased pest and disease outbreaks, exacerbating crop failures and food shortages. Small holder farmers in developing nations are particularly vulnerable due to limited access to resources, technology, and financial support. Climate variability further complicates planting cycles, making it difficult for farmers to predict optimal sowing and harvesting periods. Adaptation strategies are crucial to sustaining agricultural productivity in the face of extreme weather. Technological innovations such as drought-resistant crops, precision irrigation, and climate-smart agricultural practices can enhance resilience. Sustainable crop management techniques based on current weather and additionally, improved weather forecasting systems and early warning mechanisms can enable farmers to make informed decisions and minimize losses. In conclusion, extreme weather events pose a serious threat to agricultural productivity, demanding urgent action at various levels. By leveraging technological advancements, adopting sustainable practices, and implementing effective policy interventions, the agricultural sector can enhance its resilience to climate-induced challenges, safeguarding food security for future generations. In this effort, agrometeorologists play a crucial role in guiding adaptation strategies and mitigating risks.

SII/IT-1

Management of flashflood and dry spell in *Sali* rice in the North bank plains zone of Assam

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The innate problem in NBPZ of Assam is the occurrence of 3 to 5 flash floods, each of 7 to 15 days duration, during the monsoon season, and the complete submergence of the rice fields in a sizable area of the region. The multiple waves of floods during the monsoon cause extensive damage to the

standing rice crop in the zone. At the same time, intermittent dry spells are also recurrent phenomena occurring during the growing season of winter or *Sali* rice in many places of the zone situated in the foot hills of the eastern Himalayas. Both problems extreme weather events are likely to be aggravated in the future due to the expected increase in rainfall variability driven by climate change. It is, therefore, imperative to identify and inclusion of doable technologies for the management of such extreme weather events. In this study, two opposite rice growing ecosystems from the Lakhimpur district of the zone were selected to evaluate and identify the agro-technologies for management flash flood as well as of dry-spells in *Sali* rice, the major crop of the zone. Analysis of the long-term rainfall (25 years) of the Lakhimpur district revealed a significant decreasing trend of annual and seasonal rainfall along with a significant decrease in monsoon rainfall and an increase in monthly rainfall variability. This clearly explains the recent rainfall fluctuations with increasing frequency of intermittent dry spells and flash floods in the region.The first ecological situation is *Ganakdolonivillage*, a community, often affected by 3 to 5 numbers of flash floods of 7 to 15 days in almost every year. From 2012 to 2016, different available flood tolerant technologies, such as submergence tolerant and improved deep-water rice varieties, rice varieties suitable for growing as pre-flood and post-flood crops along with normal rice cultivars were tested. At the same time, participatory on-farm trials were conducted in 30 sites covering 20 ha to evaluate the performance of five traditional floating rice (bao) varieties: Kekua, Tulshi, Dhushuri, and Bahadur Rangabao. During the study period, the rice fields were affected by flooding in multiple times, to a depth of up to 173 cm. It was observed that against the extensive damage to the normal, submergence tolerant and improved deep water rice cultivars, the traditional floating rice varieties endured the flash floods, performing better and producing grain yields from 1628 to 3000 kg ha^{-1}. It was concluded from the study that the problem of intermittent submergence due to multiple flash floods during the *kharif* season in NBPZ of Assam can be addressed by introducing traditional deep water or floating rice varieties, which can tolerate both flash floods and the occasional drought and possess genes for stem elongation, kneeing ability and submergence. The second ecological situation is Chamua village, having different land situations, which was selected to identify climate-resilient technologies to cope with seasonal drought in sali rice. From participatory trials conducted from 2011 to 2016, it was found that the high-yielding short-duration varieties, *viz.*, Dishang, Luit, Lachit and Kolong, and medium-duration varieties, viz., Basundhara, Mohan, Mulagabhoru and TTB-404 performed consistently better than the long-duration HYV or the traditional varieties under upland and medium land situations, respectively. Though the effect of dry spells on long-duration varieties cultivated on low lands was the least, the yield of these varieties was reduced up to 43.07% when sowing was delayed beyond the 23rd of June. Performance of the delayed sown varieties was further declined when exposed to dry spells at later growth stages. However, the adverse impact of dry spells can be managed effectively by replacing farmers' varieties with short and medium-duration high-yielding varieties in upland and medium lands, respectively, and manipulating the sowing time of long-duration varieties for lowlands.

SII/IT-2

Alternate land use systems for climate resilience

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Agroforestry and alternate land use systems are pivotal in promoting sustainable agriculture, particularly in regions like Assam, where climate change has exacerbated challenges such as erratic

rainfall, prolonged dry spells, and extreme weather events. Traditional practices like the bari system in Assam, which integrates trees, vegetables, livestock, poultry, and fisheries, have long supported biodiversity conservation and household sustainability. However, recent studies in Biswanath district reveal that declining soil fertility, unpredictable monsoon patterns, water scarcity, and pest infestations have further stressed agricultural productivity. To mitigate these impacts, climate-resilient interventions such as low-cost polyhouses have been implemented under the NICRA project, allowing farmers to cultivate high-value crops during off-seasons and reduce climate-induced risks. Additionally, agroforestry trials with species like *Gmelina arborea* and *Magnolia champaca*, combined with intercrops like ginger, colocasia, and Assam lemon, demonstrate that optimal tree spacing enhances yield and economic returns. Scientific innovations, including climate-adaptive tree species, water-efficient irrigation, and soil health management, are essential for sustaining these systems in rainfed regions. Economic analysis indicates that plantation crops like coconut and components such as fisheries yield high benefit-cost ratios, while marginal lands continue to degrade due to poor management and climate stress. Adopting alternate land use systems, including agroforestry, low-cost polyhouses, vermicomposting, and mushroom cultivation, is crucial for stabilizing productivity and income. By integrating traditional knowledge with modern climate adaptation strategies, agroforestry enhances resilience against climate variability and ensures long-term sustainability for Assam's farmers.

***Keywords*:** Agroforestry, Bari system, Climate change, Sustainable agriculture, Low-cost polyhouses, Vermicomposting, Mushroom cultivation, Rainfed farming, Biodiversity conservation, Climate resilience, Alternate land use systems, Soil health management

SII-O1

Evaluation of flood during 2019-20 at Northern Dry zone of Karnataka; A case study

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North Eastern dry zone of Karnataka (Northern part of Karnataka) is extremely vulnerable to impact of extreme weather events. Every year it faces extreme weather events either in the form of severe drought or floods along with extreme high temperature summer months, which have severe impacts on crop production and socio-economic status of farming families and results in huge revenue losses. Here's a look at recent flood at Raichur and Yadgir Districts of Karnataka and also Maharashtra due to heavy rainfall during 2019-20. The banks of the Krishna River in Raichur and Yadgir districts experienced one of the worst floods since time immemorial. Many villages, private and public properties were affected in this flood apart from creating problem for the land and vegetation resources along the river course.The team of scientists from University visited affected area, assessed the damage and recommended the protection measures for natural resources especially with regard to land, water and vegetation resources. This flood started in the month of August first week and continued till the third week of the month. As a result of release 6.3 lakh cusecs of excess water from Almatti and Narayanpur dams which are located at upper stream side, 5,521 residents from 72 villages were shifted in three taluks *i.e.,* Raichur, Devadurga and Lingsugur of Raichur district. Also, 104 residents from six islands have been evacuated to safer places. A total of approximately 24,056 hectares of agriculture land had been damaged due to the flood. Of which,

13674 hectares paddy, 6459 hectares cotton, 3108 hectares redgram and 744 hectares of bajra were damaged. In such scenario making agriculture system adoptable to changing climate conditions, timely dissemination of weather based Agro-advisory services plays a pivotal role in taking measures to re-build the eco- system and conserve soil and water.

Keywords: Flood, Rainfall, Vegetation and Soil conservation

SII-O2

Projected changes in agriculturally relevant temperature indices during rabi season in the Indo-Gangetic Plain: Insights from NEX-GDDP-CMIP6 models

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Among abiotic stresses, high temperature is a critical factor affecting crop growth and development, posing significant challenges to crop production in India. Temperature indices such as Growing Degree Days (GDD), Extreme Degree Days (EDD) and Chilling Hours (CH) capture cumulative and extreme temperature effects in various stages of the crop cycle. These indices enhance the prediction and management of crop growth and yield. Elevated temperatures of 3–4 °C above the optimum during the grain-filling stage can reduce wheat yields by 10–15% in Asia, even with current production technologies and varieties. Projections from the Coupled Model Intercomparison Project 6 (CMIP6) indicate that temperatures may rise by 1.1–5.1°C by 2100 under the shared socio-economic pathway (SSP) 5–8.5 scenario, with northern India expected to experience a strong positive trend. The Indo-Gangetic Plain (IGP), a key wheat-producing region in northern India, are particularly vulnerable to temperature extremes during the wheat-growing season (rabi). Therefore, analysing future changes in temperature during the rabi season in IGP is crucial for developing adaptive strategies to mitigate potential yield losses. Here, we use the NEX-GDDP-CMIP6, high resolution (0.25× 0.25), bias- corrected climate change projections of maximum and minimum temperature (Tmax and Tmin, respectively) developed by the NASA Center for Climate Simulation based on the General Circulation Model (GCM) simulations conducted under CMIP6. We have selected 5 top ranked CMIP6 models suitable for analysing the projected changes in temperature extremes over Indian subcontinent based on previous literature. With the multi-model ensemble (MME) of Tmaxand Tmin, we calculate GDD, EDD an CH in IGP during rabi season under the high emission baseline scenario (SSP5–8.5). By the far-future (2080–2100), EDD is projected to increase by 20–80 °C·days, indicating higher frequencies of extreme heat events during anthesis and grain filling stages. GDD is expected to increase by 300–450 °C·days, suggesting accelerated crop development and potential reductions in grain-filling periods. On the other hand, CH is projected to decrease by more than 40 hours, which could shorten the vernalisation period, potentially leading to delayed or incomplete flowering. These changes highlight the growing risk of heat stress and insufficient chilling during critical wheat growth phases. Consequently, wheat yields across IGP may face significant declines, threatening food security in the region. Therefore, developing adaptive strategies, such as heat-tolerant wheat varieties, altered planting schedules and improved irrigation practices, will be essential to mitigate the adverse impacts of future temperature extremes on agricultural systems.

Keywords: Temperature extremes; CMIP6; IGP; Wheat yield; Food security

SII-O3

Assessing the trends of extreme weather events over the Gangetic West Bengal using rainfall and temperature-based indices

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There is no doubt about climate change and their adverse effect on different economic sectors. It is stated that future earth will be more vulnerable not only due to mean changes of different meteorological parameters but also unprecedented change of different extreme weather events like flood, heat wave, cold wave etc. which have more devastative capabilities than mean climate change signal on global and local scale. Under this context, a study has been undertaken to see how different rainfall and temperature based extreme weather events prevailed in different districts of Gangetic West Bengal are impacting on agriculture sector using both the daily observed data as well as 10 daily CMIP6 GCMs data during the period of 1961-2014. Firstly, we calculated several conventional extreme weather indices for example, some moisture or rainfall based extreme indices like consecutive dry days (CDD), Consecutive wet Days (CWD), Maximum 1day precipitation amount (RX1day), Very Wet Days (R95p) etc. and temperature based extreme weather indices like coldest night (TNn), Coldest day (TXn), Hot days (TX-35) have been calculated. Secondly, we calculated trends for all the above-mentioned rainfall and temperature induced extreme weather events and the results were recorded to see how extreme weather events have changed over different districts of Gangetic West Bengal. The results revealed that both observed and GCMs simulated data are showing more or less same trend in case of precipitation and temperature driven extreme indices. An interesting result was also noted that there exists a negative significant trend as per indices of consecutive wet days (CWD), Consecutive dry days (CDD), Number of heavy precipitation days (R10) and Number of very heavy precipitation days (R20) indicating Gangetic West Bengal region is already prevailing drier climatic condition. Based on other indices, the reverse situation was also noticed, where a positive trend was observed on the indices of Max1 day precipitation amount (RX1), Max 5 day precipitation amount (RX5) and very wet days (R95P). In general, data analysis of extreme events indicated the intensity of rainfall has been increased than the total amount of rainfall. In case of temperature indices, all the indices showed positive trend excluding cold nights (TN10P), Hot nights (TX90P) which suggests that the extreme temperature events are increasing in different parts of Gangetic West Bengal which is to be taken as a serious threat.

***Keywords*:** Extreme weather events, GCM, CMIP6, CDD, CWD, Gangetic West Bengal

SII-O4

Frequency Analysis of Dry and Wet Western Disturbances and Associated Extreme Weather Events, Hisar, Haryana

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A long-term Agrometeorological study was performed in the Department of Agricultural Meteorology (the meteorological data was collected and used for the analysis as meteorological references of agromet observatory Lat.: 29° 10' N; Long. 75° 46' E: & Alt.: 215.2 mts), CCS HAU, Hisar, Haryana as the rabi season (period from Oct-May month). The analysis highlights a concerning increase in Dry western disturbance (DWD) and a declined trend was observed in the Wet western disturbance (WWD) respectively, with significant implications for agriculture crops & number of irrigations. The observed extremes (1972-2023) in temperature and rainfall further emphasize the growing impact of climate change and observed as variable frequencies. These findings underscore the need for enhanced monitoring, better utilization of climate data, and adaptive strategies to mitigate the adverse effects of extreme weather events. Extreme weather events, fuelled by climate change, are becoming more frequent and intense, as highlighted by IPCC findings. In North India, Western Disturbances (WDs) significantly influence winter rainfall, impacted agriculture and contributed toextreme weather conditions. Frequency and trends of Dry (D_WD) and Wet Western Disturbances (W_WD) at Hisar during 2012-2023 was highlighted in their monthly and annual variations. Results reveal that the rised in D_WD frequencies and a decline in W_WD frequencies which were indicated an alarming with D_WDs constituting 96% of disturbances in 2023-24. Extreme temperature and rainfall events at Hisar were also countified and documented (1972-2023) found that the extreme values of maximum and minimum temperature & insights into historical and recent weather extremes. The analysis highlighted a concerning increase in D_WD frequencies and a decline in W_WDs, with significant implications for agriculture and climate resilience in Hisar. The observed extremes in temperature and rainfall further emphasized the growing impact of climate change. Additionally, the utilization of rainfall as a substitute for irrigation demonstrated economic benefits for farmers. These findings underscored the need for enhanced monitoring, better utilization of climate data, and adaptive strategies to mitigate the adverse effects of extreme weather events. The above findings underscore the need for improved monitoring and adaptive strategies to mitigate the impacts of western disturbance and received was analysed declined amount of rainfall (mm) during Rabi season crops (Month of Oct to May) in Haryana.

***Keywords*:** Western Disturbances, Dry WDs, Wet WDs, Extreme Weather Events, Frequency Analysis

SII-O5

Relative impact of different plant species in improving micro climate towards alleviating Climate change in drought prone area

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The microclimatic observations recorded during May, 2023 from 11 to 3 pm across 155 locations in the close vicinity of 6 tree species (out of 40 spp) planted during 2019 and 2020 from the one million tree planting program started in 2019-2020 revealed that the 6 tree species, on an average, reduced air temperature by 3.43^0c, recorded 2.94% to 9.63% lower RH and 40.89% to 41.08 % reduction in light intensity from bottom of trees to middle level in comparison to open outside field. The harshness of weather in hot summer was modified much closer to the observations inside house (14.8% lower temperature and 12.27% lower RH compared to open space). Temperature reduction was more at tree bottoms whereas RH reduction was higher at mid-level of tree canopies. Among tree species, Umber (11.7%), Mango (11.29%) and Jamun (11.1%) reduced air temperature more effectively than other species. The RH reduction was more by Umbar followed by Mango, Idlimbu and lime plants than others. The light intensity was also brought down more effectively by Umbar followed by Idlimbu and Mango trees.

***Keywords*:** Climate change, microclimate, one million tree planting, light intensity, lux.

SII-O6

Climate Change Signals in Ludhiana: A Study of Temperature and Rainfall Variability over the past five decades

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Ludhiana District is one of the 22 districts in the Indian state of Punjab. The climate of Ludhiana is mainly dry with very hot summer and cold winter except during monsoon season. There are four seasons in a year (winter, summer, monsoon and post monsoon). The extremes of temperatures and rainfall are based on the data recorded in observatories for period 1970-2020. During winters, January is the coldest month with daily mean maximum temperatures at about 18° C and daily mean minimum temperature at about 5.8° C. The highest maximum temperature recorded during the period 1970-2020 has been 27.4° C for December (04 December, 2011), 29.2° C for January (29 January, 2007) and 30.0° C for February (26 February, 2004). The lowest maximum temperature was 8.7° C for December (22 December, 1973), 7.8° C for January (07 January, 2013) and 11.8° C during February (03 February, 2008). The highest maximum temperatures recorded were 27.4° C (04, December, 2011), 29.2° C (29 January, 2007) and 30.0° C (26 February, 2004). The highest minimum temperatures recorded in the city during the season were 16.8° C during December (08 December, 2003), 15.7° C during January (27

January, 1990) and 17.8° C during February (25 February, 2015) and the lowest minimum temperatures recorded was 0.3, -1.6 and 0.2° C (18 December, 1971, 24 January 2008, 24 January 2008, 09 February, 1974), respectively. Heavy rain is normally not experienced in winter season and it was maximum of 102.3 (08 December, 1997), 46.4 (31 January, 2019) and 90.4 mm (18 February, 2003). During summers the highest maximum temperature reached during March, April and May have been 37.0° C (29 March, 2010), 45.8° C (09 April, 2004) and 47.2° C (18 May, 1970). The lowest maximum temperature was 24.0° C (15 June, 2006 and 06 July, 2005), 22.6° C (03 August, 1995) and 22.6° C (03 September, 1995 and 04-05 September, 1996). The lowest minimum temperature ever recorded in different months of the season was 16.7° C (14 June, 1970), 15.0° C (29-30 July, 1995), 12.7° C (01 August, 1995) and 12.5° C (21 September, 1972). During post monsoon the highest maximum temperatures ever recorded in the city was 36.2° C in October (07 October, 1971, 03 October 1980 and 1989) and 35.4° C in November (01 November, 2001). Maximum temperature was as low as 20.8° C recorded in the year 1997 on 28th October and 16.5° C on 24th November 1997. Minimum temperature reached as low as 8.4° C on 31 October, 1984 and 3.1° C on 27 November, 1975. The highest minimum temperature was 26.4° C in October (01 and 02 October 2016) and 21.0° C in November (04 November, 1999). There was only one occasion of heavy rainfall in the season, when 81.6 mm rainfall was realized on 16 October, 1998 which was also the all-time record for the month of October. The highest 24 hour rainfall for the month of November during the above period has been 50.1 mm on 03 November, 1981.

Keywords: Extreme weather events, maximum temperature, minimum temperature, rainfall

SII-O7

Climate - Induced morphological alterations in Key Insect Pests of Legume Cowpea

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Climate change, characterized by elevated atmospheric CO, levels and increased temperatures, is projected to impact crop growth and herbivore dynamics. This study evaluates the effects of climatic treatments such as elevated CO, (550 ppm) and temperature (+2°C); elevated CO, (550 ppm) with normal temperature; ambient CO, (410 ppm) and temperature (+2°C); ambient CO, (410 ppm) with normal temperature and reference open plot on the growth, development, and biotic potential of cowpea (*Vigna unguiculata*) and herbivores associated with it, focusing on the morphometric changes in their life stages. Growth parameters along with morphometric data on associated herbivores were collected using a Nikon SMZ 25 Stereo zoom binocular at the Department of Entomology, University of Agricultural Sciences, Raichur. The results demonstrated significant alterations in the growth and development of cowpea grown under varied climatic conditions. Wherein, significantly higher cowpea growth in terms of plant height (71.84 cm), number branches (16.83 /plant), leaves (32.07 /plant), more number of flowers and pods (20.30 and 6.22 per plant, respectively) was documented at 60 days after sowing under eCO_2 @ 550 ppm with normal temperature. However, significantly least growth (59.74 cm plant height, branches 14.41 /plant, leaves 29.67 /plant, 14.14 flowers/plant and 4.26 pods/plant) were registered under a CO_2+ elevated temperature. Additionally, the study indicated a significant variation with respect to size and weight of the associated

herbivores *viz.,* pod borer (*Maruca vitrata*) and aphid (*Aphis craccivora*) under changing climate scenarios. For *M. vitrata*, the fifth instar larvae exhibited decreased body length of 14.87 ± 0.17 mm, and breadth of 2.05 ± 0.02 mm under elevated CO, and temperature conditions. However, the pupal stage showed a marked decrease in size and weight under these treatments, with a significant reduction in larval and pupal weights (38.15 ± 0.23 mg and 34.21 ± 0.11 mg, respectively) compared to ambient conditions (44.85 ± 0.18 mg and 50.03 ± 0.21 mg, respectively). Similarly, *A. craccivora* exhibited a reduction in body size, with the fourth instar nymph showing decreased body length (1.06 ± 0.06 mm), breadth (0.46 ± 0.01 mm), and area (411.64 ± 0.02 mm²) under elevated treatments. Furthermore, the winged and wingless adults had larger body areas in ambient conditions, suggesting a reduction in fitness under elevated climate conditions. Overall, plants grown under elevated conditions (CO_2 @ 550 ppm + temp. 2°C) showed increased susceptibility to herbivory, resulting in reduced seed yield (10.11 g/plant) compared to plants grown under ambient conditions (CO_2 @ 410 ppm alone) with 12.52 g/plant. These findings highlight the significant impact of climate change on both plant-insect interactions and crop productivity, underscoring the need for integrated pest management strategies in a changing climate.

***Keywords*:** Climate change, elevated CO_2, elevated temperature, cowpea, *Maruca vitrata*, *Aphis craccivora*, morphometrics, integrated pest management.

SII-O8

Effect of Climate Change and extreme weather Impacts on Agriculture: Vulnerability, Adaptation, and Resilience Strategies

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Climate change poses significant challenges to agricultural systems worldwide, necessitating accurate weather forecasting to mitigate its impact. This study explores the multifaceted effects of climate change on agricultural systems, focusing on vulnerability assessment, adaptation strategies, and resilience-building efforts. Rising temperatures, altered precipitation patterns, and an increased frequency of extreme weather events directly affect crop growth, soil health, and pest dynamics. Weather forecasts play a critical role in addressing climate change-induced vulnerabilities in agriculture and in developing effective adaptation and resilience strategies. The India Meteorological Department under Ministry of Earth Sciences, responsible for issue of weather forecast is also disseminating weather–based agro–advisories in collaboration with the ICAR through its Gramin Krishi Mausam Seva programme to mitigate climate-related risks. Nowcast is the latest forecast issued by the IMD in the different weather events like hail storms, cloud bursts, lightning, thunder stroms, cold wave, frost etc. In addition, real–time crop–contingency measures are necessary to minimize crop losses, safeguard allied sectors, and improve production efficiency. At present, district–based agriculture–contingency plans (DACP) for 650 districts of the country are available. DACPs have already had an impact in many parts of the country, especially during extreme events. Improved weather forecasting technologies enhance the ability of farmers to make informed decisions regarding crop selection, planting schedules, and resource management. Short-term and seasonal forecasts contribute to reducing crop losses and optimizing water usage. Integrating traditional knowledge with modern forecasting techniques is important to create locally relevant and culturally appropriate adaptation

strategies. This emphasizes the need for continued investment in forecasting technologies, capacity building for farmers, and the development of tailored adaptation strategies to ensure food security and sustainable agricultural practices in the face of evolving climate challenges.

***Keywords*:** Climate change, weather forecast, extreme weather, agro–advisories services

SII-O9

Assessment of Sustainable Organic Potato Cultivation under Changed Microclimate in Gangetic Bengal

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Potato (*Solanum tuberosum* L.), the King of Vegetables, plays an important role in global food security due to its high nutritional value, including proteins, carbohydrates, vitamin C and iron. With worldwide potato production reaching 376 million tonnes in 2021 and India's production estimated at 53.58 million metric tons in 2022, sustainable cultivation practices are essential. Increasing interest in organic amelioration, such as vermicompost, neem cake and poultry manure, highlights their potential to improve soil health, nutrient availability and microbial activity while mitigating the adverse effects of inorganic fertilization. To address this issue, a field experiment was conducted in 2022 at Jaguli Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya. This experiment explored the effects of different potato varieties, mulching practices and organic fertilizers on potato production in the new alluvial agro-climatic zone of West Bengal within this changing microclimate, focusing on agronomic practices, economic viability and environmental effects. The field experiment was conducted using a Randomized Block Design with two replications and 12 treatments. The treatments included three organic fertilizers (Neem Cake, Vermicompost and Poultry Manure), two mulching types (No Mulching and Straw Mulching) and two potato varieties (*Kufri Jyoti* and *Kufri Chandramukhi*). Poultry manure increased plant vigour and tuber size, while neem cake supported enhanced microbial activity. The study evaluated yield-related attributes, including tuber number, tuber weight, and the fresh and dry biomass of plants at harvest. Results indicated that poultry manure significantly enhanced yield- attributing traits such as the number of tubers per plant, tuber weight and biomass production during harvest. Straw mulching proved beneficial by reducing canopy humidity, conserving soil moisture and increasing soil temperature, resulting in a higher yield (1096.57 gm m^{-1} or 10.69 t ha^{-1}) compared to no mulching (760.47 gm m^{-1}or 7.6 t ha^{-1}). Among the varieties, *Kufri Jyoti* outperformed *Kufri Chandramukhi*, yielding 1079.07 gm m^{-1}(10.79 t ha^{-1}) compared to 777.97 gm m^{-1}(7.78 t ha^{-1}). Yield and meteorological factors, including reflected PAR at 30 DAP, soil moisture at 75 DAP and soil temperature at 60 DAP, were shown to be significantly correlated. Several production components, including tuber weight, fresh weight and dry weight at harvest, showed strong correlations with micrometeorological factors like soil moisture, soil temperature, reflected and transmitted PAR and canopy temperature. These findings underscore the importance of integrating appropriate organic fertilizers, mulching techniques and variety selection to optimize potato yield

in reducing environmental stress, promoting sustainable yields and enhancing nutrient-use efficiency in the new alluvial agro-climatic region of West Bengal.

Keywords**:** *Microclimate, Mulching, Organic fertilizers, Potato, Poultry manure, Sustainability.*

SII-O10

Community nursery : Case study of a contingent plan to mitigate floods in 2023 in Punjab

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Climate change induced climatic extremes are becoming frequent with the passage of time. Agriculture is vulnerable to extremes of climate such as high /low temperature, excess /deficit rainfall, strong winds, hailstorm, etc. The impact of global climate change is also being felt locally. Punjab is a major contributor towards food security of the nation and contributed 21 and 46% of rice and wheat, respectively towards central pool during 2022-23. During 2023, the incessant rainfall in Himachal Pradesh from July 7-11 that was 436% above the normal, caused heavy flooding in the downstream tracts of Punjab. The overflowing water entered Punjab through Beas, *Ghaggar* and Sutlej, and caused inundation of fields and damage to other infrastructure. Rice is the major crop cultivated during *kharif* season in Punjab. Due to flooding, freshly transplanted rice fields were submerged with rushing down flow of water. The silt deposits in the fields after the receding of flood water and loss of transplanted crop were the major tribulations for the farmers. This calamity led to submergence of ~2 lakh hectares of fields primarily under rice. The rich tradition of "Langar" in Punjab was demonstrated in letter and spirit during the floods when the "Nursery *Langar*" of short duration rice varieties (PR126 and Pusa Basmati 1509) was given free of cost to flood-affected farmers. Punjab Agricultural University became the pivota lagency to startup the concept of "Community nursery" wherein rice nursery was raised at Krishi Vigyan Kendra's and Research Farms for free distribution, and also motivated the farmers for this noble cause. The projected loss of Rs 2800 crore from failure of paddy crop as a result of floods was averted due to the "Community nursery". There was a higher state average rice productivity during 2023 (6739 kg/ha) as compared to previous year, 2022 (6479 kg/ha). This demonstrates that "Community nursery" is an innovative and cost friendly concept that can be a way forward towards resilience during climatic extremes such as floods. Hence it may be concluded that the additional expense of Rs. 245 crore by farmers and PAU-led community nursery campaign helped the farmers to achieve equivalent state average rice yield as realized during the previous year 2022.

SII-O11

Frequency and time scale analysis of the Standardised Precipitation Index in the Agro Climatic Zones of Kerala

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The standardized precipitation index (SPI) has several characteristics that are an upgrading over other indices, with its simplicity and flexibility. Although SPI is an index that highlights the rainfall anomalies, excess and deficit rainfall, in recent decades is used all over the world, to monitor dry periods. Standardized Precipitation Index (SPI) is based on the probability of precipitation for a time scale and was formulated by McKee *et al.* (1993) to give a better representation of abnormal wetness and dryness. The available monthly rainfall data for the past 40 years (1983-2022) of different stations in the five Agro-Climatic Zones of Kerala *viz.* Northern Zone, High Range Zone, Central Zone, Problem Area Zone and Southern Zone were used to compute SPI values at different time scales, *viz.* 3, 6 and 12, represented as SPI_3, $SPI_6$and SPI_{12}respectively. The specification of a time scale in the definition of drought leads to several basic characteristics of drought. Two of the most important characteristics are frequency and duration. The aim of the drought/flood frequency analysis is to identify the drought/flood of different severity levels and their probability of occurrence. Three month time scale of May month (pre-kharif/pre-monsoon), six month time scale of November (Southwest and Northeast monsoon) and twelve month time scale of December (annual time scale) were taken for SPI_3, $SPI_6$and SPI_{12} respectively. It is clearly observed that for al lthe different time scales,then ear normal droughts (-0.99 to 0.99) occurred most frequently and the extreme dryness/ drought (d" -2.0) and severe dryness/drought (-1.5 to -1.99) events occurred least frequently in all the ACZs of Kerala. A longer drought period may not necessarily be the most severe. Dry spells impact greatly on agriculture (crop production) than more intense drought/flood occurrences. The moderate dryness/drought (-1.0 to -1.49) occurrence was higher at Southern Zone for SPI_3, $SPI_6$and SPI_{12}. Thus soil moisture for agricultural production could be negatively impacted as well as the underground water availability. This is because dry spells are erratic and can happen several times and at critical periods of the rainy season led to severe plant water stresses and reduced yields. The frequency of occurrence of severe dryness at SPI_3 and extreme dryness at $SPI_3$and $SPI_6$was higher at High Range Zone. The frequency of wetness (Extreme/ Severe/Moderate) occurrence was also studied at ACZs level. It was understood that SPI_6 and SPI_{12} can more clearly reflect the stage changes of drought and flood, better reflection on the underlying soil moisture, river runoff, ground water level and reservoir water storage capacity and 3- month time scale (SPI_3) represents short-term water deficits, can reflect the seasonal drought, it is closely related to agricultural drought. Hence, the small droughts can have bigger impacts than bigger droughts.

***Keywords*:** Standardized Precipitation Index; frequency; time scale; drought

SII-O12

Assessing the impact of rainfall extremes on maize yield in high potential areas of Tamil Nadu

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Maize (*Zea Mays* L.), known as the "Queen of Cereals," is vital to the global agricultural economy due to its adaptability and status as a staple food. In India, maize ranks third among grain crops, covering 9.18 million hectares and producing 27.23 million metric tons annually. Understanding the variations in long-term and extreme weather patterns is crucial, as they can lead to catastrophic events such as floods and droughts, causing significant agricultural and economic losses. The Expert Team on Climate Change Detection and Indices (ETCCDI) developed 27 core climate extreme indices to analyze these events. Data and methodology: The study aims to evaluate the impact of extreme rainfall indices such as consecutive dry days (< 2.5 mm) for 5 days (CDD), maximum one day rainfall (Rx1day), and number of days with rainfall more than 2.5 mm (rainy day), 10 mm (R10 mm), and 20 mm (R20mm) on rabi maize yield using multiple linear regression. Area, production, and productivity data from 2011 to 2020 were obtained from the Directorate of Economics and Statistics (GoI). The efficient maize zones were delineated, and only the most efficient areas of maize in terms of both area and yield were identified, including Ariyalur, Dindigul, Erode, Perambalur, Salem, Theni, Tiruchirappalli, and Tiruppur were included for impact analysis. Extreme analysis revealed that Ariyalur had the maximum number of rainy days (35 days), R10 mm (16 days), R20 mm (8 days), and Rx1day (65.5 mm), while Tiruppur had the maximum CDD (63 days). The maximum yield of 7633.33 kg/ha was observed in Salem, followed closely by Tiruppur with 7590 kg/ha. When relating these extremes to maize yield, all districts experienced a negative impact from CDD, except for Erode and Theni, which had a positive impact. Specifically, for every 1% increase in CDD, the yield increased by 2.2 % in Erode and 44.3 % in Theni. In terms of rainy days, all districts benefited, with Tiruchirappalli exhibiting the highest yield increase of 40.8%. However, r10 mm and r20 mm had detrimental effects, leading to a maximum yield decrease of 38.3 % in Tiruppur and 32.2% in Erode. Rx1day contributed positively to yield, with Theni showing the largest increase of 31.2%, whereas Ariyalur and Salem experienced an opposing effect. In almost all districts, CDD, r10mm, and r20mm negatively affected maize yield, whereas rainy days and Rx1day significantly boosted productivity. This proves that although the effects of extreme weather vary by region, CDD and r20mm lead to the greatest yield decrease; in contrast, rainy days contribute to the most significant yield increases over the region.

***Keywords*:** Climate change, extreme rainfall, maize yield, regression

SII-O13

Impact of Climate Change on the Yield of Major Crops in Different Agro- climatic Zones of Madhya Pradesh, India

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The study aims to estimate the impact of climate change on the yield of major crops across the Agro- climatic Zones of Madhya Pradesh. A detailed district-level panel was created for each district across the 9 agro-climatic zones, covering the period from 1990 to 2023. Kharif crops such as rice and soybean, and Rabi crops like wheat and mustard, which are predominantly grown in these zones, were deliberately selected for assessment. Crop yields were paired with key climate parameters, including temperature and rainfall, as well as specific control variables such as irrigation, pumpset, and tractor, to develop a comprehensive large-scale panel. This panel allows for both inter-temporal and spatial assessments, providing insights into the dynamics of crop productivity over time and across regions. Additionally, the model controls for district-specific factors and temporal trends. During the period 1990-2023, rainfall showed a positive trend across all agro-climatic zones except for Bundelkhand, Kymore Plateau, and Satpura Hills. Maximum Temperature showed a positive trend across all agro-climatic zones except Jhabua Hills. Minimum Temperature showed a positive trend across all agro-climatic zones except for Satpura Plateau. The results revealed significant heterogeneity in the climate impact over kharif and rabi crop yields, with both negative and positive estimates observed across agro-climatic zones. Thus, it is evident that the relative impacts of climate change and the associated vulnerabilities differ significantly across agro-climatic zones, due to varying local climate conditions, agricultural practices, and socio-economic factors. As a result, it is crucial to emphasize crop- and region- specific adaptation measures to enhance the resilience of agricultural systems, enabling them to better cope with climate-related stresses and ensuring sustainable framework in the short to medium term.

***Keywords*:** Agro-climatic Zone, Climate Change, RCPs, Crop yields, Climate Impact

SII-O14

Spatial variability in association of heat stress and wheat yield anomaly in Gujarat state of India

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Wheat productivity in Gujarat, India, is susceptible to heat waves and warm winter temperatures. This sensitivity arises from the crop's delicate balance with temperature. The cardinal temperatures of the crop and temperature response functions can be used to quantify the heat load on the crops which

influenced crop growth cycle and productivity. This study investigated the relationship between heat stress and wheat yield anomalies across 18 apportioned districts covering entire state for years 1966 to 2017. This long-term analysis allowed for a comprehensive understanding of the historical trends and spatial variations in the impact of heat stress on wheat yields across the state of Gujarat. Daily gridded maximum and minimum temperatures data (0.25° spatial resolution) and generalized crop phenology were used to calculate heat loads on wheat grown during rabi seasons. Hourly temperatures were derived by fitting a sine curve to daily minimum and maximum temperatures to provide a more accurate representation of temperature fluctuations throughout the day, w hich can influence the crop responses. The study employed a base temperature of 4.5°C and an optimal temperature of 25°C. Wheat exposed to high temperatures (exceeding 32°C) during flowering may disrupt in ovary development, pollen viability, and floret survival, ultimately leading to reduced grain set. Short term exposure to elevated temperatures during the grain development can result in the production of smaller and less developed grains. So, the hourly cumulative temperatures exceeding 34°C, referred to high-temperature degree-days (HDD), used to quantify heat load on the crop. Results showed a predominantly negative correlation between heat stress and wheat yield across most districts. This finding confirms the detrimental impact of heat stress on wheat yields in Gujarat. Banaskantha and some central districts exhibited the relatively high negative correlations (r -0.29 to -0.34), indicating a considerable inverse relationship between heat stress and yield in these areas. Other districts also displayed negative associations, except for Ahmedabad and The Dangs. The varying strength of these correlations suggests that different regions of Gujarat have varying vulnerabilities of wheat to heat stress. Local climate conditions, soil types, seasonal soil moisture status and wheat varieties likely contribute to these differences. These findings highlight the importance of considering heat stress in wheat production strategies for Gujarat.

***Keywords*:** Heat stress, Heat wave, Wheat, Gujarat, Degree days

SII-O15

Rainfall and drought characteristics over the Agro-Ecological Zones ofIndia

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The study area is Agro Ecological Zones (AEZ) of India. The study used a dataset of CHIRPS rainfall with a spatial resolution of 5 km spanning from 1981 to 2020. Rainfall pattern and drought (SPI) were calculated at annual and seasonal (SWM, NEM, Summer and Winter seasons), respectively. SPI is calculated using monthly rainfall data and SPI values were categorized as Extremely wet, moderately wet, Near normal, moderately dry, extremely dry and severely dry. Results indicated that at the annual scale, mean annual rainfall was highest in the North- Eastern Hills (Purvachal) zone with 2472.3 mm/year ±793.5 mm Standard Deviation (SD), followed by the Northern-Eastern Hills zone (2472.3 mm/year ±615.3 SD) and the Western Ghats and Coastal Plain Zone (2331.2 mm/year ±712.4 mm SD),

respectively. Lower rainfall was observed in the Western Himalayas zone (218.5mm/year±93.2mmSD), followed by the Western Plain zone (379.9mm/year±164.8mmSD) and 511.5 mm/year with a standard deviation of ±76.0 mm in the Karnataka Plateau region of AEZ. The Agro- Ecological Zones *viz.,* Central Highlands (Malwa and Bundelkhand), Eastern Coastal Plain, Eastern Plain, Eastern Plateau and Moderately to Gently Sloping Chhattisgarh zones received more than 1000 mm of rainfall on average. South west monsoon rainfall contributed to most zones except the southern part of India, while the Eastern Ghats and Tamil Nadu uplands regions received more rainfall from Northeast monsoon rainfall followed by the summer season. Based on SPI values, the extremely wet years ranged from 1 to 4 years with higher frequency in the AEZ of the Western Ghats and coastal plain, Central Highlands, and North Eastern Hill region of India. Similarly, extremely dry years also ranged the same with higher frequency in the Western Plain, Eastern Plateau, and some parts of the Western Himalayan zone of India. The percentage of areas experiencing drought was higher in the Western Plain region. Near normal years ranged between 19 and 40 across all the AEZ of India. Drought frequency and Intensity were higher in Western Plain compared to all other agroecological zones of India. The spatial analysis of rainfall and drought trends across India's AEZs provides a comprehensive understanding of both current and future drought risks, helping in the development of region-specific mitigation strategies.

***Keywords*:** Drought, CHIRPS, Agro-Ecological Zone and Rainfall

SII-O16

Crop weather relationship and climate change implications on black pepper productivity

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Black pepper (*Piper nigrum* L.), known as the 'King of Spices', holds significant economic and cultural importance in Kerala and globally. Its yield is profoundly affected by weather parameters, as its phenological stages and productivity are highly sensitive to variations in temperature, rainfall, humidity and wind speed. Understanding crop-weather relationship is essential for optimising management practices and ensuring sustainable production. This study analysed weather and crop data spanning seven years (2017 to 2023) from the Department of Agricultural Meteorology, College of Agriculture, Vellanikkara. Black pepper growth was divided into different phenophases: spike initiation, emergence, enlargement, berry development, maturity and harvest. Weather variables included were maximum temperature (Tmax), minimum temperature (Tmin), total rainfall (RF), morning relative humidity (RH1), afternoon relative humidity (RH2) and wind speed (WS). Corresponding data on per vine fresh berry yield of the black pepper hybrid Panniyur-1, phenophases and weather were analysed using software tools such as SPSS and Microsoft Excel to establish crop- weather relationship. The results indicated that rainfall during spike initiation and emergence exhibited a positive correlation with yield, as adequate moisture supports spike formation and pollination. Conversely, excessive rainfall during spike enlargement, berry development and harvest negatively impacted yield. Tmax showed a significant negative correlation with yield during initial growth stages, particularly spike initiation and emergence, whereas higher Tmax

accelerated maturity and harvest. Rainfall during spike enlargement positively correlated with the duration of this phenophase, while Tmin during this period showed a significant negative correlation. Morning and afternoon relative humidity during August to October demonstrated significant negative correlations with yield, as elevated humidity increased disease incidence. Tmin and WS showed minimal direct influence but interacted with other weather variables. To evaluate the influence of future climatic change on black pepper productivity, Representative Concentration Pathways (RCP) 4.5 and 8.5 for the years 2050 and 2080 were taken. The growing degree days (GDD) required for each phenophase were calculated using the seven years of data, which is used for calculating the duration of each phenophase in the future. The projected average weather variables for each phenophase under future climatic scenarios were estimated. Stepwise Multiple Linear Regression analysis was conducted using the seven years data, resulting in the development of two predictive models. Yield predictions under these scenarios indicated that an increase in temperature beyond 34°C during the spike enlargement stage would lead to a significant decline in yield, highlighting the vulnerability of black pepper to rising temperatures under future climate conditions. This study emphasize the importance of developing climate-resilient strategies and adaptive management practices to sustain black pepper productivity amidst changing climate patterns.

Keywords: Crop-weather relationship, Black pepper, Phenophase, Climate change, GDD

SII-O17

Statistical Assessment of Diurnal and Seasonal Rainfall Variability and Its Impact on Rice Productivity in Vellanikkara, Kerala from 2016 to 2023

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Extreme precipitation events pose substantial challenges in flood-prone regions like Kerala, often resulting in severe damage to infrastructure, agriculture, and livelihoods. As the state's agricultural sector heavily depends on monsoon rainfall, it is particularly susceptible to variations in rainfall timing, duration, and intensity. This study examines the diurnal and seasonal variability of rainfall in Vellanikkara, Thrissur, Kerala, using data collected from the self-recording rain gauge at the Agrometeorological Observatory of Kerala Agricultural University (KAU) over the period 2016–2023. It also evaluates the impacts of the 2016 drought and the 2018 and 2019 floods on local rainfall patterns. To analyze rainfall distribution across seasons, the 24-hour day was divided into two intervals: 8 am to 8 pm and 8 pm to 8 am. The results revealed that the highest rainfall during the South-West Monsoon (SWM) typically occurred at night (8pm to 8am) in all years except 2023. Similarly, North-East Monsoon (NEM) rainfall peaked during the night, Winter rainfall was negligible, with light precipitation recorded in 2016 and 2018 (8pm to2am) and in 2021 (8am to 8pm). Now inter rainfall was observed in 2017, 2019, 2020, 2022, or 2023. Summer rainfall consistently peaked between 8 pm and 8 am throughout the study period. Statistical parameters, including mean, median, and standard deviation, were calculated for each season and diurnal interval to identify the wettest and driest years. The study further investigated the

relationship between rainfall variability and agricultural productivity, focusing on the rice variety *Jyothi* during critical growth phases, including transplanting to active tillering and 50% flowering to physiological maturity, during the kharif season (June to October). A significant negative correlation was identified between night-time rainfall (8 pm to 8 am) and rice yield, highlighting the detrimental effects of excessive nocturnal rainfall on crop productivity. Additionally, an ARIMA model was employed to project future trends in rice yield and rainfall variability. Long-term rainfall trends were analyzed using linear regression, which revealed significant variations in seasonal and diurnal rainfall patterns. Analysis of variance (ANOVA) further validated differences in rainfall distribution across seasons and intervals. These findings emphasize the critical interplay between rainfall variability and agricultural outcomes. The study underscores the importance of rainfall timing and distribution in agricultural planning. Night-time rainfall emerged as a pivotal factor in fluencing rice productivity, suggesting the need for adaptive measures such as revised cropping patterns, enhanced drainage infrastructure, and optimized irrigation practices. Incorporating diurnal rainfall patterns into climate models, agricultural strategies, and disaster management frameworks is essential to building resilience against extreme weather events. These findings offer actionable insights to inform policies aimed at promoting sustainable agriculture, bolstering disaster preparedness, and enhancing climate resilience in Kerala, a region increasingly vulnerable to the impacts of climate change.

Keywords: Rainfall variability, Diurnal rainfall patterns, Seasonal rainfall distribution, South-West Monsoon (SWM), North-East Monsoon (NEM), Rice productivity

SII-O18

Crop-weather relationship of strawberry under subtropical conditions of Punjab

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Strawberries are one of the most beloved and iconic fruits around the world. Known for their vibrant red color, sweet and tangy flavor, and distinctive fragrance. Punjab's climate being favorable for strawberry cultivation has lots of potential for commercial strawberry production. However, the cultivation of strawberries in Punjab is still in the infancy stage with limited varietal options. In different agro-climatic conditions, the performance of different cultivars depends on their interaction with the prevailing environmental conditions. The best cultivars can be selected by assessing the patterns of growth, yield, and quality attributes under prevailing climatic conditions of the region. A study was taken at PAU, Regional Research Station Faridkot during 2022- 2023, on twenty strawberry varieties (Catskill, Nabila, Ofra, Selva, Red Coat, Oso Grande, Majesty,Camarosa, 13-B, Jutogh Special, Fairfox, Kaitrain Sweet, Missionary, Dilpasand, Larson, Douglas, Black More, Anthena, Chandler and Winter Dawn). A wide range of variability among different varieties was observed. The 'Winter Dawn' showed earliest flower initiation but longest flowering duration was recorded in 'Chandler'. Similarly, a notable variation in the time of full bloom among various strawberry genotypes was observed. Cultivar 'Catskill 'exhibited earliest blooming phase. Days to flower after transplanting extending from 68.5 to 90.1 days was maximum in 'Ofra' and minimum in 'Winter Dawn'. The flowering duration was significantly longer in Chandler (90.11 days) compared to other varieties. The 'Winter Dawn'

was categorised as an early fruit maturity group, while 'Ofra' variety was identified late season variety, which took maximum time for fruit maturity. Conversely, the shortest time for fruit maturity was observed in the varieties 'Camarosa','BlackMore'and'Majesty'. Among cultivars, the perplantfruityieldvariedfrom60. 64 to 287.12 g. The highest yield per plant was recorded in 'Douglas', among the cultivars. The lowest yield per plant was recorded in variety 'Fairfox'.The minimum and maximum temperature ranged from11.2to12.3°C, and 25.7 to 26.7 °C, respectively during flowering and 9.5 to 10.0 °C and 22.1 to 22.8°C, respectively during the ripening. Correspondingly, growing degree day (GDD) for each cultivar was computed as the summation of the difference between the mean and base (5°C) temperatures. Results revealed that the GDD values for different cultivars ranged between 1491 °C days and 2649 °C days. Among different cultivars, Winter Dawan and Anthena exhibited minimum GDD conversely, Ofra and Fair fox resulted highest GDD. The heliothermal and photo-thermal units also followed the patterns similar to GDD. The difference in the agrometeorological indices appeared due to the variation in the prevailing weather conditions and cultivar specific phenological stages. The study confirmed the association of various crop growth stages of strawberry and the weather parameters in the south western region of Punjab.

***Keywords*:** Strawberry, cultivars, phenology, growing degree days, photothermal unit, heliothermal unit

SII-O19

Assessment of extreme climate indices and their impact on rabi pulse crops of Costal saline and undulating red-lateritic agro-climatic zones of West Bengal

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Extreme events of weather and climate play an important role in agricultural production. The long term meteorological data of 20 years period (2001 to 2020) for two agroclimatic zones i.e. coastal saline zone (station: Diamond Harbour (22°11'37.54" N 88°11'42.18" E)) and undulating red-lateritic zone (station: Sriniketan (23°40'02.46" N; 87°39'37.99" E) and Midnapore (22°25'20.8"N; 87°18'40.5"E)) were used for this study. To evaluate different climate change extreme indices related to temperature and rainfall recommended by Expert Team for Climate Change Detection Monitoring and Indices (ETCCDMI) were evaluated by using CLIMPACT web based plateform. Rabi pulses (Gram, Lathyrus, Lantil, and Peas & beans) yield data of west Bengal state were collected from department of agriculture and farmer welfare for the period of 2001-2020. Sen's method used as a linear model estimate the slope of the trend for rabi pulsesfor two agroclimatic zones. Among annual rainfall trends, threshold (R10mm, R20mm and R30mm) and absolute indices (Rx3days and Rx5days) were shown negative trend for all locations. Consecutive Dry Day (CDD) showed positive for Sriniketan, whereas negative for Diamond Harbour. While consecutive wet days (CWD) was not shown any trend for Sriniketan whereas positive for Diamond Harbour. The Annual temperature based absolute indices, significantly decreasing trend was indicated for TNn (-0.022) and TXn (-0.028), whereas significantly increasing trend found for TXx (0.004) at sriniketan. Significantly increasing trend found for TNx (0.023) for Diamond Harbour. No trend for any extreme climatic indices was obtained

from Midnapore meteorological data. All the pulses were shown negatively correlated with the temperature of above 30°C, average temperature (T_{avg}), maximum and minimum (T_{max}, T_{min}) except for Lathyrus under undulating red-lateritic zone and coastal saline zone conditions. All the extreme climate indices were indicating negatively correlation for all the pulses yield Sriniketan only, while positive correlation obtained for Lathyrus and lantil under undulating red- lateritic zone conditions. No trend was found for gram, whereas other pulses shown positive correlation with extreme climatic indices under coastal saline zone conditions.

