Abstract Book for

International Agriculture Conference

AGRINEXT:

FUTURE TRENDS IN AGRICULTURE

(ICANFTA- 2025)

Organised by:

Dept. of Agriculture,
Brainware University, Kolkata
in collaboration with
Just Agriculture Education Group &
ISAHRD, Chandigarh
held on 10-12 February, 2025
at Brainware University, Kolkata

Editors:

Dr. Sushila Hooda
Dr. D. P. S. Badwal
Dr. Mohit Bharadwaj
Dr. Piyush Choudhary

JUST AGRICULTURE PUBLICATIONS

Abstract Book for

9th INTERNATIONAL CONFERENCE

AGRI-NEXT
FUTURE TRENDS IN AGRICULTURE
(ICANFTA- 2025)

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on

10th-12th February, 2025

at

Brainware University, Kolkata

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Preface

It is with great pleasure and enthusiasm that we present the proceedings of the International Conference on *Agri-Next: Future Trends in Agriculture (ICANFTA-2025)*, a platform dedicated to fostering innovation, sustainability, and advancements in the field of agriculture. This conference, organized by the Department of Agriculture, Brainware University, in collaboration with Just Agriculture Education Group and ISAHRD, Chandigarh, brings together distinguished researchers, academicians, policymakers, and industry leaders to address the evolving challenges and opportunities in agriculture.

The agricultural sector is undergoing a transformative phase with the integration of cutting-edge technologies such as precision farming, artificial intelligence, and sustainable agro-practices. As we navigate the challenges posed by climate change, resource depletion, and global food security, this conference serves as a forum for knowledge exchange and the development of strategic solutions that align with the future of farming. The discussions and research shared here will significantly contribute to shaping policies, enhancing productivity, and ensuring sustainability in agriculture.

We extend our heartfelt gratitude to all the contributors, keynote speakers, session chairs, and participants whose dedication and insightful contributions have enriched this event. Our sincere appreciation goes to the organizing committee, volunteers, and our esteemed collaborators for their relentless efforts in making ICANFTA-2025 a grand success.

We hope that the discussions and findings presented in this conference will inspire new ideas, collaborative efforts, and impactful innovations that propel the agricultural sector towards a more resilient and sustainable future.

Sourav Roy

Dr. Sourav Roy
Joint Organising Secretary, ICANFTA-2025

Soham Hazra

Dr. Soham Hazra
Organising Secretary, ICANFTA-2025

सत्यमेव जयते

डॉ. हिमांशु पाठक
DR. HIMANSHU PATHAK
सचिव (डेयर) एवं महानिदेशक (आईसीएआर)
Secretary (DARE) &
Director General (ICAR)

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली–110 001

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
Krishi Bhavan, New Delhi 110 001
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MESSAGE

I am happy to know that the Department of Agriculture, Brainware University, Barasat, West Bengal is organizing the International Conference on **"AgriNext: Future Trends in Agriculture"** during February 10-12,2025.Agriculture stands at the crossroads of transformation, where innovation, sustainability, and emerging technologies are redefining the way we produce, process, and market agricultural products. This conference, with its diverse theme areas encompassing sustainability, modern tools, biotechnology, agricultural marketing, agri-tourism, and other recent advancements, presents a crucial platform for knowledge exchange and collaboration among researchers, policymakers, industry experts, and students.

I hope the discussions and deliberations at this conference will significantly contribute to shaping a resilient, productive and technology-driven agricultural sector for the future. I urge all participants to engage actively, share their insights, and explore innovative solutions that address global challenges in agriculture. I congratulate Brainware University for organizing this important event

I wish the conference a grand success

.

(Himanshu Pathak)

Dated the 10th February, 2025
New Delhi

Bidhan Chandra Krishi Viswavidyalaya

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Dr. Ashok K. Patra, Ph.D (IARI)
FNASc, FNAAS, FAScT, FISSS, FRMSI
Vice Chancellor

No. VC/BCKV/ 114/289
Dated: 07.02.2025

MESSAGE

I am happy to know that the Department of Agriculture, Brainware University, Barasat, West Bengal is organizing an International Conference on **"AgriNext:Future Trends in Agriculture"** from 10th to 12th February, 2025. The theme of the Conference is very much relevant in the present context of the challenges put before the human civilization due to the changes in global climatic conditions.

Agriculture stands at a pivotal moment of transformation, where innovation, sustainability, and emerging technologies are reshaping how we produce, process, and market agricultural products. This conference serves as a vital platform for researchers, policymakers, industry experts, and students to exchange knowledge, collaborate, and explore groundbreaking solutions in key areas such as sustainability, modern agricultural tools, biotechnology, agri-tourism, and market dynamics. The discussions and deliberations at this event will play a crucial role in shaping a resilient, technology-driven, and highly productive agricultural sector. I encourage all participants to actively engage, share their insights, and contribute to innovative strategies that address global agricultural challenges.

I heartily welcome all the delegates and dignitaries and wish the International Conference a great success with the active participation and contribution made by the intellectuals, faculties, young scholars and professionals from across India and other countries.

(Ashok K Patra)

বিশ্বভারতী
विश्वभारती
Visva-Bharati

आचार्य:श्री नरेंद्र मोदी
ACHARYA (CHANCELLOR)
SHRI NARENDRA MODI

संस्थापक: रवीन्द्रनाथ ठाकुर
Founder: Rabindranath Tagore

उपाचार्य(स्थानापन्न): प्रोफेसर बिनय कुमार सरेन
UPACHARYA (VICE-CHANCELLOR) (Offg.)
PROF. BINOY KUMAR SAREN

MESSAGE

I am delighted to extend my warmest greetings to all participants of the International Conference on **"AgriNext: Future Trends in Agriculture"**, organized by the Department of Agriculture, Brainware University, Barasat, West Bengal, from **10th to 12th February 2025**.

Agriculture is the foundation of our civilization and economy, and today, it stands at a pivotal juncture where **innovation, sustainability, and emerging technologies** are reshaping its future. This conference, with its diverse themes covering sustainability, modern tools, biotechnology, agricultural marketing, agri-tourism, and other recent advancements, provides an excellent platform for meaningful discussions and collaborative efforts among **academicians, researchers, policymakers, and industry experts.**

At **Visva-Bharati**, founded on the visionary ideals of Gurudev Rabindranath Tagore, we have always emphasized the integration of knowledge with rural development and sustainable agricultural practices. I am confident that this conference will foster innovative ideas, inspire young minds, and contribute significantly to the evolution of a **resilient, inclusive, and technology-driven agricultural sector**.

I congratulate **Brainware University** for organizing this important event and extend my best wishes for its success. May this conference lead to fruitful discussions and lasting collaborations that help shape the future of agriculture for the benefit of society and the environment.

Best wishes for a successful and enriching conference!

Binoy Kumar Saren
(B. K. Saren)

উত্তরবঙ্গ কৃষি বিশ্ববিদ্যালয়

পুণ্ডিবাড়ী, কোচবিহার , পশ্চিমবঙ্গ-৭৩৬১৬৫

UTTAR BANGA KRISHI VISWAVIDYALAYA

P.O. PUNDIBARI, DIST. COOCH BEHAR, WEST BENGAL- 736165

প্রফেসর দেবব্রত বসু
উপাচার্য
Prof. Debabrata Basu
M.Sc. (Ag.), Ph.D., DDE
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Ref. No.: VC/UBKV- 4055

Date: 06 February 2025

Message

It is with great enthusiasm that I extend my best wishes to the organizers, participants, and distinguished guests of the International Conference on "AgriNext: Future Trends in Agriculture", hosted by the Department of Agriculture, Brainware University, Barasat.

Agriculture, the backbone of our civilization, is undergoing a profound transformation driven by innovation, sustainability, and cutting-edge technologies. This conference serves as a vital platform for intellectual exchange, fostering collaborations among academicians, researchers, policymakers, and industry experts to shape the future of global agriculture.

As we navigate the challenges of food security, climate resilience, and sustainable farming practices, such discussions become imperative. The diverse themes of this conference—from modern agricultural tools and biotechnology to agri-tourism and marketing—will undoubtedly inspire new ideas and solutions for a more resilient and productive agricultural ecosystem.

I am confident that this gathering will pave the way for groundbreaking insights and partnerships that will benefit farmers, stakeholders, and the agricultural sector at large. I extend my heartfelt congratulations to the organizers and wish the conference great success in achieving its objectives.

With best regards,

D Basu 6/2/25

Vice-Chancellor

Uttar Banga Krishi Viswavidyalaya

Dr Dharani Dhar Patra PhD (IARI, New Delhi) FNASc, FNAAS, FAScT, FISSS
Former Vice Chancellor, BCKV, Mohanpur, WB, India
Former Professor, AcSIR & Chief Scientist, CSIR-CIMAP, Lucknow, India
Commonwealth Fellow (Rothamsted,UK; Aberdeen University, UK)
Visiting Scientist (HNAES Hokkaido, Tokyo University, Japan; Reading University, UK)
Former President (Agriculture & Forestry), Indian Science Congress Association, Kolkata:2009-10

Message

It gives me immense pleasure to know that the Department of Agriculture, Brainware University, Barasat is organizing an International Conference on **"AgriNext: Future Trends in Agriculture"**, from **10th to 12th February, 2025**.The topic of the Conference has a great significant in the present context when population is increasing, cultivable area is degrading and decreasing, water scarcity is looming and above all, climate change is warning. Climate change has added to the enormity of India's food security challenges. India has achieved food sufficiency but a significant number of people in the country are still mal- and under-nourished. The global agrifood system must, therefore, deliver on multiple fronts. There is an absolute necessity to develop a redefined sustainable innovative climate-resilient agriculture. It is highly interesting that the conference will have deliberation on an array of modern technologies including AI, ML, biotechnology etc

I am confident that the deliberations of the conference will significantly contribute in developing a technology-driven agriculture for the times to come. The participants, particularly the budding scientists and students will definitely engage themselves in exchange of problem-solving ideas and enrich their scientific acumen.

I express my heartiest congratulations to Brainwave University, Barasat, Kolkata and the Department of Agriculture in particular, for organizing such a great conference, and wish it a great success.

Shatiniketan
07th February, 2025

(DD Patra)

DR. GOURANGA KAR
Director, ICAR-CRIJAF

भाकृअनुप
ICAR

केपसरेअसं
CRIJAF

10 February 2025

MESSAGE

Greetings!

The International Conference 'AgriNext: Future Trends in Agriculture' serves as a vital platform for visionary scientists and academician to converge and catalyse transformative change in the realm of agriculture. It envisions a future where cutting-edge technology seamlessly intertwines with ecological wisdom, birthing sustainable agricultural practices that nurture both the planet and its people. This conference aims to ignite a paradigm shift, inspiring innovative solutions and forward-thinking strategies that revolutionize the way we cultivate our land and nourish our communities. By bringing together brilliant minds from diverse fields - from agriculturists and environmentalists to tech innovators and policymakers - AgriNext fosters a dynamic exchange of ideas, sparking collaborations that transcend boundaries. The event delves into critical issues such as deforestation, soil erosion, water scarcity, and the implications for agricultural productivity in the face of climate change. Innovative approaches in scientific and sustainable forest management, modern crop production technologies, precision agriculture, and organic farming take centre stage.

I am happy that Brainware University is organizing this International Conference during 10-12 February, 2025. This Conference may serve as a platform to recognize the scientific contributions, exchange knowledge, and chart a course for future innovation. Let us commit ourselves to harnessing the full potential of science and technology to empower our agricultural sector, ensuring prosperity for farmers and sustainability for future generations. Together, we can make India a leader in agricultural innovation and a model for the nation.

Thank you, and I look forward to the meaningful discussions and ideas that will emerge from this international conference. I convey my best wishes to organize the conference successfully.

Gouranga Kar

भाकृअनुप -कृिष तकनीकी अनुप्रयोग सस्थान कोलकाता
ICAR-Agricultural Technology Application Research Institute Kolkata
भारतीय किष अनुसधान परिषद INDIAN COUNCIL OF AGRICULTURAL RESEARCH
सॉल्ट लेक, कोलकाता - 700 097 Salt Lake, Kolkata–700 097
Website: www.atarikolkata.org

डॉ. प्रदीप डे / Dr. Pradip Dey
निदेशक / Director

MESSAGE

A resounding applause to Brainware University, Barasat, for its visionary initiative in hosting the International Conference on *AgriNext: Future Trends in Agriculture* from February 10-12, 2025. This prestigious gathering of academicians, researchers, policymakers, and industry leaders is not just an exchange of ideas—it is a collective step toward redefining the future of agriculture in an era of unprecedented challenges and opportunities.

Agriculture, the bedrock of civilization, stands at a crossroads where the convergence of science, technology, and sustainability holds the key to feeding a growing global population. This conference, with its focus on smart farming, sustainable crop production, climate-resilient agriculture, and the integration of AI, IoT, and biotechnology, is a timely intervention. It is a call to action—to embrace innovation, rethink conventional practices, and harness cutting-edge solutions that ensure both productivity and environmental stewardship.

Brainware University's commitment to creating a platform for meaningful discourse and collaboration is truly commendable. By bringing together brilliant minds from across the world, this conference will ignite new research directions, forge transformative partnerships, and inspire actionable strategies that can shape a more resilient, efficient, and food-secure world.

As agriculture continues to evolve, the significance of such initiatives cannot be overstated. May this conference spark groundbreaking ideas, fuel progressive policies, and pave the way for a future where agriculture thrives in harmony with nature and technology.

May the impact of *AgriNext* resonate widely, sparking a wave of innovation and sustainability that shapes a technologically empowered and sustainable agricultural landscape, enriching both our fields and communities !

(Pradip Dey)

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भाकृअनुप-राष्ट्रीय मृदा सर्वेक्षण एबं भूमि उपयोग नियोजन ब्यूरो
ICAR-National Bureau of Soil Survey & Land Use Planning
कृषि सहयोग एबं किसान कल्याण मंत्रालय, भारत सरकार
Ministry of Agriculture and Farmers Welfare, Govt. of India
क्षेत्रीय केंद्र, कोलकाता, सेक्टर- II, साल्ट लेक, कोलकाता - 700091, पश्चिम बंगाल। भारत
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डॉ. एफ. एच. रहमान
क्षेत्रीय प्रमुख

Dr. F. H. Rahman
Regional Head

No. NBSS&LUP/Kol/Gen/169
Date: 08.02.2025

MESSAGE

It is with great pleasure and pride that I extend my best wishes to Brainware University, Barasat for its insightful anchoring the International Conference on *AgriNext: Future Trends in Agriculture* during 10-12 February, 2025. This gathering of brilliant minds, dedicated researchers, innovative thinkers, and passionate practitioners marks a significant step forward in shaping the future of agriculture.

As we stand at the crossroads of rapid technological advancements, climate challenges, and evolving food security demands, this conference provides a vital platform to exchange ideas, share pioneering research, and foster collaborations that will drive sustainable agricultural practices worldwide. The theme of *"Future Trends in Agriculture"* is not just timely but essential, as we explore cutting-edge solutions to ensure resilient, productive, and environmentally friendly agricultural systems.

I encourage all participants to engage actively in the sessions, discussions, and networking opportunities. Your insights, experiences, and contributions will be instrumental in shaping innovative strategies that address the global agricultural challenges of today and tomorrow.

Let us use this occasion to inspire one another, spark new ideas, and build partnerships that will pave the way for a more sustainable and food-secure future.

Wishing you all a successful, thought-provoking, and enriching conference.

Warm regards,

(F. H. Rahman)

Email: hd_rck.nbsslup@icar.gov.in , head.nbsscal@gmail.com, Feroze.Rahman@icar.gov.in, fhrahmancal@gmail.com

10-02-2025

Mr. Phalguni Mukhopadhayay
Chancellor, Brainware University

Foreword

It is with great pride and pleasure that I extend my warm congratulations to all who participated in the International Conference on "Agri-Next: Future Trends in Agriculture," held from February 10th to 12th, 2025. This landmark event, organised by the Department of Agriculture, brought together an impressive assembly of esteemed dignitaries, distinguished scientists, professors, alongside industry leaders and participants representing over ten nations.

The conference has served as a vibrant platform for sharing innovative ideas, addressing emerging challenges, and charting new directions in agriculture. I believe that the insights and innovations presented in this book of abstracts will not only enrich our understanding of future trends in agriculture but also pave the way for transformative developments that will benefit communities worldwide.

I extend my sincere gratitude to the organisers, participants, and esteemed guests who contributed to the success of Agri-Next 2025. Together, we shall continue to drive progress and innovation in agriculture, shaping a sustainable and prosperous future for all.

Warm regards,

Phalguni Mookhopadhayay
Chancellor, Brainware University

Prof. (Dr.) Sankar Gangopadhyay
Vice-Chancellor, Brainware University

Message from the desk of the Vice Chancellor

It is my immense pleasure to welcome the honourable speakers, esteemed guests, researchers, teachers, industry professionals, students and other participants in "AGRI-NEXT: Future Trends in Agriculture," organized by the Department of Agriculture, Brainware University, in collaboration with Just Agriculture Education Group & ISAHRD. I also take this opportunity to congratulate the organizers of this conference.

I am confident that this conference will provide the ideal platform for constructive interaction among the participants resulting in novel contribution to the literature in the field of agriculture.

I am also of firm belief that hosting of such conference with larger frequency will pave the way for more enrichment in this area of huge contemporary interest.

I look forward to the grand success of this conference.

Sankar Gangopadhyay

Prof. (Dr.) Sankar Gangopadhyay

Vice-Chancellor

Brainware University

10-02-2025

Ms. Mahua Pal
Registrar, Brainware University

Forwarding message from The Registrar

It is with immense pleasure that I extend my warm greetings to all the participants, researchers, and esteemed guests attending the International Conference, "AGRI NEXT: Future trends in Agriculture", organized by the Department of Agriculture, Brainware University in collaboration with Just Agriculture Education Group & ISAHRD.

This prestigious event serves as a significant platform for knowledge exchange, innovation, and collaboration in the fields of agriculture.

Brainware University remains committed to fostering scientific research and academic excellence. The advancements and discussions taking place in this conference will undoubtedly contribute to the progress of agriculture and its applications for societal benefit.

I encourage all participants to engage actively in the sessions and utilize this opportunity to network and share ideas with experts and peers.

I extend my best wishes to the organizing committee and all contributors for the successful conduct of AGRI NEXT. May this conference serve as a beacon of inspiration and a stepping stone toward future innovations.

Yours faithfully,

Mahua Pal
Registrar, Brainware University

MESSAGE FROM CONFERENCE DIRECTOR

The development and adoption of innovative technologies have been instrumental in improving the lives of millions of farmers across the country by increasing their income, reducing their costs, and minimizing losses. As agriculture continues to evolve, the role of innovation will become even more critical in enhancing sustainability, resilience, and competitiveness in the sector. Keeping these facts in mind 9th International Conference on "Agri-Next Future Trends in Agriculture" (ICANFTA- 2025) was planned by Just Agriculture Education Group & ISAHRD, Chandigarh in collaboration with Dept. of Agriculture, Brainware University, Kolkata during 10th-12th February, 2025.

The conference was a great platform for professionals and experts from different industries to come together, exchange ideas, and explore new opportunities. The keynote speakers and panelists provided valuable insights on a range of topics, from the latest developments in technology and innovation to the challenges facing businesses in a rapidly changing world. The success of this conference would not have been possible without the hard work and dedication of our organizing committee and volunteers. We are grateful for their support and contributions towards making this event such a huge success. Thank you to all the attendees for making this a memorable and enriching experience. We look forward to seeing you again at our future events, where we will continue to bring together the best minds in the industry and create valuable opportunities for learning and growth.

Dr. DPS Badwal
Founder & CEO,
Just Agriculture Education Group

MESSAGE FROM SOCIETY PRESIDENT

It gives me immense pleasure to share that ISAHRD, Chandigarh and Just Agriculture Education Group in collaboration with Brainware University, Kolkata have successfully organized the 9^{th} International Conference on "Agri-Next Future Trends in Agriculture" (ICANFTA- 2025) at Brainware University, Kolkata during 10^{th}-12^{th} February, 2025 in a hybrid mode. I believe that this conference has played an important role in bringing together experts, researchers and practitioners from across the world to exchange ideas, share their experiences and contribute towards the development of the agriculture sector. We have witnessed several innovative approaches, emerging technologies and sustainable practices that have the potential to revolutionize the agriculture sector and create a positive impact on our environment and economy.

The conference has also highlighted the significance of collaboration among different stakeholders including government, academia, industry and farmers. Through constructive discussions, we have identified the key challenges faced by the agriculture sector and the possible solutions to address them. In conclusion, I would like to congratulate the organizing team for the successful organization of the 9^{th} International Conference (ICANFTA- 2025). We look forward to the next edition of this conference and hope to witness more innovative ideas and practices in the field of agriculture. Thank you all for your participation and support.

Dr. Sushila Hooda
President,
ISAHRD, Chandigarh

MESSAGE FROM ORGANIZING SECRETARY

I am very glad that Just Agriculture Education Group and ISAHRD, Chandigarh in collaboration with Dept. of Agriculture, Brainware University, Kolkata has successfully organized two days 9th International Conference on "Agri-Next Future Trends in Agriculture (ICANFTA- 2025)" at Brainware University, Kolkata during 10th-12th February, 2025 in a hybrid mode. The efforts made by the organizing committee are truly commendable, and I congratulate all of them on the successful organization of this conference. I am confident that the deliberations held during the conference would pave the way for future growth and prosperity of the agriculture sector.

I would like to extend my sincere gratitude to the organizers and all the stakeholders who had contributed to making this conference a grand success. I hope that the knowledge and insights gained from the conference would empower all of us to contribute more effectively towards the development of sustainable agriculture practices that are environmentally friendly and socially responsible. I once again express my heartfelt appreciation to all the stakeholders who had participated in the conference, and I look forward to seeing the outcomes and recommendations of the conference being put into practice.

Dr. Mohit Bharadwaj

Chief Editor,
Just Agriculture- the Magazine

MESSAGE FROM CHIEF ORGANIZING SECRETARY

I am delighted to announce that Just Agriculture Education Group and ISAHRD, Chandigarh in collaboration with Dept. of Agriculture, Brainware University, Kolkata has successfully organized two days 8th International Conference on "Agri-Next Future Trends in Agriculture" (ICANFTA- 2025) at Brainware University, Kolkata during 10th-12th February, 2025. The conference witnessed an impressive gathering of delegates, researchers and practitioners from across the globe, actively engaging in diverse discussion and presentations aligned with the conference theme. The keynote speakers delivered outstanding and thought-provoking speeches, inspiring attendees and sparking new ideas. The presentations were both informative and engaging, fostering lively discussions and constructive debates. Delegates had valuable networking opportunities, forging connections with colleagues from diverse geographical backgrounds, exchanging innovative ideas and exploring potential avenues for collaboration.

The organizing committee deserves tremendous praise for orchestrating a flawlessly organized and impactful event. Their exemplary efforts in planning, coordinating, and executing the conference ensured seamless operations from start to finish. In conclusion, the conference achieved remarkable success, leaving us eagerly anticipating the next edition in the future. We extend our heartfelt gratitude to all those who contributed to making this event possible and for their unwavering dedication and enthusiasm, ensuring a resounding triumph.

Piyush

Dr. Piyush Chaudhary
Vice-President (Branding & Marketing)
Just Agriculture Education Group

Message from the Desk of the Convenor

It is with great pleasure and enthusiasm that we present the proceedings of the International Conference on *Agri-Next: Future Trends in Agriculture (ICANFTA-2025)*, a platform dedicated to fostering innovation, sustainability, and advancements in the field of agriculture. This conference, organized by the Department of Agriculture, Brainware University, in collaboration with Just Agriculture Education Group and ISAHRD, Chandigarh, brings together distinguished researchers, academicians, policymakers, and industry leaders to address the evolving challenges and opportunities in agriculture.