***Keywords*:** Extreme climate indices, CLIMPACT, rainfall, temperature, *rabi* pulses

SII-O20

Muga silkworm rearing in cooler areas during Summer: managing effects of climate change on Muga

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Production of DFLs and maintenance of muga silkworm lines is facing challenges during summer months in the traditional muga growing regions in Assam due to high temperature and humidity rendering the muga cocoons weak finally resulting in sterility and reduced hatchability. Rearing of muga silkworm during summer months in muga growing regions leads to high mortality leading to huge crop loss. Also, grainage performance will be severely affected due to high temperature and humidity during summer months, which leads to utility and reduced hatchability of eggs. This makes it difficult to prepare DFLs for next commercial season and also for maintenance of muga lines for breeding. Studies on rearing management of muga silkworms in cooler regions during summer months holds a lot of promise in increasing overall production of muga raw silk. Efforts have been made to rear muga silkworms in cooler areas in Northeast India and West Bengal during July-August period. Muga silkworm rearing in cooler regions viz. Wokha, Nagaland and Rompara, Meghalaya has been carried out to prepare good quality DFLs for commercial rearing in Sep-Oct season. An average 25% increase in cocoon yield was observed in cooler regions compared to warmer region. Cocoon yield, ERR and pupation % were highest in Som farm, Wokha district of Nagaland. Therefore, this farm in Wokha may be utilized for summer rearing for seed production. In general, the cocoon yield and all the other parameters of cooler zones rearing were remarkably higher than the farm rearing of CMER&TI, Lahdoigarh. Temperature, Humidity and also Rainfall directly affect the biological activities of the muga silkworm. Hence, an alternative organized strategy for obtaining good quality seed material will help farmers get good yield during the commercial season.

Keywords: muga, grain age, DFLs, *Antheraea*, silk reeling, raw silk

SII-O21

Whispers of Change: Unraveling the Impact of Rising CO_2 and Temperature on Muga and Its Sacred Host

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Muga silk obtained from the silkworm *Antheraea assamensis* is unique to Assam and is deeply ingrained in Assamese heritage and culture. The multivoltine, polyphagous insect favours consuming the aromatic leaves of Som (*Persea bombycina*) and Soalu (*Litsea monopetala*). The optimal rearing conditions are 24–32 °C of temperature with an 80–85% relative humidity. Reports project a 1.5 °C increase in global surface temperature with atmospheric CO_2 reaching 560–700 ppm by the year 2100. North-eastern regions of India are expected to experience a 1.8 –2.1°C temperature rise, with the past century having seen a 1.3 °C rise in Assam's mean temperatures, which can possibly challenge the sustenance of sacred muga culture. A systematic study to ascertain the impact of climate change especially the increase in CO_2 and temperature on muga culture is meagre in India challenging the researchers or policy makers to devise effective resilience/ mitigation strategies. Thus, the current study was designed to investigate the magnitude of the positive and negative impacts of climate change and quantify its impact on quality and yield attributes of Som and muga seed crop production with due importance to climate-resilient sericulture. The study was conducted in four Open Top Chambers (OTCs) under elevated CO_2 (eCO_2: 550 ± 20 ppm), elevated temperature (eTemp: +1.5 °C over ambient), combined eCO_2 and eTemp, and ambient control (aCO_2: 400 ± 20 ppm) for three years. The leaf carbohydrates increased significantly under eCO_2 by 54.8%. Under eCO_2, leaf protein and amino acid content decreased significantly by 14.56% and 23.55%, respectively. The ascorbate content was significantly reduced by 25.1% in combined stress (eCO_2+eTemp). Leaf damage was recorded higher in eCO_2+eTemp (63.2%) followed by eTemp (55.5%). In the Muga larva, carbohydrate content was higher in eCO_2 by 11.1% and eCO_2+eTemp by 12.34%. Larvae completed their lifecycle early under stress as compared to ambient control.

***Keywords*:** Muga, Som, Climate Change, elevated CO_2, elevated temperature, climate resilient sericulture

SII-P1

Assessing the Impact of Climate Change on Future Demand and Supply Projections of Fish in Assam

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The fishery sector makes a substantial contribution to livelihood and nutritional needs, and hence plays an essential role in ensuring the food security of India. Despite, of witnessing a two-fold increase in fish production from 2.43 lakh tons in 2011-12 to 4.43 lakh tons in 2022- 23, the state still depends largely on imports to meet its local demand because of a recurring shortage in domestic production. According to projections, there would be a substantial discrepancy by 2050, with the supply falling short of 53.5 lakh tons in case of normative demand and 30.48 lakh tons in case of actual demand. With climate change been taken to consideration this problem is made more complicated which has an immediate effect on fish productivity and ecosystems. The quality of water, fish development, breeding cycles and disease prevalence are expected to be impacted by rising temperatures, altered patterns of rainfall, and an increase in the frequency of extreme weather events. Due to these reasons, the state's capacity to supply fish in the future might be hampered. The analysis of demand- supply that takes climate change estimates into consideration shows a growing disparity under different climate scenarios. For instance, unpredictable rainfall may lower the productivity of aquaculture, while rising temperatures may restrict cold-water species. These effects highlight how necessary it is to use climate-resilient tactics, such as improving adaptive aquaculture techniques, developing fish breeds that can withstand high temperatures and making efficient utilization of water resources. Targeted legislative and government interventions along with scientific advancements will be needed to address these issues, thereby bridging the gap between demand and supply and securing fish production in Assam in the face of climate change.

Keywords: Climate Change, Fish, Supply, Demand, Assam, Impact

SII-P2

Optimizing Rapeseed Productivity and Agroclimatic Indices through Sowing Date Adjustments in Assam

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A field experiment was conducted during the rabi season of 2022–23 at the Instructional cum Research (ICR) Farm, Assam Agricultural University, Jorhat, to study the impact of sowing date adjustment

on the optimization of rapeseed yield and agroclimatic indices. The rapeseed variety TS 67 was chosen for this study, with three sowing dates 15thNovember (D1), 30thNovember (D2), and 15thDecember (D3) to enhance the yield component under delayed sown moisture stress conditions of Assam. The results revealed that the sowing date significantly influenced the growth, physiological, and yield parameters.The crop sown on 15thNovember (D1) exhibited the highest values for growth parameters such as plant height, the number of primary and secondary branches, and dry matter production per plant. On the otherhand, the crop sown on 15th December (D3) showed significantly higher root-to-shoot ratios and proline content, indicating better adaptability to stress conditions but reduced overall growth. Physiological attributes, including chlorophyll content, relative water content, leaf area, and growth indices such as leaf area index (LAI), leaf area duration (LAD), crop growth rate (CGR), and relative growth rate (RGR), were also markedly superior in the 15th November sowing (D1). The 15th November sowing (D1) required the longest time for key phenological stages such as flower initiation (28.50 days), 50% flowering (34.50 days), siliqua formation (34.58 days), and physiological maturity (87.08 days). These plants also accumulated the highest agroclimatic indices, including growing degree days (1,199.77 °C days), helio-thermal units (7,567.22 °Cday-hours), and photo-thermal units (12,766.70 °Cday-hours), reflecting favorable growing conditions for the crop. Yield-contributing characters such as siliqua length, the number of siliquae per plant, and seeds per siliqua were significantly higher in the crop sown on 15th November (D1) than other sowing dates. This treatment also produced the maximum seed, stover yield and oil yield. In contrast, the crop sown on 15th December (D3) recorded the lowest values for these parameters, with a seed yield of 4.99 q ha^{1} and stover yield of 12.21 qha^{1}, indicating that delayed sowing adversely impacted crop productivity. The findings underscore the importance of sowing date adjustment in enhancing rapeseed production. The 15th November sowing date (D1) emerged as the most suitable, offering the best growth, physiological efficiency, and yield performance. This can be attributed to the better utilization of agroclimatic resources during the critical growth phases of the crop. On the other hand, the 15th December sowing (D3) faced unfavorable conditions due to reduced growing degree days, helio-thermal units, and photo-thermal units, which negatively affected growth and yield parameters. The study highlights the significance of early sowing (15th November) to achieve better growth, phenological development, and productivity in rapeseed cultivation under the agroclimatic conditions of Assam.

***Keywords*:** Agroclimatic Indices, Moisture stress, Helio-thermal units, Growing degree days

SII-P3

Enhanced Thunderstorm Activity Over Assam During 2022, a La Niña Year

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This study examines lightning activity over Assam during the pre-monsoon period (March, April, and May) from 2019 to 2023, utilizing ground-based lightning observation data. The analysis focuses on the frequency, intensity, and spatial distribution of thunderstorms during this critical season. Results reveal that maximum lightning activity consistently occurred in April, coinciding with the seasonal Nor'wester activity (locally known as *Bordoisila*). Spatially, the highest concentration of lightning events

was observed over West Assam and parts of South Assam. Notably, the pre-monsoon season of 2022 exhibited a two-fold increase in thunderstorm occurrences compared to the other years studied. This enhancement is attributed to the interplay of moisture influx from the Bay of Bengal, upper-level divergence, and increased convective instability driven by La Niña conditions, as indicated by negative Nino 3.4 values (d™ **-0.5°C**) from January 2022 to March 2023. The findings underscore the significant influence of La Niña-induced atmospheric patterns on thunderstorm activity, particularly over Western and Southern Assam. These thunderstorms play a dual role in the region, providing vital pre-monsoon rainfall for agriculture while posing risks such as hail damage and strong winds. Understanding these dynamics is crucial for developing adaptive strategies to mitigate agricultural losses and manage associated risks effectively.

SII-P4

Strategies and actions adopted for managing livestock during floods: Astudy in Udalguri district ofAssam

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Livestock provides livelihood to two-thirds of rural communities in India. It also employs about8.8 percentof the population. This sector contributes 5.50 percent to the total GDP and 30.38 percent of the total Agriculture GDPof the country as of 2022-23. Assam has a notable livestock population, accounting for 3.25% of India's total livestock, with significant contributions from cattle, pigs and poultry. But at the same time, the sector has remained highly vulnerable to almost all sorts of natural disasters and the most frequent and vulnerable of all types is the occurrence of flood. Udalguri, one of the districts of Assam with 4.97 lakh of total livestock population which is 3.83 % of the total in Assam has experienced severe floods yearly with 38488 hac flood inundated area (19 percent of the total area of the district i.e 197518 ha). Considering the above fact, the present study was taken up with the objectives of figuring out the livestock losses, identifying the problems livestock growers faced and strategies they adopted during the flood. Both purposive and random sampling techniques were followed for selecting 25 numbers of farmers from each eight villages of the two revenue circles i.e., Kalaigaon and Udalguri which makeup 200 numbers of respondents in total. The data collection was done during November and December 2023 by personal interview method with the help of a pre tested schedule. The data were subjected to frequency, percentage, rank and Pareto graph analysis. The results revealed that during 2022-23, there was a monetary loss of around Rs. 25830.20 with an average of 7 livestock losses per household. The problems faced by the livestock growers were loss of grazing areas (100 %), disease spread (94.5 %) and animal treatment (92.5 %) with rank I, II and III respectively. The mitigating strategies adopted were classified into three categories i.e., housing management, feeding management and health care management. In the first category, the strategies adopted were the construction of animal sheds in the highlands (94.5%) followed by making pucca shed for animals (28.5%). In the second category, feeding of locally available crop residues and making hay/ bales (100 %), storage of sufficient quantity of feed material (71%) and in the third category, vaccination of animals before or after flood (48%) followed by stocking of

emergency common medicine for flood period (41%) were some of the mitigating strategies adopted by livestock growers during flood in Udalguri district of Assam.

***Keywords*:** Livestock growers, Flood, Mitigating strategies, Udalguri, Assam

SII-P5

Impact of Extreme weather events on Fruit Crops: A Review

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The ongoing human activities have been affecting the weather patterns of different regions in different ways, thus resulting in unusual weather phenomenons, which are out of its normal range or extreme weather events. Such abnormal weather patterns resulting from changing climate, has threatened the productivity of fruits through high and low temperature regimes, increased or decreased rainfall and other weather related problems, thus posing major challenges through reduced production, improper growth and development, poor quality etc, which varies from crop to crop. In the present review study, certain mitigation measures have been discussed so as to come up with strategies to overcome the impact of extreme weather events on fruit crops, along with a brief discussion on various impacts of such events on some major fruits. Also the impact of Jorhat's weather on low chilling apple varieties at some specific growth stages have been mentioned.

***Keywords*:** extreme weather events, fruits, mitigation measures, low chilling apple varieties

SII-P6

Impact of diurnal variation of micrometeorological parameters on different phenological stages of rice over New Alluvial zone of West Bengal

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Diurnal variation of radiation and its different components has a huge impact on the growth and development of rice crops. But how different radiation driven micrometeorological parameters are impacting at different major phenological stages of rice has been less addressed for different varieties of rice grown over New Alluvial zone of West Bengal**.** In addition to radiation, other meteorological parameters like cloud cover have also impact on radiation and hampered the growth and development of rice on various phenological stages need to be investigated properly. Present study has taken an attempt to investigate how different radiation based micrometeorological parameters like APAR, IPAR, Crop albedo, Soil albedo, canopy temperature and net radiation has influenced the growth at three major phenological stages of rice. To address the issue, a field experiment was carried out at the "D" block farm of the Bidhan Chandra Krishi Vishwavidyalaya, Kalyani, Nadia for year 2021 in Kharif season. The details of the experiment are with three varieties (V1: Shatabdi, V2: Heera, and V3: Triguna) as the first factor, three spacings (S1: 20 cm x 15 cm, S2: 20 cm x 20 cm, and S3: 15 cm x 15 cm) as the second factor, and

two seedling ages (A1: 32 days old seedlings; A2: 25 days old seedlings) as the third factor, for a factorial randomized block design (FRBD) with two replications. There is no discernible difference in the diurnal variation of radiation used by rice crops between 7:30 and 9:30 AM, but at 11:30 AM, the difference was evident, and it was more pronounced during the 32-day period of seedlings than the 25-day period. In the Kharif season, the flowering stages, which are between 28 and 70 DAT, had the maximum diurnal variation, suggesting that radiation is crucial for rice growth during this time. Due to the healthy growth and development of leaves, which absorb more radiation and reflect less during the vegetative and reproductive stages and reverse at the maturity stage, the tendency of crop albedo and soil albedo showed contrary patterns with regard to APAR and IPAR. In general, all varieties showing a cycling trend IPAR after the end point of attaining the maximum DAT. It is observed the IPAR showed the highest values for Triguna variety followed by the Shatabdi and Heera varieties for 32 days age of seedling. Similar to 32 ages of seedlings, the 25 days of seedling is also showed similar variation for all consider time of the day for the entire growing period.

***Keywords*:** Solar radiation, Weather, Age of seedling, Phenological stages and Diurnal variation.

SII-P7

Identification of the most vulnerable districts and time for the occurrence of "Kalbaisakhi" for shifting the harvest time of Boro rice in Gangetic West Bengal

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The pre-monsoon thunderstorms, locally known as Nor'wester or "Kalbaisakhi", prevalent in the Gangetic West Bengal encompassing the southern districts, has significant impact on agricultural crops especially the Boro rice nearing harvest maturity. To address this exigent situation, there is an immediate need to identify the occurrence window of thunderstorm with maximum probability during the entire pre-monsoon season which may provide a crucial insight to the farmers about harvesting rice before the vulnerable period of thunderstorm occurrence. So, in the present paper an attempt has been made to identify the occurrence period of different categories of thunderstorm namely moderate, heavy and very heavy based on daily rainfall gridded data from the India Meteorological Department (IMD) for the period 1961-2023 over the 13 districts of Gangetic West Bengal. During the pre-monsoon season *viz*. March, April and May, over Gangetic West Bengal, commonly the source of rainfall is the late afternoon thunderstorm activity or occasionally the cyclonic storm that develops in the vicinity of Bay of Bengal. In the present study, the occurrence of any rain event during pre- monsoon season is due to late afternoon thunderstorm activity has been taken as hypothesis. Any rainfall event due to cyclonic activity as per the IMD records has been excluded from analysis. The results revealed a significant spatio-temporal variation of thunderstorm occurrence over different districts of West Bengal. As per our objective we classified different categories of thunderstorm events based on rainfall amount into moderately heavy (23-43 mm/day), heavy (>43-88 mm/day) and very heavy (>88 mm/day). Out of the 13 districts, majority of the districts showed maximum number of thunderstorm activity in the month of May followed by April and March during the pre-monsoon season. It was observed that under the category of moderately heavy rainfall, the most vulnerable districts are Howrah, Kolkata, Hooghly, South 24 Parganas and North 24 Parganas district experiencing more than 100 thunder storm events during the entire period, more than

60% of which have occurred in the month of May. Moreover, districts like Birbhum, Bankura, Purulia representing the Red and Lateritic zone were less prone to thunderstorm activity, Purulia being the least affected. In case of heavy rainfall category Hooghly, Kolkata, Howrah, South 24 Parganas and North 24 Parganas were found to experience a greater number of thunderstorm activities than the rest majority of which has occurred during the May; whereas, Bankura, Purulia, Bardhhaman and Birbhum were less vulnerable in terms of thunderstorm activities during the same period. However, under the category of very heavy rainfall, Paschim Medinipur and Purba Medinipur experienced 3 events each during the month of May across the entire time period which was higher than the rest. Analysis of daily rainfall suggests an increasing trend of thunderstorm occurrence in case of both the entire pre-monsoon season and the month of May, posing threat to the harvest of Boro rice.

Keywords: Thunderstorm, Gangetic West Bengal, Pre-Monsoon season, daily rainfall, Kalbaishakhi

SII-P8

Pest and diseases in Tea crops under climate stress

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Tea (*Camellia sinensis*) is one of the most economically significant crops globally, with cultivation spanning across tropical and subtropical regions. However, the tea industry is increasingly facing challenges from pests and diseases, which are being amplified by climate change. Rising temperatures, altered precipitation patterns, and more frequent extreme weather events are altering the dynamics between tea plants, pests, and pathogens, thereby threatening crop productivity and quality. This poster examines the effects of climate stress on pest and disease prevalence in tea crops and explores potential adaptive strategies for managing these challenges. Under climate stress, pests and diseases in tea crops can manifest in various ways. Warmer temperatures can accelerate the life cycles of many pests, such as tea mosquitoes (*Scirtothrips dorsalis*) and tea looper (*Buzura suppressaria)* leading to increased populations and higher levels of damage. Similarly, the increased frequency of rainfall can create favourable conditions for fungal and bacterial diseases, such as blister blight (*Exobasidium vexans*) and root rot, both of which are significant threats to tea plants. Additionally, climate change is shifting the geographical distribution of pests and pathogens, leading to the introduction of new, non-native species that may not have natural predators, further complicating management efforts. This poster highlights the interconnectedness of climate stress and pest-disease dynamics in tea crops, emphasizing the need for a multifaceted approach to pest and disease management. Integrated pest management (IPM) strategies, such as biological control, crop rotation, and resistant tea varieties, are essential for mitigating the negative effects of pests and diseases. Moreover, understanding the specific climatic conditions that favour pest outbreaks and disease spread is crucial for predicting and preventing future threats. Climate-resilient farming practices, such as optimized irrigation systems, soil health management, and agroecological techniques, are key to maintaining healthy tea crops in the face of climate variability. The poster also discusses the role of policy and research in supporting sustainable tea farming. Research into climate-resilient tea varieties, early-warning systems for pest and disease outbreaks, and the development of adaptive pest management strategies is critical for minimizing the impact of climate stress on tea

production. Collaborative efforts among farmers, researchers, and policy makers will be crucial in ensuring the long-term sustainability of the tea industry. In conclusion, the impact of climate stress on pests and diseases in tea crops represents a growing challenge that require s urgent attention. By employing integrated, adaptive management strategies and fostering collaborative research efforts, the tea industry can better navigate the uncertainties posed by climate change while ensuring food security and ecosystem stability.

Keywords**:** *tea, climate change, blister blight, tea mosquito bug.*

SII-P9

Adaptation strategies for horticultural crops under changing climate conditions

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Climate change variability and its impacts are a major global problem in the 21st century. The physiological reactions of horticulture crops to climate changes, such as decreased growing period, are negatively affected by terminal heat stress and limited soil water availability. This leads to a significant decrease in the output of fruits and vegetables, ultimately impacting the growth and development of these crops. The variability of climate change has adverse consequences on horticulture crops, including lower irrigation water availability, increased warmth, flooding, salt, and a negative impact on production and quality. The unpredictable nature of climate change fluctuation would negatively impact the performance of commercial types of fruits, vegetables, and flowers. The physiological disorders, such as spongy tissue in mango, fruit cracking in litchi, and blossom and fruit abscission in solanaceous font vegetables, are more severe in horticultural crops exposed to high temperatures and air pollution. These conditions also lead to decreased yields in numerous horticultural crops. To ensure the long-term production and adaptation of current horticulture techniques, it is necessary to reduce the impact of climate changes and increase the utilization of greenhouse technology. The primary efforts to address these difficulties will involve the development of horticultural crops that exhibit tolerance to high temperatures, resistance to pests and diseases, shorter growth cycles, and the ability to produce high yields even under stressful conditions.

Keywords: Climate change, fruit crops, physiological disorder, spice crops and vegetable crops

SII-P10

Growth and yield of brinjal varieties under varied growing environment

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Vegetable crops are vulnerable to the weather and depends on a narrow range of environmental conditions. Even a little variation in the microclimate at critical stages of crop growth leads to yield reduction. Vegetables crops are also sensitive to climatic variables such as temperature, precipitation and light. Therefore, to improve the production of vegetable crops climate crop relationship must be taken into consideration. A field experiment was conducted during autumn-winter season of 2020 at Vegetable Science Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar to examine the impact of growing environment on growth and yield of different varieties of brinjal crop. Brinjal (*Solanum melongena* L.*)* is a common vegetable crop belonging to family Solanaceae. The experiment was conducted in Factorial Randomized Block Design with four dates of transplanting (5, 15, 25 July and August 4) and three varieties (Hisar Shymal, BR-112 and HLB-12) with three replications of each. It was observed that maximum vegetative growth (plant height, more number of branches per plant) and maximum fruit yield were observed in 15th July, 2020 (D_2) transplanted crop of brinjal while among varieties, maximum vegetative growth (plant height, more number of branches per plant) and maximum fruit yield were observed in variety 'Hisar Shyamal'. On the basis of results obtained from the above study, it may be concluded that 15th July found to be most suitable period for transplanting of brinjal seedlings which resulted into maximum growth and yield while among the varieties Hisar Shyamal proved superior in growth and yield under prevalent weather conditions.

***Keywords*:** Brinjal, growing environment, varieties, weather conditions

SII-P11

Impact of Climate Change on Tea Physiology and Production: A Comprehensive Review

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Tea is one of the most popular beverages in the world. Tea has lots of health benefits due to its anti-oxidative properties. It began as medicine but today it is the most common drink in the world. India is the 2nd largest producer of tea and 4th largest exporter. Assam tea is famous around the world because of its body, briskness, malty flavor, and strong, bright color. Assam produces more than 50 per cent of tea in India. Climatic changes are one of the major issues in today's world. Agriculture is most vulnerable to climate change. With the changing climate, tea industry is also facing severe issues due to the changing of the climatic conditions. In Assam, tea bushes emitted 5.2 to 70.8 g CO_2 year/plant due to

aerobic respiration. From different studies, it was found that tea cultivation leads to significant increase in the amount of CO_2 in the atmosphere. The study is conducted with the objectives to understand the effect of climate change on tea. It was attained by using a systematic methodology, known as the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), to identify and analyze the available literature on effect of climate change on physiology and yield of tea and strategies to meet up with the changing climate. A literature search was done using relevant review literature and grey literature published from seven electronic databases, including Web of Science, Google Scholar, Sage Publisher, JSTOR, and Springer. A detailed case study was carried out. Climate change has impacted tea cultivation unlike any other crops. It had caused severe damage to tea production impacting the economy. It has a negative effect on both quality as well as yield of tea. Various climatic factors such as increasing temperature, rainfall,relative humidity, etc. the components content in tea leaves has decreasing affecting its quality. The warm winters and high temperature had also affected the physiology and growth of the tea plant causing early sprouting of leaves. High temperature, excessive and erratic rainfall, increase in soil temperature and solar radiation the yield of tea is decreasing at an alarming rate. It was suggested from the study that all the stakeholders such as government, tea board members, advisory members, tea growers, managers, small tea cultivators, scientist and researchers should come together to meet with the challenges of the changing climate. Effective and efficient adaptation and mitigation strategies/ policies should be formed by the policy makers in order to improve the tea industry and proper implementation should be done at all level of tea cultivation.

***Keywords*:** Tea, Climate Change, Physiology, Yield, Adaptation and Mitigation strategies

SII-P12

Impact of Climate Change on Insect Physiology and Tea Cultivation in Northeast India

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Climate change has emerged as a critical challenge for tea cultivation, particularly in Northeast India, where tea is a key economic crop. Rising temperatures, fluctuating rainfall patterns, and increasing atmospheric carbon d ioxide levels are reshaping tea ecosystems, with significant implications for pest dynamics and tea production. This study explores the physiological responses of insect pests to temperature and carbon shifts, alongside the broader climate change trends impacting tea-growing regions in Northeast India. Insects such as the tea mosquito bug, red spider mite, and looper caterpillars demonstrate enhanced reproduction, shortened development periods, and increased feeding efficiency under elevated temperatures. Higher atmospheric CO_2 concentrations further exacerbate pest activity by altering plant nutritional quality, increasing susceptibility to chewing and sucking pests. These physiological changes in pests, coupled with their adaptability to shifting climatic conditions, pose severe challenges for tea growers, leading to heightened infestation rates and crop losses. Simultaneously, climate change trends in Northeast India, including declining annual rainfall, erratic precipitation distribution, and rising minimum temperatures, exacerbate abiotic stress on tea plants. Regions such as the Brahmaputra Valley, Dooars, Terai, and Darjeeling Hills have witnessed an increase in extreme weather events, including droughts and

floods, threatening long-term tea productivity. The cumulative effects of these trends have created complex interactions between pests and host plants, further complicating pest management. This research underscores the urgent need for adaptive strategies, such as the development of pest-resistant tea clones, sustainable pest management practices, and effective water conservation measures. Promoting integrated pest management (IPM), afforestation, and microclimate creation through agroforestry systems are vital steps toward mitigating climate change impacts on tea cultivation. Addressing the intertwined challenges of pest physiology and climatic trends is essential for ensuring the resilience and sustainability of Northeast India's tea industry in the face of a changing climate.

***Keywords*:** Tea, Climate change, Pest

SII-P13

Brewing Challenges: The Influence of Weather on Tea Production

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The cultivation of tea [*Camellia sinensis* (L.) O. Kuntze], a major global plantation crop and vital economic resource for millions, is highly sensitive to climatic factors such as temperature, rainfall, humidity, and solar radiation. Recent trends in climate change, marked by erratic weather patterns, have posed significant challenges to tea production, particularly in regions like Northeast India. Extreme events, including prolonged dry spells, intense rainfall, and storms, disrupt crop cycles, reduce yields, and degrade tea quality. These weather variations also exacerbate soil erosion, nutrient leaching, and pest outbreaks, compounding the stress on tea plants. Optimum tea growth requires stable conditions, including annual rainfall of 250–300 cm and temperatures ranging between 13°C and 30°C. However, changing rainfall patterns and rising temperatures are leading to moisture stress, altered phenological phases, and a decline in photosynthetic efficiency. Drought stress reduces soil moisture, leading to stunted growth, hardened leaves, and sterile buds, ultimately decreasing yield and quality. Conversely, heavy rainfall causes water logging, soil erosion, and nutrient leaching, increasing dependency on fertilizers and raising production costs. Fluctuations in temperature directly affect the photosynthetic efficiency, shoot initiation, and metabolic activities of tea plants. The resulting ecological stress further affects the phytochemical profiles and organoleptic properties of tea. Given the increasing vulnerability of tea cultivation to climate extremities, understanding the inter play between environmental variables and crop responses is crucial. Adaptation strategies, including the development of climate-resilient tea cultivars, optimized irrigation systems, and agroforestry practices, are essential to sustain productivity and mitigate the long-term effects of climate change.

***Keywords*:** Tea**,** weather pattern, stress, yield, quality

SII-P14

Mitigation of climate change by natural farming inputs in tea

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Tea [*Camellia assamica* (Masters)] is regarded as one of the oldest most seasoned, most prevalent, non-alcoholic beverages which is consumed globally. Tea as a natural resource involves several challenges, including environmental constraints such as climate change, which significantly impacts tea production. Optimal tea cultivation requires specific temperature ranges, rainfall patterns, and overall climate conditions. Rising temperature cause stress in tea plants, reducing their ability to produce high-quality leaves and also increase the rate of evapotranspiration, leading to water scarcity. Warmer temperatures create more favorable conditions for the growth and spread of many tea diseases, particularly fungal infections like *Colletotrichum* and *Pestalotiopsi*, which affects plant health and productivity. Tea plants require consistent rainfall for optimal growth, and drought conditions can reduce yields. Shifts in rainfall patterns and higher humidity levels due to climate change create an ideal environment for the development of fungal and bacterial diseases. Tea plants are particularly susceptible to diseases like blight, rust, and mildew when the air is consistently moist. By integrating principles of natural farming such as reduced chemical input, soil health management and water conservation, the natural farming helps to sequester carbon, enhance soil fertility, reduction of pest and disease incidence and improve resilience to extreme climate change in tea. Natural farming inputs such as jeevamrit, ghanajeevamrit, panchagavya, neemastra, agniastra, bhramastra contribute to climate change mitigation, focusing on their ability to reduce greenhouse gas emissions, increase carbon storage in soils, and promote sustainable tea cultivation. It significantly reduces pesticide residues in tea leaves and minimize nutrient loss in runoff. This approach not only protects the environment but also maintains tea yield and quality along with pest and disease control.

***Keywords*:** Tea, climate change, natural farming, yield, quality, diseases.

SII-P15

Impact of Extreme Weather Events on Agriculture: Challenges and Adaptation Strategies

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Extreme weather events, driven by climate change, pose significant threats to global agriculture, affecting food security, livelihoods, and ecosystems. This abstract examines the impacts of extreme weather

phenomena, such as droughts, floods, heat waves, cyclones, and unseasonal frost, on agricultural productivity and sustainability. These events disrupt crop growth cycles, reduce yields, and damage infrastructure, leading to economic losses and social vulnerabilities. Droughts, characterized by prolonged periods of water scarcity, reduce soil moisture, hinder photosynthesis and decrease crop yields, particularly in rain-fed farming systems. Conversely, floods lead to waterlogging, nutrient leaching, and the spread of waterborne diseases, causing extensive damage to crops and livestock. Heat waves exacerbate heat stress in plants and animals, impairing productivity and increasing mortality rates in sensitive species. Cyclones and storms destroy crops, uproot plantations, and disrupt supply chains, while unseasonal frost damages flowering and fruiting stages, affecting high-value crops. These impacts are exacerbated by the interplay of socioeconomic factors, including small landholdings, limited access to technology and inadequate disaster preparedness, particularly in developing regions. Smallholder farmers are disproportionately affected, with cascading effects on rural economies and food systems. Adapting to these challenges requires integrated strategies to enhance resilience. Innovations in climate-resilient crop varieties, improved irrigation techniques, and sustainable farming practices can mitigate the adverse effects. Early warning systems and accurate weather forecasting enable timely decision-making, reducing vulnerability to extreme events. Policies promoting crop insurance, disaster risk management, and capacity building are crucial for protecting farmers and ensuring agricultural sustainability. Moreover, leveraging technological advancements such as remote sensing, artificial intelligence, and big data analytics enhances monitoring and predictive capabilities, enabling region-specific interventions. Community-based approaches, including agroforestry and soil conservation, strengthen ecosystem resilience and support sustainable resource management. Extreme weather events significantly impact agriculture, necessitating a multi-dimensional response integrating technology, policy and community engagement. Strengthening adaptation mechanisms is essential to safeguard agriculture, ensure food security and build resilience against the escalating challenges of climate change.

***Keywords*:** Extreme weather, climate change, agricultural resilience, crop damage, adaptation strategies, food security.

SII-P16

Impact of climate change on floriculture: Flowering Patterns and Productivity

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The floricultural industry is an important component of global horticulture. With the change in climate, the floriculture sector is in threat. Resulting in disruption in flowering patterns, reduces productivity, and alters the market value of ornamental crops. Mainly in open field conditions, climate change may induce flowers to fail to bloom or affect the flowering period, reduction on flower size, and out of standard colour development. Higher temperatures can have a direct impact on flowers' volatile fragrances (essential oils) emitting and pigment deterioration. Some other factors had already been observed as a reduction of shelf life in cut flowers and poor pollination in seed production. Indirectly, the changes in climate leads to the intensity of droughts and floods, soil erosion and modification of organic matter transformation, changes in the occurrence and severity of pests and diseases. In sensitive crops like roses (*Rosa hybrida*) and snapdragons (*Antirrhinum majus*) fluctuations in temperature can

also lead to heat stress, floral bud abortion, and reduced flower quality. Similarly, changes in precipitation patterns, including drought and waterlogging, further complicate floral development by impairing water and nutrient uptake. Elevated CO generally promotes biomass accumulation and water-use efficiency but may not necessarily translate into improved floral yield or quality. Many strategies followed up for the conservation, multiplication, production, improvement of these ornamental species of flowers. The adoption of adaptive strategies such as breeding climate-resilient varieties, implementing optimized agronomic practices, and utilizing controlled environment agriculture is crucial. Identification of potential and efficient native ornamental species, species tolerant to high temperatures and low soil water, as well as efficient and sustainable production systems with low emitting of greenhouse gases, including indoor ornamentals. Vertical gardens, on the other hand besides their aesthetical characteristics, are efficient structures to improve air quality and reduce surface temperature. The design and planning of the gardens should also considered in sustainable concepts, creating resilient spaces with efficient use of natural resources with a higher contribution to climate change mitigation. In agriculture, the change in climate remains a major challenge. This topic has given rise to many actions for the development of research and policies to minimize the impacts of alterations and consequences, which has favoured the implementation of sustainable production practices in floriculture as well as in the agricultural field.

Keywords: Floriculture, Climate change, High temperature, Elevated CO_2, Climate Resilient Varieties.

SII-P17

Analyzing long term climate variability for lower Shivalik foothills of Punjab

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Climatic variability describes variations in climate characteristics including temperature, precipitation, and wind patterns throughout time. Ecosystems, agriculture, and human activities are all greatly impacted by these fluctuations, which are caused by both natural and human- induced factors. El Niño and La Niña, volcanic eruptions, variations in solar radiation, and oceanic cycles like the North Atlantic Oscillation are examples of natural sources of climate variability. On the other hand, human activities, particularly the release of greenhouse gases, have exacerbated some patterns of variability, leading to an increase in extreme weather events, changes in rainfall patterns, and an increase in world temperatures. Understanding long-term climate trends, forecasting future changes, and creating adaptation and mitigation plans for areas most at risk from climate change all depend on the study of climatic variability. For this purpose, the daily data for different weather parameters (maximum temperature, minimum temperature, rainfall, rainy days, humidity etc.) from 1984-2023 for Ballowal Saunkhri, SBS Nagar, Punjab had been used for trend analysis on the annual and seasonal basis. The daily weather data of about 40 years from agrometeorological observatory of Regional Research Station Ballowal Saunkhri representing *Lower Shivalik foothills* was used. While rainfall, evaporation, sunshine hours, and wind speed have all dramatically decreased in this area, the annual maximum temperature and morning and evening relative humidity have increased. The diurnal range and annually minimum temperatures have not changed significantly. While the monthly minimum temperature increased for February, March, and October and dropped for

June. The monthly maximum temperature showed a large increase with the exception of January, June, and December. All seasons had a considerable increase in maximum temperatures, with the exception of winter, whereas the kharif and post-monsoon seasons had a notable increase in minimum temperature. The relative humidity, evaporation, sunshine hours, and wind speed have shown a decreasing trend. The declining trend in the rainfall for the *kharif*, monsoon, and post-monsoon season had also been observed. Decreasing rainfall in rainfed areas can have significant, often detrimental effects on agriculture, as these areas rely heavily on natural precipitation for crop growth. Prolonged lack of rainfall can cause drought conditions, reducing crop yields or even causing total crop failure. The yield reduction is due to decreased rainfall which leads to lower soil moisture levels, which are critical for crop growth. Insufficient moisture can stress crops, particularly during key growing phases like flowering and fruiting.

Keywords: Climate variability, Temperature, Rainfall, Trend analysis

SII-P18

Impact of climate change on major oilseed crops

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Oilseed crops like soybean, rapeseed, sunflower, and groundnut are essential for edible oils and industrial applications. Globally the US and Brazil are dominant soybean producers, while Canada and China lead in rapeseed. India, a leading global oilseed producer, cultivates a diverse range of these crops, including groundnut, soybean, mustard, sunflower, and sesame. Key producing states include Rajasthan, Gujarat, and Madhya Pradesh. Climate change poses significant challenges to oilseed crops worldwide, with rising temperatures, erratic rainfall, and extreme weather events disrupting their growth and reducing yields. Key crops such as soybean, mustard, sunflower, and groundnut, essential to food security and global economies, are particularly vulnerable, especially in tropical and subtropical regions where productivity losses and seasonal shifts are more severe. In India, the fourth-largest oilseed producer, reliance on monsoon and agriculture-driven livelihoods amplifies these impacts, with irregular rainfall, temperature fluctuations, and drought affecting yields, while coastal regions face additional threats from salinity intrusion. These climatic disruptions have significantly reduced crop yields, shifted growing seasons, and exacerbated vulnerabilities to pests, diseases, and extreme weather events. Here advocates for a robust framework of adaptation strategies, including advanced irrigation systems, the development of climate-resilient crop varieties, integrated pest management, and evidence-based policy interventions. Emphasizing the urgency of concerted action, it calls for enhanced research, targeted farmer training programs, and the promotion of sustainable agricultural practices. This comprehensive approach aims to bolster India's agricultural resilience, ensuring food security and economic stability amidst the mounting threats of climate change.

***Keywords*:** climate change, oilseed crop, temperature, rainfall, extreme weather.

SII-P19

Role of climate smart technologies in stabilizing paddy yield under the Agroclimatic condition of Barak Valley Zone of Assam

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Climate change is looming large towards humanity in the coming decades. Rise in temperature due to increasing concentration of CO_2 in the atmosphere indicates that climate change is happening in most of the places hampering agricultural production. Analysis of temperature data and rainfall data in Cachar district of Barak valley zone of Assam indicated an increasing tendency of maximum and minimum temperature during 1990-2022. The rate of increase of maximum temperature during rice growing season (June-November) is more than that of minimum temperature. Rainfall during monsoon season in the district is 1840 mm and it was observed that July rainfall showed an increasing trend by 30 mm/decade during 1990-2022 causing frequent floods in the district. As the district comes under low lying flood prone areas, heavy rainfall during monsoon season caused extensive damage to kharif paddy crop. To minimize crop losses from the extreme weather event, climate resilient technologies are to be adopted by the farmers. District Agromet Field Unit (DAMU) under IMD-ICAR is focusing on popularization of different climate resilient technologies to the farming community through agromet advisory services. Keeping this in mind, Ranjit Sub-1, a flood resistance variety was demonstrated by conducting one On Farm Testing (OFT) by transplanting the variety in three different dates at 10 days interval during 2019 and 2020 at two villages. The variety was transplanted on 15th June, 25th June and 5th July in both the years. Analysis of different agroclimatic indices showed that all the accumulated agroclimatic indices were higher on second transplanted crop (25th June) compared to the other two dates of transplanting. The second transplanted crop recorded maximum yield (65 q/ha) as compared to the first (55 q/ha) and third (50q/ha) transplanted crop during both the years. The result indicated that the negative impact of flood on kharif rice can be minimized by selecting suitable variety and manipulating transplanting dates suitably.

SII-P20

Urban Heat Island: Impacts, Challenges and Strategies for Sustainability

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The Urban Heat Island (UHI) phenomenon, marked by elevated urban temperatures compared to rural areas, presents significant challenges amid global climate change and rapid urbanization, with urban populations projected to reach 70% by 2050 (United Nations, 2019). Key drivers of Urban Heat Islands (UHI) include dark surfaces, reduced vegetation, urban geometry, impermeable materials, and anthropogenic heat. UHI exacerbates energy demand, greenhouse gas emissions, air pollution, and health risks, while also impacting agriculture and ecosystems. The interaction with Urban Pollution Islands (UPIs) further

amplifies these issues, highlighting the need for mitigation strategies like reflective materials, urban greenery, green roofs, and sustainable planning to improve resilience and livability. The impacts of UHIs extend to agriculture, influencing crop productivity, water availability and soil quality through altered precipitation patterns, increased pest proliferation, and water stress. In aquatic ecosystems, thermal pollution from heated urban runoff threatens biodiversity and disrupts natural processes. Mitigation strategies, such as adopting reflective materials, increasing urban greenery, implementing green roofs and enhancing sustainable urban planning are critical fo r addressing UHI effects. Specific practices, such as restoring wetlands, creating green parking spaces, and public awareness campaigns, contribute to reducing UHI intensity and enhancing urban resilience. The current scenario in Assam, India highlights the urgency of addressing UHI effects, with satellite data revealing a significant rise in land surface temperatures over the past decade due to rapid urbanization and deforestation. Integrating mitigation measures in urban planning is essential for sustainable development, improving thermal comfort and safeguarding the ecological balance. By addressing UHI dynamics, urbanareas can achieve greater resilience against climate change, enhance livability and foster harmony between urban and rural ecosystems.

Keywords: Urbanization, sustainability, heat stress, mitigation strategies, sustainable urban planning, agriculture, thermal pollution.

SII-P21

Assessment of drought for contingency crop planning in India

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Drought is characterized by extreme hydrological events that cause severe water shortages, persisting over a large area across an extended period of time having harmful impacts on humans, vegetation, animals and ecosystems, thereby, affecting the socioeconomic condition of a place. It directly impacts the agricultural ecosystem, thus causing significant threat to regional and global food security. In the present era, global warming has led to an increase in the frequency and severity of extreme weather events over the past two decades, including floods, heat and cold waves, cyclones, irregular rainfall patterns, and frequent instances of severe droughts. Of the entire agriculture land area of India, 35 percent receives rainfall between 750 mm and 1125 mm which is considered as drought prone, while 33 percent, which receives rainfalls between less than 750 mm is considered to be chronically drought prone. According to the World Economic Forum report, India lost almost 35 million hectares of crop area due to drought between 2015 and 2021. To counteract such deleterious events, effective drought assessment and monitoring network using indices based indicators have proven to be very crucial for ensuring food security. Meteorological indices such as the Standardized Precipitation Index (SPI), Reconnaissance Drought Index (RDI), Deciles Index (DI), Aridity Anomaly Index (AAI), Percent of Normal Index (PNI), Palmer Drought Severity Index (PDSI), China Z Index (CZI), Standardized Precipitation-Evapotranspiration Index (SPEI) and Effective Drought Index (EDI) play a crucial role in identifying drought severity, duration, and spatial distribution. Further, remote sensing- based indices

such as Vegetation Condition Index (VCI), Temperature Condition Index (TCI), Vegetation Health Index (VHI) and Shortwave Angle Slope Index (SASI) were identified to be a better way to map agricultural drought. Long term (1901–2008) trend analysis and yield significance test using monthly gridded SPEI data for the Indian region, including North-West India (NW India), North-East India (NE India), Central India, and Peninsular India, indicate an overall increase in drought conditions, with extended duration and higher intensity across all four meteorological regions. Effective mitigation strategies are recommended to minimize the agriculture drought risks and economic loss which includes adaptation of agronomic practices such as utilizing conservation tillage, employing cover crops, practicing efficient irrigation methods like drip irrigation, intercropping, mulching, shifting of sowing window, selecting drought-tolerant crop varieties, and managing soil fertility to optimize water retention capacity etc. Furthermore, use of plant growth-promoting rhizobacteria (PGR) to reduce drought stress and PGPR treatments has shown reduction in drought stress in crops like soybean. Adverse effects of water deficit conditions on wheat were also managed by silicon application which minimizes drought stress's detrimental effect up to certain extent. Studies reveal that, monitoring and evaluating the impacts of droughts in India remains a significant challenge under varied meteorological, hydrological, and agricultural scenarios and a full-fledged operationalization of impact assessment and early warning systems is crucial for advancing drought monitoring efforts and ensuring climate-resilient rain-fed agriculture in India.

Keywords: Drought, impact, index, monitoring, mitigation, adaptation

SIII/LT-1

AI-Driven Weather-Based Early Warning System for Crop Diseases: A Case Study on Early Blight in the Khorda District

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Early blight (*Alternaria solani*) is one of the most devastating fungal diseases affecting potatoes in Odisha. Timely warning of disease occurrence is crucial for effective crop protection. Critical weather factors, such as leaf wetness duration and temperature, play a key role in early blight infection. In India, agrometeorologists typically rely on weather-based agro-techniques for disease prediction, while AI and machine learning remain largely unexplored. This study aims to develop operational weather-based predictive models leveraging AI and machine learning to forecast early blight in potatoes grown in the Khorda district. Binary data on the earliest infection (PI) were collected from unsprayed potato field experiments conducted in Bhubaneswar from 2018–19 to 2022–23, with four to five varieties planted between late November and early December, varying by year. Weather data recorded at the Odisha University of Agriculture and Technology (OUAT) observatory in Bhubaneswar from 2021 to 2024 were used for analysis. Collinearity and trend analyses were performed on weather variables preceding early blight occurrence. Weather inputs were expanded by incorporating lagged data (3 to 15 days), weather indices, and biologically relevant variables. Traditional statistical regression and threshold-based methods showed poor predictive performance. Consequently, four machine learning models—Decision Tree, Logistic Regression, Random Forest, XGBoost and Naïve Bayes (GNB)—were employed for classification. Model performance was evaluated using Precision, Recall, Accuracy, F1-score, and ROC-AUC. A feature importance analysis was conducted to assess the influence of

weather variables. Models were iteratively tuned using the most relevant features to enhance performance. In the Decision Tree model, 5-day minimum temperature (Tmin) was the most influential factor (79.3%), followed by 5-day maximum temperature (Tmax) with a moderate impact (17.2%). Despite achieving high accuracy (0.993), the model's performance was misleading due to class imbalance. The Logistic Regression model demonstrated high accuracy (82.61%) and strong precision (92.31%) in detecting disease presence, indicating that when the model predicted disease, it was usually correct. The Random Forest model yielded an R^2 score of 0.4915, suggesting moderate predictive power; however, classification would have been more appropriate than regression. XGBoost out performed Logistic Regression in accuracy (86.96% vs. 82.61%) and achieved perfect precision (100%), meaning no false positives, though its recall (80.00%) was slightly lower, indicating some missed disease cases. The Naïve Bayes (GNB) model achieved an accuracy of 82.6%, with a recall of 75% for 'Class 0' (no disease) and 87% for 'Class 1' (disease presence). Machine learning models (MLMs) show promise as a frontier technology for weather-based early warning of early blight in potatoes. However, further refinement is needed for operational implementation.

SIII/IT-1

Precision Agriculture in the Digital Era: The Role of Geospatial Technology

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Geospatial technology has revolutionized precision agriculture by enabling data-driven decision-making to optimize crop production and resource management. This technology integrates Geographic Information Systems (GIS), Global Positioning Systems (GPS), Remote Sensing (RS), and Unmanned Aerial Vehicles (UAVs) to collect, analyze, and interpret spatial data. By leveraging multispectral, hyperspectral, and thermal imaging sensors, satellite-based remote sensing enables farmers to monitor vegetation health, soil moisture, pest infestations, and crop stress over vast agricultural landscapes. Unmanned Aerial Vehicle (UAV) technology has emerged as a transformative tool in precision agriculture. UAVs equipped with high-resolution multispectral, hypersparctral, thermal, and RGB cameras provide detailed insights into crop health, and farmers can perform site-specific analysis, optimize input application (fertilizers, pesticides, and irrigation), and detect early signs of plant diseases. Unlike traditional multispectral imaging, hyperspectral sensors capture a continuous spectrum of wave lengths, allowing precise identification of plant health indicators, nutrient deficiencies, and early stress symptoms. Similarly, IoT-based sensors deployed in fields collect real time critical data on soil moisture, temperature, humidity, and crop health. The fusion of IoT and geospatial analytics, supported by artificial intelligence (AI) and big data processing, enables predictive modeling for disease detection, weather forecasting, and precision irrigation etc. Despite challenges such as high implementation costs, data complexity, and infrastructure requirements, continuous advancements in sensor technology, cloud computing, and AI-driven analytics are making geospatial solutions more accessible. As agriculture faces increasing demands for sustainability and climate resilience, geospatial technology will remain a key enabler of smarter, more efficient, and precision-driven farming practices.

SIII-O1

Internet of things (IoT) based Agromet advisories tool development and its use in dissemination system, Haryana

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As since last two decade the department was engaged in the dissemination of agromet advisories service to the farmers of Haryana with use of Internet of things (IOT). Also involved in the developed few IoT based tools by Department of Agricultural Meteorology with the collaboration of others. As on is our new IOT based technology known "out-door weather display system" (ODWDS), this is LED based display, available the weather-based information'sby dynamically and it will be utilized by scientific community, farming, students, planner, media and live stock management persons. It has been displaying the actual-forecasted weather data along with satellite picture (real time cloud condition/cover and its movement over the country). The second product Emausamhau smart mobile app, Emausamhau mobile app is design ed to interact with IoT devices, collect data weather forecast data, satellite images and districtwide agromet-weather base SMS, that will be fetched from different on line website and AWS-forecast weather data, as real time platform thought the internet availability. The product which developed by department as Products (IoT base weather services) like 1. Emausamhau Mobile App (available at playstore, its>50 thousand downloads &2.9 rating out of 5), (Android Users), 2. Kiosk. Third one is outdoor Weather Display System (ODWDS) (it is under the operation with the initially installed three units) at university premises. Basic key Characteristics and output results (sequential mentioned). Collects and displays real-time weather data. Use online meteorological/ astronomical equations to computation of daily sunrise, sunset and moonrise-moonset (as per our longitude, latitude), Tmin-Tmin (°C) along with weather remarks, display. Actual weather and current weather data display in two grid layouts. Emausamhau weather app provides weather forecasts, agromet advisories and other insect-pest and crop varieties information as per our season al recommendation by universityor package of practices. Requires internet connectivity for data retrieval and AWS weather data fetching. Integrate with IoT devices, like automatic weather stations of IMD and website.

***Keywords*:** Internet of things in agriculture, Agromet advisories, Weather SMSs, Outdoor weather display, weather information apps.

SIII-O2

Ranking of CMIP6 GCMs for precipitation over the Periyar River Basin by using MCDM techniques

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This study determines the suitable general circulation models (GCMs) for the prediction of future precipitation in the Periyar River Bain, India. The observed precipitation data for 21 grid points covering the Periyar River Basin, Kerala is used for the selection of suitable GCMs. Four performance

indicators namely correlation coefficient, normalized root mean square error, Kling-Gupta efficiency and Nash Sutcliffe efficiency (NSE), are applied to evaluate the performance of 27 CMIP6 GCMs for the study area. The weights of the indicators are determined by using entropy method. Compromise programming (CP) and technique for order preference by similarity to ideal solution (TOPSIS) methods are used for the ranking of GCMs at each grid point. The group decision- making approach (GDMA) is also employed to make a collective decision about the ranks of 27 GCMS considering all the grid points. The study found that, effect of the performance indicator NSE on the ranking of GCM models is the most significant. From the GDMA, it is found that, the GCMs BCC-CSM2-MR, IPSL-CM6A-LR and CanESM5 are the top three ranked GCMs for the prediction of precipitation in the study area corresponding to both CP and TOPSIS techniques.

***Keywords*:** Periyar River Basin, Precipitation, Ranking, CP, TOPSIS, CMIP6 GCMs

SIII-O3

Machine Learning-Based Estimation of Sorghum Water Content Using Spectral data: A Comparative Study under Contrasting Irrigation Regimes

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Efficient water management is critical for improving crop productivity in precision farming as it enables optimized irrigation management and enhances water use efficiency. This study aimed to estimate the relative water content o f sorghum by integrating spectral data with machine learning algorithms. The field experiment was conducted during *Kharif* seasons of 2023 and 2024 at Haryana Agricultural University. The experiment was laid out in a split-plot design with two irrigation levels (Irrigated and Rainfed) as main plots and seven varieties of sorghum as sub-plots. The data was collected only after southwest monsoon season to allow water stress to develop in the rainfed plots. The data was collected during the October and November months, coinciding with crop's reproductive stage, when the stress was most evident. The irrigated plots received three supplemental irrigations in 2023 and two in 2024, where the rainfed plots relied entirely on rainfall. The spectral data was collected using the PSR-1100 f Spectro radiometer, covering a wavelength range of 320 to 1100 nm. The observation was taken at two points in the leaves and averaged to get the single value for the particular leaf. The same leaf sample was used to estimate the relative water content. A total of 118 data points were collected over the two seasons representing both irrigation levels. The data analysis was performed using R studio, applying machine-learning algorithms namely, Random Forest (RF) and extreme gradient boosting (XGBoost) to estimate the RWC. The models were applied on the full spectrum of wavelength and Recursive feature elimination (RFE) was used to identify the significant wavelengths associated with RWC of the leaf. The results of the study showed that the RF yielded better results for both full spectrum and RFE selected wavelengths with similar R^2 of 0.98 and RMSE

of 0.89 under irrigated condition. For rainfed condition, Random Forest had a slightly lower R^2 of 0.84 and an RMSE of 2.63 with the full spectrum, and an improved R^2 of 0.85 and RMSE of 2.59 with RFE-selected wavelengths. XG Boostal so performed well under irrigated conditions, with an R^2 of 0.93 and RMSE of 1.39 on the full spectrum, and improved to an R^2 of 0.95 and RMSE of 1.21 using RFE-selected wavelengths. However, under non-irrigated conditions, XG Boost showed lower predictive accuracy, with an R^2 of 0.75 and RMSE of 3.28 on the full spectrum, and an R^2 of 0.77 and RMSE of 3.41 on RFE-selected wavelengths. The results showed that the r^2 and RMSE values of the models were good under irrigated treatments and RFE slightly improved the model accuracy. These findings highlight the ML potential in real-time monitoring of crop water status, enabling differentiation of water-stressed plots and helps in targeted irrigation application.

***Keywords*:** Sorghum, Relative Water Content, Random Forest, XGBoost

SIII-O4

Weather Prediction and Climate Analysis using Machine Learning with special reference to NE Region

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Weather prediction and forecasting is very important and it has big impact on the national as well as global economy. It affects many aspects of human life. It affects many sectors like agriculture, transportation, tourism and industry as they directly rely on good weather conditions for operations and production. It also plays a crucial role in decision making for severe weather condition and management. The erratic and uncertain complex nature of the weather makes traditional weather forecasting tedious and a challenging task. Traditional weather forecast involves applying technology and scientific knowledge on Numerical Weather Prediction (NWP), and weather radar to solve complex mathematical equations to obtain forecasts based on current weather conditions. These traditional processes utilize expensive, complex physical and computational power to produce forecasts, which can be inaccurate and have various catastrophic impacts on society. Due to the dynamic nature of atmosphere, statistical techniques fail to provide good accuracy for weather forecasting. Researchers are developing new models using different Machine learning algorithms for weather prediction, forecasting and climate analysis. The machine learning algorithms which are implemented by different researchers are -Random Forest classifier, Gradient Boosting Classifier, XGBoost gradient descent, Gaussian Naïve Bayes model, Decision Tree Algorithm, Multivariate linear regression (MLR), Logistic Regression, and K-nearest Neighbour (KNN). The paper review work gives a comparison of different techniques and algorithms used by researchers for weather prediction and climate analysis. After review it is found that Random forest, Decision tree and Support vector machine algorithms are mostly used by Researchers for development of weather prediction model. On the other hand, some Researchers are getting good accuracy result by using Gradient descent XGBoost algorithms, Multivariate linear regression etc. Here, we propose to use Random Forest, Decision tree, Support vector machine and

Gradient descent XGBoost algorithms to develop a model for weather prediction, forecasting and climate analysis.

Keywords: Weather prediction, Numerical Weather Prediction (NWP), Random Forest, Gradient Boosting, XGBoost gradient descent, Decision Tree algorithm, Support Vector machine (SVM)

SIII-O5

Attribution of regionally significant trends detected in gridded PET data over the Tapi Basin, India

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Tapi Basin (TPB) is climatically responsive basin. An earlier study had performed trend analyses of gridded potential evapotranspiration (PET) data over the TPB. In the current study, attribution of regionally significant trends detected in gridded PET data over the TPB is performed by using ANN model as continuation to the earlier study. ANN model is developed by using mutual information criteria for input selection followed by interleaved data division and selection of best performing algorithm (BPA) and optimum number of hidden neurons (HNs) based on mean squared error (MSE). BPA and optimum number of HNs are used in the final ANN attribution model (FAAM). Performance evaluation measures (PEMs) are calculated corresponding to simulated output derived from the FAAM and observed target output, which are then used in the attribution of climate change (CLC). The mean PEM values obtained from the FAAM corresponding to regional post- monsoon PET time series showed the role of combined forcing (anthropogenic forcing + natural forcing) behind the observed CLC. Mean PEM values obtained from the FAAM corresponding to regional winter PET time series and regional annual PET time series showed the role of only natural forcing behind the observed CLC.

***Keywords*:** Climate Change, Attribution, Tapi Basin, Potential Evapotranspiration, ANN Model

SIII-O6

Strategies to minimize the wind drift potential in agricultural drone spraying

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Application of pesticides and nutrient sprays using drones makes a significant shift in agriculture. Precision farming, addressing labour scarcity, cost-effectiveness, simplicity, user-friendliness, access to hard-to-reach areas, and faster coverage are key factors making drone intervention indispensable in modern agriculture. However, the potential for pesticide and nutrient drift, especially under windy

conditions, poses a substantial concern. Wind drift can impact neighboring crops, animals, and humans. Smaller droplet sizes, higher wind speeds, and greater drone heights increase the risk of chemical drift. Additionally, the volume of the spray solution, nozzle type, and orientation can affect droplet size distribution, spray pattern, and drift potential. Tamil Nadu, experiencing highly dynamic wind speeds due to the direct solar radiation from its proximity to the equator, faces challenges with wind drift potentially causing severe damage to nearby susceptible crop. Study showed that faster wind speeds and finer droplet sizes were associated with more drift (Grantetal., 2022). Evaluation of drone nozzles under various wind speeds found that centrifugal nozzles have a higher drift risk compared to hydraulic nozzles, with wind speed having a linear relationship with drift rate (Wang *et al.*, 2023). An open field experiment was carried out at Tamil Nadu Agricultural University during 2023-24 aimed to develop strategies to minimize wind drift at different drone heights and spray volumes under varying wind speeds and distances from the source. The experiment involved nine treatments with three levels of wind speed (6/9/12 kmph) and three levels of spray fluid (30/60/90%). Water mixed with different colored ink was used as spray fluid. White colored water sensitive filter sheets of 0.03 sqm size were placed at 1.5m intervals for 30m distance. The agricultural drone flew at 2m height with all three wind speeds and spray fluid levels. The lowest drift was observed at 6 kmph and 30% spray fluid, reaching up to 6m distance. Higher wind speed and more spray fluid volume increased drift distance, the maximum drift observed at 12 kmph wind speed and 90% spray fluid level, reaching 18m distance from the source. The drift density decreased gradually and only 1–2 tiny drops were seen after half of the maximum distance.

SIII-O7

Integrating Phenological Stage Based Weather Indices for Improved Wheat Yield Prediction Using Artificial Neural Network and Statistical Modelling Techniques

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The growing global population and agricultural challenges intensified by climate change signify the need for precise and timely crop yield prediction models. These models can help manage crops more effectively, strengthen food security and empower decision-makers to frame better agricultural policies and strategies. Accurate prediction models can mitigate the adverse impacts of climate variability and optimize resource allocation, contributing to sustainable farming practices. This study evaluated the performance of machine learning and statistical techniques for predicting rabi wheat yield, utilizing an extensive dataset of weather parameters from Udham Singh Nagar district in Uttarakhand, spanning the years 2001-02 to 2021-22. We developed prediction models using Artificial Neural Networks (ANN), Multiple Linear Regression (executed stepwise) and Ridge Regression, utilizing various sets of predictors: unweighted and weighted weather indices derived from phenological stage-based weather data, unweighted and weighted weather indices from weekly weather data and deviations of average weather parameters from optimum values at different phenological stages. Prediction models based on unweighted and weighted weather indices from weekly weather data are extensivelyused. An alternative approach of utilizing phenological stage-

specific weather indices as predictors is proposed in this study. Each crop has specific optimal climatic conditions during different phenological stages. Significant deviations from these ideal conditions can lead to substantial fluctuations in crop yield. The growth phases of wheat are divided into Vegetative phase (Germination, Crown root initiation, Tillering and Jointing stage) and the Reproductive phase (Flowering, Milking, and Dough stage) each requiring specific climatic conditions. The study evaluated the predictive performance of ten developed models using Coefficient of determination (R^2), Root Mean Square Error (RMSE), normalized Root Mean Square Error (nRMSE), Mean Absolute Error (MAE) and Error percentage. Our findings reveal that nonlinear models outperform linear models in effectively modeling the complex relationship between crop yield and input data. The Artificial Neural Network (ANN) model that utilized Phenological stage-based Weather Indices, as predictors for yield prediction provided the best results during calibration and validation among all other models (R^2= 0.96) furthermore, it surpassed the conventionally preferred yield prediction model based on weekly weather parameters. The Multiple Linear Regression and Ridge Regression models exhibited average performance with R^2 values ranging from 0.70 to 0.94. Prediction model based on Ridge Regression which utilized deviations of average weather parameters from optimum values at different phenological stages as predictors also provided notable results. The proposed ANN model offers a reliable framework for rabi wheat yield prediction, significantly advancing agricultural decision-making and resource management in the area under study. The study underscores the potential of non-linear models like Artificial Neural Networks and the need to use appropriate regressor variables to develop yield prediction models.

***Keywords*:** Yield Prediction, Artificial Neural Networks, Phenological stage-based weather indices, Ridge Regression

SIII-O8

AI and Machine Learning-based wheat yield estimation for future food security in Haryana

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Wheat is a key crop in Haryana, India and predicting its yield accurately is crucial for food security. Traditional methods like manual surveys or single-source data analysis often fall short because they aren't flexible enough to handle all the factors affecting crop production, such as changing weather and soil conditions. In this study, we used advanced data analysis tool and techniques like Artificial Intelligence (AI) and Machine Learning (ML) to predict wheat yields more accurately. By combining data on climate and crop management, we built and tested models like Lasso Regression, Ridge Regression, Support Vector Regression (SVR) and a hybrid Lasso-SVR model. First, we developed the equation using yield data from the Hisar district, sourced from the State Statistical Abstract of Haryana and the Directorate of Economics website (https://data.desagri.gov.in/website/crops-apy-report-web), along with weather data for the district obtained from the Department of Agricultural Meteorology, CCSHAU, Hisar. We analyzed the yield fluctuations under existing weather conditions to determine how crop yield varies with potential weather scenarios. After that

we simulate the data for the *Rabi* season (2022-23), these models performed exceptionally well, with the hybrid Lasso- SVR model standing out. It predicted a yield of 4631.19 kg/ha, almost identical to the actual yield of 4644 kg/ha, with an impressive R^2 score of 0.99. Our findings show that using AI and ML can give highly accurate and timely predictions and projections helping farmers make better decisions, reduce crop losses and ensure food security. This method can also be adapted for other crops and regions, making it a valuable tool for sustainable agriculture practices under changing climatic conditions.

***Keywords*:** Wheat Yield Prediction, Artificial Intelligence, Machine Learning, Food Security

SIII-O9

Machine Learning-Enhanced Modelling and Prediction of Soil Clay Content in Biswanath District, Assam, using Diffuse Reflectance Spectroscopy

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Our study investigates the use of machine learning-enhanced Diffuse reflectance IR spectroscopy (DRIS) for predicting soil clay content in Biswanath District, Assam. A total of 150 soil samples were analyzed using the International Pipette Method, with spectral data preprocessed using Savitzky-Golay (SG), Multiplicative Scatter Correction (MSC), and Standard Normal Variate (SNV) techniques. Raw spectra revealed critical absorption features for soil constituents, while preprocessing improved spectral quality. SG preprocessing was the most effective, enhancing small spectral features and minimizing noise. Mean reflectance spectra and kernel density plots confirmed consistent data distributions across calibration (n=120) and validation (n=30) data sets, ensuring reliable model performance. Geospatial analysis using empirical Bayesian kriging highlighted spatial variability, with thematic maps providing a detailed visualization of the distribution of soil clay content across Biswanath District. These maps allow for identifying areas with distinct clay content levels while exhibiting the variability between the maps of measured and predicted clay values. The SG-PLSR model demonstrated robust generalizability, with strong agreement between measured and predicted values, and reliable geospatial mapping. Statistical analysis indicated that the SG-PLSR model performed best during validation, achieving R^2=71.3%, RPD=1.81, RPIQ=2.56, and RMSE= 1.25 closely followed by the SG-RF model that achieved R^2 = 70.8%, RPD = 1.67, RPIQ = 2.19, and RMSE =1.68. Support Vector Machine (SVM) under performed across all pre-processing techniques, with validation metrics falling significantly short of the top-performing models. Calibration metrics for the SG-PLSR model showed R^2 = 89.8%, RPD = 3.14, and RMSE = 1.34, confirming its superior performance during training. This study affirms the feasibility of SG-PLSR and DRIS as moderately precise, cost-effective alternatives for soil clay prediction, providing valuable insights for precision agriculture and regional soil management.

SIII-O10

Real-Time Monitoring of Wheat Crop Growth Using IoT-Based Smart Irrigation System

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The Internet of Things (IoT)-based smart irrigation systems provide an innovative approach to monitoring soil and environmental conditions, ensuring optimal wheat growth and sustainable water use. These systems integrate advanced sensors to measure parameters such as soil moisture, temperature, humidity, and rainfall, offering real-time insights into field conditions. The data is processed using micro controllers like Arduino and transmitted wirelessly using ESP32 to cloud platforms through light weight communication protocols such as MQTT. This allows farmers to remotely monitor their fields using smart phones or web-based interfaces, enabling precise irrigation decisions. The monitoring system is designed to maintain ideal growing conditions for wheat crops by continuously analysing sensor data. Soil moisture sensors track water levels, ensuring crops receive just the right amount of water to prevent under-or over-irrigation. Temperature and humidity sensors (DHT11) monitor the environment, providing insights into conditions that may impact plant health. Rain drop sensors detect precipitation, allowing the system to adjust irrigation schedules dynamically, further conserving water. These real-time adjustments minimize resource wastage and promote efficient agricultural practices. Field tests have demonstrated the efficacy of IoT-based monitoring systems in enhancing wheat crops health and growth. By providing consistent soil moisture levels and tailoring water delivery to the specific needs of plants, the system supports improved yields. Wheat crops grown using this technology show better resilience to environmental stressors such as drought or excessive rainfall, as the system reacts promptly to changing conditions. The integration of IoT technology in agriculture marks a significant step toward sustainable farming practices. The continuous monitoring and data-driven adjustments ensure efficient use of resources while maintaining environmental balance. As demonstrated in controlled field trials, the system reduces water consumption by up to 30%, a critical factor in regions facing water scarcity. By improving the monitoring process, IoT-based systems not only support agricultural productivity but also contribute to global efforts to ensure food security in the face of climate change challenges. In conclusion, IoT-based smart irrigation systems revolutionize agricultural monitoring by leveraging real-time data and automation. Their ability to maintain optimal soil and environmental conditions ensures healthy wheat growth and maximizes yields. The combination of low-cost technology, user- friendly interfaces, and advanced analytics makes these systems a practical and scalable solution for farmers worldwide. With further advancements in sensor accuracy and predictive models, IoT-driven monitoring systems are set to play a pivotal role in the future of sustainable agriculture.

SIII-O11

Downscaling Land Surface Temperature Using Random Forest and Multi- Sensor Satellite Data: A Case Study in Diverse Terrain

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Downscaling remote sensing-derived Land Surface Temperature (LST) data sets is crucial for various research areas, such as urban heat studies, irrigation management, and volcanic activity monitoring, among others. In this regard, this study focuses on the downscaling of LST using Landsat and Sentinel-2 data on the Google Earth Engine (GEE) platform. The primary objective was to enhance the spatial resolution of LST to 10 meters using Random Forest Regression (RFR) at two study sites, Kangra and Saharanpur, which exhibit different climatic characteristics. Independent variables such as spectral bands, vegetation indices (e.g., NDVI, NDBI, NDWI), and topographic factors (elevation, slope, aspect, and hillshade) were incorporated into the model. The downscaled LST results were validated using field data from FLIR thermal camera and flux tower measurements of longwave radiation. In the Kangra region, thermal camera-based LST showed a good correlation with downscaled LST (R^2 = 0.73, RMSE = 2.70°C), while flux tower-based LST exhibited an even better correlation (R^2 = 0.86, RMSE = 1.79°C). In Saharanpur, the downscaled LST demonstrated higher accuracy with thermal camera-based LST (R^2=0.77, RMSE = 1.98°C). These results show that satellite-derived LST aligns well with tower-based measurements, particularly at flux tower sites, and highlight the importance of accounting for both spatial and temporal variations in LST. Five window sizes were tested, with a window size of 20 providing optimal performance in both regions, resulting in the lowest RMSE values (2.72°C in Kangra and 0.62°C in Saharanpur). The study underscores the significance of incorporating multiple covariates, particularly in complex terrains like Kangra, where topography heavily influences LST distribution. The Random Forest model can outperform traditional methods like TSharp in downscaling LST, especially in heterogeneous landscapes. These findings demonstrate that remote sensing-based LST downscaling using RFR and multi-sensor data provides a reliable tool for enhancing LST resolution, facilitating environmental monitoring, urban heat management, and irrigation planning.

***Keywords*:** Land Surface Temperature, Sentinel-2, Landsat8, Random Forest regressor, FLIR Thermal Camera

SIII-O12

Comparative evaluation of Random Forest, ANN and LASSO models for turmeric yield prediction

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Turmeric (*Curcuma longa* L.) is an annual tropical herb belonging to the order *Zingiberales*and family Zingiberaceae and mainly used as spices, condiments, dye, drug and cosmetic in India. Accurate prediction of turmeric yield is vital for optimizing agricultural practices, especially inregions like Kerala with fluctuating weather conditions. This study explores the application of machine learning techniques to forecast turmeric yield based on weather parameters. The field experiment was carried out at the Instructional Farm, located at College of Agriculture, Vellanikkara, KAU for three consecutive years (2021 to 2023). The turmeric variety, *Kanthi* was cultivated at four dates of planting. The weather data for the experimental period was collected from the Department of Agricultural Meteorology, College of Agriculture, Vellanikara, Thrissur, Kerala. The collected data were analysed using RStudio, Python, SPSS and Microsoft Excel. The yield prediction models were developed using Machine Learning techniques. The comparison of various models have been done using Mean Absolute Error (MAE), R^2 and Mean Absolute Percentage Error (MAPE). Among the models, Random Forest model stands out with remarkable accuracy and reliability. It demonstrated the lowest Mean Absolute Error (MAE) of 625.45 and the highest R^2 value of 0.88, indicating its superior capability to explain the variance in turmeric yield. Additionally, the Random Forest model achieved the lowest Mean Absolute Percentage Error (MAPE) of 4.48%, underscoring its robustness and precision in yield prediction. The Artificial Neural Network (ANN) model also performed well, with R^2 value of 0.843 and an MAE of 1195.86. While ANN showed significant potential, it did not surpass the performance metrics of Random Forest. The ANN's Mean Absolute Percentage Error (MAPE) was 8.22%, highlighting its effectiveness, but still trailing behind the Random Forest model. On the other hand, the LASSO (Least Absolute Shrinkage and Selection Operator) model, known for its feature selection capabilities, achieved R^2 value of 0.26 and an MAE of 1320.33. LASSO overall prediction accuracy was lower compared to Random Forest and ANN. The LASSO model had a MAPE of 9.74%, indicating relatively higher prediction errors. Based on the comprehensive analysis, the Random Forest model emerges as the best fit for predicting turmeric yield, offering accurate and interpretable insights that can significantly aid farmers in making informed decisions to enhance production through cultivation practices.

Keywords: Random Forest model, ANN, LASSO, Turmeric yield prediction

SIII-O13

Mapping Apple Orchards in Himachal Pradesh: Advanced Object-Based Classification Using Multi-Source Satellite Imagery

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Apple, being one of the major agricultural products of Himachal Pradesh, there is a need to create an insurance product catered to the need of apple farmers. To understand the risk exposure to farmers in the state, it is important to map the exact extent and locations of apple orchards per insurance unit. The Government of India's Insurance scheme Restructured Weather Based Crop Insurance Scheme (RWBCIS) covers a widerange of horticultural crops, and this study is an attempt to create a basemap for the apple insurance product. This study aims to map and classify apple orchards in the Kullu and Shimla regions of Himachal Pradesh, India, leveraging multi source remote sensing data and advanced image processing. The research employs a multi-step workflow combining vegetation indices-Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Normalized Difference Water Index (NDWI), Digital Elevation Models (DEM) and its derivatives, and an object-based approach to create an apple extent map catered for insurance implementation. A novel approach of refining classification was employed which involved the use of Global Forest Canopy Height (GFCH) dataset for differentiating between apple trees and other tree vegetation, such as coniferous forests. An object-based classification of Sentinel-2 images was conducted following a segmentation algorithm which created spectrally homogenous 'objects', which was critical in extraction of orchard patches. To further improve classification accuracy, a decision tree-based machine learning classifier was applied, incorporating the segmented data and geospatial layers (e.g., NDVI, EVI, NDWI, DEM, and slope). Post-classification refinement involved filtering out non-orchard areas using a set of logical conditions based on these variables. The final product of this study is a detailed, classified map of apple orchards in Kullu and Shimla districts for the year 2024. This map can be used to create an insurance unit wise area and distribution of apple orchards, and help the stakeholders, namely government and insurance companies in identifying intensity of risk faced for creating term sheets. Additionally, this map can be utilized for long term land use planning and creating district wise production estimates and supply chain maps.

Keywords: GFCH, Object-Based, and Geo-spatial layers

SIII-O14

Machine Learning-Based Seasonal Drought Assessment in Agriculture-India

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The assessment of agricultural drought is critical for understanding its impact on crop production, water resources, and rural economies, particularly in regions like India, where agriculture plays a central role in livelihoods and food security. Traditional drought assessment methods, which rely on meteorological data and field observations, often fall short in addressing the spatial and temporal variability of droughts, especially in large and diverse regions like India. In this context, drought assessment using machine learning (ML) has emerged as a promising approach to improving the efficiency, and timeliness of drought monitoring and management. This study focuses on machine learning-based approaches for spatial-temporal historical drought assessment and monitoring in India's agricultural sectors. The research utilizes remote sensing and climatic inputs, including precipitation, temperature, soil moisture, and vegetation indices such as the Normalized Difference Vegetation Index (NDVI), to assess drought conditions during the monsoon season from 2002-2024 year. Anomalies in NDVI, along with temperature, soil moisture and rainfall data, are integrated to analyze drought severity, monitor crop stress, and evaluate the duration of drought events. A range of machine learning algorithms, including Random Forest, Support Vector Machines (SVM), and deep learning models like Convolutional Neural Networks (CNN), are employed to examine the complex relationships between these variables and assess their broader impact on crop health. Integrating time-series datasets and advanced ML techniques, the study aims to provide more granular insights into drought dynamics and provide insights into crop vulnerability to changing climatic conditions. Furthermore, ML models integrate with Geographic Information Systems (GIS) to spatially analyze drought-prone areas, offers actionable insights for policymakersandfarmers.Theseinsightsenabletimelyinterventionssuchaswatermanagementstrategiesand optimized crop selection. ML-driven drought tools can play a significant role in monitoring early drought warnings, enabling better forecasting models and more effective drought management strategies in the future.

***Keywords*:** Agricultural drought, Machine learning algorithms, spatial and time-series analysis.

SIII-O15

Crop Yield Forecasting Using Different Techniques of Machine Learning for Prayagraj Region

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Accurate crop yield forecasting is crucial for efficient agricultural management, optimal resource utilization, and ensuring food security. Precise yield predictions enable farmers, agronomists, and policymakers

to make informed decisions that enhance productivity and sustainability. This study evaluates the performance of various machine learning techniques for forecasting the yields of five major crops—Rice, Wheat, Maize, Mustard, and Potato—using data from the Prayagraj region. The long-term weather data and crop data (1999-2022) were taken into consideration to evaluate the performance of different regression and neural network. The evaluated machine learning models included Multiple Linear Regression (MLR), Least Absolute Shrinkage and Selection Operator (LASSO), Ridge Regression, Elastic Net (ELNET), Stepwise Multiple Linear Regression (SMLR), Artificial Neural Networks (ANN), and Random Forest. The results demonstrate that the ANN model outperformed all other models across both simple and composite weather indices for all five crops.For Maize, ANN achieved RMSE values of 0.29 (simple) and 0.19 (composite) during testing. For Wheat, ANN showed strong performance with RMSE values of 0.31 (simple) and 0.12 (composite). Similarly, ANN exhibited superior performance for Rice (RMSE = 0.31 simple, 0.26 composite), Mustard (RMSE = 0.31 simple, 0.32 composite), and Potato (RMSE = 0.05 simple, 0.20 composite). In comparison, models such as MLR, SMLR, LASSO, ELNET, Ridge, and Random Forest demonstrated poor performance, particularly during testing. The ANN model consistently provided higher accuracy and lower RMSE values in both training and testing phases, making it the most reliable model for crop yield forecasting in the Prayagraj region. These results demonstrate how well Artificial Neural Networks (ANNs) predict agricultural yields and point to how they could greatly improve precision farming decision-making. Artificial Neural Networks (ANNs) can analyze large, complex datasets and find patterns that help improve crop management, optimize resource allocation, and make more accurate predictions. As a result, farming methods may become more sustainable overall, more productive, and less wasteful.

***Keywords*:** Crop Yield Forecasting, Weather Variables, Machine Learning, ANN, LASSO

SIII-O16

Drought Monitoring and Forecasting in the Chhattisgarh Plains Using the Drought Risk Index and Machine Learning Techniques

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This research tackles the critical challenges of drought monitoring and forecasting in theChhattisgarh Plains, integrating machine learning techniques with the Drought Indices Calculator (DRINC). Utilizing an extensive dataset spanning from 1990 to 2023, sourced from the Indian Meteorological Department, thestudyfocuses onfive key districts: Baloda Bazar, Kabirdham, Raipur, Bemetara, and Mungeli. The aim is to enhance the accuracy of drought forecasts which are crucial for effective agricultural planning and water resource management in this predominantly agricultural region. The methodological approach harnesses the capabilities of Artificial Neural Networks (ANNs) and AutoRegressive Integrated Moving Average (ARIMA) models within MATLAB to forecast meteorological and agricultural drought scenarios up to 2050. These forecasts employ a variety of drought indices, including the Standardized Precipitation Index (SPI), Agricultural Standardized Precipitation Index (aSPI to evaluate drought occurrences and their severities. The study employs XLSTAT toanalyseclimaticvariability, applyingstatisticaltechniques suchas trendanalysis withthe Mann-Kendall test. This dual approach of using advanced predictive models and traditional statistical tests provides

a comprehensive understanding of climatic impacts on agricultural productivity, particularly focusing on rice yields which are highly sensitive to water stress. The forecasting results highlight a trend of increasing temperatures and fluctuating precipitation patterns across the Chhattisgarh Plains. These changes are expected to significantly impactagricultural outputs, indicating a need for strategic adjustments in agricultural practices and water management. The study identifies critical periods and regions at heightened risk of drought, aiding in the proactive management of resources. In conclusion, this study showcases the importance of sophisticated forecasting models and traditional statistical methods in understanding and managing drought risks effectively. By leveraging the DRINC for in-depth drought assessments and employing MATLAB and XLSTAT for modelling and analysis, the research offers valuable insights into the patterns and impacts of drought. These insights support stakeholders in implementing informed, effective drought management strategies, enhancing the resilience of agricultural systems against the backdrop of evolving climate dynamics.

Keywords: Drought Monitoring, DRINC, Machine Learning, Chhattisgarh Plains, MATLAB, XLSTAT, Artificial Neural Networks, ARIMA, Drought Indices, Forecasting, Climatic Variability

SIII-O17

AI Enabled Farm-Specific Crop Disease Identification and Control

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Advance Image Processing in in-situ survey and remote sensing data can play major role in agriculture using artificial intelligence (AI/ ML) to facilitate crop monitoring and agro-services inreal time. We have also attempted to build an application model to enhance crop production by integrating crop status and agro-met advisories in an customized manner through automated (1) recognition plant diseases and impact analysis of treatment provided so far in oparticular disease, (2) monitoring crop performance using VCI data, and (3) check for disease control. In the proposed application, facility for capturing the plants pictures is provided to assess real time status of plant organs, vegetation, their colour and textures. Further, the same is uploaded to server where AI based data analytics takes place to recognize disease in crop if any, spread probability of disease, need for pesticide, fertilizer and irrigation in well advance (10-15 days) *etc*. India Meteorological Department issues district/ block level agro-meteorological advisory, which does not include ground level real- time solution customized to particular farmer. With the proposed solution through an AI application, (1) users (farmers through their phone), or (2) remote sensing instruments such drones can capture and send the pictures time to time to the server to monitor the impact of disease and treatment being applied. The application will be very useful in automatic recognition of disease for uneducated farmers as well as for the prediction of non-regional disease in the plants. A cloud server has realtime videos/ images, predefined dataset for the purpose of matching the data, being provided by different users and remote sensing dataset (VCI) received from satellite observations. Here, Autoencoder based Classifier *i.e.* a multi-layer Deep learning model is designed for large-scale classification of plant and farm images, which are collected from various farmers, are analyzed with predefined images over GIS platform using machine learnings algorithms for the indication of plant diseases and infections along with its various parameters including crop organs status, crop-stage,

disease stage *etc*. After crop status and weather analysis together, customized advisory is issued to the user through application either in visual or audio form. At present, the proposed application provides solutions for the diseases of potato, wheat & corn leaves along with estimated loss, smart irrigation (helping in saving water) for the States of Madhya Pradesh. Several KVK's in M.P. assisted to validate the predcitions of disease and in collection of data, which shows 93% accuracy in disease identification based on 6 years data period (2018-2024), indicating the strong feasibility to adapt it for integrating in agro-met advisory DSS platform.

***Keywords*:** Artificial Intelligence, Deep learning, Agro-met advisory, Remote sensing, Crop disease, Autoencoder, Disease classifier, VCI.

SIII-O18

Enhancing Mulberry growth and Leaf Productivity through Sensor-based Drip irrigation and Nitrogen management

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The research entitled "Enhancing mulberry growth and leaf productivity through sensor-based drip irrigation and nitrogen management" was conducted at the department of sericulture, UAS, GKVK, Bengaluru during 2022-23. There were nine treatment combinations comprising of three different drip irrigation and nitrogen management methods replicated three times and laid out in strip plot design and observations were recorded at 30, 45 and 60 days after pruning. Horizontal factor (irrigation management) included conventional drip irrigation, yellow soil moisture indicator-based irrigation and sensor-based drip irrigation, whereas vertical factor (nitrogen management) included no nitrogen (control), 100% recommended dose of nitrogen and NDVI based nano urea application. Results revealed that growth and yield parameters of mulberry and water productivity were significantly influenced by different methods of irrigation and nitrogen management. Among different treatment combination, sensor-based drip irrigation with NDVI based nano urea application recorded highest shoot length (54.61, 105.37 and 119.06 cm at 30, 45 and 60 DAP, respectively), number of shoots plant^{-1} (18.47, 25.27 and 25.73 at 30, 45 and 60 DAP, respectively), number of leaves plant^{-1} (144.92, 305.93 and 334.76 at 30, 45 and 60 DAP, respectively), leaf area (74.18, 131.72 and 166.07 cm^2 at 30, 45 and 60 DAP, respectively), leaf dry matter accumulation (54.39, 211.03 and 335.15 g plant^{-1} at 30, 45 and 60 DAP, respectively) and highest leaf yield (718.20 g plant^{-1}) at 60 DAP compared to other treatment combinations, whereas lowest growth and yield parameters were observed under yellow soil moisture indicator based irrigation with no nitrogen application. Higher water productivity (630.02 kg hacm^{-1}) and higher water saving percentage (20.40%) found in mulberry plots laid under sensor-based drip irrigation compared to conventional drip irrigation. These results showed that sensor-based drip irrigation with NDVI based nano urea application is appropriate to enhance leaf yield and water productivity in mulberry.

***Keywords*:** Sensor based irrigation, Mulberry, Water productivity, Growth parameters

SIII-O19

Integrated AI-Powered Pollinator Drones and IoT-Driven Environmental Monitoring System for Enhanced Pollination and Sustainable Agriculture

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Pollinator decline has become a big challenge to agriculture in the world, especially those relying on insect pollination. This was envisioned as the first aggregated solution that enables AI-enabled pollinator drones with IoT-enabled environmental health monitoring for optimizing pollination and sustainable agriculture. The system employs autonomous drones with micro-pollen dispensers, operated using specialized adaptive path planning algorithms, to perform precision pollination based on real-time data. IoT sensors will be embedded in critical areas of agricultural fields to monitor soil moisture content, temperature, and air quality to communicate feedback to regulate drone operations and resource allotment. Predictive analytics using deep reinforcement learning will consider sensor data to give optimal pollination timing, estimate crop yield, and subsequently redistribute resources such as water and pest control. Integrating real-time environmental monitoring and AI-driven pollination helps address the limitations of existing artificial pollination technologies, reduces resource waste, and increases crop productivity. This is the first scalable, flexible, and ecologically friendly approach for agricultural pollination, thus slowly contributing to sustainable food production and environmental stewardship.

SIII-P1

Harnessing Artificial Intelligence, Machine Learning and IoT for Precision Agriculture: A Comprehensive Review

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Digital agriculture is revolutionizing modern farming systems through the integration of Artificial Intelligence (AI), Machine Learning (ML) and the Internet of Things (IoT). These advanced technologies address pressing agricultural challenges, including resource management, climate variability and global food security, by enabling precision agriculture- a data-centric approach to optimizing farm operations. This review synthesizes insights from 14 foundational studies, exploring key applications, challenges and future directions in the adoption of AI, ML and IoT within agricultural sector. AI enhances predictive modeling and decision-making by analyzing complex datasets to forecast crop yields, optimize irrigation schedules and detect pest infestations with high accuracy. ML further supports these processes by automating tasks such as soil quality assessment, crop health monitoring and weather prediction, enabling informed decision-making and reducing resource inefficiencies. Additionally, AI-driven robotics has transformed labor-intensive operations, including planting, weeding and harvesting, thereby improving operational efficiency and scalability. IoT-based smart sensor networks provide real-time data on soil moisture, temperature, pH levels and other critical environmental

parameters. The integration of IoT with AI delivers predictive and prescriptive capabilities, allowing autonomous irrigation adjustments and efficient resource allocation. This dynamic interplay among technologies fosters sustainable farming practices, cost reduction and productivity enhancement. Despite these advancements, there exist certain barriers. High implementation costs, limited technical expertise, data privacy concerns and the complexity of integrating diverse technologies pose challenges to widespread adoption. Addressing these issues necessitates a comprehensive approach involving technological innovation, capacity building and supportive policy frameworks. This review reveals the need for cost-effective, scalable solutions tailored to smallholder farmers, particularly in developing regions. It calls for robust data governance frameworks to safeguard privacy and equitable technology access. Collaborative efforts between research institutions, industry stakeholders and policymakers are imperative to drive innovation, enhance technology adoption and ensure sustainable agricultural transformation. By synthesizing current research, this review highlights the transformative potential of AI, ML, and IoT in advancing precision agriculture and emphasizes their critical role in securing a resilient and sustainable global food system.

***Keywords*:** Digital agriculture, Artificial Intelligence, Machine Learning, Internet of Things, Precision agriculture

SIII-P2

Assessing Trends in Crop Productivity and Their Role in Assam's GSDP Using Machine Learning

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This study investigates the trends in agricultural productivity and its contribution to Gross State Domestic Product (GSDP) in Assam, emphasizing the importance of accurate modelling for agricultural economics research and policy formulation. We explore various curve-fitting techniques, including Exponential, Modified Exponential, Gompertz, and Power curves, and find that the Modified Exponential curve provides the best fit, as evidenced by higher , lower MSE, and AIC, along with significant t-values. Additionally, we apply Mann- Kendall and Sen's slope tests to determine the direction and magnitude of trends and utilize ArcGIS mapping through exploratory data analysis. Furthermore, we calculate key growth indicators, such as growth rate, average growth rate, compound growth rate, and compound annual growth rate, to assess the performance of the agricultural sector. Our findings highlight the essential role of agricultural productivity in driving economic growth, improving GSDP, and promoting food security and employment. By integrating advanced statistical techniques and machine learning methods, this study provides valuable insights for policymakers, helping them make data-driven decisions to foster sustainable agricultural development and economic welfare.

***Keywords*:** Agricultural Productivity, GSDP, Trend Analysis, Modified Exponential Curve, Mann-Kendall Test

SIII-P3

Critical Assessment of Drone Applications in Agriculture: A comprehensive overview from the North eastern Region of India

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The transition of traditional agricultural methods to modern agricultural practices is encapsulated in the concept of Smart Agriculture, which integrates automation, robotics, artificial intelligence (AI), big data, and information and communication technologies (ICT). Drones, or Unmanned Aerial Vehicles (UAVs), have emerged as valuable asset in agriculture, capable of performing tasks that include surveying crops, monitoring field conditions, and applying pesticides. Research indicates that drones can significantly outperform conventional spraying techniques, reducing pesticide use and minimizing health hazards associated with manual applications. The following study aims to provide a comprehensive overview of agricultural drones as an effective UAV technology for specific agricultural applications across various locations in Assam and Sikkim during 2022-2023. The research involved detailed evaluations of drone technical parameters and field performance metrics against traditional knapsack sprayers. Field experiments were conducted across multiple districts in Assam and Sikkim. The UAV used in this study was a hexa-copter equipped with advanced features including GPS modules, sensors, and a spraying system designed for agricultural applications. The comparative analysis focused on several key parameters: yield outcomes from drone-sprayed fields versus those treated with conventional sprayers; pest control effectiveness; operational costs; and overall efficiency. Initial results indicated that fields treated with drone technology yielded higher rice production compared to those using traditional methods. For instance, yields varied across different regions,with drone-treated fields achieving up to 5.5 tons per hectare compared to lower yields from conventional methods. In terms of pest control efficacy, the reduction in insect population post-spraying was significantly more pronounced in fields treated by drones than those using knapsack sprayers. This enhanced effectiveness is attributed to the finer droplet size produced by drones, which allows for better coverage and penetration of the crop canopy. Economic evaluations revealed that while initial costs for drone technology may be higher due to the need for skilled operators, the overall operational costs are lower when considering labour efficiency and reduced chemical usage. Manual sprayer requires approximately 2.5 days to cover one hectare, while a UAV sprayer can accomplish the same task in just 25 to 30 minutes. The average expenditure for a drone spray was found to be Rs. 756.25/hectare, significantly lower than the Rs. 1, 806.25 spent on manual spraying. The study also notes that water consumption plays a crucial role in determining cost-effectiveness; only 10 liters of water are needed for UAV spraying compared to 150-200 liters for manual methods. Furthermore, it was registered that drones require less chemical input of 40-50 grams of Thiamethoxam for field spraying versus 150 grams for manual spraying, resulting in lower operational costs. This efficiency not only contributes to economic viability but also supports water conservation efforts, which are essential for sustainable farming practices. Overall, the findings suggest that drone technology presents a more economical and environmentally friendly alternative to conventional agricultural methods, prompting a shift towards digital management tools among farmers as they seek to optimize costs and resource usage amidst rising prices in irrigation and chemicals.

SIII-P4

Machine learning models for predicting strawberry yield: A comparative study of Random Forest, Ada Boost, and Gradient Boosting

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Accurate prediction of strawberry yield is essential for optimizing agricultural practices, especially in regions with variable weather conditions such as Wayanad, Kerala. This study employs machine learning techniques to predict strawberry yield using weather parameters and phenophase- specific data. Three popular machine learning models—Random Forest, AdaBoost and Gradient Boosting – were evaluated in two stages. Initially the weather data from each phenophase of strawberry growth were used for the evaluation followed by weather data from planting to flower opening, combined with yield data. The model performance was assessed using Mean Squared Error (MSE) and R-squared (R^2), quantifying the accuracy and reliability of yield predictions. Random Forest demonstrated superior performance among the individual models evaluated with phenophase-specific weather data, achieving the lowest MSE (1102.96) and highest R^2 (0.61). indicating high predictive accuracy and reliability. AdaBoost and Gradient Boosting also exhibited competitive performance, with MSE values of 1189.35 and 1379.69 and R^2 values of 0.58 and 0.51 respectively. When analyzing the performance of the models using the parameters such as the flower count and weather data from strawberry planting to flower opening, Random Forest again outperformed the other models with a lowest MSE of 538.18 and a highest R^2 of 0.81, indicating its robustness for yield prediction. AdaBoost followed closely, while Gradient Boosting performed poorly in this context, with a high MSE of 1556.34 and a low R^2 of 0.45. Feature importance analysis using Random Forest identified key weather parameters influencing yield across different phenophases, with afternoon relative humidity consistently being a critical factor, along with other variables such as evaporation, rainfall, and bright sunshine hours. These findings underscore the importance of understanding phenophase-specific environmental interactions in predicting strawberry yield. The results indicate that Random Forest is the most reliable model for predicting strawberry yield, providing accurate and interpretable predictions that can assist farmers in making data-driven decisions.

Keywords: AdaBoost, Gradient Boosting, Random Forest, phenophases, Feature importance analysis

SIII-P5

Role of Artificial Intelligence in Vegetable Production

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Role of Artificial Intelligence (AI) in vegetable production, emphasizing its potential to address critical challenges such as climate change, population growth, and resource scarcity. AI technologies, including machine learning, computer vision, and robotics, are revolutionizing agricultural practices. AI-driven innovations in crop management, pest control, and soil analysis enhance productivity, reduce labour costs, and ensure sustainable farming practices. Notable advancements include precision spraying by Blue River Technology, significantly reducing herbicide use, and deploying autonomous tractors and drones for efficient farm management. AI applications, such as PEAT's Plantix and Trace Genomics, provide accurate diagnostics for soil health and pest management. Satellite-based solutions like Farm Shots and a Where offer real-time crop monitoring and weather prediction, optimizing resource use and mitigating risks. The review highlights the importance of making AI technologies more affordable and accessible to farmers, particularly in developing regions. Collaboration between researchers, industry stakeholders, and policymakers is crucial to harness AI's full potential in agriculture. As AI continues to evolve, its integration into vegetable production promises a more efficient, resilient, and sustainable agricultural sector, contributing to global food security and environmental preservation. The aim of the study is to evaluate the impact and effectiveness of Artificial Intelligence (AI) in vegetable production, focusing on how AI technologies enhance productivity, efficiency, and sustainability. The objectives are to assess current AI applications, analyze their benefits and challenges, and provide recommendations for future improvements and wider adoption in the agriculture. The study on the role of Artificial Intelligence in vegetable production involves a comprehensive literature review of existing AI technologies and their applications in agriculture, coupled with the analysis of case studies to evaluate real-world implementations. Additionally, expert interviews and surveys with farmers and industry professionals will be conducted to gather insights on the benefits, challenges, and future potential of AI in this sector. The theoretical implications of the study on the role of Artificial Intelligence in vegetable production include advancing the understanding of AI's capabilities in agricultural optimization and contributing to the academic discourse on sustainable farming practices. Practically, the study provide sactionable insights for farmers and agri-businesses on implementing AI technologies to enhance crop yields, reduce resource wastage, and improve overall farm management efficiency.

***Keywords*:** Artificial intelligence; vegetable production; crop management; autonomous tractors; drones' devices; sustainable and smart farming

SIII-P6

Rainfall Forecasting in North Bank Plain Zone of Assam Using ARIMA and LSTM

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Prediction of rainfall is one of the major concerns in the domain of meteorology. Several techniques have been formerly proposed to predict rainfall based on statistical analysis, machine learning and deep learning techniques. This paper presents Autoregressive Integrated Moving Average (ARIMA) and Long Short-Term Memory (LSTM) based Recurrent Neural Network (RNN) to predict rainfall. The neural network is trained and tested using a standard dataset of rainfall. The parameters considered for the evaluation of the performance and the efficiency of the proposed rainfall prediction model are Mean Square Error (MSE), accuracy, number of epochs, loss, and learning rate of the network. The results obtained are compared with each other in order to exemplify the improvement in the ability to predict rainfall. The present study was undertaken with the objective of forecasting of rainfall for different locations of the North Bank Plain Zone (NBPZ) of Assam. Long-term rainfall data from 1991-2020 across three districts *viz*. Lakhimpur, Biswanath, and Sonitpur of NBPZ were collected from IMD, Pune. Autoregressive Integrated Moving Average (ARIMA) and Long Short-Term Memory (LSTM) methods were used for developing forecasting models of monthly rainfall for three selected districts using the 90% (1999 to 2017) and 10% (2018 to 2020) of rainfall data as training and testing data, respectively. The different combinations of parameters, such as number of nodes, epochs, batch size, and verbose were considered following standard procedures for developing Long Short- Term Neural Network (LSTM) models separately for each district using Python software. The models with low MSE for training and testing data sets were selected as the best-fit models for forecasting rainfall of the selected districts. The LSTM models have a lower MSE than the ARIMA models, indicating that LSTM models performed better than the ARIMA models. Among the LSTM models, the predictive model developed for the Lakhimpur district was the best model with the minimum MSE. The best-fit LSTM model for Lakhimpur was refit for the entire period from district up to July 2024. It was found that the predicted rainfall closely matched the pattern of observed monthly rainfall from 2021 to 2024. The positive and linear correlation (r= 0.885) observed between the observed and predicted rainfall indicating the accuracy and usefulness of the model.

Key words: Rainfall Forecasting, Autoregressive Integrated Moving Average (ARIMA), Long Short-Term Memory (LSTM) and Mean Square Error (MSE)

SIII-P7

Artificial Intelligence (AI) and Machine Learning in Soil Analysis

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The integration of Artificial Intelligence (AI) and Machine Learning (ML) offers innovative approaches to soil analysis. AI, as defined by McCarthy at the Dartmouth Conference (1956), enables machines to simulate human intelligence through learning, reasoning, and problem-solving (Russell and Norvig, 2021). Its application in agriculture includes predictive analytics for yield forecasting, soil health surveillance, and disease prediction Machine learning models like Artificial Neural Networks (ANN) and Decision Trees have demonstrated high accuracy in analyzing soil parameters such as pH, bulk density, and organic carbon. Tools like MATLAB and CNN-RNN models further enhance precision, achieving training accuracies of upto 89.26%. Emerging ML methodologies like Support Vector Machines (SVM) and Weighted K-Nearest Neighbors (K-NN) are proving effective in classifying soil nutrient levels and predicting crop suitability. Greater estimation accuracy was achieved for soil shear strength and soil aggregate stability by SVM comparable to that of traditional multiple linear regression. An accuracy of 100% can be achieved in determining soil nutrients through image processing combined with artificial neural networks (ANN). Spectral techniques for predicting soil organic carbon (SOC) have shown potential as an alternative to conventional chemical measurement methods. Using spectral reflectance data and machine learning algorithms like PLSR, R-squared values of 90.50 and 94.10, along with RMSE values of 0.10 and 0.08, were achieved in the calibration and validation datasets, respectively. Random Forest algorithm showed more accuracy with R-sqaured value 0.84 in determining soil organic matter content across different machine learning algorithms. The use of drone-based imaging and sensor fusion in soil microbial assessments further highlights the diversity of AI applications in the field of agriculture. AI's ability to process large datasets allows for real-time decision-making, improving resource efficiency and reducing agricultural waste. Experiments across diverse agro-climatic zones validate the scalability of these technologies in precision agriculture. With continuous advancements, AI and ML are expected to redefine soil management practices, paving the way for innovative, sustainable farming solutions globally.

***Keywords*:** Artificial Intelligence, Machine Learning, Soil Analysis, Drone, Image, Accuracy, Datasets

SIII-P8

Advanced Application of Unmanned Aerial] Vehicles for Precision Agriculture

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In recent years, significant advancements have been observed in the domain of precision agriculture, particularly in the area of monitoring. This surgein activity is not only directedat enhancing agricultural

productivity but also at addressing the growing food demands of an ever-increasing global population. Moreover, the aerial application of agrochemicals provides a cost-effective, adaptable, and efficient approach, minimizing the risk of crop damage and preserving the physical integrity of the soil during application, unlike ground-based methods. At a broader level, the accurate and efficient monitoring of large-scale agricultural fields presents considerable challenges due to their extensive and diverse nature. Additionally, spray drift can lead to low utilization of UAV sprayers application, environmental pollution and by stander exposure risk. Consequently, this paper gives a comprehensive review of the techniques utilized in precision agriculture monitoring, with a specific focus on employing drones equipped with multi spectral, thermal, and visible-spectrum cameras.