The agricultural sector is undergoing a transformative phase with the integration of cutting-edge technologies such as precision farming, artificial intelligence, and sustainable agro-practices. As we navigate the challenges posed by climate change, resource depletion, and global food security, this conference serves as a forum for knowledge exchange and the development of strategic solutions that align with the future of farming. The discussions and research shared here will significantly contribute to shaping policies, enhancing productivity, and ensuring sustainability in agriculture.

We extend our heartfelt gratitude to all the contributors, keynote speakers, session chairs, and participants whose dedication and insightful contributions have enriched this event. Our sincere appreciation goes to the organizing committee, volunteers, and our esteemed collaborators for their relentless efforts in making ICANFTA-2025 a grand success.

We hope that the discussions and findings presented in this conference will inspire new ideas, collaborative efforts, and impactful innovations that propel the agricultural sector towards a more resilient and sustainable future.

Prof (Dr) Prasanta Kumar Patra
Convenor, ICANFTA-2025

Soham Bachaspati

Mr. Soham Bachaspati
Co- convenor, ICANFTA-2025

Parijat De

Dr. Parijat De
Co- convenor, ICANFTA-2025

Pabitra Kumar Ghosh

Dr. Pabitra Kumar Ghosh
Co- convenor, ICANFTA-2025

BOOK OF ABSTRACTS

9th INTERNATIONAL CONFERENCE
on

AGRI-NEXT
FUTURE TRENDS IN AGRICULTURE

(ICANFTA-2025)

10th – 12th February, 2025

TABLE OF CONTENT

Potential Non-Timber Forest Products (NTFPs) under Agroforestry Systems in the Western Ghats of Karnataka

Girish Shahapurmath[1], Hanumantha, M[2] and Akshaya Madiwalar[3]

[1,2,3] College of Forestry, UASD, Uttara Kannada (Karnataka), INDIA

Introduction

India has diverse forest resources. The forests of the country include around 20.55% of the land area. A major part of the natural forest area in the state of Karnataka is in the Western Ghats region. More than 80% of the total collection of NTFPs of state comes from this region. Western Ghats area in Karnataka comprises 21,756 sq. kms, which is one of the 18 biodiversity hot spots of the world. The Western Ghats together with the west coast, forms an important ecological region, springing from the Arabian sea coast to the mountain heights of over 2000m. The landscape here are very heterogeneous.

The forests of the region provide wood, the timber of commerce; firewood apart from group of produces known as Minor Produces (MFP) or Non-Wood Forest Produces. Since the wood being considered as major forest produce, the produces of forest other than wood being considered as Minor Forest Produces or Non Wood Forest Produces (NWFPs).

Non Timber Forest Products (NTFPs) are the most sustainable source of revenue in lieu of the present scenario of restricted harvesting or no harvesting of trees, apart from Eco-tourism. Over 50% of the forest revenue and 70% of income from exports come from NTFPs and they provide 50% of income for 20-30% of the rural and tribal people in India (Theagarajan, K.S., 1994). In India, more than 30 million people are employed in NTEP sector (Masih et al., 2001). A large number of NTFPs are still handled by the forest contractors and only few NTFPs are nationalized. Despite acquiring a certain degree of marketing skills, the primary collectors have remained the lowest rung of NTFPs marketing either working as labourer on daily wages or being underpaid collectors. On gross return basis, the collector's share, on an average, in consumer's price has been estimated to be Rs. 32% to incase of dhup and kuru in Himachal Pradesh (Negi and Pankaj, 2002). The main reason being the market inefficiency crated due to lack of market information. Since the NTFPs are often sold in informal primary tribal weekly markets, information about prices, product flow, demand and supply pattern is less known (Masih *et al*., 2001).

The forests of Uttara Kannada district are abundant with so many Non-Timber Forest Products such as *Sapindus laurifolia* (Antawala / Soapnut), *Vateria indica* (Dhoop), *Garcinia indica*

(Murugalu), *Garcinia gummigatta* (Uppage), *Artocarpus lakoocha* (Vate), *Mangifera indica* (Mango), *Anacardium occidentale* (Cashewnut), etc. These NTFP trees are naturally grown in the betta lands and not planted by land holders, whereas cashewnut and mango trees are planted by betta holders and the yield from these trees is used only for house hold purposes.

The Non Wood Forest Produces have a vital role to play in the socio economic development of different communities in rural areas of our country. Many people who live in the Forests and near by forests collect, process and market many of the Non Wood Forest Produces. These produces provide full or part time employment opportunities to large number of rural folk and supplement their income to a large extent. Some of the minor forest produces are collected, harvested and utilized locally and few others are exported to the neighboring states and even to other countries. These are essential for the livelihood and well-being of rural communities. These produces narrow the gap between the people and forests.

Now this concept of wood as major forest produces, needs a revision or change as the felling of green in the forest trees being stopped, the quantity/extent of timber extracted from the forests has decreased. The collection and harvesting of minor forest produces in the forests is not affected to the same extent as that of wood. These produces play a major role in meeting the requirements of society apart from earning revenue to the government and employment generation to the communities as both inside and around the forests.

The topography and climate of the tracts

The type of NWFPS available in the forests depends upon forest types. This area covers many hills and hillocks with altitudes ranging from 250-1200 m. The average rainfall varies from 1500-4000 mm per year. The natural forest types of these tracts include evergreen, semi-evergreen, and moist deciduous forests. The major crops grown by the farmers include rice, areca, coconut, coffee, and other subsidiary crops like pepper, cardamom, ginger, cocoa, turmeric, vegetables, and home remedial plants to some extent. The types of NTFPs and the plants that produce them have been listed in Table 1.

The present system of procurement and harvesting of the producers

People and forests are interrelated. Forests are a source of many utilities and services like environmental pollution, soil erosion, and water conservation. Forests also generate employment for many people as full-time work and part-time work to utilize their leisure time to increase the meager income of the rural people.

The produces are disposed by open auction per Unit area of forest which is clearly described in the Tender Notification. The person who offers highest price usually have the right to collect or harvest NWFP of that area for a prescribed period which is ordinarily for two years on contract. The contractors engage their persons to collect/harvest the produces generally under the supervision of Forest officials. After collection the produces require transit permits for the transporting them to markets. Though this is the procedure prescribed by the government, many of the produces are extracted/ harvested without the knowledge of the forest department. The contractors aim at maximum collection / procurement of the produces, with minimum extent of labour force applied. The contract labours are not generally trained in harvesting or collection. Since the contract period is limited for two years contractors are not interested in methods, leading decrease in proper harvesting quality. This destructive or improper method of harvesting has resulted in reduction of quality and quantity of NWFPS.

Role of agroforestry in the present situation

As agroforestry is a land use system including combination of Agriculture, Horticulture, Forestry, Animal husbandry which involves deliberate retention of trees, introduction of mixture of trees and woody perennials and other plants to benefit from resultant ecological and economic inter sections. There is a vast scope for planting of many of the plants (as mentioned in Table-1) in the lands of farmers and even betta lands (for each acre of Arecanut garden land, nine acres of forest lands are being granted to the farmers known as betta land) of arecanut farmers which will supplement their income and improve the environment, and help to retain the biodiversity of the plants.

The principle of agroforestry in the of raising of tree species is already in practices. The planting of woody perennials on the field boundaries homesteads in front of temples and community is an age-ole tradition in our country. Many plants are invariably found in front of house, back yard of buildings and so on. The sacred plant thulasi (which has many medicinal properties) finds a place in front of almost every house in the village, similarly, woody perennials like mango, jack, champak, nagakesar, bael, (henna) Citrus species, Guava, Parijatha. Herbs like lemongrass, patchouli Gibger, Artrmisia, Coleus, Aloe, catheranthus, etc. to meet their own requirement as well as to supplement their income from the surplus produce, they have grown. These plants also play some role in the traditional rituals of local communities. Apart from these few plants found as wild ones are also retained in farm lands. These include Bringraj (*Eclipta alba*), Brahmi (*Centella asiatica*), Sarpagand (*Rauvolfia serpentina*), Gouri Huvu (*Gloriosa superba*), Gangarmana balli / jyothosinnmathi (*Celasturs paniculatus*). The farms

had the tradition of planting and conserving of some trees like Nagakesar (*Mesua ferrea*). Suragi (*Mammea surgiana*) rarely Kedige / *Keora pandanus* species in and around the boundaries of their gardens of holding or in the blank or fallow areas. These are also found in the forests nearby, which are collected as NWFPS. Spices like Nutmeg, Cinnamon, Clove and Allspice and other useful plants like Soapunt (*Sapindus laurifolius*), Shikakai, (*Acacia concinna*), Watehuli (*Arotocarpus lakoocha*), Muragala (*Garcinia indica*), Uppage (*Garcinia gummigutta*) and Tamarind (*Tamarindus indica*) are grown only some extent. These plants meet the culinary purposes of the people and traditional home remedial practices (Table 1 and 2).
Some cash crops like Areca, and coffee which gained much more importance in the recent past. Due to this, some of the above NWPF Plants which have been planted and conserved by the locals remained uncared for and destroyed in many cases. As the price of cash crops have come down, the local people who have earlier relied on allopathic medicines for the almost all of their requirements have experienced some of the side effects. Moreover, the cost of medicines is being found costly, as their cash crop did not realize the expected income. Hence, these people once again realized the importance of traditional herbal medicines from the plants cultivated and found around them.
People are convinced regarding the importance of NWFPs found in their own land and surrounding forests. There is also rising awareness among the people regarding the importance of fast depleting plants in their own land and the forests around them. Once again people have started planting of the fast-depleting NWFPs in their own fields. They have also improved the harvesting techniques and reckless collections of the produce which they have followed in the forest around them through the contractors. The Forest Department has also encouraged the conservation of these forest produces by the forming Village Forest Committees (VFCs) as a part of Joint Forest Planning and Management (JFPM). Each village forest committee member has his/her share in NWFP of that area, thus the plants, which produce NWFPs, are being protected.

The method of disposal of forest produces and shares patterns

Mechanism of Sharing:

The total proceeds derived from the sale of forest produce shall be shared between the Government and the VFC as follows-

1. **Non Timber Forest Produce**: 10% to Government and 90% to VFC

Out of the share of the VFC, a minimum of 50% shall go to the Village Forest Development Fund (VFDF) and the balance will be shared by the members of the VFC as dividends or will go to the Village Development Fund (VDF) as decided by the VFC.

2. **Other Forest Produce**: From the assets created with the help of VFC:
   i. 25% to Government and ii. 75% to VFC
   Out of the share of the VFC, a minimum of 50% will go to the VFDF and the balance will be shared by the members of the VFC as dividends or will go to the VDF as decided by the VFC.
3. **From the assets created prior to formation of VFC** including older fuel wood, fodder and small timber plantations but excluding Teak plantations: i. 50% to Government ii. 50% to VFC
   Out of the share of the VFC, a minimum of 50% will go to the VFDF and the balance will be shared by the members of the VFC as dividends or will go to the VDF as decided by the VFC.
4. **From the natural growth** prior to the formation of VFC excluding valuable species viz., Sandalwood, Rosewood, Teak, Honne, Matti, and Nandi subject to the provision of Working Plan prescriptions: i) 50% to Government and ii) 50% to VFC

Out of the share of the VFC, a minimum of 50% is for the VFDF and the balance will be shared by the members of the VFC as dividends or will go to the VDF as decided by the VFC.

Many of the NWFPs, can be grown in the lands of farmers and natural forests as well. These will generate income and employment to the people. Many areas which are covered under waste lands can be improved by planting these plants, thus biodiversity of the plants in the area can be conserved. Moreover, the quality of the produce grown in farms expected to be uniform and better. This is the right time to initiate and conduct Agroforestry activities for NWFP, which have the potential of changing the landscape of the country to a great extent.

Table 1 : Types of forest produces found in the natural forests/cultivated in the tract.

Sl. No.	Types of NTFPs	Plants that yield NTFPs	Remarks
1	Leaves	*Cinnamomum spp*. (Dalchinni), *Butea monosperma* (plalas), *Corypha umpraculifera* (Talipot palm)	Found in natural forests

2	Gums, resins	*Lannea coramandelica,* *Pterocarpus marsupium,* *Canarium structum,* *Veteria indica,* *Hopea odorata,* *Ailanthus malabaricum,* *Dipterocarpus spp.* *Kingiodendron pinnatum,* *Garcinia morella,*	Found in natural forests
3	Oil seeds	*Pongamia glabra,* (Karanj, Honge), *Madhuca indica,* (Mohua, ipple), *Mangifera indica* (Mango)	Mango found in wild as well as us cultivated.
4	Essential oils	Lemon grass, Citronella grass, Palm rosagrass (Leaf grass), Khus grass, (Roots), *Eucalyptus citriodora (*Leaves), *Mammea spp.* (flower bunds).	Grasses are cultivated by farmers.
5	Fibres and flosses	*Bombax malabarica*, (semal, buruga), *Ceiba pentendra,* (Kapok), *Sterculia villosa*, *Agave species,* *Ananas cosmosus.*	Ananas is cultivated
6	Drugs and spices	*Myristica fragrans*, *M. malabarika,* *Zanthoxylum rhetsa,* *Mesua ferrea* (Nagkesa) *Z. ovalifolium,* *Cinnamomum spp.* (fruits and bark) *Piper nigrum, P. longum,* *Asparagus racemosus,* *Artemissia sp,* *Rauvolfia serpentina,* *Caesaria esculenta,* *Mesua ferrea,* *Gymnema sylvestre,*	Almost all are from the natural forests except Artemisia spp. Coleus and Myristica fragrans.

		Terminalia bellirica, T. chebula, Phylanthus emblica, P.niruri, Centella asiatica,Coleus species.	
7	Edible produces	*Garcinia indica,* (Kokum), *Garcinia gummigutta,* (Uppage, Punarpuli), *Artocarpus lakocha,* (wate), *Carissa caranda,* (Kavalikai), *Mangifera indica*, (Mango), *Zigypus species*. (Wild ber), Young bamboo culms, Edible mushrooms, Many other plants.	Partly cultivated partly are from natural forests.
8	Bamboos and canes	*Bambusa arundinacea, Dendrocalamus strictus, Oxytenanthera stocksil, Ochlandra reedii, Calamus rhotang, C.flagellum*	Mainly wild ones except Oxytenanthera stockii
9	Detergents	*Acacia concinna,* (Shikakai), *Sapindus laurifolius,* (soap nut).	Partly cultivated
10	Animal prodicts	Honey and wax	Partly collected from forests.

Table 2. Oil bearing plants with regions suitable for cultivation

Sl.	Scientific name	Common name	Regions suited for cultivation
1.	*Vateria indica*	Dhupa	Western Ghats, Maharashtra, Kerala.
2.	*Simmondsia sinensis*	Jojoba	Rajasthan, Gujarat.
3.	*Pongamia glabra*	Karanja	River streams throughout India.
4.	*Sohleichera oleosa*	Kusum	Dry areas of Uttar Pradesh, Bihar and Orissa.
5.	*Garcinia indica*	Kokum	Western Ghats, Maharashtra, Kerala.

6.	*Acrocomia sclerocarpa*	Macauba,	Madhya Pradesh, Orissa, Deccan Plateau, Andaman and Western Ghats.
7.	Mesua ferrea	Nahor	Assam, Himalayan, Andaman and Western Ghats.
8.	*Butea monosperma*	Flame of the Forest, Palah	Uttar Pradesh, Tamil Nadu, Orissa, Maharashtra, Karnataka, Bihar and Andhra Pradesh.
9.	Salvadora oleoides	Pilu	Dry desert areas, Uttar Pradesh, Punjab, Rajasthan, Gujarat and Madhya Pradesh.
10.	*Jatropha curcas*	Ratanjyoth	Assam, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh, Karnataka.
11.	*Caryocar brasiliense*	Pigui	Throughout India.
12.	*Actinodaphone hookeru*	Pisa	Hill slopes of Sikkim, Western Ghats, Orissa, Konkan.
13.	*Astrocaryum tucuma*	Tacuma	Assam, Karnataka and Madhya Pradesh
14.	Calophyllum inophyllum	Undi	Western Ghats, Maharashtra, Kerala and Andaman.

Table 3. Some oil yielding plants with oil content (in per cent)

Sl. No.	Botanical name	Oil content (%)	Sl. No.	Botanical name	Oil content (%)
1.	Aphanamixes polystachya	47	13	*Hydnocarpus laurifolia*	63
2.	*Argemone mexicana*	22-36	14	*Jatropha curcas*	35-40
3.	*Azadirachta indica*	35-40	15	*Litsea glutinosa*	35-51
4.	*Bombax ceiba*	20	16	*Madhuca indica*	30-35
5.	*Caesalpinia bonducella*	20	17	*Mallotus phillippinensis*	35
6.	*Calophyllum elatum*	70	18	*Minusops elengi*	16-25
7.	*Cannabis sativa*	32-35	19	*Perrilla frutescens*	35-51
8.	*Dapbne papyraceae*	36	20	*Pongamia pinnata*	30-35

9.	*Diplokhema butyraceae*	42-47	21	*Prisepia utilis*	37
10	*Garcinia echinocarpa*	49.6	22	*Simarouba glauca*	30-35
11	*Gynordia odorata*	27	23	*Terminalia chebula*	36
12	*Holarrhena antidysentirica*	19-30			

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Growth and Productivity of teak (*Tectona grandis*) in different bioclimatic zones of Uttara Kannada, Central Western Ghats

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INTRODUCTION

Teak (*Tectona grandis* Linn. f.) is an important world tropical timber species (Family: Lamiaceae), growing naturally in India, Burma, Thailand, Indonesia and the Philippines. Teak is one of the most valuable and widely planted species of south India. It has a long history as a plantation species due to its valuable timber which is considered as king of timber species. The total area under teak in India is about 104 m ha. In Karnataka, teak forests cover an area of 77, 900 ha with an annual production of 7,080 m^3. The growth of teak is influenced by several biotic and abiotic factors. According to the India State of Forest Report, the growing stock of India's forests is estimated to be 6047.16 million m^3 (ISFR, 2013). Significantly, out of this volume, 1550 million $m^{3,}$ or 26% is found outside the actual forest area and mainly managed by smallholder farmers. Of the total growing stock, 4.6% consists of teak, which is the most common species in forest plantations in the country. The total area of teak plantations is reported as 1.7 million ha. (Gilbert, 2012).

Generally, the management practices in pure plantation are poor over agroforestry or farmlands. The comparative data pertaining to growth and timber yield or volume of teak in pure plantation and farmlands are scanty. Moreover, there is an urge to study the growth of teak in plantations and farmlands for implication of correct management practices to the farming community and make them to produce good quality teak timber. The main objective of the study is to compare the growth and productivity of teak grown in farmlands with pure plantations in the different zones of Uttara Kannada district of Karnataka.

MATERIAL AND METHODS

The experiments were carried out in three different zones (Coastal zone, Upper-Ghats zone and Eastern plain zone) of Uttara Kannada district of Karnataka during 2014-15. The geographic locations (latitude, longitude and altitude) of the teak plantations and farmlands in all the three zones of Uttara Kannada district of Karnataka. Plantations and farmlands were selected in different locations of the three zones with different age classes. Age of the plantation was recorded from the report of forest department of concern Range; however, age of the teak trees in farmlands was recorded from the farmers. In this study, growth and volume of teak trees were recorded from different age groups in two different growing conditions. Factor 1 is considered as growing conditions as *Pure plantation* and *Farmland*, and Factor 2 is considered as *age classes* (four age classes, *viz.,* 5-10 yrs, 11-15 yrs, 16-20 yrs and 21-25 yrs). In each treatment, three trees were selected and following observations were recorded GBH, total height, clear bole height, height of forking, spacing adopted, crown height, crown length, crown diameter, volume as per standard procedure (Chaturvedi and Khanna, 1994). Other observations like thinning regime, pruning, number of branches at first six meters, knots and any other management practices, if adopted, were also recorded in the study area. Biometric data were subjected to statistical analysis with two factorial Complete Randomized Design (CRD) following Gomez and Gomez (1984) and analysis of variance was constructed and used in interpretation of data.

RESULTS AND DISCUSSION

Among the two growing conditions *viz.,* pure plantations and farmland, the growth of teak (height and diameter at breast height) was significantly higher in trees located at farmlands (12.24 m and 28.04 cm, respectively) as compared to pure plantations (12.09 m and 25.73 cm, respectively). The total volume of teak differed significantly among the two growing conditions. The teak volume was higher in farmlands (0.925 m^3) as compared to pure plantations (0.727 m^3). The clear bole height (CBH) and timber volume of teak were significantly higher in farmlands (7.38 m and 0.596 m^3 respectively) as compared to pure plantations among the growing conditions studied.

Among the four age classes, the growth of teak (height and diameter at breast height) was significantly higher in A_4: 21-25 years age class followed by A_3: 16-20 years age class and A_2: 11-15 years age class. The lowest growth of teak was observed in A_1: 5-10 years age class. The interaction effect growth of teak between the growing conditions and age classes was significant. The volume of teak was significantly higher in A_4: 21-25 years age class (1.593 m^3) followed by A_3: 16-20 years age class (1.092 m^3) and A_2: 11-15 years age class (0.387 m^3). The lowest volume of teak was recorded in A_1: 5-10 years age class (0.232 m^3). The interaction effect of volume of teak between the growing conditions and age classes was significant (Table 2). Clear bole height (CBH) was significantly higher in A_4: 21-25 years age class followed by

A_3: 16-20 years age class and A_2: 11-15 years age class. The lowest clean bole height (CBH) of teak was recorded in A_1: 5-10 years age class. The timber volume of teak was significantly higher in A_4: 21-25 years age class (1.001 m^3) followed by A_3: 16-20 years age class (0.731 m^3) and A_2: 11-15 years age class (0.176 m^3). The lowest volume of teak was recorded in A_1: 5-10 years age class (0.105 m^3). The interaction effect of clear bole height (CBH) and timber volume of teak between the growing conditions and age classes were significant.

The growth performance of teak was better on farmlands as compared to plantations due to better management by the farming community. Teak grown under commercial plantations is subjected to competition for space, light, nutrients, and any other resources available as compared to teak on farmlands. Better growth of clear bole height and girth in teak on farmlands was attributed to early pruning (5-10 yrs age class) of lower branches by the farmers. It was noted that a thinning regime was not applied in both cases (plantations and farmlands). However, some of the trees on farm bunds were randomly removed/harvested for small poles (timber) at an age of 11-15 years without any thumb rule by the farmers (intermediate yield) whenever they required for their self-utilization, especially for agricultural implements and household purposes.

A study conducted on smallholder teak plantations in two villages in central Java: Silvicultural activity and stand performance revealed that (A total of 66 farmers were interviewed and 121 inventory plots measured) most of the usual silvicultural practices were implemented, although thinning was rarely conducted. In older plantations (>5 to 7 years old), low growth was most likely due to a lack of thinning. Farmers allocated minimum inputs for silvicultural management, mainly because teak was not one of the farmers' main income sources. None of the farmers' socio-economic and perceptional characteristics influenced their silvicultural management activity. In order to improve teak growth and quality, farmers need motivated and skilled extension officers to advise them in site selection and in thinning and pruning techniques (Kallio *et al.,* 2012).

There is an obvious need to develop new silvicultural guidelines and offer technical assistance for teak cultivation, which would then guarantee a better quality of teak products (Roshetko *et al.,* 2013). The plantations managed by smallholders have the potential to create sustainable economic, environmental, and social benefits for their growers if trees are integrated in the production system following well-established local practices. Benefits seem to be accrued especially if the costs of tree planting and management can be reduced; farmers also have the ability to quickly adapt to new marketing opportunities (Pokorny *et al.,* 2010).

The present study showed that teak tree grown in farmlands performed better than pure plantation. However, it is necessary to provide proper guide of planting, protection, silviculture management like fertilizer application, pruning and thinning, to the farmers to attain higher growth and productivity potential of teak under different agroforestry systems. Furthermore, a recent guide for policymakers (FAO, 2002) takes this into consideration and provides an outline of how policy can support agroforestry and how new models for teak growing could also be achieved. A feasible approach would be to highlight planted trees as components of sustainable food production systems and providers of economic, environmental, and social benefits and services, primarily to the rural population but also for countries.