SIII-P9

Climate-Driven Precision Agriculture in Cold Regions Using IoT and AI

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Precision agriculture helps to improve cropping systems, especially in cold agricultural areas, by providing solutions to challenges posed by adverse weather and environmental conditions. In cold areas, farming is influenced by weather uncertainties, risks of frost, and temperature variations, all of which could affect yields. This research, entitled "Climate-Driven Precision Agriculture in Cold Regions Using IoT and AI," highlights how advanced technologies address these hurdles. This approach, for instance, incorporates IoT sensors to collect real-time climatic records concerning temperature, humidity, soil moisture, and radiation. This data is fed into a cloud-based platform, where they are further processed and analyzed, thus allowing farmers to obtain actionable insights and climate predictions. AI-driven models can also aid in predicting climate trends, identifying abnormal conditions, and giving recommendations for ideal crop management. The system includes automated solutions like smart irrigation, frost prevention, and greenhouse management, which act autonomously based on real-time data. These functionalities aim to minimize resource waste, optimize water use, and provide ecological preservation. Drones equipped with thermal and optical imaging systems are also used to monitor temperature variations over large land areas and find localized microclimates to act and counteract the risks of frost. Blending IoT, AI, and drones, this research provides farmers with a comprehensive tool kit for climate-smart agriculture. A scalable and sustainable approach to increasing productivity, reducing waste, and adapting to climate change is also introduced in this research work. Ultimately, the overall vision of this research is to improve food security through strengthening agricultural resilience in cold climates while promoting ecological sustainability and conservation of resources.

SIV/LT-1

Geomatics and Crop Models: Innovative Tools for Climate-Smart Agriculture

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Geomatics comprising innovative geospatial technologies *viz*. remote sensing, GIS, GNSS and data analytics has been providing newer dimension to solve problems of agriculture. In the current era of climate crisis, geospatial technology plays a crucial role in every facet of climate-smart agriculture including improving resilience, mitigating GHGs and ensuring sustainable food production. Crop models are one kind of simulation tools to understand behavior of crops and their response to weather/climate patterns and extremes. Integration of these versatile tools provide critical insights on agricultural systems and helps in developing decision support systems and early warning system to support agricultural hazard risk, advisory services and food security on regional or Global scale. Geospatial technologies now-a-days providing valuable and spatially explicit data as well as new insight for optimizing agricultural resource use and agronomic practices including precision farming. Satellite Imageries from earth resource and meteorological satellites can be integrated with crop models, and in-situ weather / forecast scenarios to develop lead-time crop yield prediction, drought forecasting as well as DSS for irrigation advisory and pest-disease warning. GIS integrated crop models like GEPIC (GIS based Erosion Productivity Impact Calculator) has enormous potential in achieving climate smart agriculture by assessing the of crops impact of climate change on p roductivity in spatial manner and identifying agronomic adaptation strategies. High resolution satellite imageries with frequent snapshot and drone imageries are revolutionizing agriculture by providing early and vital information on biotic/abiotic stresses, crop health, evapotranspitration and crop yield for informed decision making to farmers on precise farm input applications and crop insurance payout. Rapid evolution of geospatial technology including satellite sensor capability, data assimilation into crop models and big data analytics (artificial intelligence & Machine Learning) will have significant impact on realization of climate-smart agriculture in developing countries.

***Keywords*:** Geomatics, Crop Model, climate-smart agriculture, satellite remote sensing, climate change

SIV-O1

Estimation of NPP Using Casa Model at Saraswati Wildlife Sanctuary (SWS), Haryana

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Net primary productivity of Saraswati wildlife sanctuary (SWS), an important forest ecosystem of Haryana existing in semi-arid climate was estimated using CASA model. Total 36 locations each of 0.1 hectare were used for the ground data collection in the forest. NDVI (Normalized difference vegetation index) and LSWI (Land surface water index) were analysed and Net primary productivity

(NPP) of the forest was worked out using CASA (Carnegie-Ames-Stanford Approach) model. The meteorological data supplied to derive the CASA model included growing-season monthly mean temperatures, monthly precipitation amounts, and monthly solar radiation. NDVI calculation in SWS for all the months in the year 2021 showed arange of 0.3 to 0.8. Maximum NDVI was reported from February month *i.e.,* 0.8. While, minimum NDVI was achieved during May, June and November *i.e.,* 0.3. LSWI values for the year 2021 of all months ranged from 0.59 – 0.88. Maximum LSWI values were obtained from the months January, March, May, September, October and December *i.e.*, 0.84, 0.81, 0.80, 0.87, 0.88 and 0.85 respectively. Minimum LSWI value was gained from June *i.e.*, 0.59. It was observed from the images that maximum LSWI values fell in the places where *Eucalyptus* sp. was growing in abundance. While, locations with medium values of LSWI were having *Prosopis juliflora* on the ground. NPP value ranged from 0.2 to 6 gcm^2 in the forest. Location based Net primary productivity of the forest showed maximum production in the southern region of the sanctuary, owing to the presence of mixed plantation in the particular region.

Keywords: *CASA, LSWI, NDVI, NPP, Semi-arid*

SIV-O2

Evaluating Predictive Models for Potato Yield in the New Alluvial Zone of West Bengal: SMLR, PCA and ANN Approaches

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Potato is a vital cash crop in India, with West Bengal ranking as the second-largest potato-producing state, contributing approximately 30% of the country's total production. The New Alluvial Zone alone accounts for nearly 40% of West Bengal's potato output, highlighting its significance in the agricultural economy. However, the productivity of potato, like other crops, is highly susceptible to weather fluctuations, which can have profound implications for food security and economic stability. Yield forecasting in this region is crucial for optimizing production planning, estimating the import-export balance, and ensuring food security. Accurate yield predictions can assist policymakers, farmers, and stakeholders in managing resources, mitigating risks associated with weather variability, and formulating effective strategies for sustainable agriculture. In this context, the present study aims to develop weather-based potato yield forecasting models for the New Alluvial Zone of West Bengal using Stepwise Multiple Linear Regression (SMLR), Principal Component Analysis (PCA), and Artificial Neural Networks (ANN). Furthermore, the study evaluates the performance of these techniques to identify the most reliable model for yield prediction. This study focuses on developing weather-based yield forecasting models for potato at the maturity stage for six major potato-growing districts of the New Alluvial Zone of West Bengal, namely Burdwan, Nadia, Murshidabad, Hooghly, Howrah, and North 24 Pargana. Thirty-six years (1989–2024) of weather data, i.e., maximum temperature (Tmax), minimum temperature (Tmin), rainfall (RF), morning relative humidity (RH I) and evening relative humidity (RH II) and yield data were analysed, and the dataset was divided into a 7:3 ratio for calibration and validation. Three modelling techniques were employed: SMLR, PCA and ANN. The models' performances were evaluated using the coefficient of determination (R^2), root mean square

error (RMSE), and normalized root mean square error (nRMSE). Among the techniques, ANN demonstrated superior predictive capability, with R^2 values ranging from 0.8 to 0.9 during calibration and validation phases. PCA models showed moderate performance, with R^2 values ranging from 0.6 to 0.8, while SMLR yielded the lowest R^2 values, ranging from 0.4 to 0.8. nRMSE analysis further confirmed the effectiveness of ANN models, with their performance rated as good to excellent for most districts. In contrast, PCA and SMLR models were found to perform good to poor in most cases. Moreover, the percentage error between observed and forecasted yields revealed that ANN models consistently predicted yields with higher accuracy (within ±10%) compared to PCA (within ±15%) and SMLR (within ±25%). The findings highlight the efficacy of the ANN approach for developing weather-based yield forecasting models for potato. ANN outperformed SMLR and PCA across all evaluated metrics, making it a robust tool for forecasting potato yield in the New Alluvial Zone of West Bengal. This research underscores the importance of integrating advanced machine learning techniques like ANN into agricultural yield prediction to support informed decision-making and sustainable agricultural practices.

Keywords: Potato yield forecasting, Stepwise Multiple Linear Regression, Principal Component Analysis, Artificial Neural Network, New Alluvial Zone

SIV-O3

Advancing Rice Disease Management: Hyperspectral Radiometry Analysis of Leaf Blast (*Magnaporthe oryzae*)

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Hyper spectral radiometry has proven to be an effective and innovative approach for monitoring and managing crop diseases such as rice leaf blast (*Magnaporthe oryzae*). This study, conducted over two consecutive years (2020–21 and 2021–22), utilized a GER 1500 spectroradiometer (350–1050 nm) to analyze the spectral and biophysical characteristics of rice leaves across varying disease severity levels (Grade 0 to Grade 3). Healthy leaves (Grade 0) exhibited significantly higher reflectance in the Near-Infrared (NIR) region (up to 40%), while diseased leaves showed a progressive decline in NIR reflectance as severity increased—35% (Grade 1), 30% (Grade 2), and 25% (Grade 3). Conversely, reflectance in the visible spectrum (400–700 nm), including blue, green, and red wavelengths, increased due to chlorophyll degradation and structural damage in infected leaves. Advanced vegetation indices, including the Normalized Difference Vegetation Index (NDVI), Pigment-Specific Simple Ratio (PSSR), and Transformed Chlorophyll Absorption Reflectance Index (TCARI), were applied to differentiate healthy from diseased plants. NDVI values for healthy leaves were significantly higher (0.940 in 2020–21 and 0.915 in 2021–22) compared to severely infected leaves (0.624 and 0.656, respectively). Similarly, PSSR values for healthy leaves were 19.807 and 15.088 in the respective years, dropping to 3.756 and 4.160 for Grade 3 infected leaves. Other

indices, such as GI, SR, PRI, and NPCI, also highlighted clear spectral and biophysical changes associated with disease severity. Biophysical measurements supported these findings, with healthy leaves demonstrating larger leaf area (41.84 cm^2) and higher chlorophyll content (4.94 mg/g) compared to severely infected leaves (21.44 cm^2 and 2.44 mg/g at Grade 3). The integration of spectral reflectance data and vegetation indices across two years underscores the reliability and robustness of hyperspectral radiometry for real-time, non-invasive disease detection. This research provides a foundational framework for remote sensing-based disease surveillance systems, enabling timely interventions and sustainable agricultural practices to mitigate rice leaf blast impacts.

***Keywords*:** Rice, Leaf Blast, RS and GIS, Hyper spectral radiometry, NDVI

SIV-O4

Impact of dry spell on kharif rice in New Alluvial Zone of West Bengal : crop simulation approach

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Rice is the staple food of more than 60% of the world' spopulation, especially for most of the people of South-East Asia. In India, rice is grown in 43.86 million ha, the production level is 104.80 million tones and productivity are about 2390 kg ha^{-1}. Abnormal dry spell of rainfall during different period within a crop growing season reduce the crop yield drastically but supplemental irrigation(s) to some extent recovers the yield loss. Crop modeling is a tool for using bio-physical knowledge through mathematical equations to simulate the dynamics of the plant-soil-atmosphere system. It can be applied to increase agronomic productivity and support environmental management in addition to assisting in the prediction of biological system behavior. On the basis of this background the objective of this study is to simulate the effect of dry spell (s) on performance of *kharif* rice and as well as to simulate the effect of supplemental irrigation(s) on rice productivity under dry spell situation. To simulate the effect of supplemental irrigation (s) on rice productivity under dry spell situation this virtual experiment has been done on DSSAT 4.7 platform. The transplanting dates of kharif rice (*var* Swarna) were fixed on 1st and 15th July for both 2018 and 2019. Under this two dates rice was exposed to three dry spells (rainless period) i.e., EM (Environment Modification) during 1: Tillering to Panicle Initiation (EM1), 2: Tillering to Booting (EM2), 3: Panicle initiation to Milking (EM3). Final treatments considered for simulation under this study were as follows: 1. No stress, 2. Normal rainfall 3. Dry spell, 4. Dry spell + 1 irrigation 5. Dry spell + 2 irrigations Consistent results were observed across various transplanting dates and years. Under no stress conditions, the rice yield for both the 1st July and 15th July transplanting remained remarkably stable, averaging 3465 kg ha^{-1} and 3329 kg ha^{-1} across the years. However, this yield decreased by an average of 5.6% when subjected to normal rainfall conditions. In the year 2019, the impact of environmental modifications (EM) was particularly pronounced, with a substantial 11.1% reduction in yield for EM1, a significant 39.2% reduction for EM2, and relatively minimal variation in yield for EM3 across both transplanting dates. Supplemental irrigation interventions proved to be highly effective in mitigating these adverse effects, boosting the yield to 3865 kg ha^{-1} for EM1 and 3903 kg

ha^{-1} for EM2, similar to the results observed in 2018. These findings underscore the vulnerability of the rainless period from tillering to booting stage (EM1) to environmental stressors, making it the most sensitive phase fo r crop yield. Furthermore, the results emphasize the pivotal role of irrigation in alleviating the detrimental impacts of environmental changes on crop yield. This underscores the significance of effective water management strategies in optimizing agricultural productivity in the face of changing environmental conditions.

Keywords: Kharif rice, dry spell, supplemental irrigation, DSSAT, environmental modification.

SIV-O5

Geospatial assessment of cyclone-induced potato crop area loss using sentinel-2 data in West Bengal's Purba Bardhaman district

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Potato cultivation is of significant importance to West Bengal's agricultural economy, contributing one-third of India's total potato production. Purba Bardhaman, the state's second-largest potato producer, experienced substantial crop losses in the 2021-2022 Rabi season due to cyclone Jawad, which resulted in unprecedented rainfall from 3 to 5 Dec., 2021. This weak tropical cyclone originated over the Bay of Bengal and affected Andhra Pradesh, Odisha, and West Bengal, disrupting agricultural activities and necessitating potato tuber replanting, thereby reducing the harvest area. The study area, situated between latitudes 22°562 N and 23°532 N and longitudes 87°562 E and 88°252 E, was analysed using multi-temporal Sentinel-2 satellite imagery, NDVI- based classification, and decision tree algorithms to assess land use and land cover (LULC) changes in potato- growing regions during the Rabi seasons of 2020-2021 (a typical year) and 2021-2022 (cyclone-affected year). Preprocessing steps, including atmospheric correction, radiometric adjustments, geometric corrections, layer stacking, merging, and clipping, were completed using QGIS and SAGA GIS software. Potato cultivation areas were identified via a decision tree based on NDVI threshold values at key growth stages, with sample points from field surveys as references. Cloud-free Sentinel-2 images were selected for rule-based decisiontree classification, and the CART algorithm was employed to construct the tree, which splits into sub-trees based on Yes/ No responses. Ground-truth data for validation were collected via the Kobo Toolbox. Results indicated a decrease in potato cultivation area from 59667.8 ha (2020-2021) to 48554.5 ha (2021-2022), with a total reduction of 11113.3 ha attributable to the cyclone. Significant declines were observed in blocks such as Jamalpur, Ausgram II, Purbasthali II, Memari I, Memari II, Jamalpur, and Kalna I, indicating the vulnerability of certain regions to extreme weather events. NDVI analysis revealed reduced vegetation vigour in cyclone- affected fields, suggesting waterlogging and crop stress. This study demonstrates the efficacy of remote sensing and GIS technologies in promptly monitoring crop area losses with minimal field surveys. It underscores the importance of remote sensing in accurately assessing detailed block-wise (third-level administrative unit) crop area loss, facilitating informed decision-making in agricultural planning and disaster management. Future research will integrate soil moisture and climatic data with remote sensing indices to refine crop loss models and develop resilience strategies for high-input crops

such as potatoes, offering a blueprint for managing agrometeorological risks in other potato-growing regions in India.

Keywords: Potato, Sentinel-2, Decision tree, NDVI

SIV-O6

Enhancing Crop Area and Yield Estimation: Integrating Remote Sensing with Crop Simulation Models for Maize Cultivation

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Effective agricultural management and policy-making rely heavily on accurate estimates of crop area and yield, both of which are essential for ensuring food security and optimizing resource allocation. This study aims to enhance these estimates by integrating remote sensing technology with crop simulation models. Remote sensing offers high-resolution, temporal data on crop conditions, while crop simulation models, such as the DSSAT model, predict yields under various environmental and management scenarios. This integration provides a powerful tool for monitoring crop health, forecasting yields, and improving decision-making processes in agriculture. Focusing on maize cultivation in Thoothukudi district during the 2022-23 *rabi* season, this study leverages radar-based temporal backscattering signatures to track maize growth stages. The backscattering values showed a decrease from -20.57 dB at sowing to -15.33 dB at maturity, reflecting increased crop biomass and the development of a denser canopy. These changes in backscattering were consistent with maize growth stages and provided insights into crop health. The estimated maize area across Thoothukudi district was 46,598 hectares, with significant variation across different blocks. Ottapidaram and Pudur had the largest maize areas, with 10,588 and 9,880 hectares, respectively, while Thiruchendur and Udangudi had the smallest, with areas of 46 and 263 hectares, respectively. These disparities can be attributed to differences in soil fertility, water availability, and farming practices. The study also assessed the accuracy of maize area classification, with an overall accuracy of 88.80% and a Kappa index of 0.77, indicating a strong agreement between the predicted and actual crop areas. This classification method is a reliable tool for mapping maize areas and supports effective agricultural planning. The classification's accuracy was further validated by a comparison with official maize area data from the Department of Agriculture and Farmers Welfare, which reported 50,003 hectares for the rabi season. Additionally, the study estimated the Leaf Area Index (LAI) for maize using both remote sensing data and the DSSAT model. The remote sensing (RS) based LAI estimates ranged from 2.94 to 3.63, while the DSSAT estimates ranged from 2.99 to 3.94. Both methods demonstrated strong agreement with observed values, with mean agreement percentages of 95.88% for RS and 96.46% for DSSAT, highlighting the effectiveness of these technologies in estimating LAI. The strong correlation between the RS and DSSAT estimates suggests their applicability in monitoring crop health and optimizing management practices. The maize yield

estimates obtained from the DSSAT model ranged from 4,277 to 5,733 kg/ha, with an average of 4,852.36 kg/ha, while the spatially integrated yield estimates ranged from 4,239.35 to 5,144 kg/ha, with an average of 4,507.46 kg/ha. Both methods showed high agreement with observed crop cutting experiment (CCE) yields, with mean agreement percentages of 93.43% for DSSAT and 96.40% for the integrated spatial methods. These results demonstrate the reliability of both approaches for predicting maize yields, with the integrated spatial methods showing closer alignment with actual yields, as indicated by lower RMSE and NRMSE values. This integrated approach not only aids in efficient resource management but also contributes to informed decision-making and enhanced agricultural productivity.

SIV-O7

Use remote sensing ground data to determine the sowing information for hurda sorghum

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The changing farming system and climate change force to go with trending market so it calls to sow the hurda sorghum in summer season. The present study is conducted to find suitable date of sowing to sow the hurda sorghum in summer season using satellite data and ground observations for three years 2018-2019, 2019-2020 and 2020-2021. During this three year crop growth parameter and yield data were recorded as ground data and satellite data was prepared and month wise NDVI was acquired from the month of January to April and composite of images was prepared for analysis of the temporal profile of NDVI. The temporal profile trend starts from the emergence of crops and shows the maximum value at the physiological maturity stage of crops and at harvesting it starts decreasing and shows a minimum NDVI value. In addition to this from ground data and NDVI value found that sowing of hurda Sorghum during first fourthnight of January is benefited after that yield of hurda decreases.

***Keywords*:** Sowing dates, NDVI temporal profile, hurda sorghum

SIV-O8

Climate-Land Dynamics: A Decadal Study of Ahmednagar district of Maharashtra

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Understanding the dynamic interplay between climatic variables and land surface characteristics is critical for monitoring environmental sustainability and agricultural resilience. This study examines the correlation between key climatic factors—rainfall, temperature, and soil moisture and remote sensing-

based indices, including the Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), and Land Use Land Cover (LULC) changes to assess spatio-temporal changes in Ahmednagar district, Maharashtra over the decade from 2012 to 2022. Ahmednagar, characterized by semi-arid climatic conditions and diverse cropping patterns, is highly sensitive to climatic variability. Historical rainfall, temperature, and soil moisture datasets were integrated with Landsat satellite imagery to derive NDVI, NDWI, and LULC. Advanced geospatial and statistical tools were employed to analyze correlations and detect significant changes in land use, vegetation health, and water availability. The integration of these indices with climatic data sets enabled a robust analysis of their interrelationships. Our findings reveal significant correlations between rainfall and NDVI during the growing seasons, underscoring the dependence of vegetation vigor on precipitation variability. Similarly, NDWI exhibited strong sensitivity to soil moisture and temperature fluctuations, particularly during periods of drought or water stress. LULC analysis unveiled notable shifts in agricultural land, forest cover, and built-up areas, driven by both climatic changes and anthropogenic activities. By employing advanced geospatial techniques and statistical analyses, the study offers insights into the cascading effects of climatic variability on land surface dynamics. The results highlight the importance of integrating remote sensing tools with meteorological data for sustainable land management and adaptive agricultural practices in the face of climate change. This research contributes to the growing body of knowledge on climate-vegetation interactions and provides actionable information for policymakers, agronomists, and environmental planners. The study's approach can serve as a replicable framework for similar investigations in other regions.

Keywords: NDVI, NDWI, LULC, rainfall, temperature, soil moisture, change detection, remote sensing, climate variability, sustainable agriculture.

SIV-O9

Thermal Comfort and Urban Heat Island Intensity in Coimbatore: A Remote Sensing Perspective

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Urbanization, driven by rapid socioeconomic development, has become a critical concern in many metropolitan areas, significantly altering natural landscapes and disrupting energy and water balance processes. These transformations modify air circulation patterns, contributing to the Urban Heat Island (UHI) effect, characterized by elevated temperatures in urban areas compared to their rural surroundings. The UHI effect presents multifaceted challenges, particularly in tropical regions, by degrading the quality of life, increasing energy demands, and intensifying socio-environmental issues. Climate change, with its rising global temperatures, further exacerbates these challenges, underscoring the urgency for effective mitigation strategies. Remote sensing techniques have proven to be effective tools for analyzing the Urban Heat Island (UHI) phenomenon and associated land surface changes.

In this study, Landsat 8 satellite images with a spatial resolution of 30 m were obtained from the United States Geological Survey (USGS) for the years 2014 and 2024 to analyse spatiotemporal variations in Land Surface Temperature (LST), UHI intensity, Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), Index- Based Built-up Index (IBI), and Urban Thermal Field Variance Index (UTFVI). The thermal bands of Landsat 8 were used to retrieve LST values, while optical bands were utilized to derive NDVI, NDBI, and IBI indices.The results revealed a significant increase in LST, as evidenced by notable rises in minimum, maximum, and mean values. There was also an expansion of areas experiencing the strongest thermal stress and urban hot spots. Specifically, the mean LST showed an approximate increase of 10.83% from 2014 to 2024. Additionally, the area classified under the strongest UTFVI zone increased from 4.8% in 2014 to 6.4% in 2024. The indices NDBI and IBI demonstrated a corresponding increase in built-up areas, highlighting the role of urban expansion in amplifying thermal stress. A negative correlation was observed between LST and NDVI (2014:-0.674;2024:-0.702), emphasizing the cooling effect of green spaces. Conversely, LST exhibited a positive correlation with both IBI (2014: 0.726; 2024: 0.766) and NDBI (2014: 0.712; 2024: 0.753), underscoring the heating effect of built-up areas on the urban microclimate. These results underscore the need for a multidisciplinary approach to tackle rising temperatures and improve thermal comfort in urban ecosystems. Measuring and monitoring the intensity of UHI across spatial and temporal scales is crucial for analyzing the thermal environment at the city level. Identifying such anomalies in the urban thermal landscape not only provides valuable insights for equipping urban areas to be more resilient and sustainable but also serves as a valuable resource for planners, land administrators, and decision-makers. This information can support the development and adoption of relevant land use plans and green city initiatives to mitigate rising temperatures and reduce thermal discomfort in urban areas.

***Keywords*:** Urbanization, urban heat island, thermal comfort, climate change, remote sensing

SIV-O10

Weather based prediction model for meteorological week of vegetative flush in mango cv. Alphonso in Konkan region of Maharashtra

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In general mango cv. Alphonso put forth vegetative flush in October month (after withdrawal of SW monsoon). Necessary stress is not imposed on mango due to delayed withdrawal of monsoon and unseasonal rain in November month, this results in delay of vegetative flush. It is mandatory to protect vegetative flush after emergence against pests-diseases in normal weather condition and require extravigilance in aberrant weather condition otherwise, will affect subsequent stages. The attempt was made to predict meteorological week for vegetative flush in mango across Konkan region by using meteorological variables. It will help mango growers to take appropriate measures to protect vegetative flush as well as help extension workers in formulating effective Agro-advisory concern to mango. The observations regarding commencement of vegetative flush were recorded for 22 years from selected

twenty Alphonso mango with recommended practice at Agronomy Farm, Department of Agronomy, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) situated on west cost of India between $17^{0}45'$ N and 73°26' with altitude of 250 m. The daily weather data recorded at agrometeorological observatory situated on farm for 22 years were utilized for computation of weekly average. The weekly data for different weather parameters of preceding season were used for correlation and regression analysis for forecasting of meteorological week for emergence of vegetative flush and it was calibrated for two years and validated for two years at five locations from South Konkan region and one location from North Konkan region by using weather data of respective centers.The step-down multiple regressions of meteorological week of vegetative flush as dependent character and weather components as independent character for different weather scenario for 22 years are analyzed and equation was selected by keeping in view of higher applicability and more time period. In view of applicability, higher applicability (75 %) was with regression equation of 1and 3 week before occurrence of vegetative flush with least weather parameters. However, in farmers view time period for arrangement of protection for vegetative flush of mango is important hence regression equation four week with least weather parameters will provide additional time period for farmers which has applicability of 64 percent. Hence, prediction model for forecasting of meteorological week for vegetative flush in mango cv. Alphanso were proposed as under Meteorological week (3 weeks before) = 31.600+0.757*TMax-0.551*TMin R^2=0.75** Meteorological week (4 weeks before) =26.848+1.110*TMax-0.768*Tmin R^2= 0.64**. The error percent in predicting meteorological week of vegetative flush in mango cv. Alphanso, three and four weeks before vegetative flush at different locations in Konkan region was in range of 1.15 to 9.52 per cent in both years of validation with RMSE value of 1.07 to 3.09 per cent. This means models developed for predicting meteorological week of vegetative flush in mango cv. Alphanso, three and four weeks before vegetative flush is predicting to correction of 90 percent and above and model is accepted for prediction of meteorological week of vegetative flush in mango cv. Alphanso, three and four weeks before vegetative flush.

SIV-O11

Rice yield prediction by integration of CERES-rice crop simulation model and MODIS LAI (MOD15A2) in Palakkad, Kerala

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Authentic and well timed crop yield forecasts ahead of harvest are very important for proper, forward-looking and timely planning of the agricultural activities which has high degree of uncertainty. In the study assimilation of MODIS LAI (MOD15A2) into DSSAT-CERES-rice crop simulation model was used to develop advance yield estimates of rice crop during pre-harvest stage (F3) in Palakkad district of Kerala during *Mundakan* season 2021-22 and 2022-23. The free parameters identified were adjusted and optimized sequentially during assimilation process into DSSAT-CERES- rice crop simulation model based on a minimum value of cost function. The average predicted yield during 2021-22 and 2022-23

was 5590 kg ha^{-1} and 5124 kg ha^{-1} respectively. When the overall accuracy of the deviation in yield prediction was assessed yield prediction by simulation model integrated with remote sensing products had higher accuracy than using simulation model alone during both the years in majority of the panchayats under study. *During* 2022-23, twenty panchayats out of thirty one panchayats under study had deviation above ±10 percent in simulation model method while in integration method only eleven panchayats had deviation above ±10 percent. During 2022-23 also the accuracy of prediction increased in integration method. The results clearly indicate that assimilation of satellite products in crop simulation models can provide rice yield estimates with higher accuracy compared to crop simulation techniques when used alone.

***Keywords*:** DSSAT-CERES-rice, remote sensing, rice yield prediction, MODIS LAI

SIV-O12

Assessing Land Surface Temperature Dynamics and Heat Vulnerability in Kerala, India : A Multi-Temporal Analysis Using Remote Sensing Derived Land Surface Temperature and Indices

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Urbanization and land use changes significantly impact local climate patterns, particularly in tropical regions like Kerala, India. This study uses MODIS LST data to investigate the spatiotemporal variations in land surface temperature (LST) across Kerala from 2017 to 2023. The analysis explores the correlation between LST and two key indices: the Normalized Difference Vegetation Index (NDVI) derived from MODIS data and the Normalized Difference Built-up Index (NDBI) derived from Landsat data. Additionally, land use/land cover (LULC) changes were analyzed using ESRI LULC data to understand their contribution to LST variations.Results indicate a negative correlation between LST and NDVI, suggesting that areas with higher vegetation cover tend to have lower temperatures. Conversely, a positive correlation between LST and NDBI highlights the impact of built-up areas on temperature increase, thus revealing the fact that buildings contribute to increase in temperature and vegetations helps in decreasing temperature. Districts were ranked based on LST, NDVI, and NDBI, and a district heat vulnerability map was generated. The findings indicate that Palakkad, Ernakulam, Idukki and Kasargod districts are more prone to heat effects, necessitating targeted mitigation strategies. The study also assessed the Urban Heat Island (UHI) and Urban Thermal Vulnerability Heat Index (UTVHI) for each district in Kerala. The vulnerability analysis was performed by adding UHI and UTVHI and was further assessed. The results showed that districts having urban clusters like Kollam, Thrissur, Ernakulam, Alappuzha were ranked in first four. This implies that without adding urban parameters, Palakkad was having high vulnerability to heat, but when urban parameters like UHI and UTVHI was used, Kerala districts with high degree of urbanization were showing high vulnerability to heat. The study finds that increase in vegetation can decrease temperature and therefore if proper green spaces are planned in cities, the increasing temperature in urban areas can be controlled. A district wise analysis helps to identify districts that are more exposed to heat vulnerability which requires prior attention in planning. The integration of MODIS, Landsat, and ESRI LULC data provides a comprehensive understanding

of the factors influencing LST and heat vulnerability in Kerala. This multi-temporal analysis underscores the significance of remote sensing data in monitoring and managing urban heat and its associated impacts.

Keyword: Land surface temperature, Kerala, Urban heat island, MODIS, Land use and land cover change

SIV-O13

Joint Assimilation of Leaf Area Index and Soil Moisture from Sentinel-1 and Sentinel-2 Data into the DSSAT Model for Rainfed Cotton Yield Estimation

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Cotton is the most widespread and profitable non-food crop in the world. It is well known that timely crop growth monitoring and accurate crop yield estimation at a fine scale is of vital importance for agricultural monitoring and crop management. Crop growth models have been widely used for crop growth process description and yield prediction. In particular, the accurate simulation of important state variables, such as leaf area index (LAI) and soil moisture (SM), is of great importance for yield estimation. Data assimilation is a useful tool that combines a crop model and external observations (often derived from remote sensing data) to improve the simulated crop state variables and consequently model outputs like crop total biomass, water use and grain yield. In spite of its effectiveness, applying data assimilation for monitoring crop growth at the regional scale in India remains challenging, due to the lack of high spatiotemporal resolution satellite data that can match the small field sizes which are typical for agriculture in India. With the accessibility of freely available images acquired by Sentinel satellites, it becomes possible to acquire data at high spatiotemporal resolution (10–30 m, 5–6 days), which offers attractive opportunities to characterize crop growth. In this study, we assimilated remotely sensed LAI and SM into the Decision Support System for Agrotechnology Transfer (DSSAT) model to estimate rainfed cotton yield using an ensemble Kalman filter (EnKF) algorithm. The LAI was calculated from Sentinel-2 using a lookup table method, and the SM was calculated from Sentinel-1 and Sentinel-2 based on a change detection approach. Through validation with field data, the inverse error was 10% and 35% for LAI and SM, respectively. The open-loop cotton yield estimation, independent assimilations of LAI and SM, and a joint assimilation of LAI + SM were tested and validated using field measurement observation from Virudhunagar district of Tamil Nau, during the 2019–2023 rainfed cotton growing season. The results indicated that the accuracy of cotton yield simulated by DSSAT was significantly improved after joint assimilation at the field scale. Compared to the open-loop estimation, the yield root mean square error (RMSE) with field observations was decreased by 120 kg/ha for the LAI assimilation, 84 kg/ha for the SM assimilation and 144 kg/ha for the joint LAI + SM assimilation. The results suggest that LAI was the first-choice variable for crop data assimilation over SM, and when both LAI and SM satellite data are available, the joint data assimilation has a better performance because LAI

and SM have interacting effects. Hence, joint assimilation of LAI and SM from Sentinel-1 and Sentinel-2 into the DSSAT provides a robust method to improve crop yield estimations. However, there is still bias between the key soil moisture in the root zone and the Sentinel-1 C band retrieved SM, especially when the vegetation cover is high. By active and passive microwave data fusion, it may be possible to offer a higher accuracy SM for crop yield prediction.

***Keywords*:** Sentinel-1, Sentinel-2; LAI; SM; DSSAT; Data assimilation; EnKF; Rainfed cotton yield.

SIV-O14

Comparative evaluation of DSSAT and InfoCrop models for kharif rice yield simulation in Kerala

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Rice is a staple food and a key crop extensively cultivated in Kerala. Rice production is significantly influenced by adverse weather and changing climatic conditions. These uncertainties pose challenges for farmers, planners and policymakers. Accurate yield predictions are essential for estimating production levels, supporting decision-making, optimizing resource allocation and enabling strategic planning. Crop simulation models are vital tools used to simulate crop growth, development and yield.This study aimed to predict kharif rice yield of Kerala using crop simulation models DSSAT (Decision Support System for Agrotechnology Transfer) and InfoCrop. The experiment was laid outin a split-plot design with five planting dates (June 5, June 20, July 5, July 20, and August 5) as main plot treatments and two rice varieties as subplot treatments with four replications. Short-duration rice varieties like *Jyothi* and *Manu Ratna* were cultivated at the Agricultural Research Station, Mannuthy, Kerala Agricultural University, Thrissur. Both models were calibrated using the experimental data and were used to predict the kharif rice yield for 2023. Predicted and actual yield of each district wereused to compare the accuracy of both models with Mean Absolute Percentage Error (MAPE) and Mean Absolute Error (MAE). The results revealed that both the models performed well in Thrissur district. The InfoCrop exhibited highest accuracy with lowest MAPE value of 3.14% and MAE value of127.19 kgha^{-1},while DSSAT exhibited highest accuracy with a MAPE value of 7.69% and MAE value of 312.00 kg ha^{-1}in Thrissur district. The DSSAT showed high performance in Pathanamthitta and Kollam districts. The highest accuracy was exhibited in Pathanamthitta district with MAPE of 5.10% and low MAE of 168.61 kg ha^{-1}, followed by Kollam district with MAPE of 5.12% and MAE of 197.83 kg ha^{-1}. However, both models showed less performance in districts like Kottayam and Kasaragod. The DSSAT exhibited the lowest accuracy in Kottayam district with MAPE of 29.40% and MAE of 891.05 kg ha^{-1}due to over-prediction, followed by Kasaragod district with MAPE of 27.84% and MAE of 1288.75 kgha^{-1} due to under-prediction. Similarly, InfoCrop exhibited the lowest accuracy in Alappuzha district with high MAPE of 26.99% and highest MAE of 1299.84 kg ha^{-1}. Overall, DSSAT performed better in Kerala with an average MAPE of 14.56% and MAE of 585.65 kg ha^{-1}, indicating closer agreement between simulated yield and observed yield. In comparison, the performance of InfoCrop was less with an average MAPE of 16.05% and MAE of656.52 kg ha^{-1}. While InfoCrop performed well in specific districts like Thrissur and Kannur, DSSAT was more consistent and reliable across all districts of Kerala. Although both models showed their potential in rice yield prediction, further calibration and parameterization are necessary

for better performance in districts like Kottayam. Kasaragod and Alappuzha. Refinements in these models will enhance their utility for agricultural planning in Kerala.

Keywords: Rice yield prediction,Crop simulation models, DSSAT, InfoCrop

SIV-O15

Integrating Remote Sensing and GIS for Comprehensive Drought Assessment

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Water is a vital resource for sustaining life and supporting economic development. Its availability depended not only on its physical presence but also on effective storage, management and allocation. The importance of water management was highlighted in the United Nations'Sustainable Development Goals (SDGs). Drought, as a key form of water stress, significantly affected agriculture, particularly in regions dependent on rainfall. It reduced crop growth, productivity, and overall production more than any other environmental factor. Detecting and addressing crop water stress was crucial for efficient irrigation and resource management. This study focused on drought assessment in the Parbhani district of Maharashtra, India, using Remote Sensing (RS) and Geographic Information Systems (GIS). Rainfall data from the past 30years were analyzed to understand long-term trends and drought patterns. Evaporation data provided insights into water loss from open water surfaces, soil, and plants, serving as a critical indicator of water availability and drought severity. Satellite-derived indices like the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) were employed to monitor vegetation health and water availability. The years 2018 and 2021 were selected for detailed analysis as they represented contrasting conditions: 2018 was a drought year, and 2021 was a wet year. A comparison of these years highlighted the variations in vegetation health, water availability, and overall drought intensity. A relationship between NDVI and NDWI was explored, as NDVI reflected vegetation health and density, while NDWI assessed water availability. Together, these indices provided a comprehensive understanding of drought impacts by linking vegetation vigor with moisture content. The results demonstrated that vegetation indices significantly complemented meteorological indices in detecting agricultural drought. The integration of satellite-derived and rainfall data provided a more accurate and comprehensive representation of drought conditions in the study area. These indices helped reduce agricultural drought intensity by promoting the adoption of improved agro- techniques. The findings were valuable for policymakers, government officials, agro-based industries, and crop insurance companies, offering a robust framework for assessing agricultural losses due to drought and enabling more efficient compensation mechanisms, thereby enhancing resilience against future drought impacts.

***Keywords*:** Drought, Remote Sensing, GIS, NDVI, NDWI.

SIV-O16

Evaluation of Potential Evapotranspiration Methods for the Dharoi Command Area, Gujarat, India

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Potential evapotranspiration (PET) is a crucial parameter for calculating crop water requirements in irrigation schemes and for water resource management. The world wide recognized PET calculation model, the Penman–Monteith FAO-56 (PM FAO-56) model, has been criticized for requiring numerous detailed meteorological parameters. However, it is widely accepted as the baseline model in many global studies. The performance of various PET models can be highly effective in certain locations but may not accurately represent conditions in other areas. The objective of this study is to identify the most suitable PET model for estimating potential evapotranspiration (PET) in the Dharoi command area (707176 ha), Gujarat, India. Four temperature-based models (Hargreaves, Hargreaves1, Hargreaves2, and Baier-Robertson) and six radiation-based models (Makkink, Priestley-Taylor, IRMAK1, IRMAK2, IRMAK3, and Caprio) were compared against the PM FAO-56 model at eight meteorological stations during January 2000 to December 2020. These stations were selected based on the Thiessen polygon method using ArcMap for the Dharoi command area. The performance of the PET models was evaluated using normalized root-mean-square error (NRMSE), relative error (Re), mean bias error (MBE), and the coefficient of determination (R^2). The results of the four statistical measures obtained from the aforementioned ten PET models were compared across the eight (Kabola, Navavas, Pilucha, Red Laxmi, Sidhpur, Umbari, Vajepur, Ziliya) meteorological stations. To determine the best method, the well-known statistical "Friedman test" was employed. The results indicated that the temperature based method Hargreaves-Samani model achieved the lowest average score (first rank), making it the best-performing method. The second-lowest average score (second rank) was obtained by the temperature-based method Caprio. Therefore, out of ten model, the Hargreaves-Samani model is recommended as the most suitable model for estimating PET in the Dharoi command area. This proposed method can be used for calculating crop water requirements, particularly in future scenarios where projected climate data are limited.

Keywords: Dharoi command area; Penman–Monteith FAO-56; potential evapotranspiration; radiation-based model; Hargreaves-Samani; temperature-based model.

SIV-O17

Simulation of the DSSAT-CROPGRO cotton model for phenology, growth, and yield-attributing characters

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Crop models are excellent tools to study agricultural systems as they simulate the biological interactions under the influence of prevailing weather during crop growth, soils, cultivar characteristics and management practices. One important aspect of crop growth simulation modeling is its calibration and validation test, which is usually done by comparing simulation results with observed ones. Models like CROPGRO-Cotton embedded under Decision Support System for Agro-technology Transfer (DSSAT),when standardized for a location/region can explain cotton growth and production variability to a large extent. In Vidarbha particularly for Akola condition representing western Vidarbha agro-ecosystem, crop simulation modeling for cotton has not been attempted. Genetic coefficients were evaluated and DSSAT Model was validated for cotton cultivars: AKH-081, AKA-7 and Bt cotton Balwan. The model performance in respect of phenology was found to be good for all the three cotton cultivars and for all the growing environments. Also the model performance was good for all the cultivars, monsoonal sowing in case of seed cotton yield, biomass and maximum LAI. But the model performance was not good for the crop sown in late sowing crop.

Keywords: Cotton, DSSAT, Simulation

SIV-O18

Mapping Agricultural Water Stress Using Thermal Infrared Data for the Cauvery Delta region of Tamil Nadu, India

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Efficient management of water resources is critical to mitigate the effects of changing weather patterns on agriculture. This study employs satellite thermal infrared data to map water stress in the Cauvery Delta region of Tamil Nadu, India, an important agricultural area that often experiences water scarcity. Surface temperature and vegetation health are being monitored over time using data from Landsat-9/8 (2020–2024) and MODIS. Cloud effects are removed through preprocessing, along with temperature calibration. The TVDI combines the temperature and vegetation data to spot regions under water stress. From the results, the seasonal pattern is depicted since it shows high stress during the summer season and low productivity in the affected region. AI- based prediction models will

estimate water stress for the coming five years 2024-2029, allowing the challenges ahead to be envisioned. This would help the farmers get detailed stress maps and real-time irrigation advice through user-friendly mobile platforms, conserve water, and improve crop yields through efficient resource management. It provides policymakers with actionable data to devise better strategies for water management, and promote sustainable agriculture. The marriage of satellite technology with predictive analytics in this study delivers practical solutions to enhance water usage and help farmers overcome related challenges of water.

SIV-O19

Flood Detection and Mapping in Meghalaya Using Synthetic Aperture Radar (SAR)

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Floods are one of the most destructive natural disasters, causing wide spread disruption and damage. In Meghalaya, heavy monsoon rainfall along with the diverse terrain often results in landslides in the hills and flooding in low-lying areas. These annual events result in significant challenges for local communities, highlighting the urgent need for timely and reliable flood detection and mapping to minimize social, economic, and humanitarian impacts. This research focuses on the use of Synthetic Aperture Radar (SAR) for mapping the flood prone areas in Meghalaya. SAR offers unique advantages, including the ability to capture high- resolution images regardless of weather conditions or time of day. This makes it especially valuable in Meghalaya, where cloud cover and heavy rainfall often hinder optical remote sensing. Despite its strengths, SAR-based flood mapping presents challenges, as flooded areas can exhibit reflectance patterns similar to those of high-altitude regions, shadows, runways, and wide road networks. These similarities can complicate the identification of inundated areas, requiring advanced techniques to improve accuracy. This study explores the application of image processing techniques and classification methods to address these challenges. By integrating multiple approaches, this study aims to improve the precision and reliability of SAR-based flood mapping. The ultimate goal of this work is to promote improved disaster management techniques and contribute in long-term initiatives to lessen the effects of flooding in the diverse and complicated topography of Meghalaya.

Keywords: Flood detection, Synthetic Aperture Radar (SAR), Mapping, Meghalaya.

SIV-O20

Integrating Biophysical Parameters and Remote Sensing for Enhanced Rice Yield Prediction

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Accurately predicting crop yield is essential for ensuring food security and optimizing agricultural decision-making. This study highlights the capacity of various parameters required for yield prediction, integrating empirical and semi-physical models. Key parameters include photosynthetically active radiation (PAR), fraction of PAR absorbed by the crop canopy (fAPAR), and radiation use efficiency (RUE), which collectively determine potential crop biomass. Stress factors such as temperature scalar (Tscalar) and water scalar (Wscalar), derived from biophysical indicators like Land Surface Water Index (LSWI) and temperature data, were incorporated to estimate actual biomass. Additionally, Growing Degree Days (GDD) play a critical role in understanding the growing period of rice by quantifying heat accumulation needed for crop development. GDD helps define phenological stages, ensuring more accurate timing of crop growth phases, stress impacts, and biomass accumulation. Incorporating GDD enhances the ability to account for temperature-driven growth variability, thereby improving y ield prediction accuracy. Remotely sensed data products, such as Sentinel-1 SAR for acreage estimation and MODIS NDVI, were used for spatial and temporal parameter derivation. Biomass was calculated using intercepted PAR and stress scalars, while the final yield was computed using the harvest in dex (HI). By integrating remote sensing-derived parameters, stress factors, and GDD, this approach underscores a comprehensive framework to enhance the precision of rice yield predictions.

Keywords: Crop yield prediction, Photosynthetically Active Radiation (PAR), Growing Degree Days (GDD), Remote sensing, Stress factors

SIV-P1

Mapping Drought Dynamics in Marathwada Using Remote Sensing Indicators

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This study evaluates the rainfall and drought patterns in Marathwada during the *kharif* seasons of 2022 and 2023, utilizing data from the India Meteorological Department (IMD) and satellite-based observations. The findings reveal significant inter-annual rainfall variability, with substantial deficits in June and July, which notably affected soil moisture and vegetation indices. In 2022, many districts experienced considerable rainfall deficits, particularly Jalna (-44.6%) and Hingoli (-32% IMD), which led to severe vegetation stress, as indicated by negative trends in both the Normalized Difference

Vegetation Index (NDVI) and Vegetation Condition Index (VCI) (Hingoli: NDVI -36%, VCI 22%). Notably, a fortnight lag in rainfall recovery was observed, with significant improvements in vegetation health as rainfall increased in July, especially in Sambhajinagar and Nanded, where the NDVI and LSWI (Land Surface Water Index) showed recovery (Sambhajinagar: LSWI 9.4%, VCI 84%). By August and September, sustained rainfall led to marked improvements in soil moisture and vegetation conditions, with districts like Dharashiv and Beed showing notable NDVI increases (Dharashiv: 12%, Beed: 10.9%) and a 100% VCI in these regions by the second fortnight of September. Most districts retained 90–100% VCI, indicating stable vegetation conditions. In contrast, the 2023 season, which experienced severe drought, showed more drastic rainfall deficits, especially in Dharashiv, Hingoli, and Jalna (rainfall deviation >90% in June). Despite this, some districts such as Dharashiv and Latur demonstrated resilience, with NDVI and LSWI remaining relatively stable in the first fortnight (Dharashiv: NDVI 1.3%, LSWI 2.7%, Latur: NDVI 5.8%, LSWI 13%). However, a two-fortnight lag in vegetation recovery was noted in Sambhajinagar and Jalna, with NDVI and LSWI values improving marginally in August (Beed: NDVI 15.9%, Jalna: 5.9%). By September, vegetation conditions improved in regions like Dharashiv, Parbhani, Hingoli, and Nanded, with NDVI and VCI values reaching 95–100%. Despite slight rainfall improvements in August and September, the effects of prolonged drought persisted, particularly during the latter stages of crop growth. Further, discrepancies between satellite-derived rainfall estimates and IMD data, especially during intense rainfall events. Satellite-based estimates over estimated rainfall in semi-arid regions where precipitation is often scattered, leading to differences in observed rainfall trends. June and September showed greater variation due to the weakening and withdrawal of the monsoon, while July and August, during the active monsoon phase, showed better alignment between satellite and IMD data. This study underscores the vulnerability of Marathwada's agriculture to erratic monsoon patterns and emphasizes the importance of modern tools, such as satellite-derived vegetation indices and real-time rainfall monitoring systems, in managing these challenges. These tools provide critical insights into soil moisture and vegetation health, enabling timely interventions and informed decision-making. By understanding the lag between rainfall and vegetation recovery, farmers can optimize irrigation, select drought-resistant crops, and implement targeted soil management strategies. The integration of advanced monitoring systems can enhance preparedness, reduce crop losses, and strengthen resilience to climate variability, ultimately fostering sustainable agriculture in semi-arid regions.

***Keywords*:** NDVI, LSWI, VCI, soil moisture, drought indicators, rainfall patterns & semi-arid regions.

SIV-P2

Adaptation Strategies for Climate-Smart Redgram Production in Tamil Nadu

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Nutritional security, particularly in vegetarian diets, is closely tied to pulses, which serve as a key protein source. Redgram (*Cajanus cajan* L.),also known as pigeonpea, is a significant legume crop in Tamil Nadu, contributing to both nutrition and income for farmers. However, climate change poses a potential

threat to its production. This study assesses the impact of climate change on redgram production in Tamil Nadu and formulates adaptation strategies using the Decision Support System for Agrotechnology Transfer (DSSAT) model. These strategies aim to optimize yield under changing climate conditions.The evaluation focused on the popular Redgram variety CO (RG)7, with sowing beginning on August 1st. The study simulated two CO_2 conditions: a constant CO_2 level of 380 ppm and CO_2 enrichment based on future projections. The DSSAT model was used to simulate crop growth under various climate scenarios, incorporating changes in temperature, rainfall, andatmospheric CO2. Adaptation strategies included adjusting sowing dates and increasing nitrogen fertilizer application by 25%, particularly under CO_2 enrichment conditions. These strategies were assessed across Tamil Nadu's agro-climatic zones. The results showed that without CO_2 enrichment, the yield of redgram was negatively affected by a warming climate scenario, with reduced productivity in several regions. However,when CO_2 levels were enriched, there was an increase in average yield, especially towards the end of the century, although temporal and spatial variations were observed. Among the different agro-climatic zones of Tamil Nadu, the highest yield was recorded in the Western Zone, while the Southern Zone showed the lowest yield. The DSSAT model did not show any response for application of nitrogenous fertilizers in terms of yield improvement.The incorporation of CO2 enrichment has shown positive impact on the yield of the redgram crop. Adjusting sowing is a promising strategy to optimize yield, particularly under future climate scenarios whereas the model has not responded for increase in N fertilizer. These findings can guide future agricultural policy and on-the-ground farming practices to enhance food security and resilience in the face of climate change.

***Keywords*:** Climate change, Redgram, DSSAT model, adaptation strategies, CO_2 enrichment, sowing date

SIV-P3

Effect of Biofertilizers and Organic Manures on NDVI values and Grain Yield of *Rabi* Sorghum

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Under changing climate, increases frequency in number of extreme weather events which increasing risk in agricultural production. Considering this aspect an experiment was carried out during *kharif* season 2022-23 at experimental farm, Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The field trial was laid out in randomized block design with three replications containing treatments as; T1- Unfertilised and unmanured (control), T2- Azospirillum+PSB+KSB+ZnSB (Biofertilisers) (seed treatment @10 ml/kg), T3- FYM application before 15 days sowing (@ 2 t/ha) equivalent to RDN, T4- Vermicompost (VC) application (@ 4 t/ha) equivalent to RDN, T5- Biofertilisers (seed treatment @10 ml/kg) +50% FYM +50%VC equivalent to RDN, T6- 50% FYM +50% VC equivalent to RDN, T7- Zero budget natural Farming (ZBNF) [Based on 4 principles- beejamrita (seed treatment @10 ml/kg),jeevamrita (drenching at 20 & 40 DAS @500 lit/ha), acchadana(Wheat straw mulching @ 5 t/ha), waaphasa (FC-irrigation)]. The NDVI values taken by use of the WAVE-GO Spectroradiometer) at different crop growth stages. The leaf area and NDVI values was increased continues from seedling stage to 50% flowering and it was remaining near about constant till grain filling stage and there after it was reduced at maturity, due to crop senescence in all the treatments. The significant difference noted within the treatments at all crop

growth stages in both values of leaf area and NDVI, and at highest leaf area stage (50 % flowering), decreased leaf area by 6 to 34 % and 5 to 22 % NDVI values. According to the criteria of NDVI vales, the water stress was not recorded at all crop growth stages, except seedling stage (moderate to mild stress). The significant increase in leaf area and NDVI values, increases linearly yield from T1to T7, and significant highest grain yield was recorded in T7(3127 kg/ha) and lowest in T1(1207 kg/ha). Compared to the control (T1), grain yield was increased linearly from T2-T7and it ranged in between 59 to 159 percent. The present study clearly indicates that NDVI value is not an only parameter to estimate water stress of crop and to estimate crop yield loss. Accurate estimation of drought and loss of yield at different growth stages, required integrated agrometeorological indices (*viz.,* CTD, SPI, VCI, NDWI etc.).

***Keywords*:** Sorghum, seed yield, leaf area, NDVI

SIV-P4

Assessing weather conditions influencing the production of potato grown in six districts of West Bengal

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Potato is a cool season crop however at low temperature vegetative growth is restricted and at freezing point temperature irrecoverable frost injury occurs to the plant. Long days coupled with high temperature conditions promote vegetative growth without the formation of tubers and short day with low temperature induce tuberization. Weather and yield data of potato for twenty-five years (1997- 2021) are collected for six districts in West Bengal are belonging to diverse agroclimatic zones.These districts are the major potato-growing regions and include Hoogly, Bankura, Purba Bardhaman, Paschim Midnapore, Jalpaiguri and Coochbehar. The selected districts fall under four distinct agroclimatic zones namely, Old Alluvial, New Alluvial, Red and Lateritic and Terai zones of West Bengal. Weather variables collected for the same period include temperature, rainfall, humidity and sunshine hours. Trend analysis is done using a linear trendline. Residual (detrended yield) is calculated by subtracting the trendline yield from the actual yield to isolate the weather effects. Correlation is found between detrended yield and weather variables using Pearson correlation/spearman correlation. to identify the strength and direction of the relationship. The residual values represent deviations caused by weather conditions along with some randomness. Linear equations have been developed using this detrended yield that showcases to what extent the yield of potato is influenced by existing weather conditions. On plotting, the slope of the regression line provides a measure of the average annual change in yield. Correlation drawn with rainfall data is mostly shown significant values with a positive relationship whereas temperature increment has negatively impacted yield. A maximum temperature range of around 31°C to 33°C has been shown to critically affect crop yield.

***Keywords*:** Potato, detrending, regression, yield, correlation

SIV-P5

Potential strategies to improve sorghum productivity under changing climate : A modelling approach

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Sorghum plays an important role in the food security of dryland areas as "Miracle Nutri-Cereals" and it provides nutritional and health security to the largest population. Globally, sorghum is the fifth most important crop after rice, wheat, maize and barley, whereas in India it is the fourth largest crop. According to AR6 of IPCC, the average global surface temperature had increased by 1.1°C in 2011-2020 compared to 1850-1900 and have a significant influence on productivity of grain crops, including sorghum. Crop simulation models are used to assess the climatic impactson the stability of crop production and productivity under different management practices. The study was taken up in the Efficient Cropping Zones (ECZs) for sorghum in Tamil Nadu. Analysis of ECZ demarcation indicated that seven districts are the most efficient cropping zone (MECZs) with high sorghum area and productivity. The 14 districts falls under the yield efficient cropping zone (YECZ). The input data for calibration and validation of model were collected from the field experiments conducted in 2022 and 2023. Crop cultivar-specific parameters are given in the genotype file in the form of genetic coefficients that describes growth, phenology and yield attributes. The future climate data was generated using CMIP6 climate models for Shared Socio- economic Pathway (SSP) scenarios. The suitable adaptation options were tested using CERES- Sorghum model to enhance the sorghum yield under future climatic conditions. In the near-term future, September 8th sowing is expected to be the ideal sowing time in 13 districts. September 15th sowing is also expected perform equally to September 8th sowing in four districts. September 1st sowing would be the appropriate sowing time in other 9 districts. In the mid-term period, September 8th sowing would be the proper time of sowing to get a yield benefit over other dates of sowing in a total of 10 districts. The eight districts could obtain a higher yield with September 1stsowing. In the remaining districts other dates of sowing performed better. Crops sown at an appropriate time could receive a favourable environmental condition at critical growth phases of the crop, thus produces a good yield. Sorghum yield is expected to increase by 15 to 19 per centin the future with three splits of nitrogen applications along with additional application of 5 kg of N fertilizer from the total recommended quantity under SSP585 scenario in the majority of the sorghum ECZ regions. The optimum sowing window identified for each district for futureclimatic conditions would be helpful in sustaining sorghum productivity. Nitrogen application in splits can improve the yield in the future compared to the application of 25 % increased nitrogen dose from the 0recommended dose in each split application. Optimization of nutrient dose with the best time of application aids in mitigating the impact of climate on sorghum productivity.

***Keywords*:** Sorghum, CERES-Sorghum, adaptation strategies, sowing window, nutrient management

SIV-P6

Simulation of Maize Yield and phenology in response to Climate Change - A review

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Increasing concentrations of carbon dioxide and other green house gases has led to rising temperatures and erratic precipitation patterns which are expected to significantly affect global agricultural productivity. Maize being one of the most vulnerable crops due to its sensitivity to these changes has been projected to be affected by these climate changes. Maize yield has been simulated to decrease by around 7.4% for every one-degree increase in global mean temperature. These climate changes are evaluated using Global Climate Models (GCMs), which simulate the Earth's climate systems to provide essential insights into future climate conditions based on different climatic scenarios i.e. shared socioeconomic pathways (SSPs). These scenarios combine different socioeconomic trends with climate change projections, provide valuable insights into the potential impacts of future climate conditions on crop productivity. The probability of crop damage due to excess precipitation on climate change could be 90% greater in 2030 compared to the 2002 level. Compared with SSP1-2.6, the yield loss rates in China increased with 70.73 % and 61.52 % for SSP3-7.0 and SSP5-8.5, respectively. The precipitation, temperature and integrated climate suitability showed a downward trend under SSP2-4.5 and SSP5-8.5 for summer maize. From 2022 to 2100, maize growth periods show a decline in duration under SSP scenarios. Adoption of climate-resilient maize varieties, improvement in irrigation efficiency, implementation of conservation agriculture, and enhancement in agroforestry practices could be helpful to mitigate climate change impacts. Thesimulation results suggested that delayed sowing date from May to June is the most effective mitigation option for avoiding thermal stress at end of growth period. Late planting could mitigate the negative impacts of climate change on maize partially due to the increased precipitation in July and August in the future. Hence, crop modeling helps to mitigate climate change impacts by predicting future climate scenarios, assessing risks, optimizing resource use, guiding policy decisions, and designing adaptive strategies for sustainable development and crop resilience.

***Keywords*:** Maize, climate change, SSP scenarios, crop modeling

SIV-P7

A Spatio-temporal analysis of agrometeorological interventions using RS, GIS and Crop Models

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Development of agriculture is critical for emerging countries like India, primarily to support a sizable section of the population. However, concerns such as climate change and resource constraint demand novel techniques to increasing production and sustainability. To address these problems, this study investigates the integration of Remote Sensing (RS), Geographic Information Systems (GIS) and Crop Simulation Models (CSMs). RS and GIS give useful geographical and temporal data on agricultural factors allowing for accurate monitoring and analysis. CSMs use meteorological data as a crucial input to model crop development and production under a variety of situations. Agricultural practices may be considerably improved by combining remote sensing, geographic information systems, and crop simulation models. This connection enables better crop management by allowing for more exact yield prediction, optimum irrigation schedules, and disease identification early on. Furthermore, it allows for comprehensive risk assessment and mitigation by assessing the effects of climate change, identifying sensitive locations, and designing appropriate adaption methods. This technological synergy gives farmers, academics andpolicymakers vitalinsights into agricultural planning and resource management. This study emphasizes the importance of these technologies in furthering sustainable and resilient agricultural practices, which eventually contribute to food security and economic prosperity in poor countries.

***Keywords*:** Remote Sensing (RS), Geographic Information System (GIS), Crop Simulation Models (CSMs), Climate Change, Sustainable Agriculture.

SIV-P8

Multi-criteria landslide susceptibility zonation using AHP and GIS techniques in Idukki district, Kerala

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The Western Ghats of India, renowned for their ecological sensitivity and elevated terrains, are increasingly subjected to landslides, a prevalent natural hazard. Kerala, often termed "God's Own Country," faces heightened vulnerability due to anthropogenic pressures, including converting natural forests to plantations, ecotourism, and unregulated development. These activities exacerbate soil degradation, altering the region's stability and intensifying the impacts of adverse climatic events such as floods and heat waves. Among Kerala's districts, Idukki is a highly landslide-prone region due to its

steep topography, intense monsoonal rainfall, and human interventions. This research utilizes the Analytical Hierarchy Process (AHP) methodology and geospatial techniques to identify and assess landslide-prone zones within the Idukki district. The resulting susceptibility map categorizes the region into five distinct zones, ranging from very low to very high levels of susceptibility. A total of ten key conditioning factors such as slope, elevation, geomorphology, lineament density, topographic position index (TPI), land use/land cover (LULC), Normalized Difference Vegetation Index (NDVI), Relative Landslide Index (RLI), rainfall, and proximity to streams were analyzed and assigned weights to determine their relative significance in triggering landslides. The resultant landslide susceptibility classes stratify the district into five categories very low (1.30%), low (57.21%), medium (39.71%), and high (1.78%) susceptibility zones. Landslide susceptibility is determined by steep gradients, high altitudes, and human activities such as road construction and unregulated land-use changes. Geological factors, including lithology and structural lineaments, are equally significant. The susceptibility map, validated using the Bhukosh landslide inventory points, confirms its reliability. AHP modeling provides a replicable framework for regions with comparable geophysical settings. This research enhances disaster management by identifying risk zones. The map supports planners, authorities, and policymakers in reducing risks through sustainable land use, strategic planning, and slope stabilization.

Keywords: Landslide susceptibility, AHP, GIS, Western Ghats, Idukki

SIV-P9

Morpho metric Analysis of Watershed Using Remote Sensing and GIS-ACase Study of Darna River Basin in Maharashtra, India

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This case study examines the Darna River Basin in Maharashtra, India, emphasizing watershed delineation, morphometric analysis, and soil and water conservation strategies. The basin covers 1,308 sq. km, with annual rainfall ranging from 3,000 to 4,000 mm. Geospatial technologies, including QGIS, ArcGIS, and Cartosat DEM data, were employed to analyse hydrological, geological, and geomorphological features. Watershed delineation was performed using advanced GIS tools, generating maps of stream order, drainage networks, and slope. Morphometric analysis revealed a drainage density of 1.3524 km^{-1}, indicating moderate permeability and vegetative cover. The bifurcation ratio suggested that geological structures control drainage patterns, while the texture ratio of 4.3975 km^{-1} and a relief ratio of 3.77 highlight susceptibility to erosion. The basin's semi- circular shape, inferred from the elongation ratio, indicates higher runoff potential and associated soil erosion risks. Cadastral digitization focused on Belu Village, encompassing 673.94 hectares, with detailed mapping of survey numbers, stream lengths, and conservation structures. The study identified 22 streams within the village, ranging from 50 m to 619 m in length, and highlighted existing conservation structures, including two farm ponds and one cement nala bund. This research demonstrates the critical role of geospatial technologies in integrated watershed management. The findings provide actionable insights into hydrological characteristics, emphasizing the importance of

sustainable resource utilization and erosion control. Digital maps of flow direction, slope, and drainage patterns support effective planning and monitoring. The study concludes that the Darna River Basin's moderate relief and fine-textured soil require strategic interventions to minimize erosion, enhance groundwater recharge, and sustain agricultural productivity.

SIV-P10

Validation of CERES-wheat and InfoCrop-wheat models at farmer's fields of middle Gujarat Agro-Climatic Zone

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CERES-Wheat and InfoCrop-Wheat models are a dynamic and mechanistic model. It is capable of forecasting the potential yield as well as the yield gap. It can be used to assess the impact of climate variability and climate change on major annual crops. Models calibrated using field experiment was conducted in the Research farm of the Department of Agricultural Meteorology near the Agrometeorological observatory, AAU, Anand, Gujarat (India). The CERES-Wheat and InfoCrop-Wheat models were calibrated for the wheat crop cultivar i.e., GW 496 (V1) and GW 451 (V2) for the three dates of sowing (D1: 25 Nov., D2: 05 Dec., D3: 15 Dec.) during *rabi* 2020-21. The genetic coefficients for both cultivars have been calibrated in both models. The validation of two models was done using the actual crop data observed and collected from farmers' fields of different Blocks of Anand, Kheda and Ahmedabad districts during the *rabi* 2021-22. The statistical comparison of the observed and simulated results of the phenological events and yield of wheat cultivars (GW496 and GW 451) sown on different dates for year 2022-2023. The result revealed that simulated yields were in good agreement with observed grain and biomass yields for most of the locations. The statistical parameters such as RMSE and dr for grain yield were 0.18 to 0.63 and 215.80 to 273.94 kgha^{-1} for CERES- Wheat and 0.35 to 0.67 and 193.95 to 328.30 kg ha^{-1} for InfoCrop models. The validation measures such as RMSE and dr for biomass yield were 0.42 to 0.64 and 498.99 to 786.94 kg ha^{-1} for CERES-Wheat and 0.47 to 0.58 and 548.67 to 726.74 kg ha^{-1} for InfoCrop-wheat models. According to the result of the present study, it was concluded that both CERES- Wheat and InfoCrop-Wheat models simulated the phenology and yield of wheat crop (cv. GW 496 and GW 451) quite well for most of all the locations.

Keywords: InfoCrop-wheat, CERES-Wheat, model testing and middle Gujarat

SIV-P11

Simulating the wheat yield and phenology under different climate change scenarios-A review

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Climate change, driven by rising greenhouse gas emissions, is altering global temperature and precipitation patterns, intensifying extreme weather events, and affecting wheat productivity which is sensitive to climatic shifts. This review examines how climate change impacts wheat yield under different Shared Socioeconomic Pathways (SSP) scenarios, which combine climate projections with socioeconomic trends. By synthesizing recent advancements in modeling approaches, the paper explores the role of key climatic factors, such as heat stress, water availability, and elevated CO, levels, in shaping wheat production. Even a modest increase of 1°C in temperature can resulting a substantial 10% decrease in wheat yield under Punjab conditions. In China, climate change is projected to increase annual mean winter wheat yields compared to the baseline by 784–1172 and 332–533 kg/ha under SSP126 and SSP585 respectively. From 2021 to 2100 under ssp5-8.5 scenario, the winter wheat growing season, grain number and yield are expected to reduce by 4–17%, 3-21%, and 4-20% respectively compared to the baseline. The increase in temperature during critical growth months like January to March has notably decreased wheat yield from 4.7 tha^{-1} in 1999-2000 to 4.1 tha^{-1} in 2005–06. Changes in rainfall intensity and frequency can significantly affect the functioning of wheat agroecosystems. Grain yield stimulation does not respond linearly to increasing CO_2 but is likely to reach a maximum and level off already at ~600ppm. Late sowing with planting density of 400 plants $m^{"2}$ caused higher production which leads to less yield reduction by about 8, 11 and 10% for irrigated wheat. Crop modeling helps address climate change impacts on wheat by simulating growth under different conditions to guide effective solutions. Mitigation strategies for climate change impact on wheat include adopting heat-tolerant varieties, optimizing irrigation, improving soil health, and implementing sustainable farming practices.

Keywords: Wheat, Climate Change, Crop Modelling

SIV-P12

Calibration and validation of CROPGRO, InfoCrop-and WOFOST models for cotton growth and yield simulation in middle Gujarat

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Cotton is generally warm season crop i.e. heat loving plant and is sensitive to temperature and soil water condition.CROPGRO, InfoCrop- and WOFOST Cotton crop simulation models are based on mathematical representations of physiological and environmental processes that influence crop growth. These models integrate factors such as soil properties, weather data, genetic traits, and management practices (e.g., irrigation, fertilization, and pest control) to simulate growth stages, biomass accumulation, and yield

potential.The field experiments were conducted during kharif seasons of years 2021 to 2023. the experimental field data of cotton crop such as phenological development (days to flower initiation and physiological maturity), seed cotton yield, stalk yield and biomass accumulation of year 2021 were used for calibrating the CROPGRO-Cotton, InfoCrop model and WOFOST model. The experimental data of years 2022 and 2023 were used to validate the models for two cultivars of cotton (GTHH 49 and G.Cot H8) and for three planting time (D1: 1 June, D2: 11 June and D3: 21 June) in middle Gujarat agro-climatic zone.The percent error of CROPGRO-Cotton, InfoCrop-cotton models and WOFOST- cotton were 5.53, 15.78 and 15.15 per cent respectively while RMSE were 97.05, 277.05 and 265.94 kg/ha respectively. Associations between observed and simulated cotton yieldwere positive and highly significant during 2022-23 and 2023-24 by both models CROPGRO-Cotton and InfoCrop-cotton with correlation coefficient 0.90**, 0.62** but slightly less associations between observed and simulated cotton yieldby WOFOST-cotton with correlation coefficient 0.46. Simulation results indicated that, all three models simulate the seed cotton yield successfully. CROPGRO-cotton model is performing well as compare to, InfoCrop-cotton models and WOFOST-cotton.

Keywords: Cotton, CROPGRO, InfoCrop, WOFOST, Calibration and validation

SIV-P13

Bias correction of temperature data for different scenarios using CMIP6 models for central region of Punjab

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Climate change is emerging as one of the major challenges of the 21st century indicating a noticeable and escalating rise in global mean temperatures through anthropogenic interferences. These climatic changes are assessed through Global Climate Models (GCMs), which simulate Earth's climate systems to offer critical insights of future climate conditions using Shared Socioeconomic Pathways (SSP) scenarios, helping to assess potential risks and mitigation strategies. These scenarios allow to explore potential climate changes under varying socio-economic and policy conditions after bias removal. Bias correction methods are useful in reduce biases in model-simulated data, which improves their reliability (Digambar *et al* 2023). The study assesses the future climate change by evaluating the performance of different bias correction techniques. The bias correction was done by dividing the observed and model climate data into calibration and validation sets. For this purpose, the daily data for maximum temperature and minimum temperature from 1970-2100 for Ludhiana district of Punjab were downloaded from NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6) using outputs of ACCESS-CM2 model under four SSP scenarios (SSP 126, SSP 245, SSP 370 and SSP 585) which was extracted using the GIS software.The bias correction of model data (maximum temperature and minimum temperature) was done by developing correction functions (using a model and observed data from 1970 to 2000) from different bias correction methods (Difference method (DM), Leander and Buishand method (L&B), linear scaling (LS), variance scaling (VS), and quantile mapping (QM)). These correction functions were used to correct the model data from 2001–2023 which was validated against the observed data for same period. Thereafter, statistical evaluation of these methods

was done to check the performance and efficiency in improving the accuracy of climate projections. The best bias correction method was selected for further correction of future data under different scenarios based on the performance indicators like Coefficient of residual mass (CRM), the Normalized Root-Mean Square Error (NRMSE), the Mean Absolute Error (MAE), the Mean bias error (MBE), Mean absolute percentage error (MAPE), Wilmot d-index, the Percentage BIAS (PBIAS), Nash–Sutcliffe efficiency (NSE). The results indicated that the linear scaling method followed by quantile mapping and difference method showed less error and more efficiency values. Hence, linear scaling method was selected for correcting future model data for maximum and minimum temperature by end of 21st century. It was followed by quantile mapping and difference method. Further analysis of the corrected data showed that by end of 21st century, future maximum temperature for the Ludhiana has been expected to rise by 0.03, 0.05, 0.05 and 0.07°C per year under the SSP 126, SSP 245, SSP 370 and SSP 585 scenarios respectively. Likewise, the projected change in the minimum temperature by end of 21st centurywill be 0.02, 0.04, 0.05 and0.07 °C per year under the SSP 126, SSP 245, SSP 370 and SSP 585 scenarios respectively.

Keywords: ACCESS-CM2 model, SSP scenarios, Temperature, Bias Correction

SIV-P14

Assessing the Performance of DSSAT-CERES for Major Cereal Crops in India: A Review

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Crop simulation models are vital tools for understanding the complex interactions among soil, climate, and agricultural management practices. Among these, the Decision Support System for Agrotechnology Transfer (DSSAT) and its Crop Environment Resource Synthesis (CERES) models have been widely used for simulating the growth and yield of major cereal crops. This review evaluates the performance of the CERES model for rice, maize, wheat, and sorghum in India by synthesizing findings from past research to assess predictive accuracy.The performance of the CERES models was evaluated using statistical parameters such as Root Mean Square Error (RMSE), Normalized RMSE (NRMSE), Willmott's D-statistic, and the coefficient of determination (R^2). The analysis revealed that CERES-Maize exhibited the highest accuracy, with the lowest RMSE values for anthesis (2.0–4.2 days), maturity (3.0–5.0 days), and grain yield (NRMSE = 7.1%, D-stat = 0.97, R^2 = 0.96). CERES-Rice also demonstrated strong predictive capabilities, particularly in grain yield simulations (D-stat = 0.93, R^2 = 0.90). In contrast, CERES-Wheat and CERES-Sorghum showed moderate performance, with higher variability in predictions, especially under stress conditions such as drought and nutrient deficiencies.These findings highlight the strengths and limitations of the CERES models in the Indian agricultural context providing insights into their applicability for crop management, yield forecasting, and climate change adaptation. Further improvements in model calibration, integration of remote sensing data, and refinement of water and nutrient interaction modules are recommended to enhance predictive accuracy and support decision-making in Indian agriculture.

***Keywords*:** Crop simulation model, DSSAT-CERES, Yield Forecasting, Climate Change Adaptation, Statistical Evaluation

SIV-P15

Assessment of Futuristic Weather Scenario Under Different Shared Socioeconomic Pathways for Upper Brahmaputra Valley Zone of Assam

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General circulation models (GCMs) simulate the Earth-Atmosphere continuum and their interactions on the basis of past observations and future climate scenarios by considering the level of greenhouse gases and aerosols. In the present study, the changes in temperature (Maximum and Minimum) and rainfall on an annual basis were assessed by downscaling the data from seven GCMs (ACCESS-CM2, CNRM-CM6-1, INM-CM4-8, KACE-1-0-G, MIROC6, MPI-ESM1-2-LR, NorESM2-MM) under the three Shared Socioeconomic Pathways (SSP245, SSP370 and SSP585), analyzed for three different time period *viz*. from 2025-2050 (early part of the 21st century), 2051- 2075 (mid part of the 21st century), 2076-2099 (later part of the 21st century) for Upper Brahmaputra Valley Zone (UBVZ) of Assam. The study revealed that- all the models predict a significant rise in near-surface maximum and near-surface minimum temperature for early part of the century and mid part of the century. A further increase in temperature and variability in rainfall is predicted during the end of the century for Upper Brahmaputra Valley Zone of Assam. The hotter and drier weather with sudden splurge of rainfall coupled with extended dry spells may not be good for the crops. Therefore, a viable climate smart holistic crop contingency planning would be needed to obtain sustainable agricultural production in the zone.

***Keywords*:** GCM, SSP, Upper Brahmaputra Valley Zone

SIV-P16

Spatiotemporal Dynamics and Health Assessment of Tea Plantations in Assam Using Remote Sensing Techniques

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Assam, a leading tea-producing state in India, has witnessed significant expansion in tea cultivation over the past three decades. This study examines the spatial distribution and health status of tea plantations across key districtsSonitpur, Jorhat, Sivasagar, Dibrugarh, and Tinsukiaover a 32-year period. The analysis reveals a substantial increase in tea plantation area, with the most pronounced expansion observed in Dibrugarh and Sonitpur. Additionally, an assessment of tea health conditions indicates that the eastern districts, particularly Dibrugarh and Tinsukia, exhibit higher chlorophyll content and nitrogen balance index values, signifying optimal growth conditions. However, changing climatic factors, including temperature fluctuations and

precipitation variability, have had adverse effects on tea production, except for moisture availability, which has shown a positive correlation with yield. These findings provide critical insights for sustainable tea cultivation, pest management, and adaptive strategies to mitigate climate-induced stress in Assam's tea industry.

Keywords: Tea plantation dynamics, Remote sensing, Climate impact, Tea health assessment

SV-O1

Historical trend analysis of rainfall and frequency of rainy days over North Transition Zone of Dharwad, Karnataka

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Rainfall plays a vital role in economic development, disaster management, and hydrological planning for the country. In the context of climate change, it is essential to assess whether the characteristics of Indian rainfall are undergoing changes. Using daily observed rainfall data from the Main Agricultural Research Station (MARS), University of Agricultural Sciences (UAS), Dharwad, for the period 1995–2024, analyses were conducted to examine changes in rainfall patterns and the frequency of rainfall intensities. The contribution of the South West Monsoon (SWM) to the total rainfall was 61.5%, followed by the North East Monsoon (NEM) at 20.4%.The contribution of SWM over 30 years showed a consistent increase, with the trend being statistically significant at the 95% confidence level. The total number of rainy days (categorized as very light, light, moderate, rather heavy, heavy, and very heavy) during the study period was 97.9 days. Among these, the frequency of very light rainy days (42.7 days) was the highest, followed by light rainy days (26.4 days) and moderate rainy days (25.0 days). The Mann-Kendall and Sen Slope estimator tests were conducted for all categories of rainfall to identify increasing or decreasing trends. The data indicated significant increasing rainfall trends during the summer, winter, and SWM seasons. Several months, including August, September, November, and December, also showed upward trends. A slight decreasing trend was observed annually, as well as during the NEM and in the month of March. The overall data suggested a shift in rainfall patterns, with increased rainfall during certain seasons and months and decreased rainfall in others. This change in the distribution and intensity of rainfall may indicate the effects of a changing climate over Dharwad, Karnataka.

***Keywords*:** Rainfall, Mann-Kendall, SenSlope,Annual, South west monsoon, North east monsoon.

SV-O2

Understanding the Impact of Climate Change on Monsoon Rainfall in Chhattisgarh: Projections and Trends under CMIP6 climate scenario

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Monsoon rainfall and its changing characteristics have been a focal point of climate research due to its profound impact on agriculture, water resources, and regional ecosystems. This study investigated the future trends of southwest monsoon rainfall across 33 districts of Chhattisgarh under four climate scenarios i.e SSP1 2.6, SSP2 4.5, SSP3 7.0, and SSP5 8.5. Statistical downscaling of monthly rainfall was performed using Multiple Linear Regression (MLR) models, using 26 predictors from the National Centers for Environmental Prediction (NCEP) reanalysis datasets as independent variable for each district. Observed gridded rainfall data for the historical period (1979–2021) were obtained from the India Meteorological Department (IMD) and served as the dependent variable. Before fitting MLR model the selection of predictors were done by using correlation co efficient, literature reviews etc. The MLR models were calibrated using data from 1979 to 2001 and validated with data from 2002 to 2014. Model performance statistics, including R^2, NSE, P-bias, and RSR, indicated satisfactory performance. Using the fitted MLR models, future rainfall projections were generated using three General Circulation Models (GCMs) i.e., CanESM5, MPI-ESM1.2-HR, and NorESM2-MM. A multi-model ensemble, calculated as the arithmetic mean of the projections from these GCMs, demonstrated improved accuracy over individual models as evaluated through Taylor's diagrams. Bias correction techniques, such as Cumulative Distribution Function (CDF) and equiprobability transformation, were applied to projected rainfall. Trend analysis using the Modified Mann-Kendall (MMK) test and Sen's slope estimator revealed significant spatial and temporal variations in monsoon rainfall trends. Historical analysis identified districts like Baloda Bazar, Bilaspur, Janjgir Champa, and Rajnandgaon as exhibiting significant negative trends, while Surajpur and Dantewada showed significant positive trends. Under future climate scenarios, significant increases in monsoon rainfall were projected for all districts except under SSP1 2.6. In SSP1 2.6, only a few districts, including Balrampur and Jashpur, showed no significant trends. SSP2 4.5 projected an increase in monsoon rainfall across all districts, with rates ranging from 2.85mm/year to 5.20mm/year. Similarly, SSP37.0 indicated increases for most districts, except Jashpur and Baloda Bazar. The highest rainfall increases were projected under SSP5 8.5, ranging from 7.88 mm/year to 12.57 mm/year, with Durg district showing the maximum increase. Rainfall variability, analyzed through the coefficient of variation (CV), was projected to intensify under future scenarios, particularly under SSP5 8.5. Spatial variability maps revealed significant differences in rainfall distribution compared to the historical period, suggesting increased variability and uncertainty in future rainfall patterns. This study underscores the significant impact of climate change on monsoon dynamics, with intensifying rainfall magnitude and variability across Chhattisgarh. The findings provide critical insights for policy makers and stakeholders, aiding in the development of adaptive strategies for sustainable water resource management, disaster preparedness, and agricultural planning in the context of a changing climate.

SV-O3

Agrometeorological Insights on Shifting Monsoons and Cropping Patterns in Semi-Arid Climates

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Karnataka's central dry zone, exhibits a Semi-arid climate with distinct wet and dry seasons, receiving an annual average rainfall of 630 mm, predominantly during the South-west (324 mm) and North-east (180 mm) monsoons. The study investigates long-term rainfall trends and variability over a 58-year period (1965–2022) using the RClimDex tool to compute precipitation indices that reflect extreme events and temporal patterns. The analysis reveals significant climatic shifts. Daily precipitation intensity (SDII) shows a marked decrease during the SW monsoon, highlighting a decline in rainfall per wet day. Conversely, the NE monsoon exhibits an increasing trend in extreme rainfall events, such as very wet days (R95pTOT) and consecutive wet days (CWD), accompanied by a notable rise in total seasonal rainfall (PRCPTOT). Annual rainfall patterns echo these findings, indicating an overall intensification of wet extremes. Additionally, the count of days exceeding 10 mm and 20 mm precipitation (R10mm and R20mm) has risen for both annual and NE monsoon periods, reflecting an upward trend in moderate-to-heavy rainfall events. Contrarily, the SW monsoon, while showing an increase in these indices, does not exhibit statistical significance. Dry periods, represented by consecutive dry days (CDD), have decreased significantly during the SW monsoon, suggesting a shift in rainfall distribution. These trends indicate growing variability in monsoonal patterns, with heightened extremes presenting significant challenges for agricultural practices and agrometeorological planning. The observed increase in extreme rainfall events and shifting seasonal distributions could disrupt sowing schedules, crop growth stages, and water availability, necessitating adaptive measures. This study highlights the urgent need for tailored agrometeorological advisories, climate-resilient farming strategies, and enhanced irrigation management to mitigate the adverse impacts of evolving rainfall extremes on agriculture in Hiriyur and similar semi-arid regions.

***Keywords**:* Monsoon rainfall, Climate variability, RClimDex, Semi-arid climate

SV-O4

Spatio-Temporal Representation of Decadal Temperature and Rainfall Trends in Arunachal Pradesh (1993–2022)

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Arunachal Pradesh, a state in Northeast India located in the Eastern Himalaya's, is experiencing pronounced climatic changes that carry significant implications for its delicate ecosystems, agriculture, and waterresources. Understanding these changes is crucial given the region's role as a key source of freshwater

and its vulnerability to extreme weather events. This study examines a 30-year (1993–2022) climatic record to characterize long-term trends in temperature and monsoon rainfall, focusing on the Southwest (June–September) and Northeast (October–December) monsoon seasons, as well as annual temperature measures. Multiple robust statistical techniques were employed, including Mann-Kendall tests for non- parametric trend detection, Sen's slope estimations to quantify rates of change, analysis of variance (ANOVA) to assess decadal differences, and autocorrelation analysis to evaluate persistence in yearly anomalies. Coefficients of variation were also calculated to gauge relative variability. The results indicate a persistent warming trend, with both maximum and minimum temperatures rising markedly and minimum temperatures increasing at a slightly higher rate, suggesting reduced nighttime cooling. Statistical tests confirm these increments as significant rather than random, and strong lag-1 autocorrelation values (>0.7) in temperature series imply that once warmer conditions emerge, they persist, reflecting a shift toward a new climatic baseline. In terms of precipitation, the Southwest monsoon exhibited a clear intensification, with a 500 mm increase over 30 years supported by both Mann-Kendall and Sen's slope analyses, indicating potentially stronger monsoonal circulation or altered moisture transport. In contrast, the Northeast monsoon, though numerically higher in recent decades, displayed greater interannual variability without a statistically significant monotonic trend, underscoring the complexity of secondary rainfall systems in mountainous terrains. Overall, these findings highlight the urgent need to incorporate climate projections into local and regional planning; enhanced flood mitigation measures, adaptive agricultural strategies, and sustainable water resource management policies must be prioritized. Given the Eastern Himalaya's ecological sensitivity and its critical role in regional hydrology, proactive measures are essential to ensure the resilience of communities, ecosystems, and infrastructure under evolving climatic conditions.

***Keywords*:** Arunachal Pradesh, Climate Change, Temperature Trends, Monsoon Rainfall, Himalayan Region, Statistical Analysis

SV-O5

Rainfall Trends and Variability in Coimbatore: A 116-Year Study

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Coimbatore, known as the "Manchester of South India," is a highly industrialized district in Tamil Nadu, India, with an urban population of 3.5 million. Monthly rainfall data from 1907 to 2023, obtained from the AgroClimate Research Centre at Tamil Nadu Agricultural University, reveals a mean annual rainfall of 674.6 mm (SD ±189.8 mm), with a minimum of 271.8 mm in 2016 and a maximum of 1299.8 mm in 1979. The annual coefficient of variation (CV) is low at 28, with the lowest CV recorded in the Northeast Monsoon (NEM) season at 42.7, followed by the Southwest Monsoon (SWM) season at 49.6, and the highest CV observed in the winter season at 153.3. The Bartlett test of homogeneity of variance was used to examine the homogeneity of the monthly rainfall between the two-time series. Long-term trends in monthly rainfall were analyzed using the Mann-Kendall (MK) test and Sen's estimator of slope, revealing a non-significant increasing trend in March, May, and August to December, while other months exhibited a non-significant decreasing trend. A significant increasing trend was observed on an annual timescale, with a non-significant decreasing trend in winter and non-significant increasing trends in other seasons. The Precipitation Concentration Index (PCI) values varied from 12 to 45, with most values in the range of 15–25, indicating irregular rainfall distribution in almost 66% of the years. The average PCI value for Coimbatore was about 19, suggesting the concentration

of annual rainfall over a few months during either NEM or SWM. PCI values ona seasonal scale showed similar variability for SWM (mean - 12; range – 8–20) and NEM (mean - 12; range – 8–24), with highly irregular rainfall patterns observed in the pre-monsoon season (8 < PCI < 25) and winter season (8.3 < PCI < 16.7). Despite the major contribution of annual rainfall through NEM, with an average share of 48.7% in the annual rainfall budget, a sharp contrast is observed when SWM provides excess rainfall. When the PCI was greater than 20, the rainfall was irregular, with NEM (mean – 57%; range – 50%-64%) contributing more rainfall.

Keywords: Rainfall, PCI, Coimbatore, SWM, NEM

SV-O6

Assessment and prediction of hydroclimatic teleconnection between eighteen atmospheric/oceanic circulation indices and summer monsoon rainfall of East and West Uttar Pradesh Meteorological Subdivisions

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For the country's socio-economic gain, evaluation of the hydro-climatic relationship between various large- scale atmospheric circulations and spati temporal variability of rainfall is very crucial. Sea surface temperature (SST) has a substantial impact on the hydrologic cycle, in which precipitation is the most crucial part. Thus, in the present study, assessment and prediction of hydroclimatic teleconnection (HCT) between summer monsoon rainfall (SMR) of East and West Uttar Pradesh Meteorological Subdivisions and eighteen large-scale oceanic/atmospheric circulation indices (each index has 8 lags) is carried by using machine learning tool named support vector regression (SVR) with linear kernel function and also by using monthly composite index (MCI) which is formed by employing multivariate linear regression (MLR) technique. The assessment is carried out for each technique by forming two different models with two development/training phase periods, i.e., 1951-1985, and 1951-1988 and two different testing phase periods 1986-2014, and 1989-2014. It was found that, MLR technique performed better than SVR technique in development phases, while SVR technique out performed MLR technique in testing phase. Thus, it can be concluded that, performance of SVR technique is better than MLR technique.

***Keywords*:** Hydro-climatic teleconnection, summer monsoon rainfall, circulation index, MLR, SVR, East Uttar Pradesh Meteorological Subdivision, West Uttar Pradesh Meteorological Subdivision

SV-O7

Estimation of Minimum Assured Rainfall Using Probability of Exceedance: A Suitable Approach for Planning Rainfed Rice

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Agriculture, as a foundation of rural livelihoods and food security, is deeply intertwined with climatic variables, especially rainfall being one of the most critical factors of agricultural productivity. In rain-fed agricultural regions, where irrigation infrastructure is limited, the temporal and spatial variability of rainfall directly influences planting schedules, crop growth stages, and yield outcomes. Given the critical role of water availability in crop planning, this study proposes a systematic approach for estimating minimum assured rainfall using the probability of exceedance (P). This approach provides a statistical foundation to anticipate rainfall thresholds crucial for effective crop management, especially for water-intensive crops like rice. By analyzing 50 years (1973–2022) of weekly rainfall data from three agro-climatic zones of West Bengal: Undulating Red and Laterite Zone, Gangetic Alluvial Zone, and Terai-Teesta Alluvial Zone, the study develops rainfall exceedance probabilities at thresholds of 25%, 50%, 75%, and 90% by fitting it to a range of statistical distributions such as Weibull, Generalized Laplace, Generalized Extreme Value (GEV) and Log- Logistic distributions. These thresholds represent the likelihood of receiving rainfall amounts at or above specific levels during standard meteorological weeks (SMWs). The probability of exceedance was calculated using the Weibull formula, which ranks historical rainfall data in descending order and assigns probabilities based on frequency. The suitability of each distribution was assessed based on deviations between observed and predicted rainfall values, with the Generalized Laplace distribution emerging as the most frequently fitting model. Minimum assured rainfall estimates at different exceedance probabilities facilitates the identification of critical rainfall periods. The minimum assured weekly rainfall required for rice was determined at 75% probability. Suitable varieties were recommended according to the rainfall pattern and area of study. The findings highlight the applicability of this probabilistic approach in mitigating risks associated with erratic rainfall. By aligning crop management practices such as planting schedules, water management, and crop selection with predicted rainfall patterns, farmers can enhance productivity. This study highlights the value of exceedance probability analysis as a tool for planning rainfed rice in the context of increasing climate variability.

Keywords: Weekly Rainfall, Exceedance Probability, Crop Planning, Minimum Assured Rainfall.

SV-O8

Wind Patterns and Rainfall Contrast in Monsoon: The Impact of Hilly area of Karbi Anglong on Surrounding Regions in Northeast India

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Monsoon, a vital climatic phenomenon in India, sustains agriculture, water resources, and ecosystems. In Northeast India, the unique topography, including the Meghalaya Plateau (1,000–2,000 meters) and the

Hilly area of Karbi Anglong (up to 1,400 meters) which is a part of the Patkai Range, plays a significant role in shaping monsoon patterns. Moist winds from the Bay of Bengal interact with these features, resulting in orographic rainfall on the windward side and rain-shadow effects on the leeward side. This interaction creates one of the wettest regions globally and highlights the importance of understanding these dynamics for sustainable agriculture and resource management. The Karbi Anglong Hills stretch across the districts of Nagaon, Golaghat and Karbi Anglong, significantly influencing monsoon wind patterns. Key rivers in Golaghat District, such as the Brahmaputra and its tributaries, including the Dhansiri, Sadiya, and Jinjiram, and in Nagaon District, such as the Kopili, Kolong, and Jamuna, benefit from the region's ample rainfall, which supports irrigation, agriculture, and livelihoods. To analyze the effect of the Karbi Anglong Hills, rainfall patterns in the surrounding regions of Nagaon and Golaghat districts were examined. Rainfall data from six locations in Nagaon and Golaghat districts (West and East of the Karbi Anglong Hills) were analyzed over 10 years (2014–2024). Locations in Golaghat district, such as Barpathar (1,016.76mm), Golaghat (957.89mm), and Numaligarh (957.88mm), receive higher annual averaged rainfall due to the orographic effect of the Karbi Anglong Hills. Rainfall decreases progressively as we move westward from the Karbi Anglong Hills, in Nagaon district ,with Chaparmukh receiving the least (271.78 mm), followed by Kampur (631.03 mm) and Lumding (798.86 mm). Further analysis, supported by ERA5 reanalysis data, confirms that the Karbi Anglong Hills act as a barrier to southwest monsoon winds. These winds are deflected eastward and forced to ascend, causing orographic lifting and heavy rainfall on the windward side, especially in Golaghat district. This deflection of winds to the east reduces moisture in stations across Nagaon district, with Chaparmukh receiving the least rainfall. This phenomenon is due to Chaparmukh's location in the exact rain shadow region of the Meghalaya Plateau, where monsoon winds lose most of their moisture after crossing the plateau. Wind speed data also shows a reduction in wind speed in the eastern regions, consistent with orographic lifting. Chaparmukh (1.33 m/s) and Kampur (1.30m/s) experience slightly higher wind speeds than Golaghat (1.30m/s) and Numaligarh (1.17m/s), which is consistent with orographic lifting, where winds lose momentum as they rise and condense to release rainfall. Orographic lifting, wind deflection, and rain shadowing shape Northeast India's climate, supporting agriculture with crops like rice, tea, and jute benefiting and replenishing groundwater. Understanding these dynamics is crucial for climate adaptation, sustainable farming, and disaster management. By recognizing the relationship between monsoon and topography, planners can better manage resources and enhance the region's resilience.

***Keywords*:** Northeast India Climate, Monsoon Patterns, Karbi Anglong Hills, Meghalaya Plateau, Orographic Rainfall, Wind Deflection, ERA5 Reanalysis Data, Nagaon and Golaghat Districts

SV-O9

Future consumptive irrigation requirement in the context of climate change: Dharoi command area, India

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Potential evapotranspiration (PET) is a vital parameter for determining consumptive irrigation requirement (CIR) in irrigation systems and managing water resources effectively. The globally recognized PET estimation model, the Penman–Monteith FAO-56 (PM FAO-56) model, is often criticized for its reliance on numerous detailed meteorological inputs, which can be challenging to obtain for future projections.

Nevertheless, it is widely regarded as the benchmark model in various global studies. The performance of PET models may be highly effective in certain locations but may not adequately represent conditions in other regions. This study aims to identify the most suitable PET model for estimating potential evapotranspiration in the Dharoi command area (707,176 ha), Gujarat, India. Five temperature-based models (Hargreaves, Hargreaves1, Hargreaves2, Baier-Robertson, and Thornthwaite) were compared with the PM FAO-56 model using data from eight meteorological stations within the command area from January 2000 to December 2020. The evaluation of the PET models was conducted using statistical metrics, including normalized root-mean-square error (NRMSE), relative error (Re), mean bias error (MBE), and the coefficient of determination (R^2). The results of these metrics for the ten PETmodels were analyzed across the eight meteorological stations. To determine the most accurate method, the widely used "Friedman test" was applied. Findings revealed that the Hargreaves2 model exhibited the lowest average score, ranking it as the most effective method. The weighted PET and rainfall were calculated using thiessen polygons methodover the Dharoi command area, then CIR was calculated. Consequently, the Hargreaves2 model was selected for future PET estimations. For future projections, statistically downscaled rainfall, and forecasted temperature data from five General Circulation Models (GCMs), processed using Kernel Regression, were utilized to calculate monthly PET and CIR for the Dharoi command area for the period 2011–2100. The long-term ensemble mean values of rainfall and CIR on monthly scale have been analysed with reference data of IMD for baseline period 1980-2019.

Keywords: Climate change; Dharoi command area; General circulation model; Hargreaves; model; Penman–Monteith FAO-56; potential evapotranspiration

SV-O10

Impact of Climate Change on Future Rainfall Patterns and its Extremes Over the Agro-Ecological Zones of India

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The projected impact of climate change on flood and drought occurrence diminishes crop productivity and raises concerns regarding food security. Consequently, this study evaluated future rainfall patterns and extremes at annual scales across the agroecological zones of India under the SSP emission scenario. In this comprehensive case study, a statistically downscaled multi-model ensemble mean of ten CMIP6 model datasets was utilized. A comparative analysis and quantification of percentage changes in future rainfall and its extremes were conducted with respect to observed gridded rainfall datasets from the India Meteorological Department (IMD). Six sets of extreme precipitation indices were employed: rainy days, simple daily intensity index (SDII), consecutive dry days (CDD), consecutive wet days (CWD), heavy precipitation days (R10MM), and very heavy precipitation days (R20MM). The current study definesthe baseline period as 1985 to 2014, with the near and far future periods designated as 2021-2050 and 2071- 2100, respectively, under both scenarios. In the baseline period (1985–2014), the maximum amount of annual mean rainfall was observed in the regions of the Eastern Himalayas (AEZ16), the Northern Eastern Plains (AEZ17), and the Western Ghats and Coastal

Plains (AEZ19), with an annual mean rainfall of more than 3600 mm/year. In the future period under the SSP3-7.0 scenario, parts of the North Eastern Hills (AER17) region will receive more rainfall in both the near (2021-2050) and far future (2071-2100) periods. In the very high emissions scenario (SSP5-8.5), a similar pattern of rainfall distribution as in SSP3-7.0 was observed across the agro-ecological zones with higher rainfall in AEZ16, AEZ17 and AEZ19, respectively. In the near and far future, in the Western Himalayan (AEZ1) region and Western Ghats (AEZ19), there will be a decrease in rainfall compared to the baseline period. The percentage of rainfall ranged between-15 and 45 in both the near and future periods under all scenarios. The number of rainy days, daily intensity, consecutive wet days, and RX10MM and RX20MM were also projected to increase under both emission scenarios, with the largest increases in the northeasternregion and the Western Ghats. The number of consecutive dry days is projected to increase under both emission scenarios, with the highest number in the Deccan Plateau and northwestern agro-ecological zones of India.

***Keywords*:** Climate change, rainfall, CMIP6, monsoon rainfall

SV-O11

Seasonal rainfall change scenarios in the identified homogeneous rainfall zones over the Indo-Gangetic Plains using machine learning algorithm

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The Indo-Gangetic Plain (IGP) of India is a critically important agricultural region which is not only vitalfor food security in India but also in South Asia. Since rainfall is a major input for agriculture, it is essential to understand how rainfall patterns in the IGP have changed over time. In this context, we attempted to investigate how many homogeneous rainfall zones are available over IGP, as it is a vast area covering several states. This study utilized K-means clustering, an unsupervised machine learning method, to classify homogeneous rainfall zones in the Indo-Gangetic Plain during different seasons. Using observed rainfall data from 1961 to 2020 provided by the India Meteorological Department (IMD), the study identified three homogeneous zones during the pre-monsoon and monsoon seasons, and two zones during the post-monsoon and winter seasons. Sub-Himalayan West Bengal (SHWB) received the most rainfall during pre-monsoon and monsoon periods. Trend analysis using the Mann-Kendall method showed an increasing pre-monsoon rainfall trend (2.07 mm/year) in SHWB, a decreasing monsoon rainfall trend (-2.85 mm/year) in the western IGP, anda decreasing post-monsoon rainfall trend (-0.26 mm/year) in the western to central IGP. No significant trend was observed during winter. Changepoint detection revealed that inter-annual mean monsoon rainfall decreased in two IGP zones after the changepoint years 1996 and 2008 respectively. SHWB was the only region with a significant increase in pre-monsoon rainfall after 1973.

Keywords: K-means clustering, Indo-Gangetic Plain, homogeneous rainfall zones, Mann-Kendall trend test, changepoint detection

SV-O12

Assessment and prediction of hydroclimatic teleconnection between eighteen atmospheric/oceanic circulation indices and summer monsoon rainfall of East and West Rajasthan Meteorological Subdivisions

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Oceanic/atmospheric teleconnection patterns have the potential to influence hydro-climatic phenomena across the globe over large distances. Prior understanding of monsoon behavior would aid policymakers and Indian farmers in maximizing benefits of good monsoons while reducing agricultural loss and human suffering during bad monsoons. For reservoir operations, crop planning, water distribution to various users, and other purposes, the monthly rainfall quantity of a given month is more useful than the total monsoon rainfall quantity. Thus, in the present study, assessment and prediction of hydroclimatic teleconnection (HCT) between summer monsoon rainfall (SMR) of East and West Rajasthan Meteorological Subdivisions and eighteen large- scale oceanic/atmospheric circulation indices (each index has 8 lags) is carried out by using machine learning tool named support vector regression (SVR) with linear kernel function and also by using monthly composite index (MCI) which is formed by employing multivariate linear regression (MLR) technique. The assessment is carried out by forming two different models for each technique with two development/training phase periods, i.e., 1951-1985, and 1951-1988 and two different testing phase periods 1986-2014, and 1989-2014, respectively. It was seen that MLR technique performed better than SVR technique in development phases, while SVR technique performed better than MLR technique in testing phase. Thus, it can be concluded that SVR technique has performed better than MLR technique. The HCT between circulation indices and SMR of East and West Rajasthan Meteorological Subdivisions changes over time.