Conclusion

The present study concluded that the teak performed better on farmlands as compared to plantations due to better management by the farming community. Better growth of clear bole and girth in teak on farmlands was attributed to early pruning (5-10 yrs age class) of lower branches by the farmers. But some of the trees on farm bunds were randomly removed / harvested as small poles (timber) at an age of 11-15 years without any thumb rule by the farmers (intermediate yield) whenever they required for their self-utilization for agricultural implements or any other household purpose. So it can be suggested that pruning (5-10 yrs) and thinning (5-10 and 10-15 yrs) are the important tools for better silviculutral management for commercial growth of teak (girth and clear bole) to fetch more economic value in the market. Trenching along the teak rows on farm bund helped trees for soil working, loosening of soil, moisture conservation, weed control that would influenced positively on tree growth.

Table 1: Influence of age on total tree volume of teak in pure plantation and on farmlands in different zones of Uttara Kannada district of Karnataka.

Age class (yrs)	Total Tree Volume (m^3)								
	Coastal zone			**Upper Ghat zone**			**Eastern Plain zone**		
	Pure plantation (G_1)	**Farmlands (G_2)**	**Mean**	**Pure plantation (G_1)**	**Farmlands (G_2)**	**Mean**	**Pure plantation (G_1)**	**Farmlands (G_2)**	**Mean**
A1: 5-10	0.0154	0.232	**0.193**	0.103	0.234	**0.169**	0.229	0.236	**0.232**
A2: 11-15	0.267	0.275	**0.271**	0.230	0.647	**0.438**	0.381	0.392	**0.387**
A3: 16-20	0.428	0.643	**0.535**	0.797	1.021	**0.909**	1.002	1.182	**1.092**
A4: 21-25	0.865	1.321	**1.093**	1.410	1.296	**1.353**	1.294	1.891	**1.593**
Mean	**0.429**	**0.618**		**0.635**	**0.800**		**0.727**	**0.925**	
For comparing		**SEm ±**	**CD @ 5%**		**SEm ±**	**CD @ 5%**		**SEm ±**	**CD @ 5%**
Growing Conditions (G)		0.01	0.02		**0.011**	**0.032**		**0.013**	**0.041**
Age classes (A)		0.01	0.03		**0.015**	**0.046**		**0.019**	**0.058**
Interaction (G x A)		0.01	0.04		**0.021**	**0.065**		**0.027**	**0.083**

Table 2: Influence of age on timber volume of teak in different growing conditions in different zones of Western Ghats in Uttara Kannada district of Karnataka.

Age class (yrs)	Timber Volume (m^3)								
	Coastal zone			Upper Ghat zone			Eastern Plain zone		
	Pure plantation (G_1)	Farmlands (G_2)	Mean	Pure plantation (G_1)	Farmlands (G_2)	Mean	Pure plantation (G_1)	Farmlands (G_2)	Mean
A1: 5-10	0.055	0.108	**0.081**	0.057	0.102	**0.080**	0.101	0.108	**0.105**
A2: 11-15	0.096	0.111	**0.103**	0.078	0.312	**0.195**	0.158	0.193	**0.176**
A3: 16-20	0.228	0.380	**0.304**	0.460	0.664	**0.562**	0.629	0.832	**0.731**
A4: 21-25	0.363	0.742	**0.552**	0.753	0.773	**0.763**	0.762	1.249	**1.001**
Mean	**0.185**	**0.335**		**0.337**	**0.463**		**0.413**	**0.596**	
For comparing		**SEm ±**	**CD @ 5%**		**SEm ±**	**CD @ 5%**		**SEm ±**	**CD @ 5%**
Growing Conditions (G)		0.01	0.01		0.006	0.019		0.104	0.319
Age classes (A)		0.01	0.02		0.009	0.026		0.147	0.451
Interaction (G x A)		0.01	0.03		0.012	0.037		0.208	0.637

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Effect of different fungicides on bark recovery in *Terminalia arjuna* (Roxb. ex-DC.) Wight & Arn.

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INTRODUCTION

Terminalia arjuna (Arjuna), belonging to family Combretaceae, grows along the streams or rivers and often in the shallow streambeds and riverbeds in central India. It has been considered by the Ayurvedic physicians as well as by the modern practitioners as a cardiac tonic (Pandey and Kori, 2009). Clinical evaluation indicated that it has been found to be beneficial in the treatment of coronary artery disease, heart failure, and possibly hypercholesterolemia. It has also been found to possess antibacterial, antimutagenic and antioxidant activities (Pandey and Kori, 2009). Demand for *Terminalia arjuna* bark, both in India and abroad has been increasing rapidly; however, the present annual estimated demand for bark of this species is 2000 to 5000 MT (Ved and Goraya, 2007). About 95 percent of the requirement is met from the wild and collected in a pattern that is not concomitant with sustainable harvesting practices. Keeping above into consideration it has been planned to carry out systematic study on sustainable harvesting of bark and efficacy of different fungicides on recovery of bark.

MATERIAL AND METHODS

Experiment was conducted during 2014-15 in natural forests nearby Thatwala village of Yellapur Range,Yellpur Division. Bark was removed in two patches from 45 trees (in three different girth classes) during December month (10 x 3 cm and 6 x 5 cm) and after three days applied different fungicides to protect from pest, diseases and also two enhance the recovery of bark on. Observations on bark recovry were recorded at three months interval. The following treatments were imposed: T1: Bordeaux Paste (10%); T2: Burgundy Paste (10%); T3: Neem Seed Kernel Paste; T4: Trichoderma Paste; T5: Simarouba oil; T6: Control.

RESULTS AND DISCUSSION

After three months of bark removal and application of fungicides nine trees showed signs of gum production, very few showed sign of fungal growth, few trees with no sign of gum and fungal growth and four trees initiated bark development. Among different treatments applied, *Simarouba* oil, burgundy paste, trichoderma paste and Neem seed kernel paste showed better results with initiation of cambium. After six months and nine months of treatment, maximum per cent of bark recovery was noticed in Neem seed kernel paste (71 % and 96%) followed by burgundy paste (58% and 94%) and least was found in control (28% and 49%).

After one year of treatment, a maximum per cent of bark recovery was noticed in neem seed kernel paste (98%), followed by burgundy paste (95%) and it was least in control (55%). Hence, it is observed that bark recovery rate is higher in trees treated with neem seed kernel paste followed by burgundy paste (Table 1). Perhaps, this could be the first report on influence of fungicides on recovery of bark in this species. Similar research in *T. arjuna* was also carried out by Pandey and Kori (2009), where bark removed up to ¼ to 1/3 of total girth of the tree resulted in 42 per cent bark recovery after one year in *T. arjuna.* Different growth regulators such as IAA, IBA, bordeaux mixture, leaf extracts of neem, aak and karanj were applied on harvested surface of the tree trunk in order to study their influence on bark regeneration (Pandey and Kori 2009 and Pandey, 2015); however, information on application of these treatment on bark recovery is scanty. In the present study, higher bark recovery obtained through treatments like paste of neem seed cake and burgundy paste may be due to anti-fungal activities, where the neem seed kernel has been reported to contain several biologically active constituents such as azadirachtin, gedunin, and gedunin, which has antifungal properties (Rao *et al.,* 1977). Copper ions present in the burgundy paste are capable of interfering with enzymes found within the spores of many fungi, preventing germination of fungal spores (Anon., 2017). Both of these treatments (Neem seed Kernel paste and Burgundy paste) contain antifungal agents. Hence, these chemicals might encourage the new bark regeneration in this species.

Finally, it is suggested to apply paste of neem seed kernel or burgundy paste on the extracted portion of bark on the standing tree to obtain fast recovery of bark as well as to avoid fungal infection cut portion of the bark in the tree of *Terminalia arjuna*.

Table 1. Effect of different fungicides/chemicals on bark recovery in *Terminalia arjuna*

Treatments	**Periodic bark recovery (%)**			
	3 months after application	6 months after application	9 months after application	12 months after application
T_1: Bordeaux Paste	0	32	75	88
T_2: Burgundy Paste	9	58	94	95
T_3: Neem Seed Kernel Paste	7	71	96	98
T_4: Trichoderma Paste	5	57	85	92

T_5: Simarouba oil	10	49	78	89
T_6: Control	0	28	49	55

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Agroforestry Policies, Implementation, and Future Approaches for Enhanced Impact: A Case Study of Chhattisgarh and India

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Abstract

This paper provides a comprehensive review of agroforestry policies and their implementation in India, with a focus on Chhattisgarh. It evaluates the effectiveness of existing agroforestry systems, explores challenges, and outlines future approaches for enhancing the impact of agroforestry in terms of ecological, economic, and social benefits. Based on current data, the paper also examines the role of government initiatives, local adaptation strategies, and policy shifts required to further promote agroforestry as a sustainable land-use practice.

Keywords:

Agroforestry, Policy, Chhattisgarh, India, Sustainable Agriculture, Environmental Impact, Climate Change, Implementation, Future Approaches

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1. Introduction

Agroforestry, the integration of trees and shrubs into agricultural landscapes, has been recognized globally for its ability to enhance environmental sustainability, economic benefits, and climate resilience. In India, agroforestry has emerged as a crucial approach for addressing land degradation, biodiversity loss, and the challenges posed by climate change. The Indian government has developed several policies aimed at promoting agroforestry practices, yet the implementation and long-term success of these policies remain a subject of concern.

Research Objective: This paper aims to:

1. Investigate the current agroforestry policies in India, with a focus on Chhattisgarh.
2. Assess the implementation of these policies and the challenges faced.
3. Suggest future approaches to improve agroforestry practices and their impact.

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2. Literature Review

This section provides an overview of the history, policy landscape, and previous research on agroforestry in India. It highlights key studies that have evaluated agroforestry systems and their socio-economic, environmental, and policy dimensions.

- **Global Agroforestry Trends**: Global successes and challenges in agroforestry.
- **Agroforestry in India**: Government policies such as the National Agroforestry Policy (2014), and the National Mission on Sustainable Agriculture.
- **Agroforestry in Chhattisgarh**: Unique agroforestry systems in Chhattisgarh, focusing on the integration of local tree species (like Tectona grandis, Azadirachta indica) and agricultural crops.

3. Agroforestry Policies in India and Chhattisgarh

National Level: The Government of India has introduced several policies and schemes aimed at promoting agroforestry, with significant emphasis on creating favorable policy frameworks for tree-based farming systems.

- **National Agroforestry Policy, 2014**: Establishes guidelines for integrating trees with crops and livestock, aiming to increase the green cover while promoting food security, biodiversity, and economic growth.
- **National Mission on Sustainable Agriculture (NMSA)**: Supports agroforestry as a climate-resilient strategy for agriculture.

State-Level: Chhattisgarh, being a predominantly agrarian state, has adopted agroforestry systems to combat deforestation and soil erosion, as well as to increase the productivity of smallholder farms.

- **Chhattisgarh Agroforestry Mission (CGAFM)**: The state has launched specific programs to encourage the adoption of agroforestry practices among farmers by providing financial support, capacity-building initiatives, and technical assistance.

Policy Gaps and Challenges:

- Limited awareness among farmers regarding agroforestry benefits.
- Insufficient financial incentives and credit systems for smallholder farmers.
- Lack of integration between forest departments, agricultural departments, and farmers.

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4. Implementation of Agroforestry Practices

Current Implementation Models in Chhattisgarh:

- **Tree-Crop Integration**: In regions like Bastar, farmers grow crops alongside timber species such as Teak (Tectona grandis) and bamboo, which offer both short- and long-term economic returns.
- **Livelihood Diversification**: Agroforestry has contributed to enhancing farmers' incomes through the sale of timber, fruits, and non-timber forest products (NTFPs).
- **Soil and Water Conservation**: Agroforestry systems in Chhattisgarh have demonstrated significant potential in improving soil quality and preventing water runoff, especially in drought-prone areas.

Challenges:

- **Inadequate Knowledge and Training**: Farmers often lack the technical knowledge to effectively integrate trees into their farming systems.
- **Market Access**: Lack of proper market linkages for agroforestry products.
- **Policy Gaps**: Delayed implementation of subsidies and technical support services.

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5. Future Approaches for Enhanced Impact

1. Strengthening Policy Frameworks:

- **Subsidies and Financial Incentives**: The government needs to enhance financial support for smallholder farmers, such as tax incentives for agroforestry products, direct subsidies for tree planting, and low-interest loans for agroforestry-related activities.
- **Farmer Training Programs**: Increase awareness and training programs for farmers on agroforestry practices, benefits, and market linkages.

2. Improved Research and Technology Transfer:

- **Agroforestry Research**: Focus on research to identify suitable tree species for different agro-climatic zones of Chhattisgarh, as well as integrated pest management and disease control for tree crops.
- **Climate-Smart Agroforestry**: Research on climate-resilient tree species and agroforestry practices that mitigate the impacts of climate change.

3. Collaboration and Partnerships:

- **Public-Private Partnerships (PPP)**: Encourage collaboration between the government, NGOs, research institutions, and the private sector to create more effective implementation strategies and ensure the sustainability of agroforestry systems.
- **Community-Based Approaches**: Involve local communities in decision-making processes to ensure that agroforestry systems align with local needs and cultural practices.

4. Integration of Technology:

- **GIS and Remote Sensing**: Use satellite imagery and GIS to identify areas suitable for agroforestry and monitor the growth of trees over time.
- **Digital Platforms for Market Linkages**: Development of digital platforms to connect agroforestry farmers to wider markets, increasing access to competitive prices for timber and NTFPs.

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6. Conclusion

Agroforestry has the potential to become a cornerstone of sustainable agriculture in India, particularly in states like Chhattisgarh, where agricultural land degradation and climate challenges are prevalent. However, its success depends on effective policy implementation, overcoming existing barriers, and ensuring that farmers are equipped with the necessary resources, knowledge, and market access. The future of agroforestry lies in strengthening policy frameworks, promoting research, enhancing financial incentives, and leveraging technology.

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ENVIRONMENTAL AND ECONOMIC BENEFITS OF THE SYSTEM OF RICE INTENSIFICATION (SRI): A REVIEW OF RECENT STUDIES

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ABSTRACT

To meet future food demands, it is essential to enhance productivity while minimizing resource use, such as land and water. One promising approach for increasing rice yields is the System of Rice Intensification (SRI), developed in Madagascar in the mid-1980s. Unlike conventional methods, SRI was innovatively designed and has since been adopted in over 50 countries. It consists of a set of improved rice cultivation techniques tailored to local conditions. While SRI includes standard agricultural practices like sowing, transplanting, irrigation, weed control and fertilization, it differs significantly in execution. These optimized methods lead to remarkable plant growth, with rice responding more productively than in traditional systems. The primary goal is to enhance the development of both aboveground shoots and underground root systems, ultimately increasing yields. As a result, SRI stands out as a highly effective method for boosting rice production to support the needs of a growing population.

Key words: System of rice intensification, less inputs, water saving, high yield, productivity

INTRODUCION

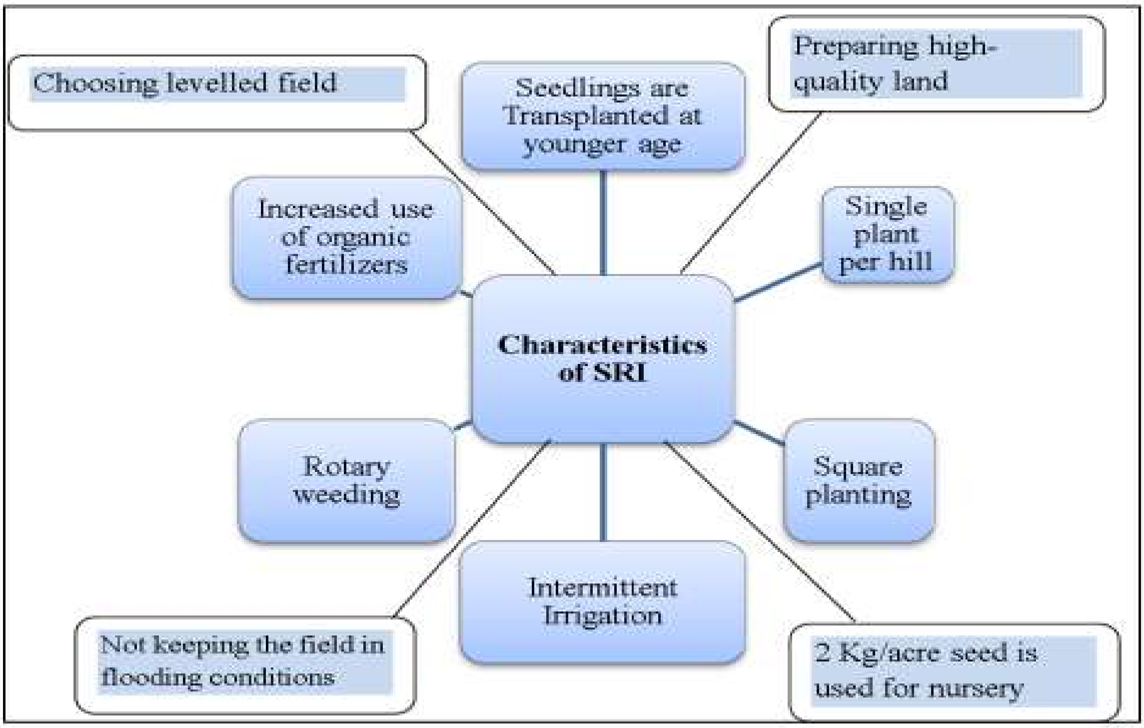
Rice (*Oryza sativa* L.) is one of the most essential cereal crops and belongs to the Poaceae (Gramineae) family. It serves as a staple food for more than 60% of the global population, second only to wheat. Asia dominates both rice production and consumption, accounting for nearly 90% of the world's total rice output. Being a water-intensive crop, rice requires significant irrigation, consuming approximately 3,000 to 5,000 liters of water to produce just one kilogram of grain. In Asia, over 80% of the available freshwater resources are used for irrigation, with nearly half of this allocation dedicated to rice cultivation (Dawe *et al*., 1998) [8]. The rapid depletion of these water resources poses a serious threat to the sustainability of irrigated rice farming, thereby endangering food security and the livelihoods of rice farmers and consumers (Tuong *et al*., 2004) [26].

There is substantial evidence indicating that water scarcity is increasingly affecting rice-growing regions. This challenge necessitates the adoption of innovative technologies to manage water more efficiently and sustain rice production in the face of limited water availability (Tuong and Bouman, 2002) [25]. One of the most effective and environmentally sustainable solutions for water conservation in rice farming is the System of Rice Intensification (SRI). Developed in the 1980s by French priest Father Henri de Laulanié in Madagascar, SRI was designed to promote sustainable agricultural practices by enhancing productivity while reducing input costs, optimizing the use of labor and capital and minimizing water consumption.

SRI is a strategic approach to rice cultivation that emphasizes controlled water management, making it a viable method for addressing increasing food demand while ensuring water conservation and environmental sustainability. This system enhances rice growth by optimizing the interactions between soil, water, sunlight and plants, allowing crops to reach their full potential, which is often limited by conventional farming methods (Zotoglo, 2011) [29]. Unlike traditional rice farming, SRI introduces an alternative wetting and drying method for rice fields instead of continuous flooding (Kepha, Bancy, and Patrick, 2014) [10]. The purpose of this review is to explore various SRI practices and advancements, highlighting its advantages over conventional rice cultivation methods.

- In the System of Rice Intensification (SRI), seedlings aged between 10 and 15 days are preferred for transplanting.
- Seedlings are transplanted individually at a shallow depth of 1-2 cm, ensuring minimal time between removal from the nursery and planting.
- Proper plant spacing is maintained by planting in a square pattern of 20 × 20 cm or 25 × 25 cm using a rope or marker. In highly fertile soils, the spacing may be increased to 30 × 30 cm or more.
- Until the panicle initiation stage, irrigation is applied to a depth of 2.5 cm once the previously ponded water disappears and fine cracks start forming on the soil surface. After panicle initiation, irrigation continues at the same depth, one day after the water has evaporated.
- Starting 10-12 days after transplanting and continuing until the canopy closes, inter-cultivation should be carried out every 10-12 days by walking between the rows and using mechanical weeders.

- The use of organic inputs such as cow dung, green manure, vermicompost and other organic manures is recommended for soil enrichment. While chemical fertilizers can be applied, they do not provide the same long-term benefits to soil health.



COMPONENTS OF SRI (SYSTEM OF RICE INTENSIFICATION)

Impact of the System of Rice Intensification on Growth, Yield, and Economics of Rice

The System of Rice Intensification (SRI) can be implemented with any rice variety, but careful seed selection is essential. In SRI, only one seedling is transplanted per hill using a square planting method, which helps reduce the dependency on multiple external inputs (Stoop *et al.*, 2002) [22].

Traditional rice cultivation is a significant source of greenhouse gas emissions, particularly methane (CH_4) (Ciais *et al.*, 2013) [6]. However, SRI reduces methane emissions through intermittent irrigation, which enhances soil permeability and improves soil redox reactions (Tyagi *et al.,* 2010) [27]. Additionally, the modified transplanting techniques and crop management practices in SRI have been found to be more effective in controlling weed growth and minimizing nitrogen depletion by weeds, ultimately leading to improved yield characteristics and higher productivity (Singh *et al*., 2021) [21].

A study by Kumar *et al*. (2021) [11] reported that all growth and yield parameters were highest under the SRI method. In most cases, SRI performed on par with conventional puddled transplanted rice (CPTR) when 12-day-old seedlings were used, highlighting its potential as an efficient and sustainable rice cultivation technique.

Table 1: Difference in growth parameters of plants in SRI and conventional methods of cultivation

S. No.	Parameter	SRI	Conventional method	Reference
1.	Plant height	110.6 cm	106.3 cm	Vijayakumar et al., 2006 [12]
2.	Plant height	121.4 cm	117.4 cm	Tejendra et al., 2011 [24]
3.	Plant height	121.6 cm	115.2 cm	Kumar et al., 2021 [11]
4.	Plant height	137.73 cm	135.12 cm	Midya et al., 2021 [14]
5.	LAI	8.62	6.58	Vijayakumar et al., 2006 [12]
6.	LAI	2.55	2.48	Kumar et al., 2021 [11]
7.	Number of tillers per meter square	477	454	Vijayakumar et al., 2006 [12]
8.	Number of tillers per meter square	310	283	Kumar et al., 2021 [11]

The System of Rice Intensification (SRI) provides optimal conditions for rice plant growth by ensuring adequate spacing, sunlight exposure and nutrient availability. This is primarily achieved through square planting, which allows each plant to receive sufficient resources without competition. Additionally, the method of intermittent wetting and drying of the soil plays a crucial role in enhancing soil aeration. This controlled irrigation approach not only facilitates robust root development but also significantly minimizes weed infestation, as the fluctuating moisture levels create an unfavorable environment for weed growth. Consequently, plants cultivated under the SRI method exhibit improved growth and development, as evidenced by various research findings.

Beyond its advantages in plant growth, the SRI technique is recognized for its significant contributions to water conservation, cost-effectiveness and increased resilience against both biotic (pests and diseases) and abiotic (drought and soil degradation) stresses. The potential for achieving higher yields through this method has been extensively studied and documented (Namara *et al*., 2004). One of the key aspects of SRI is its emphasis on nutrient management, where the use of Effective Microorganism (EM) solutions in combination with vermicompost has been found to be highly beneficial. Studies indicate that this organic approach enhances various growth parameters, yield attributes and overall grain quality (Behera *et al*., 2021).

Unlike conventional rice farming, which typically involves planting multiple seedlings together in close proximity (often in clusters of 4-5 seedlings at a spacing of less than 20 x 20 cm), SRI adopts a more efficient approach. The method requires significantly fewer seeds while still achieving superior growth. Moreover, in contrast to traditional continuous flooding irrigation methods, SRI incorporates periodic drying of the fields. This strategic drainage reduces overall water consumption without negatively affecting the crop's growth (Rejesus *et al*., 2011). Research has shown that this technique can enhance rice production efficiency by more than 50% in various regions (Takahashi, 2013).