Keywords: Hydro-climatic teleconnection, rainfall variability, circulation index, MLR, SVR, East Rajasthan Meteorological Subdivision, West Rajasthan Meteorological Subdivision

SV-P1

Evolving Dynamics of the Indian Summer Monsoon in a Changing Climate: Tackling Forecasting Challenges in Uncertain Times

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The Indian Summer Monsoon (ISM) has been the harbinger of irrigation to the majority of cultivated *Kharif* crops in the Indian sub-continent. In the light of climate change, with the Earth's surface temperature likely to exceed the 1.5 threshold for atleast one year between 2024 and 2028 (World Meteorological Organization), the Climate change-monsoon dynamics will occupy a central position as determinant of agricultural scenario in the country, and by extension, its economy. Hydro-meteorological disasters have been on the rise, afflicting nearly 75% of the total districts in India, particularly attributed to evolving rainfall patterns. Moreover, the global models which are used to forecast the monsoon pattern prove inadequate for local

studies, as well as prevention and mitigation efforts, particularly in the North-East of India due to its orographically complex terrain. Spatio-attention based U-Net Deep Learning method has been explored to forecast rainfall at the district levels, displaying superiority over Weather Research and Forecasting (WRF) model, with prediction accuracy of 91.9% and a mean absolute error of less than10mm. The Variable Resolution General Circulation Model (VRGCM) for Quantitative Precipitation Forecast (QPF) of the ISM deviates from the conventional anomaly simulation and forecasting methods using long-period means, utilizing relatively high variable grid resolution (50 km) over the ISM region. In contrast, the Indian Monsoon Data Assimilation and Analysis (IMDAA) reanalysis data from 1982-2022 provides a grid resolution of 12 km for the Indian subcontinent. Anothe rstudy utilizes 12 Coupled Model Inter-comparison Project 6 (CMIP6) models to simulate precipitation and the changes thereof and accordingly the North East region was forecasted to receive the largest increase in precipitation (2.9 mm/day) as well as the largest shift in precipitation.Furthermore, this paper also analyses a phenological study, relevant in these times of extensive deforestation, which states that the presence of vegetative coverage in the Asian monsoon region, may well be a formative factor for the humid monsoon climate, by inducing a positive feedback for precipitation change over land and have a penetrative effect for moving the precipitation into the continental interiors. Another study, included in this article, explores the effect of the Tibetan Plateau (TP) on the ISM, assessing the microphysics (riming) over Tibet in the forecast of circulation and precipitation of the ISM. CMIP5-based model simulation studies, analyzing the climate change-monsoon dynamics in India from 1871 to 2100, indicate a projected shift of the Monsoon Rainfall Peak Month (MRPM) from July to August in Northern and Central India. Hence, this paper explores the key challenges associated with monsoon forecasting and outlines potential strategies for improvement.

***Keywords*:** Indian Summer Monsoon, forecast, climate change, rainfall patterns, challenges

SV-P2

Climate change effects on the output of several crops farmed in Jorhat district of Assam

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The Jorhat district of Assam is situated in North-Eastern part of Assam between 26° and 45' North latitude and 94° and 12'East Longitude. The district's climatic and geographical conditions are very suitable for agriculture activities. Agriculture occupies a very important sector in the district and is a source of occupation for the majority (90 %) of the population. Jorhat district in Assam has a net cultivated area of approximately 127,000 hectares, with a cropping intensity of 138%. R ice is the dominant crop, occupying about 82.12% (125561.48 hectares) of the gross cropped area. Winter paddy is grown on 83,100 hectares, summer paddy on 11,000 hectares, and autumn paddy on 6,500 hectares. Additionally, both rabi and kharif vegetables cover around 9,100 hectares in the district. However, the impact of climate change on crop yield threatens food security which is detrimental and destructive to the agricultural sector. Therefore, the present study was carried out to assess the impact of climate change on crop yield for sustainability of agriculture. Climatic data *viz.,* total rainfall, average maximum-minimum temperature, relative humidity of morning and evening hours and sunshine hours were collected from the observatory of the department of Agrometeorology, AAU for the last five years from 2019-20 to 2023-24. Statistical tools like mean, SD, CV and correlation analysis were employed to evaluate the potential climate change impact on productivity of fifteen major crops of the study

site. The results disclosed that there exists a correlation between the climatic parameters and crop yield which indicates that climate has a strong linear correlation with yield of crops. Among the climatic parameters, rainfall had the most significant impact on yield. A noteworthy reduction was observed in yield of Autumn Paddy and Winter Paddy during the year2022-2023 due to 3.98 and 36.22 % decrease of rainfall with *r* values 0.95 and -0.76, respectively. Also, a quantum leap of 145.32% increase of rainfall during *Rabi* season of 2022-2023 decreased the yield of Potato and *Rabi* vegetables by 22.96 and 16.89 %, respectively. The study revealed that climate change has a significant impact on crop yield which could be alleviated by adopting improved rainwater harvesting and irrigation technologies by the farming communities.

Keywords: Agriculture, Growing seasons, Climate change, Crop yield, Correlation.

SV-P3

Trend Analysis of Temperature for Dharwad, Karnataka, India

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Climate change remains a critical global issue, with ongoing temperature variations playing a keyrole in assessing its effects on both regional and global scales. This study examines the weekly, monthly, seasonal, and annual temperature trends at the University of Agricultural Sciences, Dharwad Head Quarters, Karnataka from 1995 to 2024, using daily average maximum, minimum,and mean temperature data. Temporal changes were analysed through statistical tests, specifically the standard deviation, coefficient of variation, the Mann-Kendall test for trend detection, and Sen'sslope estimator to quantify the magnitude of trends. The monthly standard deviation (STD) of maximum temperature ranged from0.71 to 1.41, minimum from 0.28 to 1.31,and mean from 0.49 to 0.81.The monthly coefficient of variation (CV) of maximum temperature ranged from 2.64 to 4.14%, minimum from 1.36 to 7.87%, and mean from 2.05 to 3.45%. The weekly STD of maximum temperature ranged from 1.4 to 5.2, minimum from 0.6 to 7.2, and mean from 0.9 to 5.7. The weekly CV of maximum temperature ranged from 4.9 to 18.6%, minimum from 2.8 to 48.0%, and mean from 3.6 to 25.4%. Monthly trends showed positive trends in maximum temperatures for January (Zc =1.8, 1995–1999) and February (Zc = 3.7, 2020–2024), while negative trends appeared in July (Zc = - 4.2, 2020–2024). Minimum temperatures showed a positive trend in December (Zc = 4.8,2020–2024) and a negative trend in June (Zc = -3.1, 1995–1999). Mean temperatures saw a significant positive trends in March (Zc = 4.2, 2000–2004) and August (Zc = 3.1, 2020–2024), with negative trends in July (Zc = -3.9, 2020–2024). Weekly trends showed positive trends in maximum temperature in SMW 5 (Zc = 4.1, 2020–2024), while negative trends occurred in SMW 2 (Zc = -3.6, 1995–1999). Minimum temperatures showed positive trends in SMW 49 (Zc = 2.4, 2020–2024) and negative trends in SMW 47 (Zc = -1.947, 2020–2024). Mean temperatures had positive trends in SMW 6 (Zc = 2.44, 2020–2024) and negative trends in SMW 3 (Zc = -3.639, 2000–2004). These findings highlighted significant variability in temperature trends. The temperature analysis from 1995 to 2024 showed that weekly data exhibit greater variability than monthly data. The data also showed temperature trend variability in Dharwad rather than a consistent change. Some months like January, March, June, September, November, and December showed warming trends in some periods. However, other months such as February, April, May, July, and August showed cooling trends in some periods. There's no clear overall trend, with varied fluctuations rather than a straightforward climate change pattern. These findings highlight the variability in

temperature trends and suggest the need for further investigation into the underlying factors influencing these changes in Dharwad.

***Keyword*:** Temperature, Mann-Kendall, Sen Slope, standard deviation and coefficient of variation.

SVI-O1

Can Machine Learning Models replace Short-Range Weather Forecasting methods for Kashmir Valley?

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Accurate short-range weather forecasting is crucial for effective planning and disaster management, especially in sensitive regions like the Kashmir Valley. This study evaluates the performance of five machine learning (ML) models: Multiple Linear Regression (MLR), Random Forest (RF), Support Vector Regression (SVR), Extreme Gradient Boosting (XGB) and Artificial Neural Networks (ANN) for predicting next-day precipitation in Srinagar, Jammu & Kashmir, under three distinct input scenarios. The scenarios involve: Scenario 1: Lagged data (1-2 days) of maximum and minimum temperatures. Scenario 2: Lagged data (1-2 days) of temperatures and relative humidity (morning and afternoon). Scenario 3: Comprehensive lagged data (1-2 days) including temperatures, relative humidity, wind speed, pan evaporation, and bright sunshine hours. Among the models, RF consistently achieved the highest accuracy in calibration (Scenario3 :R^2=0.90,RMSE= 3.62 mm, nRMSE = 2.90%) and demonstrated robustness across scenarios. Validation performance, however, indicated moderate generalizability across models, with ANN marginally outperforming others in Scenario 3 (R^2= 0.27, RMSE = 7.22 mm, nRMSE = 8.59%). The inclusion of comprehensive weather variables (Scenario 3) improved model calibration but exhibited diminishing or similar returns in validation accuracy. The results reveal that while RF and ANN show promise in predicting precipitation, their validation metrics highlight challenges in replicating observed complexities in real-world conditions. This underscores the potential of ML models as complementary tools rather than replacements for traditional meteorological methods. The findings pave the way for further research on hybrid approaches combining ML with physical models to enhance forecasting accuracy in mountainous regions like Kashmir.

***Keywords**:* Machine learning, Kashmir valley, Artificial Neural Networks (ANN), Random Forest

SVI-O2

Decadal weather-based studyof key pests and disease of cotton in Hisar, Haryana

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In this study considered three experiments with the main objective weather effects on pests and diseases and its prediction i.e. Jassid, white fly, CLCU (major disease of cotton crop). The handling, weekly data for the statistical analysis and management at open field level, in the experiments and weather data used the adjacent field of experiment at agromet observatory (Latitude: 29° 10' N; Longitude: 75° 46' E & Altitude: 215.2 Meters (AMSL), CCS HAU, Hisar). This study was performed as collaboration among the meteorologists, entomologists and plant pathologists, over period of time. This work was performed as interdisciplinary efforts which provide valuable insights into the complex interactions between weather and cotton crop health during growing season. As the many seasons was observed and analyzed the pest and disease data, here understand the relation to the weather conditions under different meteorological weeks. Underscores the intricate relationship between weather patterns and the incidence of key pests and diseases in cotton crops in the semi-arid region of Haryana. The correlation and regression were performed with the different weather parameters. On RCH650 jassid weather-relation existing as Maximum temperature (-0.04), pan evaporation (-0.06) and accumulated rainfall (-0.12) showed non-significant correlation and sunshine hours (-0.24) showed significant negative correlation. The optimum range of maximum and minimum temperatures for white fly population build-up worked out to be 29.8 to 40.9°C and 16.9 to 28.7 °C, respectively. The optimum range of morning and evening relative humidity was 55.2 to 91.8 % and 28.3 to 76.7%. The per cent incidences of cotton leaf curl disease data (2005 to 2022) were correlated with the meteorological parameters.The maximum temperature (-0.58), minimum temperature (-0.44), wind speed (-0.61), actual vapour pressure (AVP) at morning (- 0.20) and evening (-0.14), evaporation (-0.65),and rainfall (-0.07) showed negative correlation. Then Stepwise multiplelinear regression equation for whitefly was carried out 11 seasons, i.e., 2007-08 and 2012 to 2021 to identify best suited model for the predictability (explain from 30 to 45%) of white fly population on used above significant weather variables. For the Multiple regression equation for PDI prediction (Cotton leaf curl virus disease and different combination of model developed. model predictability explains 51 to 52 percentage. The variability in occurrence of cotton leaf curl disease of Hisar zone was explained up to 62% with the help of significant weather parameters. M1, M2, M3, M4 respectively. 1:1 graph plotted-Scatter plot of observed vs predicted PDI of cotton leaf curl virus disease to validate the model for the year 2022 (four set of regressio nmodels). The model 3rd was predicted more points as closer to ± 30% prediction of weekly PDI.

***Keywords*:** Cotton weather insect-Pest & disease, correlation, regression, prediction, validation

SVI-O3

Statistical evaluation of snow accumulation and depletion from remotely sensed Satellite Snow time series data

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In the remote and challenging terrain of the Himalayan region, accurate measurement of cyclic snow accumulation and depletion is a significant challenge. To overcome this, an attempt has been made in the present study by applying a statistical analysis of satellite snow time series data over the Sutlej River basin. The Box– Jenkins forecasting methodology is based on the identification using seasonality, stationarity, ACF, and PACF plots; estimation based on maximum likelihood techniques; and the last diagnostic checking based on the residual and error values have been used. Later, forecasting models have been proposed separately for the snow accumulation period (October–February) as (2,1,1) (3,1,2)12 and for the snow depletion period (March– September) as (2,1,2)(2,1,1) 23 after calibration of the data (2010–2018) and the same was then validated using data (2019–2023). The accuracy assessment of the models has been checked using performance criteria like AIC,MSE, and RSS. The comparison of the forecasting models with the observed data showed a good agreement with R^2 of 0.83 and 0.89 for snow accumulation and snow depletion, respectively. This research highlights the potential of utilizing satellite data and statistical modeling to address the challenges of monitoring snow cover in remote and inaccessible regions.

***Keywords*:** ACF and PACF plots, AIC, MODIS time series data, MSE, RSSE.

SVI-O4

Harnessing Advanced Numerical Weather Prediction (NWP) Models for Precision Agrometeorological Advisory Services and Enhancing Climate-Adapted Agricultural Systems in North-East India

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In North-East India (NEI), Regional Meteorological Centre Guwahati (RMCG), under the India Meteorological Department (IMD) serves as the primary State Agro-Meteorological Centre (SAMC), responsible for generating value-added (VA) weather forecasts for the region and disseminating them to local AgroMet Field Units (AMFUs) for the preparation of Agrometeorological Advisory Services (AAS) Bulletins, commonly known as AABs. IMD provides quantitative forecasts for eight key weather parameters: rainfall, maximum and minimum temperature, highest and lowest relative humidity, wind speed, wind direction and cloud cover for the next five days which are used to prepare AAS under the Gramin Krishi Mausam Sewa (GKMS) scheme tailored to specific crops, phenological stages and local farming practices. This

forecast is primarily derived from advanced Numerical Weather Prediction (NWP) models which are indispensable tools for modern weather forecasting.NWP models employ complex mathematical equations to simulate atmospheric dynamics and processes based on the initial conditions to predict weather conditions covering timescales from nowcasting to seasonal forecasting. At present seven NWP models including Multi-Model Ensemble (MME) e.g., GFS, GEFS, NCEP, NCUM, JMA and ECMWF are operated by institutions under the Ministry of Earth Sciences (MoES) e.g., IMD, IITM, INCOIS etc.crucial for providing accurate, timely and location-specific customized forecasts. For instance, district-wise MME rainfall forecast is used as the valuable inputs to prepare VA forecast. Besides, forecast for temperature is received in the form of 'City Forecast' provided by RMCG. It is noted that local climatological knowledge plays a crucial role in the VA forecasting process, particularly in NEI, characterized by complex topography. NWP models also contribute significantly to early warning systems by predicting extreme weather events e.g., heavy rainfall, hailstorms, ground frost, thunderstorms and lightning through the issuance of Impact-Based Forecasts (IBF). This allows farmers to take preventive measures, optimize resource usage and minimize crop losses caused by adverse weather conditions. IMD also launched weather forecast at Gram Panchayat level, offering high-resolution forecast services tailored to farmers in rural areas. The AABs are shared with farmers using various communication platforms, such as SMS/WhatsApp in bi- weekly basis to support decision-making alongside the IBF-derived AAS, issued irrespective of any days as per the probable occurrence. The farmers from different parts across NEI states recognized the value of timely and accurate forecasting which helped them to reduce crop losses and enhance crop productivity as well. As per the assessment of district-wise MME rainfall with respect to observed data during monsoon season ranging from June to September (JJAS) in 2023, IMD revealed slight improvement in model performance compared to previous years, however, further improvements are required for NEI region. Results from 747 districts indicated that the average correlation coefficient during Day 1 to Day 5 forecasts is 0.56 with RMSE of 13.3 mm and Bias of 0.91 mm. Thus, this research highlighted the significance of NWP model based forecasting in addressing climate variability and enhancing agricultural productivity. Looking ahead, IMD envisions incorporating AI/ML-based frameworks into NWP models to deliver more customized, VA forecasts for different sectors, further refining agromet services in India.

Keywords: NWP, IMD, MME, Rainfall, GKMS, AAS, NEI, AI/ML

SVI-O5

Influence of meteorological and micro-meteorological parameters on the severity of Rhizoctonia aerial blight in soybean and development of a disease forewarning model in Jorhat region of Assam

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Rhizoctonia aerial blight (RAB) caused by *Rhizoctonia solani* Kuhn. is one of the major soybean diseases in Assam and inflects heavy production loss. Field experiments were conducted at the Instructional-cum-Research (ICR) Farm of Assam Agricultural University, Jorhat, during 2022 and 2023 to investigate

the influence of meteorological and micro-meteorological parameters on the severity of Rhizoctonia aerial blight in two soybean varieties, JS 335 (V1) and KDS 753 (V2), across five sowing dates: 17th May (D1), 1st June (D2), 16th June (D3), 1st July (D4), and 16th July (D5), and thereby develop a disease forewarning model. The disease onset occurred between mid-August and early September, coinciding with the flowering stage. The disease severity was higher during the year 2022 (16%-42%) compared to 2023 (14%-32%) as the weather parameters during the disease development were favourable during the year 2022 (higher relative humidity, moderate temperatures (maximum and minimum), higher rainfall and less bright sunshine hours). The Area Under Disease Progress Curve (AUDPC) values increased progressively each week since disease initiation (flowering stage), reaching their peak at the physiological maturity stage of the crop. The apparent maximum infection rate (r) occurred during late (20th - 26th) August and all the treatments exhibited higher infection rates in the first two to three weeks of 1st appearance of the disease which reduced subsequently up to plant maturity. The two years of pooled weekly data revealed that the maximum progression in disease severity was observed from beginning pod (R3) to full pod (R4) and full seed (R6) to beginning maturity stage (R7) and it was positively correlated with plant age (R^2=0.97). Correlation studies with the meteorological and micro-meteorological parameters revealed thatrelative humidity (morning and afternoon), rainfall, rainy days and soil moisture were positively correlated with disease severity, while temperature (maximum and minimum), evaporation, wind speed, bright sunshine hours, canopy temperature and soil temperature were negatively correlated with disease severity. The regression equations, thus developed revealed that the coefficient of determination (R^2) during 2022 ranged from 0.987-0.636 and during 2023 from 0.992-0.539. The prediction model was developed for pooled data (2022 and 2023) combined over varieties and microclimatic regimes and the R^2 obtained was 0.977 indicating that 97.7% of the variability in disease severity can be explained by maximum temperature, minimum temperature, morning relative humidity and soil temperature.

Keywords: *Rhizoctonia* aerial blight, soybean, weather, correlation, forewarning model

SVI-O6

Mission Mausam To Farmers And Beyond: An Automated Village Level Farmer and Crop Specific Agro-Advisory Services In Karnataka

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Weather forecast issued by IMD is improving over time, more so in the last decade. With the launching of ambitious Mission Mausam project, the IMD has set a goal of enhancing the accuracy and precision of the current weather forecast by at least 10-15 % during the next 5 years including capturing localized extreme events including heavy rains, lightning and thunder storms. Farmers, as one of the largest clienteles and regularly consuming population for their decision-making process on the farms, badly need localized reliable weather forecast supported by crop specific advisories targeted to each farmer. In this regard, IMD has also initiated PMS – Panchayat Muasam Service, which intends to directly provide weather forecast at Panchayat level granularity so that more reliable weather forecast is provided. In line with IMD's

Mission Mausam goal, a World Bank funded project called MWAAS: micro-watershed level weather forecast based farmer specific agro-advisory services is being implemented since 2023 on project basis across 20 out of 30 districts covering 3349 micro- watersheds spread across 81 taluks of Karnataka state covering both North Interior (NIK) and South Interior (SIK) Karnataka. The objective of this project is to provide weather forecast based crop specific advisories to individual farmers in an automated mode via mobile texts. This would reach enrolled individual farmer with message-based advisories related to the crop or crops grown during a particular season in an automated mode. Each advisory message is restricted to 90 characteristics only. This means farmer growing maize would get messages concerned with maize only. Of the 3349 MWS, half are treated with all the soil and water conservation practice, suitable crops, and appropriate nutrient management package based on land resource inventory (LRI), whereas other half no LRI based interventions were imposed to make comparison of the both to quantify the impact of LRI based interventions. Using dynamic crop weather calendar, advisories are prepared for almost all the major field and horticultural crops, vetted and deposited in the system. Automation is built on a computer-based programming platform which, pulls in several parameters like; crop chosen by the farmer, sowing date to mark crop stage, soil type, realized rain of the last week and forecasted rainfall for the coming week to pick the right advisory from the repository and sends across *via* text message to each farmer. In the next phase this one-way issuing of advisory via text messages would be upgraded to two-way interactive mode wherein field based problems during the crop growing season like pest and disease incidence will be addressed and suitable advisories will be issued on real-time basis.

SVI-O7

Incidence of Insect pests of rice in Assam under changing climate

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Impact of climatic factors on incidence of insect pests of rice was carried out during *Kharif* season across Northeast India from 2016 to 2021. Extensive field surveys were conducted in 38 villages across 10 districts of Assam to identify key pests of rice in relation to changing climate. The incidence of rice yellow stem borer, leaf folder, horned caterpillar and rice yellow hairy caterpillar were found to be significant in all districts and the correlation study of pest incidence with key weather parameters such as minimum and maximum temperature, relative humidity, rainfall and bright sunshine hours indicated that minimum and maximum temperatures exhibited significant negative correlations ($p < 0.01$) with pest incidence. Rainfall has shown significant negative correlation with pest prevalence, especially in 2018 (yellow stem borer, r= -0.664, leaf folder, r= -0.746, horned caterpillar, r= -0.728, yellow hairy caterpillar, r= -0.731). The influence of relative humidity varies between phases (RHI and RHII), often exhibiting (RHII) negative correlations. Bright sunshine hour has shown non-significant positive correlation with pest incidence. The study highlights the complex interplay between climatic factors and pest dynamics which can be used to develop weather-based pest forecasting models to mitigate pest outbreaks, ensuring sustainable rice production amidst changing climatic conditions.

***Keywords*:** Assam, Correlation, pest incidence, rice insect pest, weather parameters

SVI-O8

Rainfall had no role in the recent out break of Rice Ear-Cutting caterpillar, *Mythimn aseparata* (Walker): An interpretation based on the SPI analysis

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Out of the three armyworm species that commonly attack the rice crop in Asian countries, the Rice Ear-Cutting caterpillar, *Mythimn aseparata* (Walker) can cause a direct economic loss, since it cuts off the panicles at their base before harvesting. Such a loss increases with the severity of the outbreaks. Recently, Assam has experienced the outbreak of *M. separata*in 16 districts, infesting more than 30,000 ha paddies during November, 2023. In Nagaon district, it occurred in 23 villages infesting 241 ha affecting 884 farm-families. As per the International Rice Research Institute, the *drought followed by heavy rain* is a favourable weather factor for the paddy armyworms. We made an attempt to analyse such favourable spells using Standard Meteorological Index (SPI) based on daily and weekly rainfall data for 52 SMWs a year. We analysed it for three consecutive years *i.e.* the very outbreak year (2023), one preceding non-outbreak year (2022), and one succeeding non-outbreak year (2024). We found 44, 46 and 43 dry weeks and 8, 6 and 8 wet weeks in 2022, 2023, and 2024, respectively. The patterns of occurrence of the interspaced dry/wet weeks were almost similar in outbreak and non- outbreak years.No distinct favourable spell was observed to identify it responsible for the outbreak. It can be concluded that rainfall had no role to increase the resident population of *M. separata* to cause its outbreak in Nagaon district.

Keyword: Standard Meteorological Index, Outbreak,Armyworm, Nagaon, SMWs.

SVI-O9

Recent Advances in Impact Based Forecast (MHIBF) & Risk Based Warning for Agriculture & allied sectors in Uttar Pradesh

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Uttar Pradesh occupies an important place in the polity and economy of the country. The economy of U.P. is predominately agrarian with total cultivated area of 166.83 lakh ha and the gross cropped area of 255.24 lakh ha. The cropping intensity of the state is 153%. The agriculture contributes highest 66% to the Gross State Domestic Product (GSDP). Being most populous state of the country, comprising of 75 districts & composed of 826 Blocks has broadly been classified into nine agro-climatic zones & 20 agro-ecological

zones. Each of these regions have varying weather & climatic features in terms of different temporal & spatial scales owing to their complex physiographical characteristics due to which this region is one of the most vulnerable part of the Indian subcontinent pertaining to the high socio-economic impacts due to its peculiar geophysical settings across the fertile Indo-Gangatic plains. Generalized forecasts, however, have limited use in farming. Weather information for agricultural operations shall be a tailored product that can be effectively used in crop planning and its management. Though complete avoidance of farm losses due to weather is not possible, however losses can be minimized to a considerable extent by making adjustments, through timely agricultural operation and accurate weather forecasts. A comprehensive seamless forecasting system has been adopted & successfully implemented in the India Meteorological Department to address the challenges offered due to various weather vagaries at different temporal & spatial scales. This study discusses about the potential challenges and opportunities offered by this approach in the decision-making workflow in an operational context across various spatial & temporal scales starting from seasonal outlook to nowcast level for the state of Uttar Pradesh. The methodology maybe classified into three principal aspects. The first & foremost input comes from the seasonal outlook which is again of limited utility for farm level operation but it enables administrators & major stake holders to take effective sectoral policy level decisions & strategies to address the challenges in the coming season for optimal performance in agriculture sector. The second vital input comes from the monthly outlook during course of an ensuing season. It may or may not have an immediate impact on infield crops but certainly has a great influence on the crop yield as it delineates meteorological features better at regional scales & has optimal utility to enact various line departments, major stakeholders & farmers for strategic planning for farm level operations pertaining to different crops. The third but probably most vital input for agriculture sector comes from Extended Range Forecast at weekly scale for next 2-4 weeks as it ensures actionable response from both the farmers & various line departments pertaining to it's direct practical utility for infield agricultural operations. The fourth & most important input for farm/crop level day to day strategic planning comes from the Bi-Weekly Medium Range Forecast which enables farmers to ensure day to day farm/crop level operations which plays most crucial role in final yield. Last but not the least approach in terms of time of commencement, cessation & duration of any adverse weather hazard is covered in very short range to nowcast scale for sub-daily to daily interventions for infield farm/crop operations by ensuring immediate infield farm/crop level operations to minimise the loss of agriculture, livestock & life which has proven to be a great initiative towards '*TRANSLATING HAZARD INFORMATION INTO IMPACT SCENARIOS*' for sectoral applications vide WMO resolution No 1150 with the aim to bridge the gap between scientific community, different stakeholders and end user.

Keywords: MHIBF, RBW, WMO, Risk, Impact, Hazard, GSDP

SVI-P1

Quantify the accuracy of medium range weather forecast in different districts of Chhattisgarh state

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Attempts were made to verify the weather forecast received on every Tuesday and Friday from NCMRWF/IMD for different districts of Chhattisgarh. The verification analysis was carried out for six important weather parameters on annual basis through various verification techniques *viz.,* Ratio score, Critical success index, Heidke skill score, Hansen and Kuiper score, Root Mean Square Error, Usability Analysis and Correlation Analysis for the year 2021-22. On quantitative analysis and correlation analysis on annual basis, we found that there is out to be all three agro- climatic zones (27districts) which showing significant relationship except in wind speed (i.e., Kabirdham, Mungeli and Korba districts) and rainfall parameters (i.e., Rajnandgaon). In RMSE value we found that there is the absolute error high value 18.2 (RH-I), 19.3 (Rainfall) and 40.6 (RH-II) respectively.

***Keyword*:** Weather forecast, Usability, Correlation, RMSE, Skill score

SVI-P2

Evaluation of weather parameters forecast for issuance of agromet advisories for Raipur district in Chhattisgarh

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Weather forecasts provided by the RMC, India Meteorological Department (IMD), Raipur were compared with actual weather data recorded at the agromet observatory of IGKV farm field, Raipur to assess the qualitative analysis by using their accuracy, validity and skill score during different seasons of 2023-24. Results revealed that the higher HK scores were observed the pre-monsoon (0.61) and post-monsoon (0.94) it indicating that the forecast model performance better during these periods as compared to other seasons. The prediction's annual basis for rainfall accuracy was found 86%, which is an excellent forecast performance for farmers to take action in their agricultural activities. The performance of maximum and minimum temperature during usability analysis was observed higher during pre-monsoon and post-monsoon, respectively. All weather variables showed significant performance at the 1% level on a yearly basis in the qualitative investigation. The significance of predicted weather parameters in comparison to observed ones was investigated and utilizing critical values and skill scores for error assessment across

different seasons. Accurate forecasts of weather parameters in advance are valuable for farmers, aiding them in scheduling appropriate field operations and managing crops effectively.

***Keywords*:** Monsoon, Ratio score, Skill score, Usability analysis, RMSE.

SVI-P3

Usefulness of Agromet-Advisory Services (AAS) Under AICRPAM-NICRA at Parbhani District of Maharashtra for Improving Livelihood of Rural Farmers

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Present review study was conducted during in year of 2023-24. Main aim of review study to know effectiveness and usefulness of Agro Advisory Services (AAS) regarding Climate Change in selected Villages of AICRPAM-NICRA Project for Marathwada Region. Study concluded that, Agro Advisory Services (AAS) an effective communication media for transfer of technology regarding climate changes information. Agro Advisory Services (AAS) provides basic, timely and accurately pre-information of different climate and weather conditions of different crops. Agro Advisory Services (AAS) helpful to farmers for increase interest, knowledge, adoption and impact of climate changes on agricultural practices. The crop situation of these farmers was compared with nearby fields having the same crops, where forecast is not adopted in Non AAS farmers' field. The data was recorded from both the farmers group particularly on crops expenditure incurred by the farmers from land preparation to harvest at every stage, has been worked out and crop growth and yields were observed regularly. The result observed that those farmers who adopted AAS information and implemented it in their field, found the better crop growth and high yield over the non-adopted AAS farmers. The net income of AAS farmers was about Rs. 56042 to 58278 for soybean and while non AAS farmers about Rs. 35690 respectively. Those farmers have adopted the Agromet Advisories on their day-to-day operation carried out the additional benefits of 61 to 63%.

***Keywords*:** Agro advisory services, Climate change, Weather, B:C ratio

SVI-P4

Validation and Feedback Analysis of Agromet Advisory Services in North Eastern Dry zone of Karnataka

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The success of crops in the North-Eastern Dry zone of Karnataka is significantly influenced by the uniform distributio n of rainfall during the southwest monsoon. Timely and accurate weather forecasting plays a crucial role in minimizing crop losses. This study focuseson the validation of weather forecasts in Raichur and Kalaburagi districts of Karnataka. Both Qualitative and quantitative verification methods were employed to assess farmer's perception and impact analysis to adapt the Agroadvisory Services (AAS).

Additionally, a micro level survey involving 240 farmers were conducted during the year 2022-23 to evaluate the effectiveness of agromet advisory services. The findings reveled that a majority of farmers actively utilize AAS, mainly for post-harvest operations, sowing/transplanting, pesticide and fertilizer application, minimizing irrigation costs, and other farm activities. The survey also reported a high level of satisfaction among nearly three-fourth (72.16%) of respondentsregarding the AAS.

***Keywords*:** Rainfall, Weather, Farmers, Validation, Forecast, Feedback, Agromet Advisory Services (AAS)

SVI-P5

Weather forecasting: A critical Tool for Sustainable Agriculture and Risk Mitigation

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Weather forecasting has emerged as an indispensable tool in modern agriculture, playing a pivotal role in promoting sustainability and mitigating climate-related risks. By delivering accurate meteorological data, weather forecasting empowers farmers and allied sectors to adopt climate-smart practices andsafeguard agricultural productivity. Accurate weather forecasts are crucial for making informed decisions at various stages of crop management. Timely predictions guide farmers on optimal sowing periods, irrigation schedules, fertilization, pest control and harvesting, thereby minimizing crop losses and maximizing yields. For instance, precise rainfall forecasts enable efficient water use, preventing over-irrigation or droughtstress. Similarly, pest and disease forecasts allow targeted interventions, reducing the reliance on chemical inputs and fostering eco-friendly practices. Additionally, forecasts of extreme weather events, such as droughts, floods, heat waves, and storms, facilitate the implementation of proactive measures to protect crops, livestock, and infrastructure. In livestock management, weather predictions are instrumental in planning feedstock, shelter, and vaccination schedules, ensuring animal health and productivity under adverse conditions. Fisheries also benefit significantly, with forecasts helping to navigate risks associated with storms, high tides, and extreme weather, thus ensuring the safety of fishers and their livelihoods. Similarly,in forestry, weather information aids in managing fire risks and monitoring dry spells, protecting valuable natural resources. The effective dissemination of weather information is vital for its practical application. Digital platforms such as mobile applications and SMS alerts, combined with mass media channels like radio and television, ensure that timely and actionable forecasts reach farmers and other stakeholders. Localized extension services also play a crucial role in interpreting and delivering forecast data tailored to specific regional needs. Advancements in technology, including remote sensing, artificial intelligence (AI) and machine learning, have significantly enhanced the precision and relevance of weather forecasts. These tools provide region-specific insights, enabling real-time advisories through integrated decision-support systems. For example, dynamic rainfall predictions guide precise irrigation, while pest outbreak forecasts help optimize resource use and minimize costs. Weather forecasting is a cornerstone of sustainable agriculture. By leveraging technological advancements and adopting robust dissemination strategies, weather forecasting enhances resilience to climate challenges, ensuring food security and empowering farming communities to achieve climate-smart agricultural development.

***Keywords*:** Weather forecasting, sustainable agriculture, climate resilience, precision agriculture, risk mitigation

SVI-P6

Prognostic Approach to Weather Forecasting to Improve Efficiency of Agriculture and its Allied Sector and Mitigation through Risk Assessment

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A prognostic approach involves predicting future weather conditions based on numerical models, historical data, and real-time monitoring. Weather is one of the most important factors determining the success or failure of agricultural production. Any change in weather patterns during the crop season will affect the growth of the crop and ultimately affect the quality and quantity of the crop. By leveraging modern technology, robust infrastructure, and proactive policies, it is possible to mitigate adverse impacts and ensure sustainable agricultural practices. Weather forecasting, empowered by AI, ML, IoT and remote sensing, is critical for climate- resilient agriculture, and adopting these technologies, agriculture and allied sectors can better adapt to climate change, thereby ensuring food security and sustainable livelihoods for farmers.

***Keywords*:** Agriculture, weather forecast, Climate Change and Time Series analysis.

SVI-P7

Development of weather based disease forewarning model for fruit rot of *Capsicum chinense* Jaqc. in Jorhat region of Assam

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Fruit rot of *Capsicum chinense* Jaqc. is one of the most devastating disease causing severe damage to the fruits in the field and considerable losses during storage, transit and marketing. In the present study, epidemiological data were generated from the field experiment conducted on the Horticultural Experimental Farm of Assam Agricultural University, Jorhat to develop forewarning model of fruit rot disease of *Capsicum chinense* in Jorhat region of Assam. The crop was grown at five different dates of transplanting starting from 15th of November, 2022. Incidence of fruit rot were recorded at weekly intervals and percent disease incidence (DI) were calculated based on field observation. Correlation studies were done between DI and weekly weather parameters (maximum temperature, minimum temperature, morning and evening relative humidity, amount of rainfall, number of rainy days, bright sunshine hours, morning and evening soil temperature, evaporation and wind speed) and found that the minimum temperature were significant and positively correlated with DI at different dates of transplanting. From stepwise regression analysis, predictive model had been developed for incidence of fruit rot disease in *Capsicum chinense* which revealed that minimum

or night temperature significantly attributed to the disease development to an extent of 97 per cent across different dates of transplanting.

***Keywords*:** *Capsicum chinense*, Disease incidence, Forewarning model, Fruit rot

SVII-O1

Effect of Different levels of protein with constant Energy on Reproductive traits of Vanaraja Chicken

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This study investigated the impact of dietary protein levels (16%, 18%, and 20%) with a constant energy level of 2400 kcal/kg on reproductive parameters of Vanaraja chickens during the laying period. Sixty birds were randomly divided into three groups (G1, G2, and G3) 20 birds in each group receiving diets with increasing protein and constant energy concentrations in a controlled Californian cage system. Results indicated that Group G3, fed with 20% protein, exhibited significantly ($P<0.05$) earliest age of egg laying, lesser weight at first laying and highest total egg production compared to Groups G1 and G2. These findings underscore the influence of protein and energy intake on reproductive parameters viz. age of fist laying, weight at first laying and total egg production of Vanaraja chickens during egg production.

SVII-O2

Ailanthus excelsa based agroforestry systems for climate change resilience in arid and semi-arid ecosystems

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Climate change is an established reality not only for the farmers of arid and semi-arid regions of India but is also the greatest global challenge. Climate change, evidenced by various climate indicators has been posing significant effects to agriculture and livelihoods. To handle these ill effects of climate change, the implementation of effective adaptation mechanisms is required, especially for those that are highly affected smallholder farmers in semi-arid ecosystems of developing countries. The integration of adaptation and mitigation strategies is increasingly recognized as a necessity, particularly in agriculture, forestry, and land use. Within this context, agroforestry practices have gained attention as a means to enhance the resilience of smallholder farmers to climate risks. Agroforestry has been a practice in arid and semi-arid regions of the country since time immemorial. Agroforestry contributes to livelihood improvement along with biomass and carbon stocks enrichment. Thus, help farmers to adapt to climate change through the risk-mitigating effects of additional farm products derived from trees, positive microclimate and enhanced farm productivity through nutrient cycle.*Ailanthus excelsa* Roxb. (Mahaneem) is an important fast growing agroforestry tree species

for arid and semi-arid regions. It is one of the promising fast growing multi purpose trees of dry areas due to its ability to grow well with less rainfall and high temperature conditions. Therefore, *A. excelsa* based agroforestry systems with different tree densities (50, 100, 150 and 200 trees ha^{-1}) to identify its effect on crop yield and soil attributes were assessed. In the present study, yields crops were influenced by *A. excesla* trees, irrespective of crop or tree density with advancement of tree age. Among different tree densities higher crop yields were recorded with 50 trees ha^{-1}. Soil fertility status in terms of organic matter (OM), available P and K improved under agroforestry systems as compared to sole cropping. Growth performance of *A. excelsa* under different tree densities and in association with crops was statistically atpar, maximum girth (50.10cm after two years) at breast height was recorded under density of 200 trees ha^{-1} with cluster bean-wheat cropping sequence. The experimentation showed maximum benefits under agroforestry with 200 trees ha^{-1} under both the cropping systems. Total biomass was significantly higher in agroforestry systems (tree + crops) under all tree densities as compared to sole cropping and highest biomass was recorded under density of 200 trees ha^{-1} with pearl millet - Indian mustard. Higher carbon sequestration was recorded in agroforestry systems than sole cropping.

SVII-O3

Quantification of Methane Emission from Livestock and Manure Management in Tamil Nadu, India

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Livestock has emerged as a prominent sector that contributes nearly 14.5% to global total methane emission due to anthropogenic activities, where Asian countries contribute significantly. For the present study, the census of livestock population viz., Buffaloes, Cattle, Sheep and Goat from 2007 to 2019 were obtained from Tamil Nadu livestock handbook, Government of Tamil Nadu. The emission factor is taken from the average of IPCC default emission factor for livestock. Erode, Namakkal and Tiruvallur districts recorded highest methane emission from buffaloes. Buffalo population is appreciable in numbers as part of these two districts falls in the Cauvery belt, which thrive on the fiber rich *Typha angustifolia* a perennial herbaceous plant abundantly present in this region. Further, paddy straw is the primary dry fodder fed to the livestock of this region. Tiruvannamalai, Villupuram, Kallakurichi and Salem districts recorded highest methane emission from Cattle since these districts stands with higher milk production area in Tamil Nadu. Virudhunagar, Ramanathapuram, Tiruppur and Salem are known to have high population of sheep hence the methane emission is higher in these districts. Salem, Namakkal, Tiruchirapalli, Pudukottai, Virudhunagar districts have higher number of non-descript low productive goat population which results in more methane production. Notably, the Kanyakumari district was found to emit low methane emission in all livestock and this might be due to more proportion of cross breeds to total dairy animals. Furthermore, near the coastal districts, where high temperature and high humidity prevails, livestock population will be low and the methane emission was found to be lower in those districts. To reduce the methane emission, feeding of plant based feed additives and introduction of improved recognized breeds with adoption of scientific feeding practices properly balanced

with leguminous and non-leguminous fodder and supplementing with fibre digestive enzymes and probiotics will pave way for reduction in methane emission.

Keywords: Methane, livestock, Tamil Nadu, high emission, low emission

SVII-O4

Cyclone Impact on Mangroves: The Carbon Store houses of the Sundarbans

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Mangroves are a group of tropical trees and shrubs that grow in coastal intertidal zones, thriving in hot, salty and muddy conditions. They are critical in mitigating climate change, as they store 3-5 times more carbon per hectare than terrestrial forests. The Sundarbans in West Bengal, the world's largest mangrove ecosystem, is home to diverse species and holds immense ecological value. However, mangroves face significant threats from deforestation, rising sea levels, increased salinity and intensified tropical cyclones, which endanger their survival and the health of surrounding ecosystems. This study focuses on analyzing changes in mangrove area using surface reflectance data from Landsat 5 and Landsat 8 images of the Indian Sundarbans. Remote sensing techniques were employed to assess land area changes from 1988 to 2020. In addition, the study quantified the annual blue carbon sequestration in the region during the same period. The data were divided into three decades to observe trends over time. The study revealed a significant decline in mangrove area during the first decade (1988 –1997), followed by an increase in the subsequent two decades. The carbon sequestration showed a significant positive correlation relative to the expansion of mangroves. Additionally, data on cyclones that occurred on the Bay of Bengal sub-basin were collected to identify specific cyclones contributing to mangrove destruction. The intensity of cyclone showed a significant negative correlation with the mangrove area. Mangrove ecosystems were most vulnerable to major cyclones (Category 3 to 5). Intense cyclones (Category 4 to 5) accounted for the damage risk. The findings underscore the importance of implementing effective measures during intense cyclones to minimize destruction, facilitate mangrove restoration and enhance blue carbon sequestration, thereby ensuring the long-term resilience of these vital ecosystems.

***Keywords*:** Mangroves, Remote sensing techniques, Blue carbon sequestration, Tropical Cyclones

SVII-O5

Assessing the growth performance and yield of cereal crop in an *Prosopis cineraria* based Agroforestry System under Semi-Arid Conditions

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Khejri scientifically known as *(Prosopisc ineraria)* is a vital tree species in arid and semi-arid regions, offering ecological, economic, and cultural benefits. Its resilience to drought, ability to improve soil health through nitrogen fixation, and provision of multiple resources make ita key component of sustainable agroforestry systems in water-scarce areas. Khejri is often considered a "lifeline" for rural communities, playing a crucial role in soil conservation,water retention, and providing fuelwood, fodder, and timber.The experiment was conducted at the Forestry Research Farm, CCS HAU, Hisar, using a randomized block design with five replications. Three spacings of *Prosopis cineraria* were tested: 8x3m, 9x3m, and 10x3m, with control plots devoid of trees. Therefore, cereal crop (Var. HD 2967) was sown duringthe *rabi* season under different spacings of *Prosopis cineraria* based Agroforestry System and in an open field devoid of trees. The objective was to evaluate the growth and performance of cereal crop (Var. HD 2967) under agro forestry system. The results showed that *Prosopis cineraria* exhibited significant growth at the 10x3m spacing, with the highest plant height (4.3 m) and girth at breast height (32.8 cm) at 4.5 years. Soil analysis revealed non-saline, medium organic carbon content, and low available nitrogen. The cereal crop were recorded maximum Plant (99.12 cm) under 8×3 m spacing, these differences were also statistically non-significant. Plant height varied from 96.78cm (10x3m) to 96.84 (8x3m). The other parameters *viz*, no. of effective tillers /m^2, days taken to maturity. (No.), No. of grains/spike, test weight (g) showed similar pattern under different treatmentsin the study. The grain yield varied from 4.98t/ha (control) to 5.08t/ha (8x3m) spacing with the general mean of 5.01t/ha. However, the variation in grain yield of wheat was found non-significant under different spacing and control that there is no effect of different treatments of spacings on the crude protein content of wheat. The B:C ratio varied from 1.57 to 1.60 under different spacing of *prosopis cineraria.*

Keywords*:* Agroforestry System, growth, intercropping ,tree spacing, fodder cropandyield

SVII-P1

Mapping rice area under semi-dry conditions and assessing the impact on methane (CH_4) emissions using remote sensing

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Rice cultivation in Tamil Nadu, India, significantly contributes to methane (CH_4) emission, a potent greenhouse gas. This study aimed to map rice areas under semi-dry cultivation and evaluate their impact on methane emissions during the 2022-2023 samba season in the Ramanathapuram, Sivagangai, Pudukkottai, Nagapattinam, and parts of the Thanjavur and Thiruvarur regions using advanced remote sensing and field measurements. Multi-temporal Sentinel 1A satellite data with VV and VH polarization at a spatial resolution of 20 m were analyzed using the MAPscape-RICE software. Gas samples from 40 monitoring fields were analyzed for methane using Gas Chromatography- Mass Spectrometry (GC-MS), with 18 of these fields dedicated to monitoring semi-dry cultivation of rice. The spatial estimation of methane emissions was calculated using the IPCC- and MODIS-derived LST T factors and validated against field-level measurements. The methane emission rates based on the IPCC factor ranged from 36.56 to 47.22 kg/ha/season, whereas the LST T-factor method recorded emission rates of 34.25 to 42.33 kg/ha/season. The total methane emissions for the four districtsbased on the IPCC factor were 12.69 Gg, whereas the LST T-factor-based emission was 11.54Gg.The higher percentage of agreement between spatially estimated and observed methane emissions indicated the suitability of remote sensing and model-driven methods for estimating methane emissions at regional or national levels.

Keywords: Rice, Methane emission, Sentinel 1A, MAPscape-RICE, Gas Chromatography-Mass Spectrometry (GC-MS), IPCC, MODIS-derived LST

SVII-P2

Nutritional Assessment of *Homalomena aromatica* Schott Germplasms : A Valuable Wild Medicinal and Aromatic Plant

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Homalomena'aromatica Schott is a medicinal and aromatic plant predominantly found in northeast India, where it is also consumed as a vegetable by local communities. This study aimed to evaluate the nutritional composition of the leaf and rhizome parts of eight landraces of *Homalomena aromatica* collected from different regions of Assam. The analysis revealed distinct nutrient profiles for each part. The mean values for the leaf and rhizome samples were as follows: crude protein content of 13.82±0.36% and 8.15±0.32%, ash content of 4.96±0.32% and 2.88±0.24%, crude fibre of 7.34±0.27% and 5.37±0.22%, total carbohydrate of 66.43 ± 1.63% and 74.20 ± 0.83% and total soluble sugar of 9.07 ± 0.61% and

10.19 ± 0.48%, respectively. Additionally, the leaf exhibited higher vitamin A (0.34 ± 0.003 mg/g) and vitamin C (1.33 ± 0.018 mg/g) content compared to the rhizome (0.08 ± 0.002 mg/g and 0.69 ± 0.013 mg/g, respectively). The mineral composition of the leaf and rhizome parts of *Homalomena aromatica* land races showed average values (mg/100g) of magnesium (32.75 and 35.95), calcium (12.83 and 3.91), iron (141.77 and 13.65), zinc (5.02 and 2.82), potassium (27.04 and 49.86), and manganese (13.54 and 4.04), respectively. These findings highlight the nutritional value of *Homalomena aromatica*as a wild edible and medicinal plant, emphasizing its potential for broader utilization in food and pharmaceutical industries.

Keywords: *Homalomena aromatica*; carbohydrate; protein; crudefibre; minerals

SVII-P3

Role of carbon credit on climate change mitigation

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Since the first Industrial Revolution, anthropogenic emissions rose and approximately 1 trillion tons of excess carbon dioxide have accumulated in the atmosphere. It has resulted in an increase in global temperature of approximately 1°C so far. Climate change affects our society in various ways, such as drought can harm production of food and human health, flooding can lead to spread of many diseases, death, and damage to infrastructure, which limits the overall productivity of our economy. In order to mitigate the climate change and rise in global temperature to 1.5°C, reducing emissions will not be enough as a significant amount of GHGs, mainly carbon removal would also be necessary. The Kyoto Protocol of 1997 and the Paris Agreement of 2015 were international agreements that laid out international CO_2 emissions goals. With the help of carbon credit which represents ownership of the equivalent of one metric ton of carbon dioxide that can be traded, and carbon offset, a real reduction of carbon dioxide in the atmosphere we can mitigate the climate change. 2938 Clean Development Mechanism (CDM) projects have been registered with the National Clean Development Mechanism Authority (NCDMA) and 110 CDM projects have been approved in India. Vedic Green Solutions, Kosher Climate India Pvt. Ltd., Landmark Agri Exports Private Limited are some companies which endeavour the carbon credit in India. By investing in renewal energy, improving energy efficiency, agroforestry, afforestation & switching to alternate fuel types etc. companies or government can offset carbon emissions. There are two significant markets for selling of carbon credit within the carbon market place, regulated market and voluntary market. The voluntary carbon market reached 2.5 billion US dollar in 2023 and it is projected to grow over 100-250 billion US dollar by 2030, according to various analyses. This notable growth reflects improved corporate commitments to net-zero targets and growing investor concentration in carbon markets. The market saw over 250 million carbon credits traded in 2023, which is a significant increase compare to previous years. Verifiers have also been established like Verra and Gold Standard, the Integrity Council for the Voluntary Carbon Market (IC-VCM), Science Based Targets initiative (SBTi) to verify the carbon credit quality standards. It is evident that carbon credits serve as a powerful tool in addressing the pressing issue of global climate change. Through incentivizing emission reductions and fostering sustainable practices, carbon markets play a crucial role in mitigating the adverse effects of climate change. By providing financial incentives for emission reductions and sequestration, carbon markets thus contributing to the overall reduction of GHG emissions.

Keywords: Carbon credit, carbon offset, GHGs, climate change, mitigation

SVII-P4

Carbon Sequestration and Carbon Credit in Fruit Crop

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Carbon sequestration, the process of capturing and securely storing carbon dioxide (CO) from the atmosphere, is one of the strategies to mitigate climate change. Terrestrial carbon sequestration involves the absorption of COby vegetation through photosynthesis, which stores carbon in plant biomass (tree trunks, branches, leaves, fruits, roots) and soil. Fruit crops, in particular, play a vital role in atmospheric carbon conversion and storage, due to their perennial nature, structural characteristics, high photosynthetic activity, and efficient use of resources like sunlight and soil. The efficiency of carbon sequestration in fruit crops depends on factors such as temperature, nutrient and water availability, land management practices, tree age and productivity. Research has highlighted the potential of fruit crops in carbon storage. For instance, mango orchard soils have been observed to contain higher levels of soil organic carbon (SOC) compared to orangeand pomegranate orchards. Page *et al.,* 2011 stated about the monetary benefits earned by the farmers of organic kiwi and apple farm in New Zealand. Carbon credit is a tradable asset certified by governments or accredited certification organizations to signify a verified reduction in greenhouse gas emissions, which can subsequently be bought, sold, or exchanged. Carbon has become a tradable commodity all over the world through carbon credits. In India, it is regulated by the Carbon Credit Trading Scheme under the Energy Conservation (Amendment) Bill, 2022. However various challenges hinder widespread adoption of carbon sequestration practices by farmers. Projects like ICAR-NICRA have demonstrated the benefits of adopting climate-smart farming practices. These initiatives have significantly increased carbon capture, as seen in mango, papaya, and guava orchards, which sequestered up to 227 t COeq (Reddy *et al.,* 2020). The integration of fruit-based systems not only enhances carbon sequestration but also provides opportunities for sustainable development and economic incentives through carbon trading. By overcoming existing challenges and promoting climate-resilient practices, fruit crops can play a pivotal role in global efforts to combat climate change.

Keywords: Carbon Sequestration, carbon credit, carbon trading, fruit crop, climate mitigation

SVII-P5

Agroforestry : A Nature-Based Solution for Mitigating Green house Gas Emissions and Enhancing Climate Resilience

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Agroforestry, the integration of trees with crops and livestock, is a sustainable land-use system that plays a crucial role in mitigating green house gas (GHG) emissions and addressing meteorological challenges associated with climate change. This practice significantly reduces the atmospheric concentration of greenhouse gases by enhancing carbon sequestration in both above ground biomass and soil. Agroforestry

systems influence local and regional meteorology through their ability to regulate microclimates, control soil erosion, and improve hydrological cycles. Trees in agroforestry systems act as carbon sinks, absorbing atmospheric CO_2 during photosynthesis and storingit in plant biomass and soils. This reduces the net flux of CO2 and other greenhouse gases, such as nitrous oxide (N2O) and methane (CH4), into the atmosphere. Additionally, agroforestry practices improves oil fertility and reduce the need for synthetic fertilizers, which are significant sources of N_2O emissions. The role of agroforestry in mitigating extreme weather events, such as prolonged droughts, heatwaves, and unpredictable rainfall, is particularly significant in regions vulnerable to climate change. Tree canopies in agroforestry systems moderate surface temperatures, reduce evapotranspiration, and provide windbreaks, thereby protecting crops and livestock from meteorological stressors. Moreover, agroforestry enhances rainfall infiltration and ground water charge, buffering against the impacts of irregular precipitation patterns. Research demonstrates that well-managed agroforestry systems can sequester up to 25 Mg C/ha over a century, with significant variability based on system type, tree species, and climatic conditions. This capacity makes agroforestry a vital component in climate-smart agricultural practices aimed at reducing global GHG emissions while promoting resilience to meteorological extremes. Its application is particularly relevant in tropical and subtropical regions, where smallholder farmers face heightened risks due to climate change. In conclusion, agroforestry presents a dual benefit in mitigating green house gas emissions and improving climate resilience. Its ability to influence meteorological processes, stabilize local climates, and reduce GHG emissions under scores its importance as a nature-based solution for sustainable development.

***Keywords*:** Agroforestry, Green House Gas emission, Carbon sequestration, Microclimates, Climate Change, Climate resilient, Meteorological Stress

SVIII/LT-1

Frontier Crop Improvement Strategies for the Climate Change Adaptation: Challenges and Opportunities

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The Earth's climate is changing at an unprecedented rate, posing a significant threat to global agriculture and food security. The IPCC Sixth Assessment Report (AR6) projects a global temperature increase of 1.5°C above pre-industrial levels by 2100 under even the most optimistic scenarios, leading to more frequent and intense heatwaves, droughts, floods, and altered pest and disease pressures. These changes challenge crop production systems worldwide. Ensuring a stable and sustainable food supply for a growing global population, projected to reach nearly 10 billion by 2050, demands proactive measures to develop climate-resilient crops. Crop improvement, guided by cutting-edge breeding strategies, is a critical component of this effort. Climate change impacts agriculture in diverse ways, varying significantly across geographical regions and cropping systems. For example, Sub-Saharan Africa is projected to experience significant yield reductions in maize, a staple crop, due to increased drought stress. In India, erratic monsoon patterns are impacting rice production, threatening the food security of millions. However, Breeders are increasingly leveraging advanced technologies and innovative strategies to address the complex challenges of climate change. The crop improvement offers a powerful tool to develop resilient crops capable of withstanding

these environmental pressures. The frontier crop improvement strategies discussed in this article, ranging from genomic-assisted breeding and genome editing to speed breeding, phenomics, participatory breeding, and AI, provide a comprehensive toolbox for accelerating crop adaptation to climate change. By investing in these technologies, addressing the associated challenges, and fostering collaboration across disciplines, we can unlock the full potential of crop improvement to ensure a food-secure future for all. The time to act is now, and the potential for success is within our grasp. Embracing these frontier strategies is not just an option, but a necessity for building a sustainable and resilient agricultural system in the face of a changing climate.

***Keywords*:** AR6, Climate change, Crop improvement strategies, IPCC

SVIII-O1

Novel microbial-based biopesticide formulations for sustainable insect pest management in climate change scenarios

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Insect pests have been a major constraint in agricultural production that causes 10-30% yield losses annually. Indian agriculture currently suffers an annual loss of about US$ 36 billion due to insect pest damage in major field crops. Pest management in agriculture is important to safeguard crop yield and increase productivity. The immediate need for sustainable, eco-friendly pest management has been felt very strongly with the ever-increasing awareness of the harmful effects of chemical pesticides on non-targets, human beings and environment. Microbial pesticides are promising alternatives to chemical pesticides and have opened up new vistas in insect pest management for safe and eco-friendly pest management. Nonetheless, several studies have demonstrated that changes in climatic factors, *viz*., temperature, humidity, UV radiation, and elevated atmospheric CO, result in alterations in the efficacy of biopesticides. Hence, the development of improved formulations of the microbials suitable to climate change scenarios is essential to make the bio-pesticide formulations comparable to chemical insecticides in terms of effectiveness. Concerted research efforts at ICAR-IIOR resulted in the development of Suspension Concentrate (SC) formulations of *Bacillus thuringiensis* var. *kurstaki* using a local strain, DOR Bt-127 (MTCC-5976/NAIMCC-B-01463), with a broad host range and effectiveness at high temperatures (up to 40° C) against the major lepidopteran pests. Fieldtrials were carried out in multilocations to evaluate the efficacy of the SC formulations of the DOR Bt-127 isolate, singly and in combination with the entomopathogenic fungi (*Metarhizium rileyi* and *Beauveria bassiana*), against major lepidopteran pests of oilseed crops. In sunflower crop, the per cent decrease of capitulum borer (*Helicoverpa armigera*) and green semilooper (*Thysanoplusia orichalcea*) was highest in the *B. thuringiensis* SC formulation (95.0-100% and 93.5-100%, respectively), followed by the Bt + *M. rileyi* Combination Formulation (76.4-100% and 87.9-100%). In castor crop, the per cent reduction of tobacco caterpillar (*Spodoptera litura*) and semilooper (*Achaea janata*) was highest in the *B. thuringiensis* SC formulation (97.8-99.2% and 99.3-100%) and the Bt + *M. rileyi* Combination Formulation (94.5-98.7% and 86.1-98.5%). Hence, the novel microbial-based biopesticide formulations using temperature-tolerant strain of *B. thuringiensis* may be used as an eco-friendly technology for the management of lepidopteran pests in changing climate scenarios.

SVIII-O2

Effect of Night Temperature and Night CO_2 Enrichment Stress on Green Gram and Black Gram Under Soil Plant Atmospheric Research (SPAR)

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In India, the minimum temperature has been rising at a rate of 0.1 to 0.18°C per decade. In Tamil Nadu, Projections show increases of 2.4°C by the 2050s, and 3.5°C by the 2080s, compared to the 1970–2000 baseline. In this context, pot culture experiments were conducted during summer 2021 and 2022 at the Soil Plant Atmospheric Research (SPAR) system, Agro Climate Research Centre, TNAU, Coimbatore to investigate the effect of warm night temperature (minimum temperature + 3°C) and night CO_2 (600 ppm) (WNT + *n*CO_2) stress on green gram (CO7) and black gram (CO6). The experiments were laid out in a completely randomized design with 10 treatments: stress imposed from 7-14, 15-21, 22-28, 29-35, 36-42, 43- 49, 50-56, 57-63, and 64-70 Days After Sowing (DAS), plus a control. The study revealed that stress factors significantly (p=0.05) reduced plant growth, chlorophyll content, and gas exchange parameters in both crops. WNT + *n*CO_2 imposed during specific phenological stages (15-21 DAS for green gram and 22-28 DAS for black gram) adversely affected plant height and leaf area index. Dry matter production was most impacted by stress during the reproductive phase (36-42 DAS for green gram and 43-49 DAS for black gram). Leaf gas exchange parameters of both crops were significantly influenced by WNT + *n*CO_2 stress, particularly during the 43-49 DAS, with reduced daytime photosynthesis, stomatal conductance, and transpiration, and increased night time respiration, transpiration, and leaf temperature. Yield components, including number of pods and flowers, were significantly reduced in green gram under 29-35 DAS and black gram under 50-56 DAS stress regimes compared to other treatments. However, 100-seed weight in both crops was adversely affected by 43- 49 DAS stress. As a result, warm night temperature and night CO_2enrichment stress will have an adverse effect on agriculture production in the future.

***Keywords*:** Night temperature, Soil Plant Atmospheric Research, Green gram, Black gram, Leaf gas exchange

SVIII-O3

Effect of sowing dates on growth, productivity and water use efficiency of cowpea cultivars in New Alluvial Zone of West Bengal

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Cowpea (*Vigna unguiculata*), a versatile legume, is highly valued for its adaptability to diverse agro-climatic conditions and exceptional nutritional profile. This nutrient-rich composition makes cowpea a vital component of diets in many regions. Additionally, its ability to fix atmospheric nitrogen enhances soil fertility, promoting sustainable agricultural practices. As per the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, India accounts for 2.5–3 million hectares of cowpea cultivation, with an average productivity of 800–1000 kg ha^{-1}. In West Bengal, cowpea is grown on about 12,000 hectares, with an average productivity of 800 kg ha^{-1} (ICAR,2023). In West Bengal, particularly in the New Alluvial Zone, cowpea holds promise as a rainfed crop due to its drought tolerance and efficient water use patterns. Identifying the suitable time of sowing is crucial for maximizing crop water productivity. This study was conducted to evaluate the growth, productivity and water use efficiency (WUE) of cowpea, grown at different sowing dates under rainfed conditions in the New Alluvial Zone of West Bengal. The field experiment was carried out at C block farm, BCKV, Kalyani during 2022. The study was arranged using split plot design, where three sowing dates (D1 - 10th April, D2 - 22nd May and D3 - 31st August) were kept in main plot treatment and two variety (V1 -Bidhan Barbati 1 and V2 - Bidhan Sadabahar) were allotted in sub-plot treatment. The result showed that the LAI increased steadily up to 51 DAS, followed by gradual decrease till harvesting. The highest LAI value was 3.05 under D3, which declined by 7% at D2. The lowest LAI (2.50) was recorded at D1. Among the variety, the highest LAI (3.3) was produced by Bidhan Barbati 1, which was 30% lower under Bidhan Sadabahar, The highest average pod yield (137.7 q ha^{-1}) was found in D3 (31st August), which declined by 3.5% for both D2 and D1. There was no statistically significant variation in average pod yield between the two varieties. Highest pod yield (136.1 q ha^{-1}) was noted under Bidhan Barbati 1 followed by Bidhan Sadabahar yield (132.6 q ha^{-1}). Irrespective of the variety, the highest (381.5 mm) and lowest seasonal evapotranspiration (SET) (226.7 mm) value was recorded respectively under D2 and D3. On average, V2 exhibited a SET value of 329 mm, which was only 6.2 mm less than V1. The highest water use efficiency (6.1 kg m^{-3}) was recorded under D3, which was 42% lower under D1 and D2. Both the variety achieve almost same WUE. Based on productivity and water use efficiency, Bidhan Sadabahar excels in early sowing, while Bidhan Barbati 1 suits late sowing in West Bengal's New Alluvial Zone.

***Keywords**:* Cowpea, split plot design, LAI, WUE, SET, New Alluvial Zone.

SVIII-O4

In vitro screening of sunflower genotypes for moisture stress tolerance using PEG-6000

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Productivity of sunflower under moisture stress is primarily determined by seed germination and the seedling vigour for appropriate crop stand. Screening of genotypes for moisture stress under field has uncertainties due to the uncontrolled conditions, interaction of biotic and abiotic stresses and variability in environmental factors. Hence, in the present investigation, response of seventeen sunflower genotypes to moisture stress at germination and seedling stage was recorded by using polyethylene glycol (PEG-6000) as drought stimulator under laboratory conditions. Four levels of osmotic stress (-0.3MPa, -0.6MPa, - 0.9MPa, -1.2MPa) were created and performances were monitored against the control. The results of osmotic stress indicated that osmotic stress higher than -0.9 Mpa resulted in germination below the minimum standards of seed certification and; affected the root growth as compared to the shoot growth indicating, the importance of root traits in drought adaptation in sunflower. All 17 genotypes studied recorded reduced root and shoot length, seedling length and seed vigour, root length stress tolerance index (RLSTI) and seedling length stress tolerance index (SLSTI) in higher osmotic pressure compared to control. However, five genotypes (RSLP-41, RSLP-14, CMS-104B, RSLP-24 and RSLP-33) showed seed germination and root length even at -0.9 M Pa where all other genotypes did not germination at this higher concentration of PEG-6000 indicating moisture tolerance. The higher concentration of -1.2MPa PEG proved lethal in sunflower as none of the genotypes survived.

SVIII-O5

Assessment of Dry and Wet Conditions Using Standardized Precipitation Index (SPI) in the Dryland Ecosystem of Marathwada Region, Maharashtra

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Droughts are extreme meteorological and hydrological phenomena that significantly impact the natural environment and socio economic conditions, especially in vulnerable dryland ecosystems like the Marathwada region of Maharashtra, India. This study investigates the spatial and temporal distribution of dry and wet conditions across Marathwada using the Standardized Precipitation Index (SPI) derived from diurnal rainfall data at various timescales: early, mid, late, seasonal, and annual. Trend analysis of rainfall and SPI was conducted using the Mann-Kendall test, while spatial patterns were analyzed using inverse distance weighting (IDW) interpolation. The findings reveal that the annual rainfall of most districts in Marathwada exhibited increasing trends, with notable increases in Nanded (Sen's slope: 7.99 mm/year), Chhatrapati Sambhajinagar (5.63 mm/year), and Hingoli (5.45mm/year). Incontrast, Parbhani and Latur experienced declining trends of 11.82 mm/year and 3.53 mm/year, respectively. During the southwest monsoon season, four districts

(Chhatrapati Sambhajinagar, Hingoli, Jalna, and Nanded) showed increasing rainfall trends, while Parbhani, Beed, Dharashiv, and Latur experienced seasonal decreases of 10.0 mm, 0.80 mm, 0.85 mm, and 2.83 mm, respectively. The comparison between the Mann-Kendall (MK) and Modified Mann-Kendall (MMK) tests demonstrated the enhanced ability of the MMK test to identify trends in serially correlated datasets, such as time-series rainfall data. The temporal analysis of drought and wet conditions during the monsoon season showed that near- normal conditions predominated (66.2% of months), followed by moderately wet months (10.9%). Severe and extreme dry events were also observed, emphasizing the region's vulnerability to droughts. Nanded and Parbhani districts recorded the highest frequency of very wet events (6.8% and 6.7%, respectively), while Latur had the least frequency of very wet events (1.9%). Hingoli recorded the highest frequency of severely wet events (1.9%), indicating variability in rainfall distribution and extremes across districts. The study's findings provide actionable insights into rainfall variability and drought frequency, which are critical for managing hydrological droughts in the Marathwada region. These results can be utilized to develop targeted agricultural strategies, such as optimizing cropping patterns, selecting drought-resistant crop varieties, and adjusting sowing schedules to match rainfall trends. Furthermore, the insights can inform irrigation planning, ensuring efficient water use during critical growth stages. Policymakers and agricultural planners can also use this information to design contingency plans, promote water conservation techniques, and implement drought-resilient farming practices to enhance agricultural productivity and sustainability in the region.

***Keywords*:** SPI, Mann-Kendall Test, Rainfall Trends, Drought, Hydrological Drought, Spatial Interpolation, Water Management

SVIII-O6

Biocontrol prospective of native rhizospheric microbiota to induce systemic defense in Soybean (*Glycinemax* (L.) Merr.) Defied with charcoal rot and water stress

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Out of 422 rhizospheric microbes from 220 soil samples collected from NE states of India, *viz.,* Assam, Arunachal Pradesh, Meghalaya, Nagaland and Tripura during pre-monsoon, monsoon and post monsoon seasons, 11 fungal and 7 bacterial isolates were found promising against *Macrophomina phaseolina* for their antagonistic property. Three rhizospheric microbes out of 18, were found most promising and identified as ASRF065, APRF006 and ASRB075 with 86.88%, 74.22% and 81.33% growth inhibition of *M. phaseolina* respectively. The isolates also exhibited plant growth-promoting (PGP) abilities, including the production of ammonia, and solubilization of essential nutrients like Zn, Potassium, Phosphate and enhanced seed germination capacity as well as seedling vigor index. Cultural, morphological as well as molecular identification confirmed the most promising rhizospheric microbes as ASRF065 as *Trichoderma asperellum*, APRF006 as *T. asperellum* and ASRB075 as *Achromobacter xylosoxidans*. Out of the two *T. asperellum*

isolates, the first one was isolated from Assam, while the second isolate was obtained from Arunachal Pradesh and the bacterial isolate was isolated from Assam. The microbial isolates were also evaluated for their efficacy in enhancing physiological growth and charcoal rot suppression simultaneously. *T. asperellum* Assam isolate (AI), inoculated soybean plants showed enhanced membrane stability index (63.59%), stress stability index (89.40%) and relative water stability index (77.92%). *T. asperellum* (AI) inoculated seeds induce charcoal rot suppression and drought tolerance ability through enhancement of defense related enzymes *viz.,* phenylalanine ammonia lyase, peroxidase, polyphenol oxidase, super oxide dismutase, catalase, proline and malonaldehyde. Plants pre inoculated with *T. asperellum* (AI) and *A. xylosoxidans* followed by exposure to charcoal rot disease and drought stress results in reduction of disease incidence to 40% and 56.67% and disease severity to 8.67 and 12.67 respectively at 60 days of observation.

***Keywords*:** Biocontrol, charcoal rot, drought, Soybean, *Macrophomina phaseolina*

SVIII-O7

Rice Resilience to Abiotic Stress: Analysis of Heat Stress Mitigation Strategies Using Ameliorants Across Virippu (Kharif) and Mundakan (Rabi) Seasons in Kerala

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Rice (*Oryza sativa* L.) is a vital global food crop, especially in Asia. In Kerala, it's the staple food, but its productivity has been declining over the years. Rice production worldwide faces challenges due to abiotic stresses, primarily high-temperature stress. Increasing heat waves subject crops to stress, hindering their growth. The study examined how high temperatures affect rice at various growth stages, the optimal temperature and humidity for maximum growth, and how to mitigate heat stress using various treatments. The short duration rice variety, Jyothi (110-120 days) was tested under high temperatures in a monitored polyhouse during active tillering, heading, and milking stages, with alternating conditions between polyhouse and ambient. Foliar treatments included salicylic acid (400ppm), ascorbic acid (10ppm) + citric acid (1.3%), and water spray, with a control group. Treatments were applied at each growth stage, and plants were moved to alternate environments seven days post-treatment. In virippu season, the ambient temperature varied from 23.1°C to 33.31°C, while the polyhouse temperature was 24.0°C to 48.6°C. In mundakan season, the ambient temperature was 22.2°C to 39.5°C, while polyhouse temperature was 23.3°C to 57.3°C. The humidity level in the polyhouse varied drastically, ranging from 98% in the morning to 63% in the afternoon. The rice crop showed different values for virippu and mundakan season due to their temperature difference. The number of tillers reduced when temperature was more than 41.3°C at the active tillering stage. Number of panicles reduced when the temperature was more than 33.9°C during the heading stage. The number of filled grains was less due to high temperature more than 46.8 at milking stage. Due to high temperature more than 52.8°C at the milking stage in the mundakan season, the number of filled grains were nil. In addition to that, the number of chaff was found to be higher in the heat treatments. As a result, the yield of rice was also less due to the heat stress. The control set which was kept in ambient condition had the highest number of all the yield characteristics mentioned above. In the virippu season, when temperature was 42°C -46°C, there was emergence of secondary tillers which persisted till 150DAS. The same was not

observed in the mundakan season because the temperature was more than 50°C. Among all the heat treatments in the first factor, the ameliorants salicylic acid (400ppm) gave the highest value of yield attributes followed by ascorbic acid (10ppm) + citric acid (1.3%). The highest number of tillers, panicles, filled grains and chaff were observed with the application of salicylic acid in the control set followed by set exposed to high temperature till active tillering stage and that exposed to stress at milking stage. Overall, there was a decrease in the yield due to exposure of different stages to heat but the effect was mitigated by the use of ameliorants, which showed better improvement in the yield attributes after its application. Further experiments with different concentrations of ameliorants can be helpful for heat stress mitigation.

***Keywords*:** heat stress, ameliorants, salicylic acid, tillers, grain yield, secondary tillers

SVIII-O8

Performance of ginger (*Zingiber officinale* Rosc.) varieties on yield, quality, incidence of shoot borer and rhizome rot in alfisol of Nagaland

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A field trial entitled "Performance of ginger (*Zingiber officinale* Rosc.) varieties on yield, quality, incidence of shoot borer and rhizome rot in alfisol of Nagaland" with nine genotypes (Bhaise, Gorubathani, Nadia, Karbi ginger, John ginger, Mahima, PGS 95, PGS 102 and PGS 125) and three replications was carried out in randomized block design during the year 2023- 24 at School of Agricultural Sciences, Medziphema Campus, Nagaland University. Different data on growth, yield, quality, diseases and pest parameters were collected, tabulated and statistically analysed at different stages of crop. Among the all genotypes Bhaise emerged as the top performer in various growth parameters, including plant height (76.17 cm), numbers of tillers (11.50 per plant) and leaf number (27 per plant). In terms of yield, Bhaise consistently produced the highest yields per clump (135.99g), yield per plot (2.04 kg), yield per hectare (101.99 q) and weight of mother rhizome (19.67g) followed closely by Gorubathani and Nadia. Quality assessments revealed that Nadia recorded maximum in oleoresin content (9.06%), while PGS 102 exhibited the highest crude fiber content (7.29%) and the genotype John ginger recorded maximum essential oil content (2.39%). The genotype Mahima was found to have highest dry recovery percentage (25.7%). Regarding pest and disease resistance, Mahima showed the least susceptibility to rhizome rot and shoot borer, underscoring its resilience. Bhaise also displayed notable resistance traits. The genotype Bhaise emerged as the overall superior performing growth, yield, and quality traits. Mahima excelled in pest and disease resistance, making it a viable option for sustainable cultivation. These findings provide valuable insights for selecting high-performing ginger genotypes suitable for Nagaland condition, potentially enhancing both productivity and quality in ginger farming.

***Keywords*:** Disease Resistance, Genotypes, Ginger, Pest Resistance, Quality, Yield potential

SVIII-O9

Development of climate resistant and short stature okra hybrid to boost okra production for Gujarat state

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Okra (*Abelmoschus esculentus* (L.) Moench*)* belonging to *malvaceae* family is fast growing annual herb and the tender seed capsules are used for vegetable purpose. One of the main okra production constraints is high incidence of the destructive YVMV and ELCV diseases which infects crop at all growth stages and causes production loss of 50–90%. The YVMV resistant varieties developed through inter-specific hybridization have become susceptible, probably due to pathogenic variability, use of symptom less carrier parents and B biotypes of whitefly which has a wide host range. It is necessary to find diverse sources of resistance to YVMV as well as ELCV and evolve resistant varieties by suitable gene introgression.Inspite of the numerous advantages of available open pollinated varieties (OPVs) of okra, the importance of hybrid varieties (F1hybrids) has recently been pointed out by farmers,scientists and technologists of developing countries. Heterosis is the only effective means of combining together the desirable characters of two distinct varieties. The favourable characters of hybrids like higher yield, production stability, suitability to high input agriculture, shorter life cycle, uniform growth and maturity shifted the focus towards heterosis breeding. In okra, hybrid vigour can be exploited commercially owing to the high percentage of fruit set and good number of seeds per pod.Looking to above mentioned points, okra hybrid AOH 19-04 was developed from the cross AOLF101 x AOLM102 by heterosis breeding and evaluated for Gujarat. It was tested in in different trials over locations in the state from the year 2020 to 2022 in *kharif* & summer seasons. This hybrid depicted 30.59, 38.02 and 55.70 *percent* higher fruit yield (163q/ha) over the checks GJOH 4, GAO 5 and Pusa Sawani, respectively. The hybrid had important morphological features like short plant stature with short internodes. It has strong serration of leaf blade margin, large leaf blade length and width with deep depth of lobbing. Fruits are dark green colour, tender, smooth having narrow acute shape of apex. The hybrid contains higher mucilage (28.51 g/kg) and chlorophyll a (0.400 mg/g). Under natural field condition, this hybrid has less prevalence of yellow vein mosaic disease & enation leaf curl disease (%).

***Keywords*:** okra, hybrid, yellow vein mosaic and enation leaf curl diseases

SVIII-O10

Improvement of Breeding techniques and its implications in the environment

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Crop breeding and development in its strains has been a crucial part both for human and microbial survival aspects. It is a process of improving the quality of the strain by certain modifications. Development

of high- quality crops is mandatory for more productivity and resistivity towards pests. However, new techniques which are developed for strain improvement, are replenished to provide quality assured products, in order to increase the sustainability of the plants. Breeding also increases the homogeneity of the crops. Advanced technologies such as CRISPR-Cas are profoundly helpful in improvement of breeding efficiency by gene editing method. Although many technologies have been invented to develop new traits in crops, still there is a gap between the knowledge and advancement in technologies. Due to changing climatic conditions, leading to drought, saline and water stress conditions, productivity has declined to a certain level where crop production is minimal in certain areas or regions, for e.g. Mediterranean regions. Therefore, it is a challenge for researchers to develop broad-spectrum techniques in order to create resistivity in crops so as to become stress tolerant. Both abiotic and biotic factors relating to stress conditions, are a barrier for development of agricultural crops. However, different methodologies have been applied to several crops such as wheat, barley, potato, rice, citrus fruits, grapes etc. to check resistivity towards stress conditions, altering its genetic makeup. Gene editing technologies such as ZFN (Zinc Finger Nuclease), TALEN (Transcription Associated Linker Endonuclease), are hereby approached for short-time fast sequencing analysis in breeding since direct gene sequencing is a cumbersome process. Another technique known as HTPP (High Throughput Plant Phenotyping) is phenotypical assessment or analysis which signifies the physical stress conditions such as opening and closing of stomatal aperture, regulation of osmosis inside the plant that will ultimately help in survival in stress conditions. Maintenance of the physiological activities of plants can also help provide product of interest. Genomic analysis by High Throughput Plant Phenotyping (HTPP) is a very crucial and remarkable process of sequencing through which breeding efficiency can be improved, taking care of the biotic and abiotic factors responsible for inhibition of crop transgenesis. Application of High Throughput Leaf Phenotyping (HTLP) has also an immense effect in determining the genetic makeup of the plant at root level. Control of biogeological factors that inhibit the growth of plants, which ultimately destructs the production, has its control in genotyping technologies which deals in proteomics, transcriptomics and metabolomics. Therefore, recent breeding technologies are upgraded to such an extent so that it can overcome both biotic and abiotic stressful conditions. Recombination process of RNA and DNA through enzyme-mediated regulation recognises specific gene expression for tolerance to certain environmental conditions. Development of breeding technologies, nowadays, are sophisticated with involvement of gene editing technologies as well. Therefore, implications of genetic engineering in increasing breeding efficiency can help improve crop production which would also be a milestone in developmental research in the long run

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SVIII-O11

Comparative study of root phenotypes of a few rice varieties in both control and drought stress condition

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Rice (*Oryza sativa L.*) is a staple cereal crop essential to global food security. However, increasing rice production is significantly constrained by environmental stresses, with drought being one of the primary limiting factors. The growing impact of global climate change magnifies this challenge, especially in rainfed areas, where the need for drought-tolerant rice varieties has become urgent. Plants have evolved diverse

adaptive mechanisms to survive under moisture stress, among which the development of an efficient root system plays a crucial role. A deep and robust root system enables plants to access water from deeper soil layers, helping them avoid or withstand drought conditions. Research suggests that modifying root architecture can enhance the yield of cereal crops grown in challenging environments, including nutrient-deficient or drought-stressed soils. Rice exhibits considerable variation in root traits globally. Studies indicate that deeper and thicker roots are positively correlated with plant vigour under drought stress, highlighting their genetic variability in penetration and water absorption capacity. The present study aimed to evaluate the root phenotypes of select rice genotypes under drought and control conditions, using N22 as a resistance check and IR64 as a susceptible check. Plants were grown in PVC pipes under controlled and drought conditions with three replications each. Drought stress was induced by withdrawing water 45 days after sowing (DAS) for 25 days, after which plants were uprooted for a comparative analysis of various morpho-physiological parameters, including root length, root biomass, root- shoot ratio, root length density, and chlorophyll content. Results indicated that the genotype Dehangi, followed by N22 and Shahabhagi, exhibited superior performance across all parameters under drought conditions. These findings underscore the importance of root traits in conferring drought tolerance and provide valuable insights for breeding programs aimed at developing rice varieties with enhanced resilience to water stress.

***Keywords*:** Root morphology, drought stress, Rice, Control condition, root depth.

SVIII-O12

Metabolic Responses to Drought Stress in Tea Plant

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Drought stress represents a significant environmental challenge to crop productivity in tea plants as it can severely impact its physiological and metabolic functions. Understanding the drought stress related metabolism and identification of the key metabolites is important for developing effective strategies for sustainable cultivation in water-limited environments and breeding of drought tolerant cultivars. Seedlings of drought tolerant tea clone TV23 (*Camellia assamica* sub sp. *lasiocalyx*) were subjected to wilting by water deficit stress up to a soil moisture of 6.5% to evaluate their metabolic response. Control plants were maintained with sufficient water supply. Metabolites were extracted from control and treated leaves using a methanol-based extraction. The extracts were analyzed using an untargeted LC-MS appoach to determine a comprehensive metabolic profile. The mass feature detection and identification was performed using MZ mine. The raw data were imported and cropped to a retention time range of 0-45 mins. Plant cyc/KEGG databases were used for metabolite identification with mass tolerance of 0.001 to 0.1 dalton. Univariate statistical analysis was done for the metabolite data set. Pathway enrichment analysis was done using MBROLE 2.0 server. A total of 365 metabolites were differentially regulated, with 227 upregulated and 138 down regulated. Upregulated metabolites showed fold changes ranging from 0.23 to 15.30. The most pronounced increase was observed in caffeine, brassinolide, pyridoxamine 5'-phosphate (PMP), glutathione (GSH),

naringin etc. emphasizing its critical role in drought stress adaptation. Caffeine enhances stress tolerance by activating calcium signaling, influencing cytosolic $Ca^{2}z$ gradients, and upregulating calcium-dependent protein kinases (OsCPKs) and stress-responsive transcription factors. Brassinolide, a key brassinosteroid, supports drought adaptation by enhancing antioxidant enzymes, reducing oxidative stress, and improving photosynthesis through increased photosynthetic rate, stomatal conductance, and transpiration. PMP, a crucial metabolite in vitamin B6 metabolism by maintaining redox homeostasis, strengthening antioxidant defenses, and stabilizing metabolic functions. Glutathione (GSH) is essential for sulfur metabolism, ensuring redox balance and mitigating oxidative damage, with its accumulation supports the sustained growth and water uptake. Naringin (glycosylated derivative of naringenin) scavenge reactive oxygen species (ROS) and upregulate antioxidant enzyme activity, protecting plant cells from oxidative damage. Among many down regulated, protoporphyrinogen IX (porphyrin precursor) was significantly downregulated with fold change-1.035 to limit ROS production. N6-(Delta2-Isopentenyl)-Adenosine 5'-Diphosphate a type of cytokinin was downregulated with fold change -5.488 due to the increased activity of cytokinin oxidase/dehydrogenase which degrades cytokinin. The decline in cytokinin help in conserve resources adjust under water limited condition. Several key metabolic pathways were significantly enriched (FDR < 0.05), including membrane components, energy and pyrimidine metabolism, DNA components, glycine, serine, and threonine metabolism, lipid biosynthesis and fatty acid transport, fatty acid and butanoate metabolism, and terpenoid backbone biosynthesis, along with folate biosynthesis, glyoxylate and dicarboxylate metabolism, beta-alanine, porphyrin, chlorophyll and tryptophan metabolism, and anthocyanin biosynthesis. Additionally, pathways involved in arginine and proline metabolism, biosynthesis of plant hormones, secondary metabolites, fatty acid elongation in mitochondria, and alkaloid biosynthesis derived from ornithine, lysine, and nicotinic acid were significantly enriched, highlighting their importance in metabolic regulation under stress and emphasizing a metabolic shift favouring osmotic balance, antioxidant activity, and drought adaptation.

Keywords: Tea, drought, metabolomics, LC-MS, KEGG.

SVIII-O13

Effect of gamma rays on the growth performance of saplings developed from nodal cuttings of a popular Indian tea clone

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Tea nodal cuttings of TV 23 were irradiated with sixteen different doses of gamma radiation *viz*. 2 to 100 Gy using Cobalt 60 (^{60}Co). Thereafter, the irradiated nodal cuttings were transferred to nursery, and observed for the sprouting at 4 weeks intervals. Sprouting in the irradiated tea nodal cuttings was much slower than control and continued up to 28 weeks after planting (WAP) whereas, in control treatments, sprouting was completed by 16 weeks. The mortality percentage at 36 weeks was considered for probit analysis and LD50 was found as 15 Gy. At 40 weeks after planting, all the nursery ready plants were transferred to the field, and data on the plant height, number of leaves per plant, number of primary branches per plant, base diameter, and total leaf area were recorded at 30, 60, and 90 WAP. In the

saplings developed from the irradiated cutting, there was an overall decline in all the parameters except the number of primary branches per plant. After 90 WAP, the maximum number of branching (5 nos.) was observed in the treatment of 6 Gy which was significantly higher than the control (1 no.). The result suggests that gamma radiation offers an effective way to enhance genetic variation.

Keywords: Clone, Gamma radiation, Mutation, Tea, Variation.

SVIII-O14

Study of Genetic Diversity and Drought-Tolerance Characteristics of Few Rice Varieties from Manipur andAssam Using Morphological and Molecular Markers

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The study assessed the genetic diversity of 70 indigenous rice genotypes from Manipur and Assam using morphological and molecular markers. Mahalanobis D^2 analysis grouped the genotypes into nine clusters, revealing wide genetic variation and potential for hybridisation to develop superior varieties. Traits such as Harvest Index (HI), Root Dry Weight (RDW), Filled Grains per Panicle (FG), and Root Length (RL) were identified as major contributorsto genetic divergence, highlighting their importance for yield improvement and drought resilience. Molecular marker analysis identified 29 polymorphic markers with high Polymorphic Information Content (PIC), confirming their efficacy in evaluating genetic diversity and selecting drought-resilient genotypes. Drought stress significantly influenced root traits such as Root Length (RL), Root Volume (RV), Root Dry Weight (RDW), and Root Fresh Weight (RFW), with specific genotypes like N-22, Vandana, Dehangi, Heimang Phou, and Pari Phou demonstrating superior root performance and resilience. The study emphasizes the underutilized potential of indigenous rice varieties from northeastern India as a valuable genetic resource for breeding programs. Integrating molecular tools with agro-morphological evaluations provides an efficient approach to developing climate-resilient, high-yielding rice varieties, addressing challenges posed by climate change and global food security demands.

Keywords: Genetic diversity, Rice, Drought tolerance, Molecular markers, root characteristics.

SVIII-P1

Intensification of Management Technologies In *bt*-cotton Under Drip Irrigation

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An experiment entitled "Intensification of Management Technologies in *Bt*-Cotton under Drip Irrigation" was conducted on the experimental field of Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani (M.S.) during the year 2021-22 and 2022-23 in randomized block design design with three replications. The experiment comprised of eight treatments T1- Control Wider Planting (150 X 30 cm), T2- Control DP (90 X 30 cm), T3-Removal of Monopodia at 60 DAS (DP), T4- De-topping at 75 DAS (DP), T5- Removal of Monopodia at 60 DAS+De-topping at75 DAS(DP), T6-Spraying of Mapiquate Chloride @25 ga. i. at 60 DAS (DP), T7-Use of Polymulch (DP) and T8-Polymulch+Removal of Monopodia at 60DAS+ De-topping at 75 DAS (DP). The results obtained from this experiment shows that growing of cotton under polythene mulch along with removal of monopodia at 60 DAS and de-topping at 75 DAS (T8) recorded significantly highest no. of bolls per plant (46.04, 37.23 and 41.65), yield plant^{-1} (139.53, 154.13 and 146.83 g plant^{-1}) and boll weight (4.58, 6.51 and 5.54 g), seed cotton yield (3314, 3911 and 3613 kg ha^{-1}) and GMR (Rs. 314830, Rs. 391087 and Rs 352958 ha^{-1} as compared to all other treatments respectively during 2021- 22, 2022-23 and in pooled analysis of the experiment, while removal of monopodia at 60 DAS and de- topping at 75 DAS (T5) recorded significantly highest NMR (Rs.185301, Rs.237401 and Rs. 211351 ha^{-1}) and Benefit: Cost ratio (3.28, 3.24 and 3.26) during 2021-22, 2022-23 and in pooled analysis respectively as compared to rest of the treatments in *Bt*-cotton grown under micro irrigation.

Keywords: Cotton, Drip Irrigation, Removal of Monopodia, De-topping, Plastic Mulch, Growth, Yield, Yield Attributes.

SVIII-P2

Climatic Effect on Habitat Management to Conserve Natural Enemies in Agriculture

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The existing agroecosystems and environment are not suitable for conserving natural enemies of agricultural pests. They require a constant inflow of food, host and nutrition sources. This brings notice to the process called "habitat management" or "ecological engineering", which aims to build mechanisms to conserve the natural enemies. The process of habitat management includes diversification of the environment and provides the natural enemies accessible resources. Mechanisms to conserve natural enemies such as providing the right diversity, alternative prey and host sources, shelter and microclimate, cropping systems etc., have proved to be very efficient resulting in higher fecundity, longevity, activity and growth of the same.

Climatic effects play a major role in inducing these habitat management strategies. The effects of global warming, precipitation / rainfall are crucial components of habitat management strategies for the conservation of the natural enemies in agriculture and to prevent the outbreak of pest population. The mechanisms have been designed in such a way that it is easier for the producers to establish them and is economical and sustainable. The resources should be integrated in a convenient manner which is temporally and spatially favorable to the natural enemies. The techniques of conserving natural enemies by the system of habitat manipulation keeping in view the major climatic factors, are environment friendly which has become the need of the hour and may pave the way for integrated management programme to yield better results.

Keywords: global warming, ecological engineering, conservation, microclimate

SVIII-P3

Brassinosteroids: Role in Enhancing Crop Resilience to Abiotic Stresses

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Brassinosteroids (BRs) are a unique class of polyhydroxylated steroidal phytohormones that have emerged as central regulators of plant growth, development, and stress adaptation. As compounds of isoprenoid origin, BRs are structurally similar to animal steroid hormones but are uniquely tailored to meet the demands of plant life, influencing processes such as cell elongation, division, differentiation, vascular development, senescence, and stress signaling. BRs play pivotal roles in regulating plant architecture, including shoot elongation, leaf expansion, and root growth. BRs also affect reproductive development by modulating flower and fruit formation, ensuring reproductive success under variable environmental conditions. BRs are integral to plant responses to abiotic stresses, such as drought, salinity, temperature extremes, and heavy metal toxicity. They mitigate the adverse effects of drought by improving water retention and reducing transpiration through stomatal regulation. In saline environments, BRs enhance ionic balance and osmotic adjustment, protecting cellular integrity. Under temperature extremes, BRs stabilize proteins and membranes, minimizing damage caused by heat or cold. Moreover, they play a detoxifying role by reducing reactive oxygen species (ROS) accumulation and activating antioxidant defense systems. BR signaling is initiated when BR receptors detect the hormone at the cell surface, triggering a phosphorylation cascade that activates Brassinazole-resistant 1 (BZR1), a central transcription factor that regulates BR-responsive genes. This signaling pathway, which has been extensively studied in model plants such as Arabidopsis, also interacts with other phytohormonal pathways to coordinate stress adaptation. The potential for leveraging BRs in agriculture has garnered considerable attention. Exogenous application of BRs has been shown to improve crop resilience to stress and enhance growth under suboptimal conditions. Genetic engineering to manipulate endogenous BR levels or enhance BR signaling offers another promising strategy to increase crop yields. These strategies are particularly relevant in addressing global challenges like climate change and food security, where stress-resilient crops are vital for sustainable agriculture.

Keywords: Brassinosteroids (BRs), Isoprenoid, plant growth and development, Abiotic stress response, Crosstalk with phytohormones, Senescence, BR signaling pathway, Stress adaptation

SVIII-P4

Genome Wide Association Study for Identifying Genetic Loci in Abiotic Stress Tolerance

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Climate change impacts agricultural productivity around the world affecting food security. Droughts, heat, salinity, and extreme cold are some of the abiotic factors which are threat to the plant growth and development. The complex challenges caused by such factors can be solved by traditional breeding methods, but this method requires long time to develop a resistant variety. As a modern method, Genome Wide Association Study (GWAS) opens up the identification of potential loci of known abiotic stress tolerance which can revolutionize the plant breeding approach. The potential use of GWAS for the management of abiotic stresses allows one to identify genetic variants, such as Single Nucleotide Polymorphisms (SNPs), which are related to certain important traits of interest. Such traits are water retention, ion balance, synthesis of heat shock proteins and the capacity to develop antioxidant defenses, all of which assure plant life under stressed conditions. Mapping these genetic markers also serves to explain the polygenic nature of abiotic stress tolerance, where an individual characteristic is determined by the combined impact of many traits with little individual influence. This is especially critical for stress tolerance when the final outcome is the result of interaction of many genes rather than few major genes. For example, in drought prone areas, GWAS have helped to identify the genetic loci responsible for enhanced root structure, stomatal control as well as the ability to osmotically accommodate. Similarly, those working on salt-stressed environments have been able to map loci whose gene products transport ions or are involved in thesalt excretion pathway. Therefore, GWAS will be an effective method to understand the genetic basis of stress tolerance. Despite its potential, the application of GWAS in abiotic stress management faces challenges, including environmental interactions, genetic heterogeneity, and the need for large, well- characterized populations. However, ongoing advancements in sequencing technologies, big data analytics, and computational tools are helping to overcome these challenges, making GWAS a viable and powerful tool for crop improvement.

Keywords: GWAS, abiotic stress, genomic loci

SVIII-P5

Extent of Genetic Variability and Diversity Studies in Maize

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The present investigation was carried out with the principle objective of studying the extent of variability and diversity studies in maize at an ICR Farm, Department of Agronomy, Assam Agricultural University, Jorhat during the year 2023-2024. Observations recorded for 12 quantitative characters *viz.,* plant height (cm), ear height (cm), days to 50 % tasseling, days to 50 % silking, days to maturity, number of

kernel rows/ear, number of kernel/rows, number of ears/plants, ear length (cm), ear diameter (cm), grain yield/plant (g), 100-seed weight (g).Analysis of variance revealed significant differences for all the yield and yield attributing characters. The highest grain yield per plant was recorded in LG 34.05 (114.28 g), which is at par with CHAKRA MARKA BN 103(91.614 g). The PCV estimates were high for the number of ears/ plants, while both GCV and PCV were high for grain yield/plant. High heritability was observed for ear height, days to 50% tasseling, days to 50% silking, days to maturity, number of kernel rows/ear, ear diameter and 100-seed weight. Additionally, genetic advance as a per cent mean was observed high for the number of ears/plants and grain yield/plant. High heritability coupled with moderate genetic advance as per cent of mean was observed for the traits *viz*, ear height, ear diameter and 100-seed weight indicating the preponderance of additive gene action for the traits. Correlation studies revealed a significant association of grain yield/plant with plant height, number of ears/plants, number of kernels/row and ear diameter at both phenotypic and genotypic levels and with the number of kernel rows/ear at phenotypic level only. Path analysis revealed that the character number of ears per plant had the highest positive direct effect and days to 50% tasseling had the highest negative direct effect on grain yield/plant at the genotypic level. The residual obtained was found to be very low (0.0055) indicating that the characters studied show a large amount of variability, while some other traits that also contribute to variability that are not examined in the present investigation. Based on correlation and path coefficient studies showed that grain yield per plant could be improved by exercising selection on relatively simple traits such as plant height, number of ears/plants, number of kernels/row and ear length. The Mahalanobis D^2 statistic showed all the 30 genotypes partitioned into 9 clusters, while cluster I is having more genotypes. The inter- cluster distance is observed more than the intra-cluster distance. The nearest cluster distance was observed between clusters I and VI, whereas clusters IV and VII showed the farthest distance. This indicates there is a sufficient amount of variation in these genotypes. Therefore, these can be used for further studies.

***Keywords*:** PCV, GCV, heritability, GAM, correlation, path analysis, Mahalanobis D^2 statistics

SVIII-P6

Biochemical changes in Foxtail millet associated with Abiotic Stress Conditions

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Amongst various environmental constraints, abiotic stresses are increasing the risk of food insecurity worldwide by limiting crop production and disturbing the geographical distribution of food crops. In changing climatic scenario, plants often face periods of soil and atmospheric water deficits and/or salinity stress because of scarcity of water availability and deteriorating quality across the globe. Simultaneously, lack of precipitation, high rate of evapo-transpiration and unsustainable use of water resources could also lead to drought and salinity problems in lesser productive arid and semi-arid regions. In response to these stresses plants tend to overcome by change in physiological and biochemical properties. Millets being a major source of human food in present time, and their production has been steadily increasing in the last decades to meet the dietary requirements of the increasing world population. Millets characteristically adapt to unfavourable ecological conditions including abiotic and biotic stresses. Temperature is a key climatic factor that has a

significant impact on the growth and development of the millets. Foxtail millet (*Setaria italica* L.) is an ancient crop in the subfamily of Panicoideae and is distributed globally in arid and semi-arid regions. It was domesticated over 8,700 years ago and originated from North China. This study dissect the mechanisms of how foxtail millet responds and adapts to stresses on the biochemical-level.Two cultivars of foxtail millets were subjected to induced moisture stress in order to examine the biochemical alterations that occur as a result of the stress. It was observed that there was significant reduction in leaf chlorophyll and carotenoid content after the stress. Nitrate reductase activity was estimated to increase initially during growth period and then reduce after the stress. The study also showed a substantial decrease in content of moisture, crude protein, total carbohydrates, ash content, crude fibre and total fats present.

***Keywords*:** Millet, Environment, Abiotic stress, Biochemical changes

SVIII-P7

Optimizing rice-based cropping systems for phosphorus management in low soil- pH abiotic condition

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In acidic soils, characterized by low pH abiotic conditions, soil phosphorus from applied fertilizers or other sources are heavily adsorbed by certain trivalent cations (like Al^3 and Fe^3), making only 10–20% of the phosphorus accessible for plant uptake. This limited availability of phosphorus in such soils hinders crop productivity, particularly in the context of a growing global population. Therefore, in order to meet crop nutrient demands, excessive amounts of synthetic fertilizers are often used. However, at the current usage rate, high-quality phosphorus-bearing minerals are also predicted to be depleted within the next 50–100 years. Furthermore, residual phosphorus in the soil contributes to environmental issues, including runoff-induced aquatic eutrophication. Hence, there is an urgent need to address phosphorus adsorption in acidic soils to reduce fertilizer input dependency while ensuring environmental sustainability. This study compared the effectiveness of three major rice based cropping systems viz., CS1: Winter Rice- Autumn Rice, CS2: Winter rice-Pea-Cowpea, CS3: Winter rice-Toria-Black gram cultivated for five consecutive years on P adsorption capacity in acidic soils. The soil pH, organic carbon and available P_2O_5 value under the cropping system varied from 5.18-5.34, 7.5-9.3% and 29.25-45.29 kg ha^{-1}, respectively. The citrate bicarbonate dithionate extractable aluminum (Ald) and iron (Fed) showed highest value in CS1 while the lowest value was found in the soils of CS2. The percent adsorption (% Xad) of added P ranged from 55.6 to 85, 35.48 to 86 and 45.02 to 89.5 for CS1, CS2 and CS3, respectively. When the adsorption data were fitted into Langmuir adsorption isotherm model, the CS1 showed P adsorption maxima (b) value of 1428.57 µg g^{-1} and CS2 showed the lowest value of 769.23 µg g^{-1}. The present study showed decrease in the P adsorption maxima with diversification of pre-dominant rice based monocropping system with oilseed and pulses which in turn increased the phosphorus supply for plant uptake indicated by higher P supply parameter (SP) for CS2 and CS3 as compared to CS1. Thus, diversification of these the pre-dominant cropping systems can

enhance phosphorus availability for plant uptake which may reduce reliance on synthetic fertilizers, and addresses environmental concerns. Therefore, incorporating crop diversity into rice-based systems offers a sustainable solution for managing phosphorus in low pH soil while preserving soil fertility and promoting agricultural productivity.