In addition to improving water productivity, SRI has been linked to enhanced crop yield potential (Deelstra *et al.,* 2018). The technique also plays a vital role in weed management, as studies have observed that reducing the inter-row spacing results in lower dry weed biomass accumulation (Ali *et al*., 2019). The presence of weeds typically increases due to prolonged weed competition, which is largely influenced by extended germination periods and favorable conditions for weed proliferation. However, SRI's aeration and controlled moisture techniques limit these factors, thus promoting healthier rice growth.

Furthermore, the superior performance of SRI is reflected in various yield-enhancing traits such as an increased number of productive tillers per square meter, longer panicle size and a greater number of grains per panicle. These characteristics collectively contribute to the method's ability to achieve higher grain output, making it a sustainable and highly efficient approach to rice cultivation.

The impact of varying plant spacing and weed competition on rice root development, yield attributes, and overall productivity remained significant throughout a two-year study. Research findings indicated that rice plants exhibited the longest root lengths (30.9 cm and 30.0 cm) and highest root biomass (34.5 g and 32.9 g) in plots where wider plant spacing (30 cm × 30 cm) was maintained under weed-free conditions. However, when comparing this spacing with a slightly denser arrangement of 25 cm × 25 cm in the absence of weed competition, no significant difference was observed in root growth and biomass across both experimental years.

A notable decline in root length and biomass was recorded when the spacing between plants was reduced to 20 cm × 20 cm under similar weed-free conditions. The narrowest spacing (20 cm × 20 cm) with weed control resulted in the shortest root length (12.2 cm and 11.4 cm) and the lowest root biomass (10.0 g and 9.6 g) (Chadhar *et al*., 2020). Similarly, the highest number of fertile tillers per hill (55.8 and 53.4), maximum 1000-grain weight (24.7 g and 23.8 g), and the best grain quality (normal kernel percentage of 81.37% and 79.13%) were recorded in plots with a spacing of 30 cm × 30 cm, provided that no weed competition was present. Additionally, the highest grain yield was achieved in plots where rice was transplanted at a spacing of 25 cm × 25 cm under weed-free conditions, with yields of 5.6 t ha^{-1} in both years (2010 and 2011). These values were statistically comparable to those recorded under similar conditions at the same spacing.

Conversely, the lowest rice kernel yield (1.8 t ha^{-1} in both years) was observed in plots where plants were spaced 30 cm × 30 cm but were subjected to full-season weed competition under the System of Rice Intensification (SRI). Furthermore, research on arbuscular mycorrhizal fungi (AMF) revealed that these microorganisms are influenced by different cultivation methods. When comparing AMF communities in rice roots grown under SRI with those in conventionally cultivated plots, it was found that all AMF species in conventional farming belonged to the genus Glomus. In contrast, rice roots cultivated under SRI contained genetic sequences of both Acaulospora and Glomus, indicating a more diverse fungal population in SRI-managed fields (Watanarojanaporn *et al*., 2013).

Difference in Yield between SRI and conventional methods of cultivation (Grain yield)

S.No.	Yield from SRI	Yield from conventional	Reference
1.	3.436 t/ha	3.340 t/ha	Singh et al., 2021 [21]

2.	6.7 t/ha	5.7 t/ha	Mboyerwa et al., 2022 [13]
3.	6.020 t/ha	5.280 t/ha	Kumar et al., 2021 [11]
4.	4.580 t/ha	4.119 t/ha	Shanmugasundaram et al., 2021 [20]
5.	6.10 t/ha	4.00 t/ha	Duttarganvi et al., (2016)
6.	6.21 t/ha	5.92 t/ha	Midya et al., 2021 [14]

Enhanced plant growth and development contribute to improved yield-related traits, making the System of Rice Intensification (SRI) a more productive and efficient approach compared to conventional rice farming, as presented in Table 1.2. Traditional broadcasting methods require approximately 100 kg of rice seeds per hectare, while conventional transplanting methods demand around 30-60 kg per hectare. In contrast, SRI significantly reduces seed requirements, needing only 4-10 kg per hectare. This reduction not only minimizes input costs but also lowers labor expenses for farmers.

The SRI technique emphasizes early transplanting, typically before seedlings reach 15 days of age, with only one or two seedlings per planting site. Additionally, wider spacing (at least 20 × 20 cm) and an intermittent wetting and drying irrigation strategy are applied to optimize plant health and growth (Berkhout & Glover, 2011). When incorporating green manure into the SRI method, the average soil tillage yield per square meter increased to 456 m², compared to 390 m² observed in conventional rice farming. Furthermore, SRI with green manure led to improved panicle characteristics, including longer panicles and a higher number of grains per panicle. Specifically, the panicle length averaged 22.19 cm, while the number of grains per panicle reached 148, surpassing the figures recorded in conventional rice farming (Watanarojanaporn *et al*., 2013).

The adoption of green manure within the SRI framework had a positive impact on overall grain yield. The mean grain yield under this method was recorded at 6,450 kg per hectare, marking a substantial increase compared to the 5,510 kg per hectare achieved through conventional cultivation. This represents a 17% improvement in yield. Additionally, economic analyses indicated that the cost of cultivation was lower under the green manure-SRI system than with traditional methods. A study of 21 on-farm demonstrations showed that the average cultivation cost for SRI was Rs. 55,100 per hectare, while conventional rice farming required Rs. 67,500 per hectare. This demonstrates a cost reduction of Rs. 12,400 per hectare when adopting the green manure-SRI approach, making it a more cost-effective and sustainable alternative to conventional rice farming.

Difference in B:C between SRI and conventional methods of cultivation (B: C ratio)

S.No.	B:C for SRI treatment	B:C for conventional treatment	Reference
1.	1.42	1.06	Singh *et.al.,* 2021 [21]
2.	1.46	1.2	Nirmala *et.al*., 2021 [17]
3.	1.99	1.54	Midya *et.al*., 2021 [14]

The increase in production and reduction in cost of production makes more profit to the farmers. So, the benefit cost ratio will be higher as compared to the conventional method of rice production as shown in Table 1.3.

CONCLUSION

The System of Rice Intensification (SRI) offers significant benefits, including water conservation, cost savings, and environmental stability, largely due to its emphasis on organic manure usage. The SRI method has been shown to result in the highest growth parameters, improved grain yields, and the most favorable benefit-cost ratio. SRI is particularly advantageous for reducing water consumption and lowering costs associated with seedling production and labor. By utilizing minimal water, this technique enables farmers to grow rice more sustainably. Furthermore, by reducing reliance on chemical fertilizers, SRI helps protect the land from degradation while enhancing overall crop yields.

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Residual Effect of Agrochemicals on Environment, Agriculture, and Human Health

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Abstract

Agrochemicals, including fertilizers, pesticides, herbicides, and plant growth regulators (PGRs), have played a significant role in modern agriculture by increasing crop productivity and reducing losses caused by pests, weeds, and diseases. However, the excessive and unregulated use of these chemicals has resulted in serious environmental degradation, biodiversity loss, soil and water contamination, and human health risks. In India, where agriculture is a major contributor to the economy and employment, the challenge is to balance food security with sustainable agricultural practices. The study explores the residual effects of agrochemicals, highlighting their impact on soil health, water pollution, air contamination, biodiversity, and human well-being. It also examines their role in declining soil fertility, increasing pest resistance, and disrupting ecosystem stability. Furthermore, it discusses existing regulatory measures and sustainable alternatives such as biopesticides, biofertilizers, and integrated pest management (IPM). The study underscores the urgent need for stricter regulations, increased farmer awareness, and the promotion of environmentally friendly alternatives to ensure long-term agricultural sustainability.

Keywords : Agrochemicals, environmental degradation, pesticides, human health risks, sustainable agriculture, soil fertility, water contamination, biodiversity loss, biopesticides, integrated pest management

Introduction

Agriculture is a crucial sector of the Indian economy, employing nearly half of the country's workforce and supporting the livelihoods of millions. India has the largest agricultural land area globally, covering approximately 176.5 million hectares (Wikipedia, 2024). Despite being a major food producer and exporter, India faces critical challenges, including declining soil health, environmental pollution, and pesticide overuse. According to the World Trade Organization (WTO), India ranked eighth in global agricultural exports in 2023, but quality concerns and regulatory restrictions limit its full potential (The Hindu Business Line, 2023).

The introduction of agrochemicals revolutionized agriculture, particularly during the Green Revolution in the 1960s, ensuring food security and increasing productivity (Pal *et al.,* 2006). Fertilizers supply essential nutrients, while pesticides and herbicides protect crops from pests and weeds. The global agrochemical market was valued at approximately USD 239.85 billion in 2018 and is projected to grow to USD 365.16 billion by 2027, indicating continued dependence on chemical-based farming (Buch *et al.,* 2023).

However, the overuse and improper application of agrochemicals have led to several negative consequences. Agrochemical residues persist in soil and water, contaminating natural ecosystems and harming human health. Reports indicate that pesticide runoff pollutes drinking water, while prolonged exposure to certain chemicals has been linked to neurological disorders and cancer (Onder *et al.,* 2011). Additionally, pesticide-resistant pests are emerging, further exacerbating agricultural challenges (Wikipedia, 2024). This study aims to assess the long-term effects of agrochemical residues on various environmental components, human health, and agricultural productivity while exploring sustainable alternatives.

Objectives of the Study

1. To analyze the impact of agrochemicals on soil, water, air, and biodiversity.
2. To assess the health risks associated with agrochemical exposure.
3. To evaluate the effects of agrochemicals on agricultural sustainability, particularly soil degradation and pest resistance.
4. To explore sustainable alternatives, such as biopesticides, biofertilizers, and integrated pest management (IPM).

Methodology

The study follows a qualitative research approach based on a comprehensive review of academic literature, government reports, industry publications, and case studies. Data were sourced from international organizations such as the Food and Agriculture Organization (FAO), World Health Organization (WHO), and national institutions like the Indian Council of Agricultural Research (ICAR). Case studies were analyzed to assess trends in agrochemical usage, environmental degradation, and policy effectiveness.

Result and Discussion

Agrochemicals have undeniably transformed modern agriculture, enhancing crop yields and minimizing losses from pests and diseases. However, their residual effects pose long-term risks to environmental sustainability, human health, and agricultural productivity. This section explores the diverse impacts of agrochemicals across different domains, including soil, water, air, biodiversity, and human well-being.

1. **Impact of Agrochemicals on the Environment:**

   The widespread use of agrochemicals has significantly altered natural ecosystems, leading to soil degradation, water pollution, air contamination, and biodiversity loss.

1.1 **Soil Pollution:** Soil serves as the foundation for agricultural productivity, but excessive use of chemical fertilizers and pesticides disrupts its health. Synthetic fertilizers often lead to nutrient imbalances, depleting essential micronutrients such as zinc, copper, and iron (EOS Data Analytics, 2024). Over time, prolonged exposure to pesticides alters soil microbial communities, reducing populations of beneficial bacteria and fungi that play a crucial role in nutrient cycling and organic matter decomposition (Chaudhary *et al.,* 2022). Additionally, certain pesticides, such as organochlorines, persist in the soil for decades, leading to bioaccumulation and long-term toxicity. The gradual buildup of these chemicals diminishes soil fertility, making it less productive over successive planting cycles.

1.2 Water Pollution: Water bodies are highly susceptible to contamination from agrochemical runoff. Excess fertilizers rich in nitrogen and phosphorus seep into nearby rivers and lakes, causing excessive growth of algae that depletes oxygen levels and harms aquatic ecosystems (Anjaria & Vaghela, 2024). Similarly, pesticide residues infiltrate groundwater sources, posing risks to human health, especially in rural areas where groundwater is a primary drinking water source (Kaur & Sinha, 2019). Studies have reported alarming pesticide concentrations in drinking water, contributing to an increased prevalence of waterborne diseases and long-term health complications.

1.3 Air Pollution: Pesticides and herbicides contribute to air pollution through volatilization and chemical drift during application. Airborne pesticide particles can travel long distances, affecting non-target crops, wildlife, and nearby human populations (Geeks for Geeks, 2023). Moreover, the overuse of nitrogen-based fertilizers releases nitrous oxide, a potent greenhouse gas that contributes to climate change. The combination of pesticide sprays, smog formation, and greenhouse gas emissions underscores the pressing need for sustainable agricultural practices to minimize air pollution.

1.4 Impact on Biodiversity: The loss of biodiversity is one of the most concerning consequences of agrochemical overuse. Pesticides, particularly neonicotinoids and glyphosate-based herbicides, have been directly linked to declining populations of pollinators such as bees and butterflies (Stuart, 2021). The absence of pollinators disrupts crop fertilization, ultimately affecting food production. Additionally, pesticide residues bioaccumulate in the food chain, harming predatory birds, amphibians, and aquatic life. The reduction in plant diversity due to excessive herbicide use further destabilizes ecosystems, eliminating essential food sources for various species.

2. Impact of Agrochemicals on Human Health:

Human exposure to agrochemicals occurs through direct contact during agricultural activities, ingestion of contaminated food and water, and inhalation of pesticide residues in the air. These exposures have been linked to a range of acute and chronic health conditions.

2.1 Occupational Exposure: Farmworkers and agricultural laborers face the highest risk of direct pesticide exposure. Acute poisoning symptoms include nausea, dizziness, respiratory distress, and skin irritation. Long-term exposure has been linked to serious health complications such as neurological disorders, endocrine disruption, and increased cancer risks (Anilkumar *et al.,* 2020). In many developing countries, inadequate safety measures and lack of protective equipment exacerbate these health risks. Studies show that chronic pesticide exposure among farmworkers is associated with an increased incidence of Parkinson's disease, reproductive disorders, and kidney damage.

2.2 Food Contamination and Health Risks: Pesticide residues are commonly found in fruits, vegetables, and grains, posing risks to consumers. Studies indicate that prolonged exposure to these residues is linked to immune system suppression, hormonal imbalances, and developmental disorders in children (Wohlfahrt-Veje *et al.,* 2011). Pregnant women and young children are particularly vulnerable, as exposure to agrochemicals has been associated with birth defects, low birth weight, and impaired cognitive development. Regulatory bodies like the Food Safety and Standards Authority of India (FSSAI) have established maximum residue limits (MRLs) for pesticides in food, but enforcement remains inconsistent, especially in rural markets.

3. **Impact of Agrochemicals on Agriculture:**

While agrochemicals were initially developed to enhance agricultural productivity, their overuse has led to diminishing returns, soil degradation, and pest resistance, creating challenges for long-term food security.

3.1 Declining Soil Fertility: Continuous application of chemical fertilizers can lead to soil acidification, salinity buildup, and organic matter depletion. The excessive use of synthetic nitrogen-based fertilizers disrupts the natural balance of soil nutrients, reducing its ability to retain water and support healthy plant growth (EOS Data Analytics, 2024). As soil health declines, farmers become increasingly dependent on higher doses of fertilizers, creating a cycle of chemical dependency that depletes natural resources.

3.2 Emergence of Pesticide-Resistant Pests: One of the unintended consequences of agrochemical overuse is the development of pesticide-resistant pests. Over time, repeated exposure to the same pesticides allows pests to evolve resistance, making conventional pest control methods less effective (Wikipedia, 2024). This resistance forces farmers to increase pesticide usage or switch to more potent chemicals, further exacerbating environmental and health concerns. Integrated pest management (IPM) strategies, which combine biological control methods with reduced pesticide use, have shown promise in mitigating this issue.

3.3 Water Contamination and Reduced Crop Quality: Pesticide residues in irrigation water negatively impact crop quality, affecting both domestic consumption and export potential. Many countries impose strict residue limits on imported agricultural products, leading to rejection of contaminated shipments. India, despite being a major agricultural exporter, faces challenges in meeting global food safety standards due to persistent pesticide residues (Sheikholeslami *et al.,* 2024). Farmers adopting organic and sustainable farming practices have reported improved soil fertility, reduced water contamination, and better market acceptance for their produce.

4. Sustainable Alternatives to Agrochemicals:

Given the harmful effects of agrochemical overuse, adopting sustainable agricultural practices is crucial.

4.1 Integrated Pest Management (IPM): IPM focuses on reducing pesticide dependence by combining biological, cultural, and mechanical pest control methods. This approach includes using natural predators, crop rotation, and resistant crop varieties to manage pest populations effectively.

4.2 Biofertilizers and Organic Amendments: Biofertilizers, such as nitrogen-fixing bacteria and mycorrhizal fungi, enhance soil fertility without the negative effects of synthetic fertilizers. Organic amendments like compost and vermicompost improve soil structure and microbial diversity.

4.3 Biopesticides and Natural Pest Control: Biopesticides derived from natural sources, such as neem extracts, Bacillus thuringiensis (Bt), and pheromone traps, offer effective pest control with minimal environmental impact. These alternatives are biodegradable and pose lower risks to non-target organisms.

4.4 Policy and Farmer Awareness: Strengthening regulatory frameworks, enforcing pesticide residue limits, and educating farmers about safe agrochemical use are essential for long-term sustainability. Training programs and subsidies for eco-friendly farming methods can encourage farmers to adopt sustainable practices.

Conclusion

Agrochemicals have significantly boosted agricultural productivity and food security, but their excessive use has led to severe environmental and health concerns. Soil contamination reduces fertility and microbial diversity, while chemical runoff pollutes water bodies, harming aquatic life and human health. Air pollution from pesticide drift and greenhouse gas emissions further exacerbates environmental degradation. Additionally, biodiversity loss, particularly among pollinators and beneficial insects, threatens ecological balance. The growing resistance of pests and weeds to agrochemicals forces increased chemical dependency, creating a cycle of escalating environmental harm.

Beyond environmental damage, agrochemicals pose serious health risks, especially for farm workers and rural communities exposed to toxic chemicals. Long-term exposure is linked to respiratory illnesses, neurological disorders, and cancers, while pesticide residues in food threaten consumer health. To mitigate these risks, sustainable alternatives like integrated pest management (IPM), biofertilizers, and biopesticides must be promoted. Strengthening regulations, raising farmer awareness, and enforcing strict monitoring can help achieve a balance between productivity and environmental conservation, ensuring the long-term sustainability of agriculture.

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Production and Management of Vermicompost in Chhattisgarh and India: Current Trends and Future Prospects

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Abstract

Vermicomposting is an eco-friendly, sustainable waste management process that converts organic waste into nutrient-rich compost using earthworms. It offers numerous benefits, such as improving soil health, enhancing crop yields, and reducing waste. This paper presents an overview of the production and management of vermicompost in India, with a focus on Chhattisgarh, a region known for its agricultural activities. The study examines current trends, production practices, and the challenges faced by farmers in adopting vermiculture. It also discusses the potential of vermicomposting in enhancing soil fertility and promoting sustainable agriculture. Using data from government sources and agricultural surveys, this paper highlights the status of vermiculture in Chhattisgarh and its contributions to organic farming. Additionally, the research explores future prospects, challenges, and recommendations for scaling up vermicomposting as a major agricultural practice in the state and across India.

Introduction

The growing need for sustainable agricultural practices in India has led to an increased interest in organic farming methods. Among these, vermicomposting stands out as a cost-effective and environmentally friendly solution. Vermicomposting is the process by which organic waste is broken down by earthworms into humus, enriching the soil with valuable nutrients and improving its texture. This organic fertilizer is free from harmful chemicals, making it ideal for organic farming and eco-conscious agriculture.

India, with its vast agricultural sector, produces significant amounts of organic waste annually, much of which can be processed into vermicompost. According to the Ministry of Agriculture and Farmers Welfare (2020), India generates over 500 million tonnes of organic waste annually. Vermicomposting offers a viable solution to recycle this waste into valuable compost that enhances soil fertility, reduces waste accumulation, and contributes to sustainable farming practices. In states like Chhattisgarh, where agriculture is a major economic activity, vermiculture has shown promise in improving soil health and productivity.

Vermicomposting Process and Benefits

Vermiculture Process

Vermiculture involves using various species of earthworms (such as *Eisenia fetida, Eisenia andrei, and Perionyx excavatus*) to decompose organic material. These earthworms consume organic waste and excrete it in the form of vermicast, a nutrient-rich material that can be used as fertilizer.

The process of vermiculture involves:

1. **Collection of Organic Waste:** Kitchen waste, agricultural residues, livestock manure, and other organic materials are collected.
2. **Preparation of Bed:** The waste is spread in layers in a worm bed.
3. **Worm Introduction:** Earthworms are added to the bed.
4. **Decomposition:** Earthworms decompose the organic waste into vermicast.
5. **Harvesting:** The compost is collected after a few months.

Benefits of Vermicompost

- **Soil Fertility:** Vermicompost improves soil structure, increases water retention capacity, and boosts microbial activity.
- **Nutrient-Rich:** It is rich in essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients.
- **Environmentally Friendly:** It helps in recycling agricultural and kitchen waste, reducing landfill use, and decreasing greenhouse gas emissions.
- **Improved Plant Growth:** Crops grown with vermicompost have better growth, higher yields, and greater resistance to pests and diseases.

Vermiculture in Chhattisgarh

Chhattisgarh is a largely agricultural state, with rice, maize, and pulses being the major crops grown. The state has a rich tradition of organic farming, and there has been an increasing shift towards eco-friendly farming methods such as vermiculture. According to the Chhattisgarh State Organic Farming Policy (2021), the state government has promoted vermicomposting as an alternative to chemical fertilizers, with several schemes encouraging farmers to adopt vermiculture.

Current Status of Vermiculture in Chhattisgarh

- Area of Adoption: As of 2020, approximately 15,000 hectares in Chhattisgarh are under organic farming, with vermiculture being an essential practice in many of these areas.
- Government Support: The state government, through the Chhattisgarh State Organic Farming Mission, offers financial assistance to farmers for setting up vermiculture units, creating awareness, and providing technical training.

- Farmer Participation: Around 5,000 farmers in the state are actively engaged in vermiculture, with many operating small-scale units for self-consumption and sale

Table 1: Vermiculture Adoption in Chhattisgarh (2020)

District	Farmers Engaged in Vermiculture	Area (hectares)	Vermiculture Units
Raipur	600	500	120
Bilaspur	450	400	100
Durg	400	350	90
Korba	350	300	80
Total	5,000	15,000	390

Challenges in Chhattisgarh

1. **Awareness and Training:** Despite government initiatives, many farmers are still unaware of the complete benefits and techniques of vermiculture.
2. **Infrastructure:** The lack of proper infrastructure, such as composting units and equipment, hampers the growth of vermiculture in rural areas.
3. **Market Access:** Although the demand for organic products is growing, farmers often struggle to sell their vermicompost due to limited market access and pricing issues.

Vermiculture in India: National Overview

India has seen a gradual increase in the adoption of vermiculture over the past decade. With over 60 million hectares of land under organic farming (IFOAM, 2020), the demand for organic compost, such as vermicompost, is on the rise.

National Statistics:

- **Organic Farming Area:** As of 2020, India had approximately 2.4 million hectares under organic farming (APEDA, 2020).
- **Vermicomposting Units:** India currently has over 100,000 registered vermiculture units, contributing to the production of organic compost.
- **Production Volume:** The vermicompost production in India is estimated to be around 1 million tonnes per year (Government of India, 2021).

Key States in Vermiculture:

1. **Madhya Pradesh:** Known for large-scale vermiculture and composting operations.
2. **Uttarakhand:** Promotes organic farming and vermiculture as part of its state policy.
3. **Tamil Nadu:** Major producer of vermicompost, with many farmers adopting this technique to improve soil health.

Challenges to Vermiculture Adoption in India

1) **Lack of Technical Knowledge:** Many farmers lack the technical know-how on how to properly manage vermiculture units and produce high-quality vermicompost.
2) **Cost of Inputs:** Setting up a vermiculture unit requires initial investment, which may deter small-scale farmers.
3) **Storage and Transport:** There is inadequate storage and transport infrastructure, leading to losses of compost and difficulty in reaching larger markets.
4) **Competition with Chemical Fertilizers:** Despite the known benefits, chemical fertilizers are still heavily subsidized in India, which can make them more affordable than organic alternatives.

Future Prospects and Recommendations

Vermiculture has significant potential to support sustainable agriculture and improve soil health across India and particularly in Chhattisgarh. To further promote vermiculture, the following measures are recommended:

- Training Programs: Enhance farmer education and training on vermiculture techniques.
- Financial Support: Increase government subsidies and provide soft loans to farmers for establishing vermiculture units.
- Infrastructure Development: Improve storage, transport, and marketing infrastructure for organic fertilizers.
- Public Awareness Campaigns: Promote the environmental and economic benefits of vermiculture to increase demand for organic products.

Conclusion

Vermiculture offers immense potential to revolutionize organic farming and waste management in India and Chhattisgarh. With the support of government policies, increased awareness, and technological advancements, vermiculture can become a key component of sustainable agriculture, contributing to enhanced soil fertility, reduced waste, and better agricultural productivity.

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Organic Farming with Residue-Free Production: Challenges and Prospects in India and Beyond

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Abstract

Organic farming, rooted in sustainable agricultural practices, has gained momentum globally as a response to the adverse effects of conventional agriculture, particularly the excessive use of synthetic chemicals. One of the foremost concerns in organic farming is ensuring residue-free production—producing crops without harmful chemical residues. This paper delves into the concept of organic farming with residue-free production, highlighting its significance, practices, challenges, and benefits. The study compares global practices with those in India, examining the growing demand for residue-free products and the challenges faced in meeting organic certification standards. The research also emphasizes the role of integrated pest management (IPM), crop rotation, and soil fertility management in achieving residue-free organic farming. Furthermore, statistical data on organic farming in India and other countries is provided to illustrate trends and future prospects.

Introduction

Organic farming represents an alternative to conventional agricultural methods by prioritizing sustainability, environmental health, and consumer safety. At its core, organic farming avoids the use of synthetic chemicals, such as pesticides and chemical fertilizers, instead relying on natural inputs to enhance soil fertility, manage pests, and improve overall farm biodiversity (Mäder *et al*., 2002). In addition, organic farming aims to promote the long-term health of agricultural ecosystems while minimizing pollution and maintaining environmental integrity (Reganold & Wachter, 2016). Residue-free production is an essential objective within organic farming. It ensures that crops grown organically are free from chemical residues, including those from prohibited substances like synthetic pesticides, herbicides, and fertilizers. The growing consumer demand for residue-free products, particularly in the wake of health concerns and environmental impact assessments, has elevated the importance of residue-free organic farming (Benbrook, 2009). Achieving residue-free organic production is not only essential for maintaining organic certification but also for protecting public health, enhancing consumer confidence, and sustaining long-term ecological balance (Bolognese *et al*., 2018).

This paper aims to explore the principles of organic farming with residue-free production, reviewing practices that lead to chemical-free products, the challenges that arise, and how both developed and developing countries, particularly India, are adapting to these practices. The global rise in organic farming and market statistics, as well as data from India, are presented to assess the scale of organic agriculture and its future potential.

Concept of Organic Management with Residue-Free Production

Organic Farming: Organic farming focuses on practices that reduce dependence on external chemical inputs, emphasizing crop rotation, natural fertilizers (like compost), organic pesticides, and biological pest control (Tuck *et al*., 2006). The practice maintains a balanced ecosystem by fostering beneficial organisms in the soil and minimizing agricultural pollution.

Residue-Free Production: Residue-free organic farming refers to the absence of synthetic chemical residues in agricultural products. Residue contamination can arise from the use of prohibited chemicals or cross-contamination from neighboring conventional farms. Organic certification standards, such as those set by the USDA National Organic Program and the EU Organic Regulations, ensure that all organically grown products meet stringent residue-free standards (IFOAM, 2019).

Significance of Residue-Free Production: The primary aim of residue-free production is to safeguard human health by ensuring that food products are free from harmful chemicals. Health risks, including endocrine disruption, carcinogenesis, and immune system harm, are associated with pesticide residues (Bolognese *et al*., 2018). As such, residue-free production provides a safeguard against these potential risks and aligns with consumer expectations of safer, healthier food (IFOAM, 2019).

Global Trends in Organic Farming and Residue-Free Practices

Organic farming has seen a remarkable global expansion. According to the International Federation of Organic Agriculture Movements (IFOAM), the global organic market was valued at $120 billion in 2018, with the organic farmland area growing by 20% from 2013 to 2018 (IFOAM, 2019). The European Union alone had over 13.8 million hectares of organic farmland by 2020, with organic food sales reaching over €45 billion in 2021 (EU Organic Action Plan, 2021).

In the U.S., organic farming continues to grow with over 5 million acres dedicated to organic crops (USDA Organic Agriculture Statistics, 2020). The demand for organic products, particularly those with a certified residue-free guarantee, has spurred innovations in organic pest management, certification systems, and monitoring techniques to ensure compliance with residue-free standards.

India, a key player in the global organic market, has witnessed a surge in organic farming as part of its "National Programmer for Organic Production" (NPOP) under the Ministry of Commerce & Industry. The country's organic farmland has increased from 1.2 million hectares in 2002 to 3.7 million hectares in 2018 (APEDA, 2018). Despite these advancements, ensuring residue-free production remains a challenge due to the presence of neighboring conventional farms, cross-contamination risks, and occasional non-compliance by farmers.

Challenges of Residue-Free Production in India

In India, the challenge of achieving residue-free production is particularly evident in the coexistence of organic and conventional farming systems. Several challenges contribute to residue contamination:

1) **Cross-Contamination:** With over 60% of India's agricultural land still engaged in conventional farming, the risk of pesticide drift and cross-contamination into organic fields is significant (Benbrook, 2009).
2) **Certification and Monitoring:** India's certification process, although robust, faces challenges in ensuring consistent residue-free standards across diverse regions, especially in remote or unmonitored areas.
3) **Farmer Awareness and Education:** There is a need for enhanced farmer education on organic practices, especially regarding the prevention of synthetic chemical usage and proper handling of organic certification processes.
4) **Pest and Disease Management:** Organic farms in India face a significant challenge with pest management due to limited access to organic pesticides and biocontrol agents (Tuck *et al.*, 2006).

To address these challenges, India has implemented various measures, including increasing the capacity of organic certification agencies, improving market linkages for organic produce, and providing training to farmers on best organic practices.

Strategies for Achieving Residue-Free Organic Production

To achieve residue-free organic farming, several strategies can be implemented:

1) **Integrated Pest Management (IPM):** IPM strategies, including crop rotation, use of resistant varieties, and natural pest predators, help minimize the reliance on chemical treatments (Reganold & Wachter, 2016).

2) **Soil Fertility Management:** Organic composting, green manure, and the use of biological fertilizers enhance soil health without the need for synthetic inputs (Mäder *et al*., 2002).
3) **Preventive Measures:** Preventive practices like mulching, weed management, and proper irrigation techniques help reduce the need for chemical interventions and improve the resilience of organic farms (Drinkwater *et al*., 1998).

Conclusion and Future Prospects

Organic farming with residue-free production is critical for achieving long-term agricultural sustainability. While global organic farming is growing, the challenge of residue contamination remains. Both developed and developing countries, including India, are making strides in implementing sustainable practices to meet organic standards and consumer demand for residue-free products. The future of organic farming hinges on continued innovation in farming practices, certification processes, and farmer education.

As organic farming expands in India and around the world, ensuring residue-free production will remain a fundamental objective. With advancements in technology, better monitoring systems, and enhanced policy support, residue-free organic farming can become the norm, ensuring safer and more sustainable food for generations to come.

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Profitability Assessment in Agricultural Production and Marketing of Agricultural Enterprises

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Abstract

2021 research in Bemetara district in the plain region is a study on the impact of self-help groups (SHGs) on various aspects of their operations. Jai Satnam SHG, established in 2008, is an NRLM SHG supported by the government through the National Rural Livelihood Mission. The SHG produces around 5040 packets of sanitary pads annually, with a total cost of Rs 15.00 per packet. The SHG is organized at three levels: President, Secretary and Members, as well as 2021 research in Gariyaband district in the plain region focused on the use of organic pesticides, which are beneficial to the environment and free of cost. Agni-astra, Brahmastra and Dravya Jeevamrit are produced in large quantities, with the organic pesticides yielding the highest profit. 2021 research in Kanker district in the south region shows the success of Radha SHG in producing an average of 542 kg/acre of lac, with a total net profit of Rs 15.00. 66810.97/acre in the first year and the average gross return was 103744.97/acre. And 2021 research in Raigarh district of the northern region shows better business performance in the production of various commodities by Radha Krishna Mahila SHG, with a combined net profit of Rs 21985, Rs 118457.5 and Rs 12712.

Keyword- *SHG, region, organic, production, impact*

I. Introduction-

In India, small enterprises that can effectively connect with the rural economy include: dairy farming, poultry farming, small-scale manufacturing units producing agricultural tools, retail stores selling essential goods, handicraft and handloom businesses, organic fruit and vegetable production, solar power services, and even small-scale processing units for local produce like grains or spices; all of which can leverage the existing rural workforce and agricultural output while providing essential goods and services to the local communities.

Domestic Uncategorized Country India Business Openings and Challenges within the Display Time Country India Entrepreneurship Opportunities and Challenges within the Display Time Dec 6 2024 Little Undertaking India Business has risen as a foundation of financial development and societal change in modern India With about 75 of the populace dwelling in rustic zones essentially locked in in farming and partnered exercises rustic business holds monstrous potential for driving feasible comprehensive and keen development Recognizing its centrality the Government of India has consolidated enterprise into its 2020 procedure for financial advancement Be that as it may the pathway to unleashing the entrepreneurial potential of provincial India is strewn with both openings and challenges

The Importance of Rural Entrepreneurship

Country business isn't only around making businesses it is approximately changing lives and reshaping communities It addresses basic issues like unemployment destitution and urban movement by tackling neighborhood assets and ability provincial business visionaries contribute to territorial improvement and advance impartial financial development.

Employment Generation and Migration Control

With the government incapable to meet the burgeoning work needs of the country populace enterprise gives a practical elective for work creation small scale businesses agribusinesses and rural based ventures can retain the nearby workforce lessening reliance on farming Besides by giving pay openings inside the town's business can check the tenacious movement of country youth to urban ranges in look of way better jobs.

Impact of Small Businesses in Rural India (Statistics):

- **Employment Generation:**
    - MSMEs (Micro, Small, and Medium Enterprises) account for approximately **30% of India's GDP** and employ over **110 million people**, a significant portion of which is in rural areas.
    - They are the **second largest employer** in India after agriculture, providing crucial non-farm livelihood opportunities in rural areas.
    - Small businesses often have a **higher labor-to-capital ratio** than larger enterprises, meaning they create more jobs per unit of investment.
- **Economic Contribution:**
    - MSMEs contribute around **45% of the total manufacturing output** in India, with a substantial share coming from rural-based enterprises.
    - They account for roughly **40% of India's exports**, showcasing their role in foreign exchange earnings and integration into global value chains.
    - Small businesses often operate with **lower overhead costs** and can be more agile in responding to local market demands, contributing to economic dynamism.

II. Review literature

Kumar *at. al* 2021, observed that an average production of 3.28 quintals per cubic meter is usually done in 3 cycles. The net income per cubic meter at the total cost was Rs. 1520.49. The benefit-cost ratio per cubic meter was 1: 0.61. The total cost per quintal production of vermicompost was Rs 2458.92. Most of the groups are using earthworm (*Eisenia fetida*) which is highly reproductive species, due to which its use and demand. It was observed that the producer-government agencies-consumer channel has the highest marketing usage compared to others.

Bhaskar *at. al* 2021, studies that used as flavor, aroma, frequency and for seasoning of foods. In these 3 products maximum Input-Output ratio was 1:1.25 and minimum Variable: Cost (V: C) ratio was 0.80 for turmeric powder. The minimum Input-Output ratio was 1:1.07 and maximum VC ratio was 0.93 for Chilli Powder. The business performance of Spices product Turmeric powder, Coriander powder and Chilli powder in Deep women SHG Gailugoan, Lormi were as follows. The total sale of Turmeric powder was4 quintal, net return 40 Rs/kg and total return was 16000 rupees/ year. This was the maximum among all three products. The total sale of Coriander powder was 3.5 quintal, net return 30Rs/kg and total return was 10500 rupees/ year. Whereas the total sale of Chilli powder was 3 quintal, net return 20 Rs/kg and total return was 6000 rupees/ year.

III. Material and Methods

This study has been done in the state of Chhattisgarh. This research has been done in such districts which represent the land area of our state for production and marketing.

Statistical tools- The information collected from the respondents were edited for adequacies and accuracies and cross-examined before they were subjected to tubular analysis. The primary data were classified and tabulated in the light of the stated objectives of the study and analyzed as per the suitable statistics and economic tools as follows.

3.1 Cost concept

Cost Related to Vermicompost Production

I. Cost of cultivation

Cost of cultivation = Total Fixed Cost + Total Variable Cost

(A) Fixed cost

Fixed Cost are remaining constant and do not vary with level of production. To calculate fixed cost of production, various cost components are taken into consideration.

(B) Variable cost

It includes cost of cow dung. earthworm cost, water and electricity charge, labour cost, miscellaneous cost.

3.2 Profitability Concept

(A)Gross Income

It is defined as total value of main product

Gross Income = Physical Production x Price/qt

(B) Net Income

It is defined as gross income minus total cost

Net Income = Gross Income - Total Cost

(C)Input – Output Ratio

Input - Output Ratio = Gross Income/Total Cost

(D) Benefit – Cost Ratio

Benefit – Cost Ratio = Net Income/ Total Cost.

IV. Results and Discussions

In 2021 research conducted in Bemetara district of plain area, it can be seen that Jai Satnam SHG was established on 23rd September 2008. This SHG is an NRLM SHG, which is supported by the government through National Rural Livelihood Mission. This SHG has ten members who help in making sanitary pads. This SHG makes sanitary pads. This SHG produces around 5040 packets of sanitary pads every year. The SHG is organized in three levels: President, Secretary and Members. All the members of the SHG contribute to the production activities through their individual actions. Half of the respondents are in the age group of 30 to 40 years, and the remaining half are in the age group of 40 to 50 years. Every member is married. The literacy and illiteracy percentages are 80% and 20% respectively. All the members are part of the Scheduled Caste. Jai Satnam Self Help Group manufactures sanitary pads using raw material at a cost of Rs. 15.00 per packet, packaging material at a cost of Rs. 5.00 per packet, labour at a cost of Rs. 02.75 per packet and other costs at a cost of Rs. 01.25 per packet. The total cost of each packet is Rs. 29.52. Each packet is sold at Rs. 36.00, giving a net income of Rs. 06.48 per packet. Annually 5040 packages of sanitary pads are produced. The marketing strategy for sanitary pads of the SHG can be described as a system in which they directly produce their product and sell to consumers and other self-help groups.

Table No. 1: Total cost of sanitary pads per packet and refund to small scale enterprises of plain zone

S. No.	Particular	Value (Rs.)
1.	Total Cost	29.52
2.	Total Return	36.00
3.	Net Return	6.48
	B:C Ratio	1:0.21

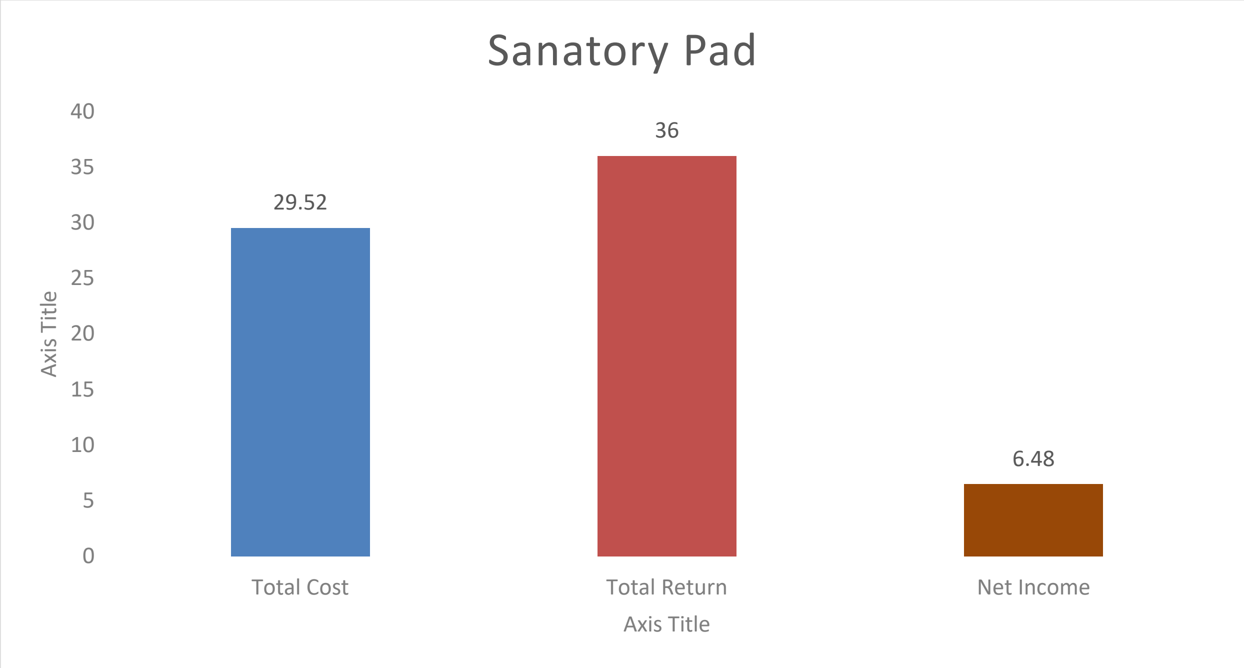

Fig. No. -1: Total cost of sanitary pads per packet and refund to small scale enterprises of plain zone

Similarly, in research conducted in Gariyaband district in 2021, it can be seen that organic pesticides are beneficial for the environment and can be obtained directly from nature. It is virtually free and has no impact on human health, soil, animals or plants. Agni-astra was manufactured in large quantities, 50 per cent, while the remaining items, Brahmastra and Dravya Jeevamrit, were 30 and 20 per cent, respectively. The literacy rate among SHG members was 90%, and most of the respondents in the study area were in the age group of 18 to 30 years, most of whom were married. The average input-output ratio for Agniastra, Brahmastra and Dravya Jeevamrut were 1:3.2, 1:2 and 1:6.5, respectively. The BC ratio was found to be 1:2.21, 1:1.0, 1:1.65 and 1:1.59, respectively. When it comes to organic pesticides or product business performance, Agniastra gives the highest profit, followed by Brahmastra and Dravya Jeevamrit. The total annual net profit of Gayatri Self Help Group from various organic pesticides was determined to be Rs 51146.

Table No. 2: Total cost of Organic Pesticide per liter and refund to small scale enterprises of plain zone

S. No.	Particular	Value (Rs.)			
		Unit-A	Unit-B	Unit-C	Average
1.	Total Cost	21.80	25.00	26.33	24.38
2.	Total Return	70	50	70	63.33
3.	Net Return	48.2	25	43.67	38.96
	B:C Ratio	1:2.21	1:1.00	1:1.65	1:1.59

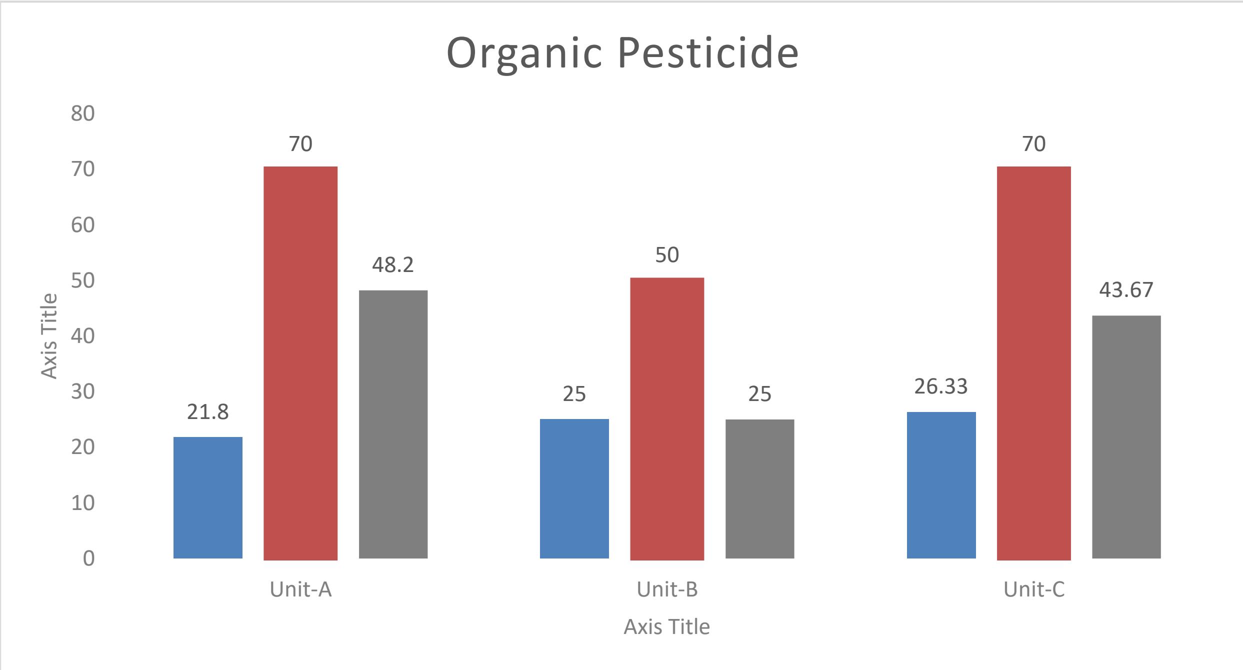

Fig. No. -2: Total cost of Organic Pesticide per liter and refund to small scale enterprises of plain zone

In 2021 research conducted in Kanker district of southern region, it can be seen that Lac was produced at an average of 542 kg/acre, with 377 kg/acre produced in the first enterprise and 707 kg/acre in the second. Radha SHG achieved a total net return of lac production of Rs. 66810.97/acre in the first enterprise, Rs. 147318.96/acre in the second enterprise, and an average gross return of Rs. 103744.97/acre. Similarly, the benefit-cost ratio of SHGs was 1:1.36 for the first enterprise, 1:2.30 for the second, and 1:1.84 for the average. The input/output ratio was 1:2.36 for the first enterprise, 1:3.30 for the second, and 1:2.84 for the average. The Radha Self-Help Group disposes of lac in the following manner: processing units account for 45.11 percent, wholesalers for 26.03 percent, lac growers for 17.85 percent, and kochiyas/primary purchasers for 10% of the total produce.