***Keywords*:** Adsorption, Langmuir isotherm, phosphorus supply parameter, rice, acid soil, cropping system

SVIII-P8

Development of Novel Blackgram (*Vigna mungo* (L.) Hepper) Mutants and Deciphering Genotype × Environment Interaction for Yield-Related Traits of Mutants

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Blackgram (*Vigna mungo* (L.) Hepper) yields are noticeably poor due to a shortage of improved varieties and an aggravated narrow genetic base. Rice fallow condition, where the seeds germinate through the stubbles of harvested paddy with the available moisture and dew. The variety should have good foliage and quick vegetable growth with early vigour, non-shattering, open type with more leaf area varieties will be suitable for rice fallow conditions. So, strategy to expand the area is promotion of blackgram cultivation under rice fallows. An attempt was made to isolate novel blackgram mutants by selecting for yield-related traits derived through gamma irradiation and testing the mutant genotype's stability across the different environments. Materials and Methods: Prospects of mutational approach in plant breeding are bright, particularly when a well-adapted variety has to be rectified for one or two characters. The irradiated blackgram populations M1-M5were established in the background of cultivars ADT 3, Co 6, and TU 17-9. Desirable mutants were selected from M3to M5generations. Results and Discussion: It was observed in M2and M3that gamma rays showed higher mutagenic efficacy and generated good in herited variance for the yield-related traits. M4 was established from the selected 543 M3 mutants in the replicated trial, and 124 non-segregating mutant lines were considered for recordingbiometric observations, this established three divergent groups in each blackgram cultivar revealed by clustering analysis. The number of pods per plant, number of clusters per plant, and number of pods per cluster showed a strong direct association with single plant yield and could be considered as selection traits. The selection was imposed on M4 mutants, and 36 uniform, non-segregating mutant progenies showing desired yield-related traits were selected to raise the M5 population. G×E interactions were higher than the variation due to genotype for single plant yield. Limited environmental interaction was observed for the genotypes G24, G16, G36, G30, and G17, as revealed by AMMI, and the genotypes G18 and G29, as revealed by GGE. GGE biplot revealed the environment-specific genotypes G13 for E1 (Aduthurai), G7 for E2 (Kattuthottam), and G34 for E3 (Vamban) and also portrayed the highly discriminating (E3) and representative (E2) environments. Selected novel blackgram genotypes from this research are useful genetic stocks for genetic improvement and breeding.

Keywords: AMMI; G × E interaction; mutation breeding; pulses; blackgram

SVIII-P9

Compatibility of *Trichoderma* spp. with ZnO nanoparticles and Au nanoparticles and its *in vitro* efficacy against *Rhizoctonia solani*

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An experiment was conducted to test the compatibility of zinc oxide and gold nanoparticles with three different *Trichoderma* spp., namely, *Trichoderma viridae, Trichoderma harzianum, and Trichoderma pseudokoningii* at five different concentrations: 200 ppm, 400 ppm, 600 ppm, 800 ppm and 1000 ppm. The results revealed that out of three *Trichoderma* spp., *T. harzianum* was compatible with ZnO NPs @ 200 ppm, as we observed a minimum mycelial growth inhibition of 10.25%. An *in vitro* test was performed with *T. harzianum* supplemented with ZnO NPs @ 200 ppm and *T. harzianum* without ZnO NPs along with a chemical check of hexaconazole @ 0.1% against *R. solani.* The results revealed that the chemical treatment (hexaconazole) showed a higher radial growth of 1.04 cm and mycelial growth inhibition of 88.47% over the control. This was followed by *T. harzianum* supplemented with ZnO NPs@ 200 ppm.

Keywords**:** *Trichoderma,* nanoparticles, zinc oxide, gold

SVIII-P10

Studies on Correlation and Path Coefficient Analysis for Quantitative Characters in Pumpkin (*Cucurbita moschata* L.)

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An experiment was conducted at Horticulture Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology; Modipuram, Meerut (U.P.) during Zayad season- 2020. Twenty-five genotypes of pumpkin were evaluated in randomized block design with three replications for ten quantitative characters. Genotypic correlation coefficients were found to be greater than phenotypic correlation coefficients for more of the characters. Fruit yield per plant was a highly significant positive correlation with the number of fruits per plant followed by the number of leaves per plant, length of vine, number of primary branches and days to first fruits. The harvest implies that these all characters were the main contributing factors to fruit

yield per plant. Path coefficient analysis exhibits a highly positive and direct effect on fruit yield per plant was observed for a number of primary branches followed by a number of fruits. per plant, days to first fruit set, number of leaves per plant, length of vine, days to first flower initiation and % of seed germination.

Keywords: Correlation, Path Coefficient, Pumpkin, Characters.

SVIII-P11

Solid Lipid Nano particle Loaded with Lemon grass (*Cymbopogon* sp.) Essential Oil as a Potent Antibacterial Formulation against Phytopathogen *Ralstonia solanacearum*

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The proliferating plant diseases are a threatening global problem on food security issues exacerbated by the alarming implications of plant pathogens with an ever-increasing population. One of the most damaging bacterial phytopathogens is *Ralstonia solanacearum*, which causes wilt disease in over 250 plant species. Dependence on synthetic bactericides such as antibiotics used to control crop loss imperceptibly increases the emergence of multi-drug-resistant superbugs and harmful environmental effects. Accordingly, it becomes imperative to find safer alternatives, such as plant-derived essential oils, which are bioactive secondary metabolites having antimicrobial and antioxidant effects. Nevertheless, the limited use of EOs due to their poor water solubility, volatility and chemical instability highlights a requirement for innovative formulations such as solid lipid nanoparticles(SLN) to optimize water solubility and biodegradability, with targeted delivery while reducing volatility. In the present study, SLN loaded with lemongrass (*Cymbopogon* sp.) EO was synthesized and characterized, which revealed a particle size of 190.3 nm with a polydispersity index of 0.231, zeta potential of -1.18 mV and entrapment efficiency of 86%. The minimum inhibitory concentration of the SLN-EO formulation against *Ralstonia solanacearum* was 700 ppm. The disc diffusion assay revealed a zone of inhibition measuring 26.8 mm in diameter. Hence, the lemongrass EO-loaded SLN is an effective antibacterial agent and offers a bio-based alternative to conventional chemically synthesized bactericides in plant disease management.

***Keywords*:** Essential oil, Lemongrass, *Ralstonia solanacearum*, Solid lipid nanoparticle

SVIII-P12

Advances in solanaceous vegetable crop breeding for biotic and abiotic stress challenges: A review

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The Solanaceae family is one of the most significant among angiosperms. The genera *Solanum* (potato and eggplant), *Capsicum* (pepper) and *Lycopersicon* (tomato) are important as vegetables, vital for global food security and economic stability. These crops are cultivated worldwide, from smallholder farms to large commercial operations, creating millions of jobs in agriculture, processing and distribution. Besides their economic significance, solanaceous vegetables play a crucial role in human nutrition by providing vitamins, minerals and dietary fiber. Despite their importance, solanaceous vegetables are vulnerable to various biotic and abiotic stresses like diseases, pests, drought, heat and soil salinity. These challenges pose a significant threat to their productivity, particularly in the face of climate change and rising global food demand. Development of varieties resistant and tolerant to these biotic and abiotic stresses is required to increase genetic potential and boost production. This can be done through breeding techniques advanced through the integration of scientific knowledge and technological innovations. Advanced breeding techniques can significantly reduce complexity by making trait selection faster, more precise and less dependent on environmental factors. This review provides a comprehensive overview of the progress made in enhancing biotic and abiotic stress resistance and tolerance in solanaceous vegetable crops through the use of marker-assisted selection (MAS), genetic engineering, next-generation sequencing (NGS), and genome-wide association studies (GWAS). It has notably enhanced the ability to assess and exploit genetic diversity. These advanced techniques have proven significant in solanaceous vegetables, where multiple stress tolerance is achieved efficiently with CRISPR/Cas9 gene editing, enhanced selection precision with MAS, critical insights into gene expression and variation through NGS and identification of genetic variations associated with specific traits through GWAS. While some constraints remain, the integration of advance breeding techniques with interdisciplinary approaches promises to enhance the sustainability and resilience of solanaceous vegetable production.

***Keywords*:** solanaceous, biotic stress, abiotic stress, advanced breeding, resistance, tolerance

SVIII-P14

"Anand Jwala": A high yielding variety with good fertility restorer gene identified through molecular markers

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Chilli (*Capsicum annuum* L.) is a very important vegetable cum spice crop grown in almost all parts of the world. World chilli production is primarily concentrated in south Asian countries to an extent of about 55% of total world production. In India, total area under green chilli crop in the year 2022-23 was 3.64 lakh hectares and production of 37.20 lakh tonnes with 10.22 t/ha productivity. In Gujarat, it is mostly grown in the district of Ahmadabad, Kheda, Anand, Vadodara, Surat, Rajkot and scattered area of Saurashtra region. The total area under chilli crop in Gujarat during the year 2022-23 was 0.11 lakh ha with the total annual production of 0.36 lakh tonnes with productivity 3125 kg/hafor red riped chilli.In India, total 8 different segments/varieties are grown in chilli across the different states including Kashmiri from Kashmir, Bhut Jolikia from North-east, Jwala from Gujarat, Byadgi from Karnataka, Guntur from Andhra Pradesh, Mundu from south India, Khola from Goa and Kanthari from Kerala. Among these, Jwala segment of chilli are most popular in the Gujarat state due to its attractive fruit shape, size, glossiness, colour and pungency in green as well as red stages. Looking to above mentioned points, genotype ACS 18-03 was developed from the cross Pusa Jwala x GVC 111 following pedigree method of selection for green fruit purpose. It was testedin different trials over locations in the Gujarat state from the year 2019-20 to 2022-23 during *kharif-rabi* season. The genotype perceived 165 q/ha average green fruit yield in middle Gujarat which depicted 23.4 *per cent* higher green fruit yield over the tested checks. Identical morphological features of genotype are dense canopy with strong intensity of anthocyanin colour ationonnodes and absent of stem pubescence. Fruits have light green colour with high pungency at unripe stage. Fruits have strong sinuation of pericarp, rough texture with medium glossiness. It contains higher ascorbic acid (11.90 mg/100g) and capsaicin content (0.219%) as compared to the check GAVC 112.

Keywords: chilli, genotype and green fruit

SVIII-P15

Morphological and molecular characterization of *Fusarium incarnatum* associated with root rot disease in Soybean (*Glycinemax,* L.*)*

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Root rot is one of the most serious diseases affecting soybean crops in Assam-A north-eastern Indian state. The objective of the present study was to confirm the identity and pathogenicity of the causal

agent isolated from the infected roots of soybean samples collected through a field survey. Based on the morphological characteristics, *Fusarium* species was found to be causing the disease. Through phylogenetic analysis based on the sequences of the ITS region and translation elongation factor 1-alpha (TEF) gene, *F. incarnatum* was confirmed to be the disease-causing pathogen. This is the first report of *F. incarnatum* causing root rot disease in soybean. Disease incidence was found to be positively associated with, ETP (Evapotranspiration), VPD (The deficit of vapor Pressure), IIHS (Insolation Incident on a Horizontal Surface), DTIR (Downward Thermal Infrared (Longwave) Radiative Flux), and Tmax (Maximum air temperature) and negatively associated with RH (Relative Humidity) and PRECTOT (total rainfall precipitation during the crop cycle).

***Keywords*:** Causal agent, *F. incarnatum*, Macro-conidia, Micro-conidia, Rootrot, Soybean

SVIII-P16

In vivo and *in vitro* study of Bhut jolokia (*Capsicum chinense* Jacq.) in response to Potato Virus Y (PVY): A comprehensive approach in disease detection and management

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Bhut Jolokia (*Capsicum chinense* Jacq.) is an important chili cultivated especially in the North Eastern region of India. It is renowned for its extreme pungency and as a rich source of bioactive compounds with nutritional, and potential medicinal properties, pest control applications, and as a natural foodpreservative. This important cash crop is vulnerable to many biotic factors. But this important cash crop is highly susceptible to viruses and the disease caused by Potato Virus Y (PVY) is the most severe. Moreover, proper germplasm screening and disease management have hindered crop progress and yield production. Therefore, in the present study, we aim to screen Bhut Jolokia germplasms against PVY in both in-vivo and in-vitro conditions to select theappropriate germplasm and establish tissue culture techniques to study PVY infection and to get successful crop production under disease pressure. This study also focuses on quantifying bioactive compounds such as capsaicin, phenolics, flavonoids, vitamin C, and essential oils using HPLC, and GC-MS in Bhut Jolokia sourced from different regions. Disease surveillance, laboratory screening, and management of Potato Virus Y infections can achieve better disease control and economic benefit to the farmers.

***Keywords*:** *Capsicum chinense*, Potato Virus Y, HPLC, GC-MS, bioactive compounds

SVIII-P17

Clathrin-coated vesicle (CCV) components as essential mediators of plant immunity–a review

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Clathrin-coated vesicles (CCVs) are important in eukaryotic cells because they orchestrate vesicular trafficking pathways vital to cellular communication, homeostasis, and defense. In the plant kingdom, CCVs are recognized as playing a pivotal role in regulating immunity through the internalization and recycling of immune receptors as well as other key components in defense signaling. The different components of clathrin-coated vesicles, such as clathrin heavy chain (CHC), clathrin light chain (CLC), adaptor proteins, dynamin proteins, and auxilin proteins, are very important in controlling endocytosis and accurate signalling for pathogen recognition and response. These components are not only key for keeping the balance of receptors on the cell membrane but also for boosting immune signals when the plant reacts to pathogen-associated molecular patterns (PAMPs) during pattern-triggered immunity (PTI). Understanding the role of CCVs inplant immunity opens new avenues for designing disease-resistant crops by targeting vesicular trafficking pathways. Such studies on the vesicles open up important insights into how cellular machinery can beexploited to improve pathogen defense and promote agricultural sustainability, and thus CCVs are a promising focus for future research in plant protection.

***Keywords*:** Clathrin-coated vesicles, plant immunity, endocytosis, adaptor protein, auxilin protein, dynamin protein

SVIII-P18

Foxtail Millet: Addressing Water logging Stress for Enhanced Climate Resilience and Food Security

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Foxtail millet (*Setaria italica L.*), is an annual grass belonging to the poaceae family. It is a short duration, self- pollinating crop, exhibiting C4 metabolism and takes only eighty five to ninety five days to reach harvestingstage. It is among world's six major cereal and is consumed by one-third of the world's population. The crop is gaining attention today particularly due to its carbohydrate content equal to rice and higher protein, calcium, phosphorus, iron, and vitamin B1 content than rice making it a perfect candidate for ensuring foodand nutritional security. It grows in semiarid and tropical regions across the globe and can adapt to various environmentalstresses like drought and salinity stress. But due to global climate change resulting in unpredictable and uneven distribution of rain across the world, it has become vulnerable to waterlogging stress since the onset of monsoon coincides with its growing season in many regions across the

globe. As a result, cultivation of this crop becomes difficult in plains or lowlands where water stagnation/ floods may occur. The waterlogging before and after heading significantly affects the grain yield as conditions like hypoxia or anoxia affects the roots, stomatal conductance, and photosynthesis. The plant exhibits various morphological changes like development of aerenchyma and adventitious roots formation along with transcriptional and metabolic changes to withstand this condition. The endogenous antioxidant enzymes and non enzymatic molecules are also up-regulated to mitigate the effect of stress. These adaptations are manifested at various stages in different capacity in response to different stress levels. Exploring advanced breeding and biotechnological strategies to enhance the nutritional value of foxtail millet and improve its tolerance mechanisms against abiotic stresses, particularly waterlogging, can empower scientists and farmers to fully harness the crop's potential in the face of climate change.

Keywords: Foxtail Millet, Water-logging Stress, Global Climate Change.

SVIII-P19

Seasonal and Climatic Influences on Green gram Yield: Insights from Microbial Treatments

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Greengram (*Vigna radiata* L.) is a crucial pulse crop susceptible to abiotic stresses like drought and biotic stresses, including Yellow Mosaic Virus (YMV) and whitefly infestations. This study evaluated the impact of nodule associated plant probiotics (NAPP) on greengram seeds through treatments such as 2%-biopriming, 4 ml- coating and their combination of biopriming + coatingalong with hydropriming and uninoculated seeds under varying drought stress was imposed at different phenological stages under field condition across two seasons of (Rabi and Kharif). The rabi season crop showed improved morphological, physiological and biochemical responses compared to the kharif season. Additionally, correlations between seed yield, pest and disease dynamics and meteorological parameters were analyzed to understand the climatic influence on productivity. Microbial treatments significantly enhanced plant growth, physiological parameters and biochemical responses, particularly during the rabi season under stress conditions. Among the microbial treatments, Combination of biopriming + coated seeds showed improvement in photosynthetic rate and relative water content (RWC), leading to enhanced plant growth under both drought stress and control conditions. The biochemical study found that a combination of biopriming + coated seeds considerably increased proline content, total soluble protein and antioxidant enzymes catalase (CAT), peroxidase (POD) and superoxide dismutase (SOD) under drought stress and control conditions. Furthermore, significantly increased yield components *viz*., number of pods, number of seeds, 100-seed weight and root nodules under both control and drought conditions. Additionally, Yellow Mosaic Virus (YMV) incidence and whitefly populations exhibited strong positive correlations with temperature and relative humidity during both seasons. Disease severity was higher in the kharif season, coinciding with higher pest pressure and fluctuating climatic conditions. Seed yield showed a significant negative correlation with pest and disease severity, particularly under severe drought conditions, but was positively influenced by moderate drought and microbial treatments.

Statistical analyses highlighted a strong positive correlation between yield and seasonal precipitation during the rabi season. The findings underscore the critical role of microbial treatments in mitigating drought- induced stress and enhancing greengram resilience. The observed correlations between climatic factors, disease and pest dynamics reveal the complexity of biotic-abiotic interactions under field conditions. These insights provide a foundation for developing integrated strategies combining microbial inoculants with weather-based crop management to optimize productivity under changing climatic conditions.

Keywords: Nodule associated plant probiotics, Drought stress, Yellow Mosaic Virus, Whitefly, Temperature and Relative humidity

SIX/LT-1

Role of Social Sciences in Addressing Climate Change

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The role of social sciences in addressing climate change is increasingly vital, particularly in shaping agricultural policies and fostering resilience among rural communities. Climate change-induced risks such as temperature fluctuations, erratic precipitation, and soil degradation threaten farmers, necessitating interdisciplinary solutions. Social sciences contribute by integrating policy analysis, behavioral insights, and community engagement into climate adaptation strategies. Climate-smart agriculture (CSA) emerges as a key policy framework, blending adaptation, mitigation, and productivity to enhance sustainability. Policies such as financial incentives, early warning systems, agricultural infrastructure, and market integration are essential to equip farmers to deal with climate change. Additionally, social sciences emphasize the importance of farmer perception, community participation, and traditional knowledge in strengthening local adaptation mechanisms. Digital technology, such as mobile applications, precision farming, and remote sensing, can be integrated to improve decision-making among farmers further. Social sciences thus ensure that climate policies are people-centric, promoting inclusive, evidence-based interventions that empower vulnerable farming communities.

Keywords: Social Sciences; Agricultural Policy; Farmers; Adaptation; Digital Technology.

SIX-O1

Enhancing Weather-Based Crop Insurance in India: AI, Machine Learning, and Remote Sensing for Climate-Resilient Agriculture

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The Restructured Weather-Based Crop Insurance Scheme (RWBCIS) has been a critical tool for protecting Indian farmers against weather-induced crop losses. However, with the accelerating impacts of

climate change, the scheme faces mounting challenges. Increasingly erratic rainfall, extreme temperature fluctuations, and shifting weather patterns exacerbate risks, rendering traditional weather indices insufficient to capture localized and dynamic climatic variations. These limitations are compounded by sparse Automatic Weather Station (AWS) networks, delays in claim settlements, and a lack of integration with real-time climate data, leaving many farmers inadequately covered. To address these climate-driven challenges, this paper presents an enhanced RWBCIS framework that integrates Artificial Intelligence (AI), Machine Learning (ML), and Remote Sensing technologies, specifically tailored for India's diverse and climate-vulnerable agricultural landscape. The proposed model leverages real-time data from AWS, IoT-enabled on-farm sensors, and high-resolution satellite imagery to generate hyper-local weather forecasts and dynamic risk indices. AI-powered systems analyze historical and evolving climate trends, enabling region- and crop-specific thresholds that adapt to shifting climate conditions. Remote sensing technology offers precise pre- and post-weather event monitoring, ensuring accurate damage assessments and equitable compensation. Inaclimate-sensitive context, the model's automated claim settlement system powered by AI ensures transparency and significantly reduces delays. Additionally, farmer inclusivity is enhanced through mobile applications, AI-driven multilingual chatbots, and SMS alerts, bridging digital and literacy gaps. By aligning with the dynamic realities of climate change, this improved RWBCIS framework not only mitigates current limitations but also future-proofs crop insurance to address emerging challenges. This innovative approach transforms RWBCIS into a resilient, technology-drivensolution that safeguards farmers' livelihoods, enhances their adaptive capacity to climate variability, and supports the sustainability of India's agricultural sector in an era of unprecedented climate change.

Keywords: RWBCIS, Artificial Intelligence, Machine Learning, Remote Sensing, Climate Change,Hyper-Local Weather Forecasting

SIX-O2

Impact of Climate change towards human wildlife conflict using partial least square structural equation modelling

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The increasing intensity and variability of climate change have profoundly affected ecosystems and human livelihoods, often exacerbating human-wildlife conflicts (HWC), which arise when wildlife encroaches on human settlements or agricultural lands. This study investigates the impact of climate change on HWC by analyzing climatic stressors, land-use changes, wildlife behavior, and socio- economic factors using Partial Least Squares Structural Equation Modelling (PLS-SEM). Data from 300 respondents revealed that climate

variability, including increased temperatures, erratic rainfall, and prolonged droughts, significantly influenced wildlife migration patterns (path coefficient = 0.68, $p < 0.01$), forcing wildlife into human settlements in search of food and water. Land-use changes, such as deforestation, agricultural expansion, and urbanization, mediated these effects (path coefficient = 0.56, $p < 0.05$), exacerbating habitat loss and driving wildlife closer to human- dominated areas. Altered wildlife behavior, including changes in migratory and feeding patterns, was strongly linked to crop depredation and livestock attacks (path coefficient = 0.62, $p < 0.01$). Socio- economic impacts included significant losses in crops, livestock, and property, further worsened by reduced adaptive capacity and limited access to resources (path coefficient = 0.49, $p < 0.05$). However, the study found that effective mitigation strategies, such as early warning systems, compensation schemes, and community-based conservation efforts, reduced conflict severity (path coefficient = -0.33, $p < 0.01$). The findings underscore the critical role of integrated land-use planning, climate-resilient agricultural practices, and collaborative efforts between governments, communities, and conservation organizations in addressing HWC. PLS-SEM provided robust insights into the interconnectedness of climate change, ecological disruptions, and socio-economic pressures, emphasizing the need for adaptive strategies and habitat restoration to minimize conflicts and ensure sustainable coexistence between humans and wildlife.

***Keywords*:** Climate Change, Human-Wildlife Conflict (HWC), Climatic Stressors, Socio-Economic Impact

SIX-O3

Use of technology for effective dispute resolution in agricultural insurance

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Pradhan Mantri Fasal Bima Yojana (PMFBY) is a crop insurance scheme implemented in India since 2016 to manage losses due to uncertainties and risks in agriculture. It provides comprehensive coverage for pre- sowing, post-harvest losses, and localized calamities to farmers at a nominal premium. During the earlier years of implementation of PMFBY, various types of yield disputes were observed, leading to unnecessarily delay in claim settlement for the farmers. To tackle these issues, the role of technology was envisaged under PMFBY. Data-driven and evidence-based crop risk assessment solutions were advocated that will enhance the loss assessment system facilitating timely insurance claim payments. The idea was to minimize manual assessment within the crop insurance system and leverage innovative solutions like satellite imagery, drones, and remote sensing in crop area estimation, crop health assessment and yield assessment to make the entire system more accurate, efficient and transparent. Currently these technologies are being used in case of any dispute related to crop area, yield and crop health. A scientific analysis was undertaken to assess crop loss occurred due to heavy rainfall in Groundnut crop during Kharif 2019 in Gujarat state. The reported yield was very low in 5 taluks of Junagarh district in comparison to adjacent taluks in the same district, which led to dispute in claim settlement. Technology-based assessment was required in the Insurance

Units (Ius) where abnormally low yield was reported. Situations were analyzed according to the protocols under PMFBY guidelines. Weather situation, remote sensing-based crop health, moisture status, soil condition, and yield obtained through Crop Cutting Experiments (CCEs) were critically analyzed to investigate the actual situation that prevailed during the crop growing period. Historical yields and CCE data for ground nut crops were collected from the state and technology-based assessment was carried out to investigate if environmental conditions could confirm the low yields reported. The groundnut crop area was also estimated through satellite using machine learning approach and proxy yields were estimated for the disputed taluks using historical yields, weather parameters and satellite-derived indices.It was observed that during Kharif 2019, higher than normal rainfall was recorded in Junagadh (over 1000 mm). The groundnut crop requires about 500 to 700 mm of rainfall over the total growing period and high rainfall and soil moisture during the critical crop stage might result in fungal damage to the crop. Satellite- based estimations indicated the high moisture content in three talukas where yield was reported as low which corresponded with the Land Surface Wetness Index (LSWI). After critical analysis of satellite derived parameters, it was established that heavy rainfall during pod development phase might affect the crop yield. Considering this, technology based yield was derived using weather and remote sensing based proxy parameters to support the state for effective claim settlement. Thus, technology is being used as an effective measure to support the state governments in decision-making for operational crop insurance schemes. It in turn assists in providing support to farmers incurring losses due to perils.

***Keywords*:** Crop insurance, technological solution, satellite estimation, ground nut, crop yield

SIX-O4

Weather Extremes and Crop Insurance in Maharashtra a Comprehensive Risk Analysis

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This study investigates the relationship between climate extremes and the risk associated with crop failure in Maharashtra, India. Extreme weather events are analyzed using data from multiple weather stations across the State. A set of climate indices specifically designed to assess extremes such as temperature anomalies, rainfall variations, and their frequency which have direct implications for agricultural productivity and insurance claims are investigated. Further, the identified extreme weather events are linked with crop insurance data across various districts of Maharashtra. The study identifies key risk zones where farmers are more likely to face extreme weather, posing higher risks. The study highlights the need for targeted insurance policy adaptations in these high-risk districts to ensure the sustainability of the agricultural sector andinsurance systems.

***Keywords*:** Climate extremes, Climate indices, Crop insurance, Risk analysis, and Spatial analysis

SIX-O5

Influence of livelihood diversification and its determinants as climate change adaptation strategy on income of tribal households in Jorhat district of Assam

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Climate change and its catastrophic impacts is a challenging issue across the planet. Assam is one of the most vulnerable states to climate change, in the Indian Himalayan Region (Assam Green Budget 2023-24, Assam SAPCC); extreme rainfall incidents will increase by 38 percent, according the Assam State Action Plan on Climate Change (ASAPCC) report. The tribal communities are more vulnerable to the adverse effect, as their livelihood are closely tied to natural resources and climate stability. Livelihood diversification has emerged as a critical strategy to enhance resilience by reducing vulnerability and ensuring income stability in the face of climatic shocks (Ellis, 2000). The study was conducted in the Jorhat district of Assam investigates the role of livelihood diversification as an adaption strategy among tribal households.The sample design of the study was an ex post-facto, cross-sectional approach combining purposive and random sampling designs. The study was conducted in eight villages from two ADO circles of Jorhat district. The research involved profiling of tribal households, assessing the determinants and extent of livelihood diversification, and analyzing its impact on per capita income of household. Simpson Diversification Index (Simpson, 1949) was used in quantifying extent of livelihood diversification and the factors influencing diversification and its impact on per capita income were analyzed through multiple regression models. The study found out that there had been moderate to high levels of livelihood diversification among the tribal households of Jorhat district. The Simpson Index of Diversification (SID) value showed a significant increase. The Regression analysis revealed that factors such as education, livestock ownership, and the extent of diversification significantly influenced per capita income of the households. Households with higher diversification scores showed better in come stability and reduced vulnerability to climate-induced shocks, supporting findings from similar studies (Adger et al., 2003). The findings emphasize on the need for targeted policy interventions to integrate livelihood diversification into broader climate adaptation frame works, with focus on capacity-building initiatives and improved institutional support; especially as the study revealed lack of trainings, low crop insurance coverage and poor institutional support among rural tribal households of the study area.This study contributes to the growing body of research on climate change adaptation by providing empirical evidence on the effectiveness of livelihood diversification in enhancing resilience among marginalized communities. The research offers actionable insights for policymakers and researchers addressing the socio-economic challenges posed by climate change in vulnerable regions.

Keywords: Climate change, livelihood diversification, tribal households, Assam, adaptation strategies

SIX-O6

Agromet Services: Tailoring Weather Solutions for Modern Agriculture

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Meteorological information is important and valuable for agricultural producers. The main aspects of agromet services include collecting, generating, and distributing agrometeorological information and advisories with the participation of agricultural sector stakeholders. Agromet advisories help farmers make informed decisions on the best management of resources as well as the time of application of costly inputs. A non-systematic literature review was conducted to study the effective participation of industries in dissemination of agrometeorological services to the community. Agrometeorological service delivery has significantly expanded since the 2019 State of Climate Services report by WMO and FAO. FAO and WMO conduct extensive research to strengthen these services globally, nationally, and regionally. In India, the IMD, in collaboration with ICAR, SAUs, IITs, and other institutions under the ACROSS scheme, popularly known as Gramin Krishi Mausam Sewa (GKMS) provide weather services to the farming community by using state of the art technology. Other than the role of public institutions several private industries have come into play in recent times to impart agrometeorological extension services. Accuweather, Met Office, DTN, and IBM are some top companies providing agro -met services across the world. In India, Skymet Weather is a leading private weather forecasting company. It provides weather services to media, insurance, agriculture, and energy sectors, leveraging advanced NWP models for precise forecasts. Skymet also offers a multilingual weather app and supports farmers and renewable energy companies through tailored solutions. IFFCO Kisan Sanchar Limited (IKSL), established a joint venture with Bharti Airtel and Star Global Resources Ltd., to empower Indian farmers by providing tailored information services through mobile technology. Farmers receive 5-day weather forecasts, including temperature, rainfall, humidity, and wind data for up to two preferred districts, sourced from IMD. Some companies even provide microclimatic forecasts based on farm level data. Fasal founded in 2018, is a AI powered farm management IoT platform that provides microclimatic forecasts for horticultural crops by collecting farm level data with sensors. Machine learning techniques are used to provide real time advisories. The services provided by the public sectors are reliable, inclusive, and affordable services with nationwide reach while the private sectors offer tailored, innovative, and user-friendly solutions with advanced technologies and faster implementation. Despite the rise of ICT, challenges in access and understanding persist particularly due to the large number of languages spoken across the country. The review emphasizes that no single approach fits all situations. The gaps and barriers in the effective communication of agromet services can be mostly overcome by adopting collaborative approach.

***Keywords*:** Public-Private Collaboration, Information Dissemination, Technological Integration

SIX-P1

Opportunities and Difficulties in Adapting Crop Insurance to Climate Change

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Due to its location & heavy dependence on agriculture, India has been experiencing increasing effects of climate change, causing widespread impact. Significant losses and damages have occurred due to temperature fluctuation, changes in precipitation patterns, drought, severe flood, storms, & other catastrophic disasters. Increased intensity and frequency of weather extremes have enhanced both agricultural and financial risks and thereby, posing serious threat to the rural people. Climate change is predicted to have immense impact on crop productivity, with cereal crops like wheat and paddy already showing substantial decline in yield as a result of rising temperatures and erratic rainfall. Therefore, Crop insurance is essential to mitigate risks by shielding farmers' investments from significant losses. Crop insurance premiums are typically collected from a large number of people while shielding a select few from losses. With the increasing number of people affected during the climatic disasters, the current crop insurance framework finds it difficult to provide adequate & sufficient compensation simultaneously.An attempt is made in this paper to identify the obstacles to crop insurance's adaptation to such climatic hazards. The conclusion suggests the need to redesign crop insurance schemes with better risk management strategies and technology integration to raise its demand, and also point out the challenges, like uncertainty in risk patterns, coverage gaps, and unaffordability etc.

Keywords: *Crop insurance, Climate change, Agriculture risks, Adaptation*

SIX-P2

A study on farmers' perception about climate change and their adaptation and mitigation strategies in undivided Barpeta district of Assam

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The study entitled "*A study on farmers' perception about climate change and their adaptation and mitigation strategies in undivided Barpeta district of Assam*" was carried out in the Barpeta district of Assam to study some of the profile characteristics of farmers, assess farmers' perception about climate change, analyze relationship between personal characteristics of farmers and their perception about climate change, describe farmers' adaptation and mitigation strategies and coping mechanisms to counter adverse effect of climate change and identify the constraints perceived by them. A descriptive research design, following an ex postfacto approach, was utilized for the study through multi stage, purposive cum random sampling design to select 120 respondents from 4 sampled villages from Barpeta district. Data was collected with the help of a pretested, semi structured research schedule and using the personal interview method. With respect to the profile of the respondents, the study revealed that the respondents were by and large of medium to old age category, with medium to high level of formal education and belonging to medium sized

family category. The study also revealed that respondents had medium to high level of farming experience with moderate level of innovativeness. The farmers were marginal to small farmers with low training exposure. They had medium level of information seeking behaviour, mass media exposure and decision making ability. It was observed that KVK personals were more preferred extension agent in the study area. Findings of the study indicated that the respondents had medium level of perception about climate change. It was also seen that age, educational qualification, farming experience, operational land holding, innovativeness, knowledge of crop insurance and socio politico participation had significant correlation with perception about climate change. The findings of the study revealed some mitigation strategies adopted by the respondentswere use of flood tolerant variety (rank I), Owning of multi specific holding of livestock (rank II), Selection of appropriate crop/varieties (rank III), adaptation of livestock farming in addition to field crops (rank IV), alteration in sowing dates, elevating the foundation of the house to protect against flood. The findings also revealed some constraints faced by farmers due to climate change were unable to work in the field for longer time due to high temperature, high incidence of disease and pest in the field, higher cost of agricultural inputs, increase in monkey and squirrel conflict, lack of proper information about accurate and timely weather forecast.

Key words**:** *Perception, Climate Change, Adaptation Strategies, Constraints*

SIX-P3

Lac: Indigenous Practices and Tribal Livelihoods in humid Assam basin of India

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Assam and West Bengal under humid regions of India, provides suitable climatic conditions for lac cultivation. Kerrialacca, a major contributor of lac in India is usually bivoltine. But seasonal variations of Assam have shown trivoltinism of the same species. Lac, a resinous substance produced by the lac insect (*Kerria* spp.), has been integral part of cultural and economic practices of tribal communities in India since time immemorial. The indigenous technical knowledge (ITK) involved in cultivation, harvesting, processing and utilization of lac is a documented proof made by the tribal communities. Tribal regions, particularly in states like Jharkhand, Chhattisgarh, Madhya Pradesh, Odisha and Assam, lac cultivation is not only an important livelihood means but also a cultural tradition passed down through generations. The process involves culturing the lac insect on host trees, primarily the *Schleiche raoleosa* (Kusum)*, Butea monosperma* (Palas)*, Ficusre ligiosa* (Peepal) and Zizuphus marutiana (Ber) and extracting the resin through traditional methods which is widely used in production of a variety of products, including dyes, cosmetics, varnishes and traditional crafts, thereby uplifting the rural economies and livelihood. This study explores the importance of ITK in lac cultivation, highlighting its environmental sustainability, socio-economic benefits, and the role it plays in preserving tribal cultural heritage. The integration of modern technologies with indigenous practices can further enhance the sustainability of lac-based industries, thereby ensuring the preservation of both cultural heritage and ecological balance.

Keywords**:** Dye, indigenous technical knowledge (ITK), lac, lac based products, tribal regions

SIX-P4

Crop Insurance in India: A State-Wise Risk and Coverage Perspective

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Agriculture remains a cornerstone of the Indian economy, despite its declining contribution to GDP over the past few decades. It continues to provide employment to nearly half of the country's workforce. However, the sector is highly vulnerable to risks and uncertainties due to its reliance on unpredictable weather, climate conditions, and frequent natural calamities, which severely impact farmers' livelihoods and crop yields. To address these challenges, mechanisms like crop diversification and crop insurance have been introduced to mitigate risks and provide financial protection to farmers. Secondary data has been used to reviews the evolution of crop insurance scenario in India. Over the years, numerous schemes have been implemented, with each successive program incorporating technological advancements and improvements to enhance their effectiveness. Currently, four major crop insurance schemes are operational in India: Universal Personal Insurance Scheme (UPIS), Coconut Palm Insurance Scheme (CPIS), Restructured Weather-Based Crop Insurance Scheme (RWBCIS), and Pradhan Mantri Fasal Bima Yojana (PMFBY). PMFBY, launched in Kharif 2016, has marked significant progress, including a 6.5 per cent. increase in insured area, a 20.4 per cent rise in the number of insured farmers, a 74 per cent growth in the sum insured, and a 298 per cent increase in premiums paid compared to the previous year. Despite these achievements, the scheme has encountered multiple challenges during its initial implementation. These include delays in farmer registration and yield data submission, concerns about the quality of data from crop-cutting experiments, and slow disbursement of claim payments due to delayed premium subsidies from state governments. The success of any crop insurance scheme lies in its ability to promptly assess damages and ensure timely claim settlements directly to farmers' accounts. Policy measures must focus on timely claim processing, risk diversification through products like double-index in surance, and fiscal strategies such as multi-year reserves and reinsurance. Strengthening India's crop insurance system will enhance agricultural resilience, benefiting over 20 million farmers annually and ensuring food security for rural communities.

***Keywords*:** Agriculture, Risk analysis, Uncertainty, Crop Insurance, Natural Calamities, PMFBY

SIX-P5

Crop Insurance Under Changing Climate

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Agriculture will not be an exception. A study conducted by the Indian Council of Agricultural Research (ICAR) under the National Innovations in Climate Resilient Agriculture project to analyse the impact of climate change found that: Rainfed rice yields may reduce marginally (<2.5%) by 2050 and 2080

Irrigated rice yields could decrease by 7% (2050) and 10% (2080). Wheat yield may reduce by 6-25% by 2100 Maize yields by 18-23% by 2100. Two ways that farmers can counter the effects of climate change on their incomes include utilizing technology for better weather management, involving stakeholders like weather information services, trained staff etc. and by buying crop insurance to safeguard their crops and income. Crop insurance can help farmers protect their crops from losses caused by adverse weather conditions and other risks. Protects farmers from adverse weather conditions like high or low temperatures, humidity, and excess or deficit rainfall. Launched in 2016 by the Indian government, this scheme compensates farmers for losses or damage to their crops. It also aims to: Support sustainable agriculture production, Stabilize farmers' income, Encourage farmers to adopt modern agricultural practices, Crop revenue coverage (CRC), Protects against yield losses and compensates for revenue shortfalls if crop prices drop. Restructured Weather Based Crop Insurance Scheme (RWBCIS) covers horticultural crops like fruits and vegetables. Some challenges with crop insurance schemes include: Delays in payments to farmers, Losss haring between the center and state governments, and Operational formalities. Path-breaking crop insurance solution Kshema Sukriti, a pioneering crop insurance solution helps farmers build a financial safety net. Starting from Rs 499 peracre, Sukritiisa customizable crop insurance solution that protects more than 100+ crops. Farmers can choose to insure their crops with a combination of perils – one major and one minor – from a pre determined list of nine perils. This flexibility ensures farmers choose the combination of perils that is most likely to affect their crop based on climate, region, location of their farm, historical pattern etc. The major perils covered are cyclone, inundation (not applicable for hydrophilic crops), flood, hailstorm while the minorperils include earthquake, landslide, fire due to lightning, animal attack (monkey,rabbit, wild boar, elephant) and damage due to aircraft. Crop insurance solutions not only secure financial interests of farmers but overtime they lead to higher investment and better practices in agriculture, leading to overall growth of the sector.

SIX-P6

Performance analysis of PMFBY as a Climate Risk Mitigation mechanism by farmers of Assam

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Agriculture is highly influenced by environmental and climatic factors such as rainfall (amount and number of rainy days), temperature, and soil nutrient status, which directly impact productivity and yield. In India, where two-thirds of the population depends on agriculture for their livelihood, managing these uncertainties is critical. Crop insurance in India has evolved over the years, with the Pradhan Mantri Fasal Bima Yojana (PMFBY) emerging as a significant milestone. Launched to improve upon its predecessors, PMFBY provides financial support to farmers in the event of crop failure, helping stabilize incomes, ensure credit flow, and encourage the adoption of modern agricultural practices. The scheme also links environmental parameters to agriculture by covering mid-season calamities such as floods and inundation, and crop failures caused by droughts and pest attacks. This study examines the role of PMFBY in supporting farmers affected by unforeseen climatic events. From 2018 to 2023, data reveals that during the Kharif season, the compound annual growth rate (CAGR) of enrolled farmers was 15.22%,with a 40.42% increase in the insured area and an 80.73% rise in the total number of farmers benefitted. For the Rabi season during the same period,

the CAGR for enrolled farmers was 19.32%, with a 17.53% increase in insured area, though the number of farmers benefitted declined by 39.07%. A SWOT analysis highlights PMFBY's strengths, such as providing financial security to farmers against crop losses, and its weaknesses, including delays in claim settlements. Opportunities include enhancing insurance penetration, while threats stem from limited awareness and operational inefficiencies. PMFBY demonstrates significant potential in mitigating agricultural risks, but addressing existing challenges is essential to ensure its long-term success.

***Keywords*:** PMFBY, Climate, Farmers, Risk Mitigation, Croploss

SIX-P7

Novel green approaches towards utilization and management of flower waste

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India, a religious nation with numerous temples across its states, generates a significant amount of floral waste due to the vibrant religious practices and occasions that attract powerful and heavenly vibrations from the surrounding environment. Every day, around half a million people visit temples, mosques, gurudwaras, and other places of worship, offering flowers as part of their rituals. It is estimated that 800 million tonnes of flowers are offered annually, with more than 8 million tonnes being discarded in rivers, along with toxic pesticides and insecticides used in their cultivation. Many places of worship in India produce about 20 tonnes of flower waste daily, and the degradation of floral waste is a much slower process compared to kitchen waste. Improper disposal of floral waste contributes to land and water pollution and increases greenhouse gas emissions. Sustainable floral waste management can reduce carbon footprints, improve soil quality, and minimize ecological harm. One of the most promising uses of floral waste is its transformation into nutrient-rich vermicompost, which serves as an excellent soil conditioner. Floral waste-derived dyes are widely used in the textile industry, providing a safer and natural alternative to synthetic dyes that often cause skin irritation. Additionally, the production of biodegradable packaging and vegan leather from flowers can significantly reduce plastic waste and animal leather, respectively. Biofuels and bioethanol obtained from floral waste offer a sustainable energy source, addressing the growing global energy crisis. These approaches not only solve the issue of floral waste disposal but also reduces water and environmental pollution and also holds economic potential by creating new revenue streams for temples, religious institutions, and communities. By adopting these novel green approaches, floral waste can be transformed into valuable resources, promoting sustainability and self-sufficiency. Further research and awareness among stakeholders are essential to enhance the scalability of these initiatives, ensuring a cleaner, greener future.

***Keywords*:** flower waste, disposal, utilization, fleather, flora-foam, Biosorption

SIX-P8

Women Responsive Climate Smart Agriculture (CSA): Need of the hour

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Climate change is a burning issue in today's world marked by various factors such as rising global temperature, increasing extreme weather events and declining agricultural productivity. Agriculture is the key sector of India forming the basic source of livelihoods for rural people. Climate change has significant impact on farming community particularly on farm women. Women constitute a sizable portion of agricultural workforce by actively participating in activities like sowing, weeding, harvesting and post- harvest activities. Due to feminisation, the roles of women farmer in agricultural sector have profoundly increased. Even after their significant contribution in agriculture, they face a lot of challenges due climate vulnerability as well as socio-economic factors and limited access to resources. Indian agriculture faces severe consequences of climate change leading to loss of production as well as productivity in the sector. This in turn affects the food security. Women who are responsible for maintaining household food security and nutrition have to go through several hurdles to meet their family's food and nutritional requirement. Additionally, indigenous seed preservation which is also one of the activities primarily handled by women is hampered as the seeds loses their viability due to rapidly changing weather. Climate change leads to increased work load for women as they have to perform dual responsibility of managing farm activities and also the household chores. During period of drought, women travel long distance to manage and fetch water investing their productive and valuable time which leads to increased physical burden and tiredness. Moreover, due to socio-economic constraints women lack credit accessibility which restrict them to invest on climate resilient practices and technologies. Besides, several health risks are also associated to climate change that disproportionately affects women farmer. While working in the field exposure to extreme heat increases their vulnerability to heat stress and dehydration. Adoption of climate smart agricultural practices by farm women such as using climate resilient crop variety, mixed cropping and agroforestry can help them to mitigate changing climate. Technologies such as women friendly farm machineries can help to reduce their work burden and increase productivity. They can also opt for water resource management strategies such as rainwater harvesting, micro irrigation, farm ponds etc. to fulfil their water needs during water stress period. ICT can help farm women to know about the upcoming weather information and also to keep a tract of market trend and information. Community groups such as SHG and other women led cooperatives can serve as essential source of knowledge and information for farm women that will promote financial inclusivity and collective action. Extension education can play a vital role to bridge the gap between women and climate change. Women can be encouraged to actively participate in climate adaptation initiatives through training programs on value addition, sustainable agriculture, and market connections. Women responsive programmes and policies can be incorporated that will empower women as a key stakeholder. Thus, we can drive sustainable agricultural development, ensuring food security, economic stability, and equitable solutions to mitigate the effects of climate change on agriculture.

Keywords: women, agriculture, climate change, sustainable agriculture, extension education

SIX-P9

Water Heritage and Innovation : India's Traditional Systems in Modern Context

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India's rich water heritage reflects advanced hydraulic engineering and sustainable practices that continue to offer valuable insights into addressing modern water challenges. From the Indus Valley Civilization to medieval India, traditional water systems like stepwells, tanks, and canals were decentralized, community-driven, and resilient to diverse climatic conditions. These systems hold significant relevance today, particularly in the face of climate change and urban water scarcity. The Indus Valley Civilization (c. 3300–1300 BCE) exemplified sophisticated water management techniques. Cities like Mohenjo-Daro and Dholavira used reservoirs, wells, and soak pits to ensure water availability in arid regions. The civilization harnessed tidal rivers and constructed irrigation canals to support agriculture, while structures like the Great Bath demonstrated advanced hydraulic engineering. These systems not only met the needs of the time but also balanced resource use with environmental sustainability. During the Mauryan era, Sudarsana Lake, located near Junagadh in Gujarat, highlighted early innovations in large-scale water management. Built under Chandragupta Maurya and expanded by Ashoka, the lake served as a vital resource for irrigation and drinking water. Its subsequent restoration by Shaka king Rudradaman I, recorded in the Junagadh inscription, emphasizes the importance of sustainable hydraulic infrastructure in ancient India. Rainwater harvesting was another hallmark of ancient water management. Buddhist monastic sites in western India, such as Ajanta, Ellora, and Karle, featured rock-cut cisterns and channels to collect and store rainwater, ensuring a steady supply even during dry seasons. Similarly, excavations at Mathura revealed ancient tanks designed to store and filter water, reflecting an advanced understanding of ecological needs and water conservation. In medieval India, irrigation systems saw significant advancements, including gravity-fed canals, improved surveying techniques, and the introduction of sluice gates. Systems like the Nahr-i-Bahisht and the Western Yamuna Canal enhanced agricultural productivity, facilitated urban water supply, and bolstered food security. These innovations enabled multiple cropping cycles and supported both rural and urban economies. Regional systems like Rajasthan's stepwells and Tamil Nadu's interconnected tank systems further demonstrate India's expertise in sustainable water management. Stepwells provided groundwater in arid regions, while tank systems regulated flood waters and replenished aquifers. Restoration efforts in places like Jodhpur and Chennai have successfully revived these traditional systems, proving their efficacy in addressing modernwater issues such as urban flooding and scarcity. This critical review reveals the sustainability of India's decentralized, community-driven practices. Unlike centralized modern systems that often require significant capital investment and risk resource over-extraction, traditional methods were adaptive to local conditions and prioritized long-term ecological balance. By integrating these historical approaches with contemporary water management technologies, sustainable and equitable solutions can be achieved.

***Keywords*:** Indus Valley Civilization, Dholavira, Sudarsana Lake, Ajanta, Ellora, Karle, Mathura, Nahr-i-Bahisht, Stepwells, Tank Systems

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- Village Resource Mapping
- Hazard Risk and Vulnerability Assessment

Water Resources
- Flood Early Warning System
- River Atlases & Watershed Management Plan

IT and Geoinformatics
- North Eastern Spatial Data Repository (NeSDR)
- Project Monitoring System/Election E-Atlas

UAV Remote Sensing
- State-of-the-Art UAV facility & High Resolution Mapping
- Disaster Management Support

Atmospheric Sciences
- Aerosol Radiative Forcing and Boundary Layer Studies
- Short and Medium Range Weather Prediction

Satellite Communication
- Tele-Education and Tele-Medicine & Emergency Communications

North Eastern Regional node for Disaster Risk Reduction
- FLEWS, LEWS, Forest fire, Earthquake Precursor Studies
- Thunderstorm and Lightning Early Warning
- Dashboard and Mobile Apps. for DMS

Capacity Building
- Training programs for user departments and academia from national and international participants in the field of RS &GIS applications, Atmospheric sciences, UAV and Satellite Communications.

For details please contact:
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Government of India, Department of Space
Umiam 793 103, Meghalaya, INDIA
Tel: 0364-2570141/140; Fax:0364-2570139/2570043
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REGIONAL METEOROLOGICAL CENTRE

INDIA METEOROLOGICAL DEPARTMENT

Guwahati, Assam

CSIR-North East Institute of Science and Technology

Jorhat, Assam

A constituent multidisciplinary research laboratory under CSIR, dedicating for Industrial development and societal upliftment of NER India by nurturing basic and applied research for developing technologies with sustainabledevelopment goals to improvequality of life in the region.

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- M/s Kudos Laboratories, New Delhi
- M/s Acinom Aromatics Pvt.Ltd, Guwahati
- M/s Mphinite Solutions Pvt.Ltd, Bangalore
- Sigma Aldrich Co., LLC, USA
- Eco Friendly Foundation, Gultekadi, Pune
- Oil India Limited, Duliajan, Assam
- Numaligarh Refinery Ltd, Golaghat, Assam
- Assam Petrochemical Limited, Namrup, Assam
- Arunachal Pradesh State Council for S & T

More than 70 ongoing research projects

CSIR-Aroma Mission, CSIR-Floriculture Mission, Millets Mission, Agro-mission, API Mission, CSIR-Safe and Sustainable Climate Resilient Building for India etc.

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- High Resolution Mass Spectrometer (HRMS)
- Thermal Analyser for DTA,TGA & DSC
- Atomic Emission Spectrophotometer (ICP-AES)
- High Resolution Transmission Electron Microscope
- Scanning Electron Microscope
- Isotope Ratio Mass Spectrometer (IRMS)
- Nuclear Magnetic Resonance (NMR)

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- Skill Development under CSIR Interagted Skill Facilities
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- CSIR-Jigyasa: Student-Scientists Connect Programme

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