Table No. 3: Total cost of Lac per Kg and refund to small scale enterprises of southern region

S. No.	Particular	Value (Rs.)		
		Unit-A	Unit-B	Average
1.	Total Cost	90.39	103.94	97.16
2.	Total Return	298.76	295.35	297.05
3.	Net Return	208	191.41	199.70
	B:C Ratio	1:2.30	1:1.84	1:2.03

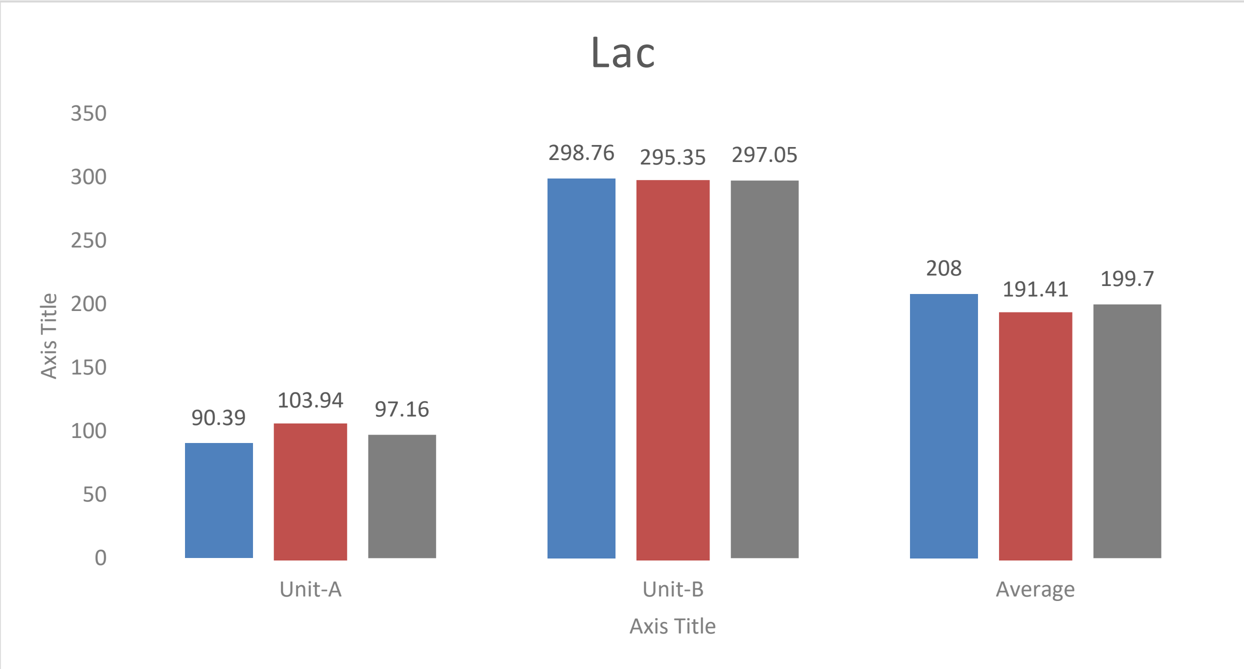

Fig. No. -3: Total cost of Lac per Kg and refund to small scale enterprises of southern region

In the research conducted in 2021 in Raigarh district of northern region, it can be observed that for different types of goods including mustard oil, rakhiya badi, moong papad and mango pickle, the input-output ratios of Radha Krishna Mahila SHGs were 1:1.11, 1:1.60, 1:1.12 and 1:1.18, respectively. The V:C ratios were also determined to be 1:0.90, 1:0.62, 1:0.89 and 1:0.85 in the same order. For different goods like rakhiya badi and moong papad, the input-output ratios of Adarsh Mahila SHGs were 1:1.57 and 1:1.11, respectively. The V:C ratios were also determined to be 1:0.90 and 1:0.64, respectively. For different products like turmeric powder, chilli powder, coriander powder and cumin powder, the input-output ratios of Maa Gayatri Mahila SHG were 1:1.22, 1:1.39, 1:1.24 and 1:1.07 respectively. The V:C ratios were also determined to be 1:0.82, 1:0.72, 1:0.80 and 1:0.94 in the same order. The business performance of Radha Krishna was better than the other SHGs selected. The combined net profit of Maa Gayatri Mahila SHG, Adarsh Mahila SHG and Radha Krishna Mahila SHG was Rs.21985, Rs.118457.5 and Rs.12712.

Table No. 3: Total cost and refund to small scale enterprises of northern region per Kg

S. No.	Particular	Value (Rs.)			
		Unit-A	Unit-B	Unit-C	Average
1.	Total Cost	180.72	208.44	215.7	201.62
2.	Total Return	227.5	275	262.5	255
3.	Net Return	46.78	66.56	46.8	53.38
	B:C Ratio	1:0.3	1:0.3	1:0.2	1:0.3

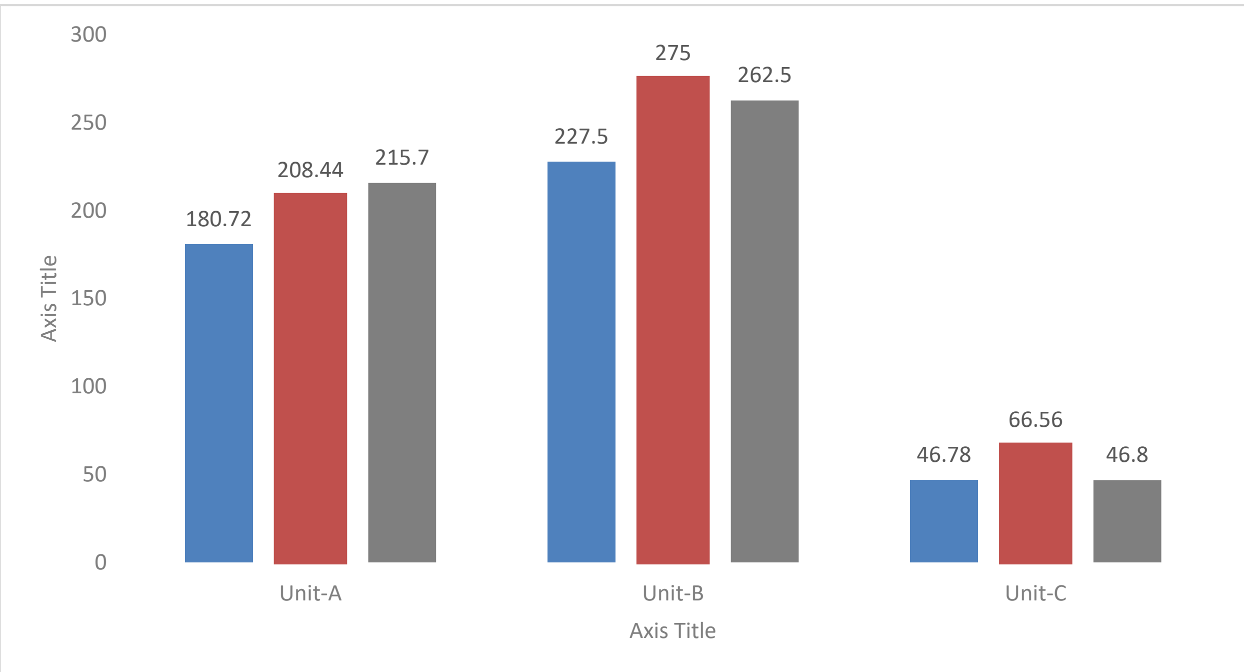

Fig. No. -4: Total cost and refund to small scale enterprises of northern region per Kg

V. Summary and Conclusions

- In 2021, Jai Satnam SHG, established in Bemetara district, manufactures sanitary pads using raw materials, packaging, labor, and other costs. Each packet costs Rs. 29.52, and is sold for Rs. 36.00, generating a net income of Rs. 06.48 per packet. The SHG's marketing strategy involves directly producing and selling the product to consumers and self-help groups.
- Research in Gariyaband district in 2021 found that organic pesticides are environmentally friendly and can be obtained directly from nature. Agneestra, Brahmastra, and Dravya Jeevamrut have the highest profit from organic pesticides, with Gayatri Self Help Group's annual net profit being Rs 51146.
- In Gariyaband district, research showed that organic pesticides are beneficial for the environment and can be obtained directly from nature. The total annual net profit of Gayatri Self Help Group from organic pesticides was Rs 51146.
- In Kanker district, research showed that Lac production was produced at an average of 542 kg/acre, with Radha SHG achieving a total net return of Rs. 66810.97/acre and an average gross return of Rs. 103744.97/acre.

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FINANCIAL ANALYSIS OF SOAP AND GULAL THROUGH SHGs OF DONGARGAON BLOCK OF CHHATTISGARH

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ABSTRACT

This research deals with "Women Empowerment" a burning issue all over the world. "Women empowerment" and "women equality with men" is a universal issue. Self Help Groups, as micro financial institutions emerged as an impetus for community action. The present study addressed the rural Chhattisgarh through “Financial Analysis of soap and gulal through SHGs of Dongargaon Block of Chhattisgarh”**.** 51 respondents selected from selected block dis. National Rural Livelihood Mission Rajnandgaon gave the guidance for producing and marketing of SHG products. All women were very much interested in different activities. I have selected soap and gulal making at home, for the study purpose, through this research analyzed the cost, returns and marketing pattern of soap and gulal. They supply all product to local market, wholesale and C-mart. To facilitate and solve problems in income Generation Programmes of SHGs as the SHGs are playing a crucial role in alleviation of poverty, in this regard, the state Government may consider giving preference to uncovered areas for promoting the SHGs. Education is very important to know about the credit facilities.

Key words: women empowerment, micro finance, community, C-Mart, alleviation of poverty.

INTRODUCTION

Chhattisgarh is a one of the states of India, which is located at the central-east of the country that was formation at 1 November 2000. Chhattisgarh have tremendous agricultural and allied opportunities and called as “Rice Bowl of India.” “Self Help Group is a small economically homogenous affinity group coming together to save small amount of money regularly, which is deposited to common fund to meet their members.” Informal association of people who are came together to find ways to improve their standard of living, the members of the SHGs are self-governed and similar in economic background. Many women are actively involved in SHGs the total number of SHGs in India:- 20,57,205 and total number of SHGs in C.G.:- 2,59,699. The study areas was Khairagarh district selected. The numbers of SHGs in Khairagarh 4354. (https://nrlm.gov.in)

OBJECTIVES

1. To analyze the cost and returns of different products produces by the SHGs.
2. To find out the marketing pattern of different products produces by the selected SHGs.

Methodology of research

The respondents selected from Khairagarh district of Chhattisgarh plains. The finding was reported under data collection and analytical tools or methods applied for analyzing the data are presented below with specific objectives:

The detailed methodological frame work is described in the following sub-sections:

Sampling Technique

Convenience sampling technique was used in collection of data using structured schedules which was sent to the members of the self-help groups functioning in Khairagarh districts of Chhattisgarh.

Statistical tool analysis

The data was tabulated using percentages and the data was presented in the form of simple analytical tables for ease of analysis. In order to get a visual and clear understanding of certain data they were represented in the form of figures. MS excel was used for tabulations and analysis. Collected data was edited and checked for their adequacy and accuracy keeping in view the objectives of the study.

Cost of production:

The expenditure incurred in producing a unit quantity of output is referred as cost of the production. The cost of production is a summation of Total Variable Cost and Total Fixed Cost.

Cost of Production = Total Variable Cost+ Total Fixed Cost

1. **Variable Cost:** The variable cost includes of raw materials, labor charges, electricity charges, water charges, maintenance charges of machinery etc. And the summation of all the variable costs is called as Total Variable Cost.
2. **Fixed Cost:** The fixed cost includes costs like taxes, insurance, land rent, infrastructure etc. And the summation of all the fixed costs is called as Total Fixed Cost.

2. Profitability Concepts:

1. Gross Income: It is referred as total amount of money you get for your product.

Gross Income = Physical Quantity X Price/ unit

2. Net Income: Gross income minus total cost is referred as net income.

Net Income = Gross Income – Total Cost

3. Input- Output Ratio: It indicates the relation between the quantity of material used in the production and the quantity of final output.

Input – Output Ratio = Gross income/ Total Input

Total input =Value of purchasing raw material and use of resources.

Total output = the quantity of various product sold by SHGs was treated as the output values.

4. Benefit Cost Ratio: Here we will compare the present worth of cots with present worth of benefits. It is a profitability indicator.

B/C Ratio = Net Income/ Total cost

5. Variable cost ratio(VC Ratio)

The variable cost ratio is an expression of a SHGs variable production costs as a percentage of sales, calculated as variable costs divided by total gross income.

VC Ration = (Variable cost / Gross income) ×100

Result and discussion

Cost and return of different products produced by selected SHG in Dongarhgaon block

This study was deal with cost and returns of different products produced by selected SHGs in Dongargaon block which were Padamshree Dhanlaxmi SHG. They are participated in many activities and earn income.

Padamshree Dhanlaxmi SHG

Padamshree Dhanlaxmi SHG is popular group of members in this block, under this SHG 14 members work together with mutual help.

a. Cost and returns of making soap,

Table 1 shows the cost and returns of making soap, the total two types of soap were produced by this SHG. Total cost of small soap and large soap were 174 Rs/10 soap and 193 Rs/5/ soap respectively. Gross income of small soap and large soap were 250 Rs/10 soap and 245 Rs/5/ soap respectively. Net return 76Rs/10 soap and 52 Rs/5/ soap respectively. The input-output ratios of small soap and large soap were 1.43 and 1.26, B-C ratios of small soap and large soap were 0.43 and 0.26 and variable cost ratio in percentages of small soap and large soap were 54.22% and 55.62% respectively.

Table 1 Cost and returns of making soap (Rs/10/5 soap)

S. No.	Particular	small size soap(Rs/10)	large size soap(Rs/5)
1	Soap base1 kg	120	120
2	Tulsi	2	6
3	Aloe Vera	3	7
4	Rose Gel	8	12
5	Additive Colors	4	9
	Total raw material	137 (78.73)	154 (79.79)
6	Transportation cost	2 (1.14)	4 (2.07)
7	Packaging cost	3 (1.72)	6 (3.10)
8	Labor cost	25 (14.36)	20 (10.36)
9	Others	7 (4.02)	9 (4.66)
	Total cost	174 (100.00)	193 (100.00)
12	Sale price	25	49
13	Gross income	250	245
14	Net return	76	52
15	Input-Output ratio	1.43	1.26
16	Benefit cost ratio	0.43	0.26
17	Variable cost ratio	0.69	0.78
18	Variable Cost ratio in %age	69.6	78.77

Note: Figures in parenthesis shows the percentage to total cost

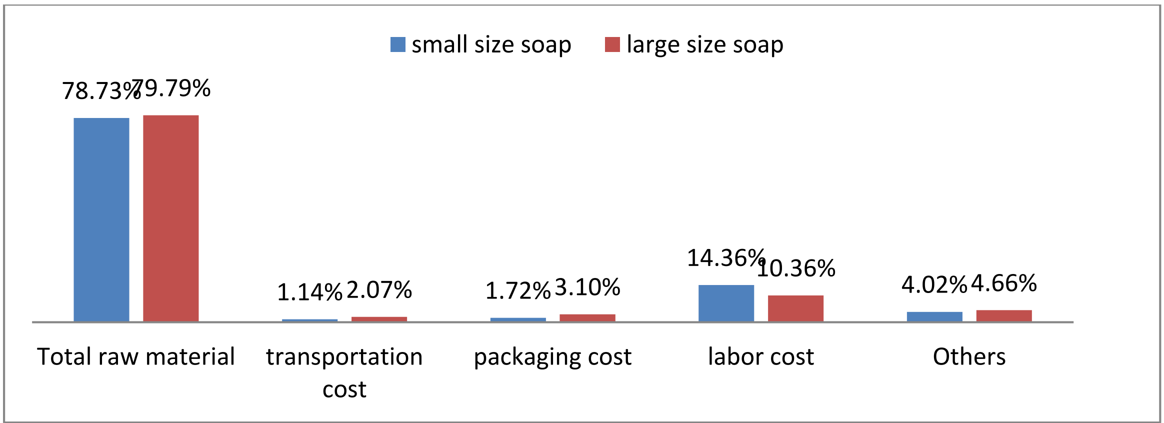

Fig 1: percent share by different cost.

b. **Cost and returns of making gulal**

Table 2 shows the cost and returns of gulal (Rs/kg). The total cost of gulal was 180 Rs/kg. The gross income of gulal was 280Rs/kg. The net income of gulal was 100 Rs/kg. The input output ratio of gulal was 1.55. The benefit cost ratio of gulal was 100 Rs/kg. The Variable cost ratio of gulal in percentage was64.28%.

Table 2: Cost and returns of making gulal(Rs/kg)

Sr.No.	Particular	Gulal
1	Raw material(vegetable/fruits/flower for colour)	50 (27.71)
2	Corn flour	40 (22.22)
3	Transportation cost	3 (1.66)
4	Packaging cost	2 (1.11)
5	Labour cost	60 (33.33)
6	Others	25 (13.88)
7	Total cost	180 (100.00)
9	Gross income	280
10	Net return	100
11	Input-output ratio	1.55
12	Benefit cost ratio	0.55
13	Variable cost ratio	0.64
14	Variable Cost ratio in %age	64.28

Note: Figures in parenthesis shows the percentage to total cost

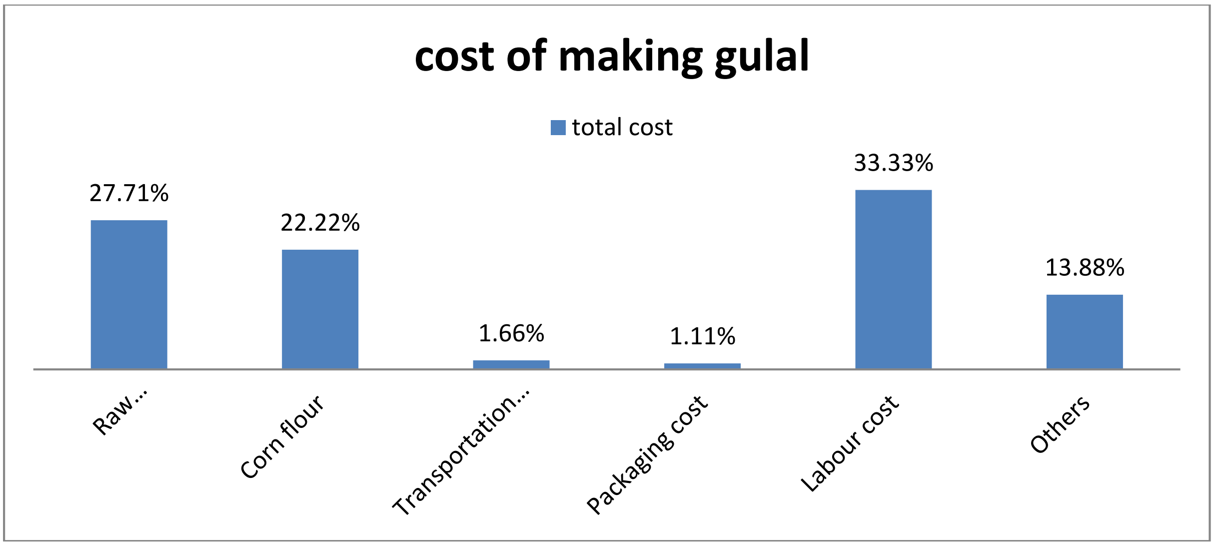

Fig 2 : percent share by different cost

Business performance of Padam Dhanlaxmi SHG

The business performance of Padam Dhanlaxmi SHG product is presented in Table 3. The total sale in a year were 2350, 1240, 430 for small soap, large soap and gulal. Net returns/ year of Padam Dhanlaxmi SHG was 73756 Rs and per member net return was 5673.53 Rs. Maximum profit earned from the gulal(58.30) followed by other activities.

Table 3: Business performance of products of Padam Dhanlaxmi SHG

S.No.	Particular	Total sale /Year	Net returns per unit in Rs.	Net returns/year in Rs.	per member net return
1	Small soap	2350	7.6	17860 (24.21)	1373.84
2	Large soap	1240	10.4	12896 (17.48)	992
3	Gulal	430	100	43000 (58.30)	3307.69
	Total			73756 (100.00)	5673.53

Note:figures in parenthesis shows the percentage to net returns per year in Rs

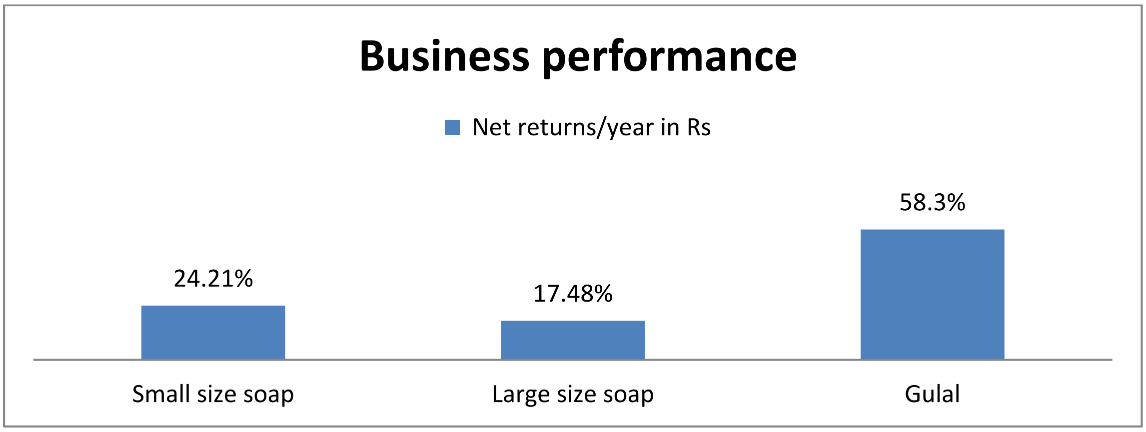

Fig 3: Business performance of SHG products

Summary and conclusion:

Padamshree Dhanlaxmi SHG

Soap and Gulal are very popular now a days in Chhattisgarh. Total cost of small soap and large soap were 174 Rs/10 soap and 193 Rs/5/ soap respectively. Gross income of small soap and large soap were 250 Rs/10 soap and 245 Rs/5/ soap respectively. Net return 76 Rs/10 soap and 52 Rs/5/ soap respectively. The total cost of gulal was 180 Rs/kg. The gross income of gulal was 280 Rs/kg. The net income of gulal was 100 Rs/kg.The total sale in a year were 2350, 1240, 430 for small soap, large soap and gulal. Net returns/ year of Padam Dhanlaxmi SHG was 73756 Rs and per member net return was 5673.53 Rs. Maximum profit earned from the gulal(58.30) followed by other activities.

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Innovation in precision agriculture, soil and water conservation for a sustainable agricultural system

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ICANTFA/001

The term innovation in precision agriculture, soil, and water conservation for a sustainable agricultural system refers to the potential and value-based adoption of precision agriculture, which is essential for ensuring the long-term sustainability of the agricultural farming system. Precision agriculture plays a vital role in advancing sustainable farming practices by enhancing resource efficiency and crop health and then improving productivity while improving and promoting long-term sustainability. Soil conservation practices, such as no-till farming and cover cropping, help in preventing soil erosion, maintaining soil fertility, and enhancing soil structure. Conserving vital water resources for that water conservation technique, like drip irrigation and rainwater harvesting. Soil and conservation maintain healthy ecosystems, improve crop productivity, and ensure long-term food security. Precision agriculture is the integration of data-driven decision-making processes that thrive on analyzing data on the soil composition, weather patterns, and crop performance. Optimize resource use and increase efficiency and improve the sustainable agriculture system. Precision agriculture facilitates this goal through advanced monitoring and management techniques, and by utilizing remote sensing technologies, farmers can monitor crop health and detect pests and diseases and implement targeted interventions. Furthermore, data analytics tools provide insight into optimal planting time, irrigation scheduling, and then pest management strategies, maximizing yield. Integrating precision farming technologies with soil and water conservation strategies provides a pathway towards more sustainable, resource-efficient, climate-resilient, and environmentally friendly agricultural practices.

Keywords: Precision agriculture, soil and water conservation, sustainable agriculture

Categorizing forest vegetation as a weed- A potential threat to biodiversity in the hilly region

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ICANTFA/002

The weed is subjective terms and will change with time, location/place and human bias; while weed also change its status with change in land management system, In this regards, invading new areas for crop cultivation which is already occupied by natural vegetation (with final stage of succession that is complex) bring them forcefully in interference with crop plants. Increasing awareness about losses caused by weeds and ease availability of tools and technology for weed management may treat these in-situ plants as weeds. This can be clarified from the overlapping of natural weed flora and weeds reported in several state where shifting cultivation and cultivation of crops in hilly area is done. The rigorous weed control measures are also expected to change the composition of the natural complex vegetation. The study of important value index which determined from relation density, relative frequency and relative abundance is needed to check any shift in flora occurring and already occurred. The increasing duration of fallow in shifting cultivation as well as depending only on cultural and mechanical methods of weed management helps in reducing the chances of shifts in flora this in-situ vegetation. The restriction at most possible on use of herbicide helps in reducing the selection pressure on any plant or natural vegetation as a whole. The organic farming and /or natural farming is also expected to reduce the changes of treating these plants as weed due to eco-friendly measure of management of natural vegetation. Besides that invading forest and grassland for agricultural activities is unavoidable due to increase in demand of provisional services and to earn more from these private owned land spaces. Hence promotion organic farming, diversification, agroforestry, farming system approach are suitable at micro level; while at macro level monitoring of plant flora shift, mecahnization for weed management, policy for promotion of organic/natural farming and quarantine for introduction of new places is needed. Besides that, generation of scientific reports/ research paper and peer review articles on changes in weed flora shift and developing integrated weed management in such area is needed in future.

Keywords: Weeds, forest, shifting cultivation, organic farming; natural farming.

LASER-ASSISTED HATCHING-AN ALTERNATIVE APPROACH IN ASSISTED REPRODUCTIVE TECHNOLOGY IN BOVINE

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ICANTFA/003

The application of assisted reproductive technologies on mammalian embryos has been increasing over the last 20 years. The use of assisted reproductive techniques includes the dissection of embryos, inner cell mass transfer, nuclear transfer, gene targeting and intracytoplasmic sperm injection and more recently assisted hatching using a diode laser. The application of laser-assisted hatching could be beneficial in the transfer of *in vitro* or *in vivo* produced embryos by increasing blastocyst hatching rates, which may increase implantation rates and subsequently increase pregnancy rates. Pregnancy rates after transfer of *in vitro* produced embryos are still lower in comparison to those produced *in vivo*. Impaired hatching is named as one of several reasons. If complete blastocyst hatching does not occur within the implantation receptivity of the uterus, a pregnancy will not be established. In the mouse, suboptimal culture conditions *in vitro* have been shown to cause hardening of the zona and consequently lead to failure rupture of zona pellucid (ZP) and shedding. Assisted hatching can be defined as the artificial opening of the zona pellucida to promote successful hatching at the blastocyst stage and to overcome implantation failures. Increased pregnancy rates have been reported after assisted hatching in animals as well as in humans. Chemical, mechanical, enzymatic and several laser methods have been used to produce holes in the ZP to facilitate blastocyst hatching. In cattle, an increased hatching rate after ZP slitting and increased pregnancy rate after mechanical puncture of ZP of bovine blastocysts. The use of a 1.48 µm diode laser system has revolutionized the field of assisted reproduction. This technique offers several advantages over already described mechanical and chemical methods. The laser beam is focused through the microscope objective to allow rapid, easy, and non-touch microdrilling of the ZP with a high reproducibility. The size of the laser-drilled openings can be regulated precisely by the time of irradiation. The drilling process can be performed in conventional culture dishes and media. Furthermore, this procedure does not require additional micromanipulation equipment.

EFFECT OF THERMAL STRESS ON OVARIAN FUNCTION OF DAIRY COW

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ICANTFA/004

All animals have a range of ambient environmental temperatures termed the thermo neutral zone. This is the range of temperatures that are conducive to health and performance. The upper critical temperature is the point at which Thermal stress effects begin to affect the animal. There are a number of environmental factors that contribute to Thermal stress. These include high temperature, high humidity and radiant energy (sunlight). Thermal stress can be simply defined as the point where the cow cannot dissipate an adequate quantity of heat to maintain body thermal balance. Exposure to elevated ambient temperature evokes a series of drastic changes in the biological functions that include depression in feed intake efficiency and utilization, disturbances in metabolism of water, protein, energy, and mineral balances, enzymatic reactions, hormonal secretions and blood metabolites. Such changes end with low live body weight and impaired reproduction. The first reproductive challenge facing the Thermal stressed cow is altered follicular development. Thermal stressed cows decrease feed intake causing less frequent pulses of the luteinizing hormone (LH) resulting in longer follicular waves. This lengthening of the follicular wave leads to the selection and ovulation of multiple, smaller dominant follicles. Follicles are responsible for producing estrogen, a hormone that causes cows to show signs of heat. Smaller follicles will produce less estrogen than larger ones; therefore, resulting in less estrus activity. Estrus activity is also lowered due to the cows' reduced motor activity, a means of trying to decrease her endogenous heat output. Thus, the occurrence of silent ovulations or “silent heat” increases, which will ultimately reduce heat detection efficiency even in well-performing heat detection programs. The high uterine temperature of the Thermal stressed cow can impair embryonic development, resulting in poor embryo implantation and increased embryo mortality.

GM Crops: Future of Food, which we can't afford to ignore for achieving Sustainable Agriculture

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ICANTFA/005

GM crops hold immense potential for revolutionizing agriculture and ensuring global food security. Their ability to enhance yields, improve nutritional content, and resist pests and diseases presents a compelling case for their adoption. However, the adoption of GM crops remains controversial due to concerns about environmental risks, human health, and ethical considerations. This paper explores the potential of GM crops as a cornerstone for achieving sustainable agriculture, evaluating both their benefits and challenges. By examining scientific evidence, regulatory frameworks, and case studies from regions where GM crops have been integrated into agricultural systems, this study underscores the importance of carefully managing the deployment of GM technologies. Despite these challenges, the integration of GM crops into agricultural systems is crucial for achieving food security and sustainability. A balanced approach, combining rigorous scientific research, transparent regulatory frameworks, and inclusive stakeholder engagement, is essential to harness the full potential of GM crops while addressing public concerns. Ignoring the role of GM crops in the future of food could hinder progress toward sustainable agriculture and global food security.

Keywords: Genetically Modified (GM) crops, food security, pest resistance, biotechnology, climate resilience.

Agroecology: A Pathway to Sustainable and Climate-Smart Agriculture

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ICANTFA/006

Agroecology combines ecological principles into agriculture for sustainability. It promotes biodiversity, crop rotation, soil health, and natural pest control. Agroecological principles such as polyculture, crop diversity, and integrated pest control help to improve food security by increasing stability and nutrition. Agroecology favor carbon sequestration, soil health, and greenhouse gas reductions, resulting in a climate-resilient farming system. The benefits of incorporating agroecological methodologies into sustainable agriculture, with an emphasis on increasing agroecosystem resilience, improving socioeconomic circumstances for smallholder farmers, rural livelihoods, and local communities, and contributing to climate change mitigation. Agroecological principles map closely to principles of adaptation with the notable exception that while they often display resilience benefits, these are incidental rather than representing an explicit response to climate signals. Current market failures and, perverse policy incentives integrate to mitigate against decisions for farmers and other food system actors to adopt agroecological approaches despite their benefits for climate resilience. Agroecological adoption encounters obstacles like knowledge gaps, technological constraints, and risk aversion. Policy challenges include regulatory frameworks, limited support, and economic pressures, while cultural barriers include traditional beliefs and societal norms. For sustainable agricultural , overcoming these challenges is important. This abstract highlights the potential of agroecology to transform agriculture, ensuring a sustainable, equitable, and climate-resilient food system for future generations. By embracing agroecology, we can create a more just, resilient, and environmentally conscious food system that benefits both people and the planet.

A NEW TECHNIQUE OF SOIL FERTILITY ASSESSMENT FOR LAND USE PRACTICES AND SOIL CHARACTERISATION

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ICANTFA/007

The soil fertility evaluation is the most basic decision-making tool in order to do an efficient plan of a particular land use system. The objective of this study was to assess the soil fertility by potentiometric titration method of soil surface charge estimation. 25 soil samples were collected from the different states of east and north-east India and analyses chemically and potentiometrically. Chemical character, net charge and %base saturation on these soil samples are estimated. A positive correlation exists between net charge, % base saturation, soil pH and CEC. From the analysis it was established that a soil consider to be most fertile when amount of net charge greater than 40 Cmol c Kg -1, medium fertile when net charge in between 40 to 10 Cmol c Kg -1, and non-fertile when net charge less than 10 Cmol c Kg -1. This process is less time consuming, cost effective and more accurate than other previous methods.

Key Words: Base Saturation, CEC, PH, Net Charge, Soil fertility

A Study on Integration of AI and Machine Learning in Genetic Crop Research

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ICANTFA/008

The integration of artificial intelligence (AI) and machine learning (ML) in genetic crop research has transformed agricultural biotechnology. These advanced computational techniques enable more efficient data analysis, predictive modeling, and precision breeding strategies, leading to improved crop yield, resilience, and disease resistance. This paper explores the applications of AI and ML in crop genetics, including genomic selection, phenotyping, and adaptive breeding. Additionally, it examines the ethical, regulatory, and practical challenges associated with the adoption of AI-driven genetic research in agriculture. The future of AI in genetic crop research promises innovations that will drive sustainable and climate-resilient agricultural practices.

Key Words: Artificial Intelligence, Machine Learning, Crop Genetics, Agricultural Biotechnology and Genomic Selection.

Performance of Different Rice Cultivars for Resistance to Yellow Stemborer

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ICANTFA/009

The field experiment was carried out at the Institutional Research Farm of Palli Siksha Bhavana, Visva-Bharati, located in Sriniketan, West Bengal, during the Boro season, from December 2022 to April 2023. A screening of 33 distinct rice cultivars was conducted to assess their tolerance levels against *Scirpophaga incertulas*. The assessment of cultivar responses was conducted at both the vegetative and reproductive stages, utilizing adjusted percentage damage metrics for analysis. Late-duration varieties were sown earlier than their early and medium-duration counterparts. The findings indicated that the varieties Anjali, Muktashree, MTU 1010, Ajaya, and IET 5656 exhibited the highest percentages of dead heart, while Jaldi-13, Parijat, Pratiksha, and Ajith demonstrated the lowest percentages. While,white earhead infestation, IR 50, Sahabhagi, IET 5656, Jaya, and Ajith showed the highest infestation rates, whereas the lowest percentages were recorded in Heera, Bhupesh, Pratiksha, and IET 5656.Cluster analyses of the 33 rice varieties revealed that in terms of dead heart and white earhead percentages, Cluster I included MTU 1010 and Pravat with the highest percentages, while Cluster II comprised IET 5656 and IR 50. Cluster III contained Muktashree and Ajaya, which recorded the highest percentages of both dead heart and white earhead, whereas Cluster IV included Nayanmoni and Sahabhagi with the maximum percentages. The minimum percentages of dead heart and white earhead in Clusters I, II, III, and IV were represented by Jaldi-13 and PNR 546, Sukumar and Heera, Triguna and Bhupesh, and Parijat and IR 36, respectively. Cultivars such as Gotra 1, Parijat, Pushpa , PNR 546, Pravat, and Gotra 2 consistently exhibited resistance or moderate resistance at various growth stages. This suggests their potential utility in the formulation of resistant breeding programs and the execution of effective pest management strategies aimed at combating the yellow stem borer in rice agriculture.

Keywords: Yellow stem borer, Resistance, Dead heart, white earhead, Cluster analyses

Assessment of Deep-Water Rice Varieties Under East and Southeastern Coastal Plain Agro Climatic Zone of Odisha

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ICANTFA/010

On farm testing (OFT) was of three deep water rice varieties TO_1: CR Dhan 508, TO_2: Cv. CR Dhan 506, TO_3: Cv. CR Dhan 505 was done and compared medium tolerant Pooja variety as farmers practice at 7 farmers field of Jatipur, Basudeipur village of Sakhigopal, Puri during kharif 2023-24 by Krishi Vigyan Kendra, Puri. From the OFT, it was found that cv. CR 508 recorded highest no of panicles /m^2 (344), longest panicle (22.4 cm) and highest no of filled grain/panicle (112 nos.) heaviest grain (22.6 g), grain yield (46.2 q /ha), net return (47855 /ha) and return/rupee (1.90) which was followed by cv. CR 505.

Managing Floral Waste and Its Utilization in Value-Added Products

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ICANTFA/011

Floral waste, generated from various sources such as flower markets, weddings, religious ceremonies, and commercial flower industries, represents a significant environmental challenge. However, it also presents an opportunity for sustainable resource management and the development of value-added products. This study explores innovative methods for managing floral waste and transforming it into useful, eco-friendly products. Techniques like composting, essential oil extraction, and the production of biodegradable products such as paper and dyes are examined. Moreover, the study highlights the potential for creating value-added items like natural cosmetics, fragrances, and bio-based fertilizers, contributing to the circular economy and reducing landfill burdens. Looking into the harmful impact of the improper disposal of wastes on the environment and the slow degradation of these wastes, emphasis should be given on how we can transform this waste to wealth, by their utilisation in diverse sectors, ranging from agriculture to various other industries, creating various value-added products that can help generate livelihood as well. This research underscores the importance of promoting sustainable practices in floral waste management to drive both environmental and economic sustainability. India is a country with lots of different religions where, worshiping is the way of living and people offer various offerings to the deities, out of which floral offerings are found in huge quantity. Therefore, temple waste has an exceptional share of flower waste in the total waste. This floral waste can be properly managed and utilized in various value added form. Handmade paper can also made by utilizing these waste products. The presentation focuses on important application of floral wastes which, helps to cope up with energy crises and environmental pollution.

Key words: Floral waste, value added products, temple waste, Composting of Floral Waste, Energy Crises and Environmental Pollution Solutions.

The Role of Extension in the Development of the Farmer as an Entrepreneur

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ICANTFA/012

Entrepreneurship is characterized as the identification of possible business opportunities and their exploitation through the recombination of resources. Agricultural entrepreneurship involves more than just farming; it also entails creating possibilities and fostering innovation within the industry. The historical background of entrepreneurship in agriculture dates back to the era of traditional farming. The growth has ranged from traditional agriculture from sustainable agriculture to precision farming. Entrepreneurship in extension supports local economic development provides economic significance to individuals and enhances the general welfare of rural communities. The entrepreneurship development programs, which encompass a wide range of endeavours from mentorship and skill development to market connections and access to capital, are crucial in enabling people to fulfil their entrepreneurial dreams. Entrepreneurial skills are important in handling business, managing finances and maintaining valuable connections. Now a days digital platforms and technological innovations have helped entrepreneurs to easily manage the enterprises. Emerging trends like digital transformation. Sustainable and social entrepreneurship, precision agriculture provide effective support to entrepreneurs. Enhancing rural livelihoods, reducing poverty and promoting sustainable development depend heavily on entrepreneurialism in agriculture. It supports local economic development, provides economic significance to individuals and enhances the general welfare of rural communities The secret to unlocking the potential of entrepreneurial endeavours in the agriculture sector is in recognizing the complex interplay between agri preneurship and its significant effect on local economies. The success stories of agripreneurs act as motivational case studies, illustrating how these people and entities have not only changed their own lives but also significantly accelerated economic growth and rural development.

Key words – Entrepreneurship, skill development, extension, entrepreneurialism

A study on delaying rapid sprouting of potatoes by controlled release of essential oils.

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ICANTFA/013

The present research explores the potential of essential oils as natural inhibitors to control potato sprouting, offering a sustainable alternative to chemical suppressants. Five essential oils lavender, rosemary, peppermint, ajwain, and palmarosa were evaluated by applying two drops (0.04g) per batch to two groups of potatoes.one fresh and unsprouted, the other in the early stages of sprouting. The oils were applied to cardboard boxes containing 500g of potatoes, ensuring gradual diffusion without direct contact. Sprout formation was carefully monitored and compared against untreated samples. Among the tested oils**,** peppermint essential oil exhibited the highest efficacy**.** The oil effectively prevented sprouting in unsprouted potatoes and significantly delayed sprout development in those already sprouting. The findings highlight the practicality of essential oils in post-harvest management**,** addressing critical challenges such as food security, economic loss, and health concerns linked to conventional suppressants like chlorpropham (CIPC). While traditional methods like chemical inhibitors and cold storage are widely used, they pose environmental and health risks, including potential carcinogenic effects. In contrast, essential oils present a safe, eco-friendly solution that aligns with global sustainability efforts to reduce food waste and promote greener agricultural practices**.** As a staple food crop worldwide, potatoes suffer significant post-harvest losses especially due to sprouting**.** Sprouting not only reduces market value but also triggers the formation of toxic glycoalkaloids like solanine, posing serious health risks. This research establishes a foundation for optimizing essential oil applications in large-scale potato storage, with future studies focusing on enhancing controlled release systems for sustained diffusion and developing practical, farmer-friendly application methods for effective post-harvest preservation.

Growing Flowers on a Rooftop

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ICANTFA/014

Roof gardens may be excellent alternatives to ground-level manicured spaces that have a natural appearance. A flat roof may be transformed into a verdant roof garden with a little creativity and inspiration. Numerous rooftops of a city can be transformed from a barren landscape into a living network of gardens. A green roof is a contained ecological oasis for nature on top of human-made structures and it constitutes an environment that is very different from a garden rooted in natural soil at ground level. Rooftop gardening is a special type of urban agriculture or urban horticulture. Standing on one of the higher floors of a building, one sees immediately how extremely large the total surface of the roofs in the city is. These roof spaces are generally unused. Even in the densest metropolitan locations, they are constantly available and frequently receive adequate exposure to sunshine and rain. Roof gardens have been proven to reduce the effects of the urban heat, the result of sunlight reflected off concrete and other reflective materials, which can make summer air in dense cities up to 10 degrees hotter than in rural areas. More energy must be used to cool buildings, and more air pollution is created in the form of smog. Rooftop gardens keep buildings cooler in summer and warmer in winter. Air conditioning costs are cut down and roof gardens can cool the whole city by several degrees in summer. use of flowers on rooftop areas for both aesthetic and energy-saving reasons. The goal of the topic "Rooftop gardening of flowers: An exploratory way" is to talk about various possible ornamentals and garden designs that can be modified for rooftop gardening.

Keywords: Urban Heat Island Mitigation, Energy Savings and Building Insulation, Space Optimization, Urban Agriculture and Horticulture, Design Considerations and Aesthetic Appeal, Biodiversity, and Ecological Benefits, Flowers for Roof Gardens.

A Study on Awareness of Farm Workers towards Handling of Pesticides in Bilaspur District of Chhattisgarh State

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ICANTFA/015

In present scenario pesticide becoming harmful for human health and environment. Excessive use of pesticides directly affects the farmers as well as soil, water and our environment. The aim of this research is to know the awareness of farm workers about the handling of pesticides. Understanding their level of knowledge, attitudes, and behaviors about pesticide application can help in identifying the gaps and designing effective interventions for safer pesticide management. The research study was conducted in bilha block of Block of Bilaspur district in Chhattisgarh. Three villages were selected for the primary data collection with help of random sampling technique. For the research, 100 respondents were selected from three villages namely Birkona, Turkadih and Lokhandi for data collection used structure questionnaire and interview schedule. All collected data were coded, classified, tabulated and analyzed using SPSS tool pack and Microsoft office excel. Descriptive results were expressed as frequency and percentage only. The results found that the knowledge and awareness on the risk of pesticides used among farmers is very low. Farmers do not even know that red, yellow, blue and green labels depict extremely toxic, highly toxic, moderately toxic and less toxic respectively. Training activities and programs can lead to increased levels of knowledge about safety precautions while handling pesticides. It is imperative that proper training programs on pesticides safety and on the hazards of pesticide exposure be developed to address gaps in farmer's knowledge about pesticides.

Keywords: Pesticides, Environment, Health, Agriculture, and Chhattisgarh

Precision Fertigation in Drip Irrigation Systems: Enhancing Nutrient and Water Use Efficiency

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ICANTFA/016

Precision fertigation in drip irrigation systems is a revolutionary solution for maximizing water and nutrient use efficiency in agriculture. Fertigation minimizes losses by leaching and runoff whilst increasing the efficiency of uptake by plants by direct delivery of nutrients to the root zone in quantities that are just sufficient. The primary purpose of this study is evaluation of real time monitoring, automated nutrient dosing, and sensor-based control system for the optimization of fertigation schedules. Advantages include yield and quality improvement, environmental and resource use efficiency. Precision fertigation is shown in case studies to improve water productivity and nutrient use efficiency in different crops. Additionally, system maintenance, the initial investment as well as the need for skilled management are discussed to encompass additional challenges. The research highlights the potential of precision fertigation as a sustainable means of modern agriculture thereby promoting increase in productivity with the conservation of water and reduction of fertilizer wastage.

Keywords: Precision fertigation, Drip irrigation, Nutrient-use efficiency, Water productivity, Smart irrigation, Sustainable agriculture

PREPARATION OF SOIL FERTILITY MAPS OF THIRUNALLAR COMMUNE, KARAIKAL, U.T. OF PUDUCHERRY USING GIS AND GPS

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ICANTFA/017

A study was conducted at Thirunallar commune of Karaikal district of U.T. of Puducherry with a view to characterize and to prepare soil fertility maps. Two hundred and thirty-three surface soil samples (0-15 cm) were collected with GPS coordinates. The samples were analyzed for bulk density, particle density, soil texture, soil colour, pH, EC, organic carbon, CEC, exchangeable cations, available macronutrients viz., N, P, K and available S and available micronutrients (Fe, Mn, Zn and Cu). The available sulphur was sufficient in range (85.16%), and mapping of soil for exchangeable calcium and magnesium revealed that 85.16 per cent (3730 ha) was sufficient in range. With regards to micronutrient status, mapping of soils for available Fe, Mn and Cu content revealed that 85.16 per cent (3730 ha) was sufficient in range whereas, the available Zn content revealed that 84.65 per cent (3707 ha) was sufficient in range and 0.51 per cent (23 ha) was deficient in range, respectively. Based on the thematic map, it was concluded that the soils of entire Thirunallar commune were neutral to alkaline in soil reaction, very less saline to less saline, low in organic carbon and available N, high in available P, medium to high in available K and sufficient in available S, exchangeable Ca and Mg and Micronutrients except Zn.

Keywords: geographical information system; soil fertility; thematic map

Millets: Climate Resilient Nutritious cereals

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ICANTFA/018

Considering the present status and importance of millets, a study on awareness and perception of millets among small farmers was conducted in Bilha block of Bilaspur District in Chhattisgarh with aims of assessing the perception and awareness of small farmers about the millets. On the recommendation of India, the United Nations proclaimed 2023 to be the International Year of the Millet. Resilient cereals, like millets, offers a cheap and wholesome alternative for nutritional values, hence encouraging their production must be prioritized. Millet's cultivation may play a significant role towards empowering small-holder farmers, accomplish sustainable development, and end hunger. The three villages namely lokhandi, birkona and turkadiah were selected from bilha block with help of purposively sampling technique and 50 respondents were selected from each village. Thus, a total of 150 small farmers were selected from three villages with the help of stratified sampling techniques for primary data collection. The results revealed that majority of the respondents (88.66%) were aware of Kodo Millet (Kodara), Paspalum scrobiculatum, followed by Sorghum (Jowar), Sorghum bicolor (82.66%), Pearl Millet (Bajra), Pennisetum typhoideum (81.33), Finger Millet (Ragi), Eleusine coracana (78.66), Little Millet (Kutki), Panicum sumatrense (59.33), Barnyard Millet (Sawa) and few others. Most of the farmers are known of Small and Coarse Millets but due to lack of awareness about their importance very few respondents adopt them in daily diet. 79 respondents considered Millets as the best food for children and 50 respondents considered it as a rich source of fibre.35% respondents agreed that it is a good source of protein. Government should encourage the farmers to cultivate Climate-resilient crops various small and coarse millets to increasing income and healthy lifestyle.

Key words: small millets, Perception, Benefits small farmers, Climate-resilient crops**,** and Chhattisgarh

Screening of Wheat Genotypes for Lodging under Simulated Field Conditions

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ICANTFA/019

Current climatic vagaries and high-input cultural practices in the key wheat-producing regions are drawing attention to the problem of lodging. Lodging refers to the permanent vertical displacement of plant stems, caused by wind, rain, or hailstone. It is estimated that wheat lodging can cause a reduction of up to 80% in grain yield. Lodging resistance is directly related to the morphological structure and physiological efficiency of stems. Improving stem mechanical strength can significantly enhance the ability of crop to withstand lodging. In order to comprehend and distinguish the effects of lodging on wheat cultivars, a group of forty newly released wheat varieties, mutant lines, synthetic wheat genotypes, selected breeding material from international nurseries and dwarf lines were utilized to study the occurrence of lodging. The sowing was done in four-line plot of two metre length in two replications at the experimental farm of ICAR-IIWBR during 2023-24. All the standard agronomical practices such as, dose of fertilizer, irrigation at all critical stages and roughing were followed to raise a normal crop. The screening for lodging tolerance was done during the grain filling period with the help of 'Wind Tunnel'. Wind tunnel is a customized instrument designed for lodging induction in field which can simulate lodging with a wind speed of upto 90Km/h along with rainfall like situation. Screening for lodging was done on the scale of 0-5 (where 0: No lodging; 5: Completely lodged). In the experimental field, plant height (88-147cm), spike length (9.3-13.6cm), thousand grain weight (34-52g), biomass (2-4.10g), peduncle length (26.2-54.9cm), along with length and width of lower three internodes, lodging percentage, lodging score, weight of three lower internodes (g) and tensile strength (kPa) were recorded in both the lodged and non-lodged conditions. Considerable variability in culm characteristics have been noted among the tested wheat genotypes. The maximum positive correlation of lodging was identified with peduncle length (r=0.72) followed by plant height (r=0.57). The internode weight of all three lower internodes showed a negative correlation with lodging. The identified wheat genotypes can be utilized to develop lodging-tolerant wheat varieties.

Understanding Of Metabolite Profiles of Pigmented and Non-Pigmented Rice Using High Throughput HS-GC-MS/MS-Based Approaches

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ICANTFA/020

Most people, especially in Asia and Africa, eat rice (Oryza sativa) as their primary food source. The therapeutic and nutritional value of rice can be increased for people with lifestyle diseases. In the current study, red, black, brown, and white rice grains were subjected to an analysis of volatile metabolites, including primary metabolites, using gas chromatography-mass spectrometry (GC-MS) and MetaboAnalyst. This analysis resulted in the identification of 162 compounds from 26 distinct classes of metabolites. Red, black, brown, and white rice's metabolite profiles showed qualitative variations. A significant separation of grains with different pericarp colors was evident in the data from semi-targeted metabolite profiling after principal component analysis (PCA). PLS-DA, or partial least square-discriminate analysis, identified 68 distinct metabolites that were all substantially different. The PLS-DA study of the variable importance projection (VIP), which revealed the top 15 key differential metabolites, further supported the identification of the 3-Hydroxy-4-methoxybenzoic acid, Oxalic acid, 2-(Dimethylamino)ethyl vaccenoate, 6-Octadecenoic acid, and Hexadecane metabolites as significant and differentiating between the genotypes.Five significant pathways were found, and as a result, the route linked to the biosynthesis of unsaturated fatty acids has the greatest impact. This is followed by nodes linked to the production of cutin, suberin, and wax, as well as the sulphur metabolism and the fatty acid pathway, which were found to be significantly different metabolomic pathways. Additionally, a pathway enrichment analysis of metabolites was conducted to determine which potential primary metabolites may be responsible for the therapeutic properties of both pigmented and non-pigmented rice.

Keywords: Pigmented rice, metabolites, principal component analysis, PLS-DA, VIP

ECOPRODUCTION OF LACTIC ACID (LA) AND CONVERSION OF POLYLACTIC ACID(PLA)

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ICANTFA/021

Plastic which is made up of polymers derived from petrochemical have negative impact on global environment and sustainable agriculture. There has been extensive research carried out for the production and development of alternative decomposable plastic of biological origin. PLA is a thermoplastic material with rigidity and clarity similar to polystyrene (PS) or polyethylene terephthalate (PET). PLA is aliphatic polyesters for wide range of applications, due to its biodegradability, renewability, excellent mechanical properties, good processability and cost effective. The production of optically pure lactic acid is essential for the polymer synthesis in which L and D-lactic acid is used. Of the total lactic acid produced worldwide every year, about 90% are made by lactic acid bacterial fermentation and the rest is produced synthetically by the hydrolysis of lactonitrile which is very expensive.

Whey is obtained from dairy industry as a waste material, which is green in colour, translucent liquid. It is obtained from milk after precipitation of casein. Lactose rich dairy by-product whey can be low-cost substrate for the production of lactic acid. The production of lactic acid through lactic acid bacteria (LAB) could be an alternative processing route for whey lactose utilization. The use of biotechnological techniques to find suitability of whey for lactic acid production can serve dual purpose, i.e. Production of valuable product, lactic acid and addressing to the whey disposal environmental pollution problem. Hence the present investigation was aimed to use waste material from dairy industry (whey), to produce lactic acid using *LAB* and optimization of whey percent in the media to maximize the production, followed by purification of the crude lactic acid by Chromatography techniques. Then the lactic acid is converted into polylactic acid (PLA). This could be used for the production of decomposable bioplastic.

Key words: whey, bioplastic, LAB, PLA

Health risks and challenges faced by tribal women in Agriculture

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ICANTFA/022

The gradual process of women entering the workforce as paid labour has been going on for several centuries, with a significant increase after World War II and industrialization. Tribal women make up half of India's workforce, and they face obstacles to a decent life and a sustainable livelihood because of environmental degradation and outside interference. No field operation is out of their reach. As farm women involve both in household and farm activities, they are more prone to health hazards. They are exposed both outdoor and indoor environment. The different types of hazards are physical, chemical, mechanical, biological, psychosocial and ergonomical. Since women in agriculture make up the majority of the country's potential human resource, their health serves as the foundation for its development. Economy and production are closely related to occupational health. India, a large agricultural country, does not have a strong legal framework to address the occupational health problems that agricultural women workers face. The main public health issue facing India in the upcoming years will be occupational diseases, so it is imperative that a network of multi-stakeholders, including the government, private sector, nonprofits, and civil society organizations, work together to improve the quality of life for agricultural women workers. Several studies reported that constraints faced by the tribal farm women in agricultural were illiteracy, lack of irrigation facilities, lack of educational facilities, uneven land, lack of knowledge about improved agricultural technology, lack of transportation facility, unfavourable climatic conditions, low selling price of farm produce, lack of regular and timely contact with experts, lack of marketing facility, lack of training, and unemployment during off season.

Keywords- health risks, Women in agriculture, agricultural activities, health hazards

Effect of Crop Establishment Methods and Weed Management Practices on Weed Growth, productivity, and Profitability of Transplanted Rice (Oryza sativa L.) under coastal and Saline Belt of West Bengal, India

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ICANTFA/023

A Field experiment was conducted to evaluate the effect of crop establishment methods and weed management practices weed growth, productivity and profitability of transplanted rice of transplanted *kharif* Rice (*Oryza sativa* L.*)* under coastal and saline belt of West Bengal at an Instructional Farm at Sasya Shyamala Krishi Vigyan Kendra, Arapanch, South 24Pgs, West Bengal during 2022 in Split-Plot Design with three replications. Conventional and System of Rice Intensification were taken in main plot treatments (2) and different weed management practices (6) were taken under sub-plot treatments. Results have shown that Pretilachlor 1000 gm *a.i.* per ha followed by one hand weeding at 30 DAT were statistically similar with weed free plots and significantly lowered total weed density by 74.2% and total weed dry weight by 60% compared to weedy plots. It has also recorded the highest grain yield which was at par with weed free plots followed by Pretilachlor 1000 gm *a.i.* per ha followed by Na-bispyribac 25 gm *a.i.* per ha at 2-3 leaf stages (15-25 DAT) and Pretilachlor 1000 gm *a.i.* per ha. SRI recorded the highest grain yield, harvest index and B:C ratio compared to conventional method. Among the different treatments, the highest net return (Rs.42514/ha) was obtained under SRI method with combined application of herbicide Pretilachlor 1000 g a.i. per ha followed by one hand weeding at 30 DAT and has also resulted the best among all other treatments.

Keywords: conventional, SRI, weed management, transplanted *kharif* rice

Closing the Gender Divide: Agribusiness as a Catalyst for Rural Women's Empowerment

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ICANTFA/024

In rural areas, economic empowerment for women remains a significant barrier. Promoting economic empowerment for women is one way to address the worldwide problem of gender inequality and achieve sustainable development objectives. Women are the backbone of the agricultural sector and are crucial to managing the use of natural resources, particularly in hilly areas. In spite of this, women's potential and actual contributions to sustainable development have been overlooked and their agricultural activities are characterized by a global gender gap in productivity, access to resources and vulnerability. Agriculture-related processing facilities and handicrafts societies are examples of women-led businesses that create significant revenue streams and job possibilities. Additionally, the addition of value by women to agricultural goods improves market connections and revenue, which helps to reduce poverty and promote sustainable livelihoods. Uttarakhand has a number of departments that offer functional schemes, including. The program currently operates in every district of the state and Supported by the state administration and the Department of Women and Child Development, the program ensures women operate and oversee milk cooperatives, aiming for 100% female participation. For real empowerment and a more sustainable future, it is imperative to dismantle gender stereotypes and support the leadership of women in agriculture. We can start a positive feedback loop by putting women farmers' welfare first and encouraging sustainable farming methods. Beyond herself and their households, these empowered women farmers help create a more stable and healthy future for their community as a whole and the environment they protect.

Keywords: Rural Empowerment, Sustainable Development, Economic Development, Agriculture

Microbial Retting of Jute Fibers

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ICANTFA/025

The bast fibers are removed from the core tissues of jute stem by a process known as retting. Conventional retting procedures are doing wonders in the field of fiber extraction from jute but have witnessed several pros and cons. With the advent of biological sciences precisely the microbial science and advanced enzymology, better quality of fibers can be obtained in an sustainable way accompanied by the superior quality of the fibers. The conventional methods used in the retting procedure have witnessed several pitfalls like poor quality of fibers, demand for large space accompanied by the time of the production. Huge manpower requirement and pollution also add fuels to the retting process. Developments in the field of microbiology has proved to a step forward in the retting process which can supplement the conventional retting lacunas. Thanks to the microbial enzymes like pectinases which are drawing considerable attention for retting of fibers owing to their eco- friendliness and production of good quality fibers. Raised eyebrows of researchers have led the foundation of developing commercial enzyme cocktails like Flaxzyme and Viscozyme to name a few. Vigorous research in the field of microbial retting can be a game changer and a candidate of the hour for production of commercially and environmentally sustainable jute fiber production. With constant research and development the jute industry will be bestowed with more commercially microflora based methods of fiber extraction.

Key words: Jute, Retting, Microbial, Pectinase

Exploring Gendered Vulnerabilities and Adaptive Strategies in the Indian Sundarban Delta: An Intersectional Study

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ICANTFA/026

Climate change is one of the most pressing issues of our time, and we are at a defining moment. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Climate change-related vulnerability encompasses the heightened risk faced by communities, ecosystems, and economies due to their exposure to climate impacts, coupled with their limited ability to adapt or recover from these disruptions. Climate change exacerbates existing social inequalities, disproportionately affecting vulnerable populations based on gender, socioeconomic status, and geographic location. This study conducted in the Indian Sundarban Delta, aims at understanding the levels of vulnerabilities in different vulnerable groups, emphasizing that these disparities are not monolithic but vary within each gender due to intersecting socio-economic factors and suggests coping strategies accordingly. The hierarchical cluster analysis dendrogram revealed the presence of diverse vulnerable groups among men and women, and their respective coping strategies were ranked according to need using Force ranking. Recognizing and addressing these gendered and intra-gender disparities in climate change related vulnerability is crucial for formulating inclusive and effective adaptation policies. Tailored interventions must acknowledge not only the different risks faced by men and women but also the diverse experiences within these groups to foster resilience and equitable climate adaptation strategies.

Keywords: Climate Change, Coping Strategies, Force Ranking, Hierarchical Cluster Analysis, Vulnerability.

Comparative analysis of microwave vacuum drying and tray drying on drying kinetics and physicochemical properties of dried dragon fruit pieces.

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ICANTFA/027

Dragon fruit has emerged as a popular superfruit in the Indian market, recognized for its health benefits, high levels of antioxidants, vitamin C and essential minerals. To prolong the shelf life of this perishable fruit, drying presents a viable alternative to refrigeration. However, the main challenge is effectively reducing moisture content while maintaining the fruit's quality.

This study investigated two drying methods—microwave vacuum drying and tray drying—to evaluate their impact on the drying kinetics and quality attributes of dragon fruit pieces. The samples were cut into three different thicknesses of 0.5 cm, 1 cm and 1.5 cm and were subjected to varying power levels (400W, 600W, and 800W) for microwave vacuum drying as well as different temperatures (40°C, 50°C, and 60°C) for tray drying.

Results showed that microwave vacuum drying significantly reduced moisture content, decreasing from 86% (wb) to 7.27% (wb), 6.34% (wb), and 6.03% (wb) at power levels of 400W, 600W, and 800W, respectively. In contrast, tray drying achieved moisture reductions to 7.59% (wb), 7.28% (wb), and 6.66% (wb) at the same thicknesses. Notably, higher power and temperature levels resulted in faster moisture removal with the most rapid rates observed at 800W and 60°C.

This research highlights the potential of innovative drying techniques to enhance the quality and longevity of dragon fruit.

Keywords: Dragon fruit, microwave vacuum drying, tray drying, drying kinetics, rehydration, vitamin C, colour

Assessment of Carbon Sequestration Potential of Urban Trees: A Case Study from Raipur, India

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ICANTFA/028

Carbon sequestration, the process of removing atmospheric carbon dioxide (CO_2) and storing it in terrestrial, aquatic, or geological reservoirs, is increasingly acknowledged as a vital strategy for mitigating climate change. This study evaluates the carbon sequestration and storage potential of trees in the urban green spaces of Raipur. Urban green infrastructure have substantial potential to absorb atmospheric carbon and play a crucial role in climate change mitigation. To extend the investigation, a comparative study was conducted at Nagar Van Udyan Sondongari in Raipur city, which is divided into four distinct sectors. The primary objective was to assess the carbon sequestration capacity of urban green spaces. Non-destructive methods were employed to estimate both above-ground biomass (AGB) and below-ground biomass (BGB).

The findings revealed notable variations in tree species diversity and biomass across the study sectors. Sector-1 exhibited the highest tree species diversity and species richness. In contrast, Sector-3 demonstrated the highest biomass and carbon stock, with values of 172.64 t/ ha^{-1} and 81.14 t/ ha^{-1}, respectively. This study contributes valuable insights into the dynamics of tree species diversity, biomass, and carbon stock within urban green spaces. The evidence underscores the importance of conserving urban green infrastructure and highlights its potential in advancing sustainable, resilient, and low-carbon urban development. The findings may support policy initiatives aimed at fostering green economic transformation and improving urban climate resilience.

Keywords: Biomass**,** carbon stock, carbon sequestration, green infrastructure, Raipur

Addressing labor shortages in agriculture: The challenges and opportunities of Farm mechanization

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ICANTFA/029

The theme of labor shortage in agriculture has become a growing concern globally, exacerbated by factors such as aging population, migration, and declining interest in farming as a livelihood. This shortage poses significant challenges for food production and sustainability, particularly in developing countries where manual labor has traditionally been a cornerstone of agricultural practices. To address this issue, farm mechanization has been proposed as a solution to increase efficiency and reduce reliance on human labor. However, the adoption of mechanized technologies faces its own set of challenges, including high capital costs, inadequate infrastructure, lack of technical skills and resistance to change from traditional farming communities.

This abstract explores the complex dynamics between labor shortages and the role of farm mechanization in mitigating this problem. It emphasizes the need for strategic investments in technology, education and policy frameworks that balance the benefits of mechanization with the realities of labor market constraints and the socioeconomic implications for rural communities.

Key Words: Labor shortage, Agriculture, farm mechanization, efficiency, technology, adoption, rural communities, workforce, infrastructure, sustainability, economic challenges.

Trade performance of honey in India: A Markov Chain Approach

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ICANTFA/030

The purpose of this study was to use the Markov chain model to predict future honey export to importing destinations and analyze the honey export from India to various major import markets. Secondary data on honey yearly export data from India to other countries were collected from 2013 to 2023.The results showed that the USA, UAE, and Qatar were stable destinations for Indian honey exports, while other importing countries like Morocco, were unstable (had low retention probabilities) in their export share to these markets. The most unstable importing countries were Saudi Arabia, Libya, and Bangladesh. The predicted export shares of honey to major importing countries revealed that the export share of Indian honey is expected to be highest in the USA and UAE over the next four years.

Keywords: Honey, Export, Import, Trade, Markov Chain Analysis

Analysis of the Factors Influencing Household Consumption Expenditure of Beedi Workers

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ICANTFA/031

This study investigates the consumption patterns and factors that influence the consumption expenditure of beedi worker households in Murshidabad, West Bengal. A pretested questionnaire was used to survey 50 households of beedi workers selected by the simple random sampling without replacement method (SRSWOR). Descriptive statistics and multiple linear regression were used for the analysis. The findings show that family size and disposable income significantly increase consumption, whereas savings decrease it. The age and education of household heads have no substantial impact. Food and healthcare constitute more than 70 percent of overall household expenditures. The regression model explains 65.7 percent of the variance in consumption, with income and family size being major factors.

Key Words: Factor, Beedi workers, Consumption, Income and saving

Enhancing Agricultural Market Stability: A Wavelet-Based Approach for Forecasting Onion Price Volatility in South India

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ICANTFA/032

Onions are a vital agricultural commodity, playing a crucial role in enhancing economic livelihoods and ensuring food security. It serves as a significant importance in driving economic activity within agricultural markets. However, the market price of onions is highly volatile, influenced by factors such as weather variability, supply chain disruptions, and market demand. This price instability poses substantial challenges for producers, traders, and consumers, as it impacts farmer profitability and consumer affordability. Accurate and reliable price forecasting is essential for addressing these challenges, offering valuable insights to mitigate risks and stabilize agricultural markets. This study explores the application of wavelet decomposition techniques for improving the accuracy of onion price forecasting in major South Indian markets. By decomposing price data into frequency components, wavelet enhanced models effectively capture short-term fluctuations and long-term trends. The model performance was evaluated using metrics such as Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and Mean Absolute Error (MAE). The results indicate that wavelet enhanced hybrid models outperform traditional benchmark models in predictive accuracy. This study highlights the importance of adopting advanced forecasting techniques to address price volatility and ensure sustainable agricultural practices. It provides valuable insights for policymakers, farmers, and traders, enabling better decision-making and efficient market management.

Keywords: Price volatility, Time Series Forecasting, Agricultural Marketing, Wavelet decomposition, Multi-resolution Analysis, Predictive Modeling

Modification and Performance Evaluation of Manually Operated Weeder

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ICANTFA/033

Weed management is one of the tedious operations in crop production. Due to labour costs, time and fully manual weeding is unfavorable. Hence effort is made to design efficient farm equipment to perform weeding without electric power. The conception and key characteristics of simulation-based design and the advantage of using it to create the driving mechanism of three-row weeding equipment were discussed. Weeding and hoeing is generally done 15 to 20 days after sowing. The weed should be controlled and eliminated at their early stage. Depending upon the weed density, 20 to 30 percent loss in grain yield is quite usual which might increase up to 80 per cent if adequate crop management practice is not observed. Rice and groundnut are sensitive to weeds. Competition in the early stage of growth and failure to control weeds in the first three weeks after seeding, reduce the yield by 50 per cent. Manual weeding requires a huge labour force and accounts for about 25 per cent of the total labour requirement, usually 900-to-1200-man h/ha. The functional efficiency of the weeder is 87%, the Theoretical field capacity is 0.0375ha/hr, the Effective field capacity is 0.03ha/hr, the Field efficiency is 81% and the Soil inversion is 87% One man can weed a 1-acre area in 42 days. One man can weed an acre area in 25 days with a manual weeder.

Keywords: Weeding, Tynes, hand pulling, soil inversion, field capacity.

Morpho-cultural studies of *Sclerotium rolfsii* causing Collar Rot of Chickpea

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ICANTFA/034

Sclerotium rolfsii is a devastating soil-borne pathogen causing destructive collar rot disease in chickpea crops. It primarily attacks the collar region of the plant just above the soil surface. It commonly occurs in the tropics, subtropics, and other warm temperate regions of the world. The morphological and cultural variability of *S. rolfsii* infecting chickpea were studied on different solid and liquid media based on the mycelial characteristics (growth pattern, shape, color and dry mycelial weight) and sclerotial characteristics (number, diameter of sclerotia and test weight of sclerotial bodies). Significant variability with reference to mycelial and sclerotial characters was observed on different media. This investigation revealed that the maximum mycelial growth (9 cm) and more no. of sclerotial germination (335/per plate) was recorded in Potato Dextrose Agar medium. More test weight (262 mg) of sclerotial bodies was recorded in Sabouraud's dextrose agar medium. Cultural studies showed the maximum dry mycelial weight of fungus in potato dextrose broth (750 mg) followed by oat meal broth (663 mg).

Key words: *Sclerotium rolfsii*, Collar rot, Sabouraud's dextrose agar and variability.

Biochemical characterization for screening of wheat genotypes against Karnal bunt infection

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ICANTFA/035

Wheat (*Triticum aestivum*), belonging to family Gramineae is one of the nutritious cereals with about 12.1% protein, 1.8% lipids, 70% total carbohydrates and a good source of minerals and vitamins (Verma *et al*., 2019). Although India has the largest area under wheat cultivation, it is the second largest producer of wheat in the world next to China. To meet the world's growing demand for food, it is urgent to develop high yielding varieties resistant to biotic and abiotic stresses (Wang *et al*., 2017). Among the many biotic constraints to wheat production, a serious and an important wheat disease is Karnal bunt (KB) caused by *Neovossia indica*. It was first reported in 1931 from Karnal town in the Indian state of Haryana, later it has been reported in several parts of Asia and several non-Asian countries as well (Emebir *et al*., 2019). The disease is characterized by the replacement of a part of the seed with a black powdery mass of spores. The major impact of Karnal bunt is reduction of yield and quality of grains by imparting a fishy odour and taste. Hence, there is a need for disease screening and identification of tolerant and susceptible genotypes. The objective of this study was to evaluate 50 wheat genotypes for various biochemical attributes related with Karnal bunt after every two days till 10 days of artificial teliospore inoculation of *N. indica*. Total phenolics (mg/gm) & Flavonoids content (mg/gm) and Peroxidase (mg/gm), Polyphenol oxidase (mg/gm) & Phenylalanine Ammonia Lyase activity ($\mu mol^{-1}\ h^{-1}\ g$) was studied. 4 genotypes (HD-3386, WH-1124, PBW-872, P-20205) were found to be highly resistant showing highest values for both the secondary metabolites & enzyme activities, whereas 1 genotype (P-14418) was found to be highly susceptible showing least values for both the attributes. On these basis, 24 genotypes were found resistant, 17 were found moderately resistant and 4 were found susceptible. Based on the identification of high variability among the wheat genotypes for Karnal bunt infection using these biochemical attributes, they can be used as biochemical markers in the breeding programs for selecting highly resistant varieties.

Status review of forest destroyer: White ant (Termite: *Microtermes* & *Odontotermes*)

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ICANTFA/036

Termites are polyphagous pests causing economic losses to a large number of crops worldwide. Among 3105 species of termites, about 185 species are considered as pests globally. The termites that belong to family Termitidae are known to cause great losses to agricultural and horticultural crops. In India, *Odontotermes obesus* (Rambur) and *Microtermes obesi* Holmgren damage crops in both vegetative and reproductive stages, especially wheat, maize, barley, pulses, oilseeds, vegetables, fruits, plantations, sugarcane, cotton etc. The damage can lead to almost 100% yield losses, especially if it occurs in early stages of crop growth. Over the past 60 years, many insecticides from several chemical groups have been used for the management of termites globally. But no single method of control provides a permanent solution. Therefore, IPM approaches viz., cultural, mechanical, biological (*Beauveria bassiana*, *Metarhizium anisopliae*, *Steinernema carpocapsae*, *Heterorhabditis indica*, *Bacillus theuringiensis*, *Pseudomonas fluorescens* etc.) methods, and botanical extracts must be integrated with insecticides in farmer's field to reduce termite problems. Chemical control is largely practiced by the farmers as a sole strategy. However, the results are not sustainable and also costlier for farmers. The complete elimination or prevention of termites in cropped areas is neither feasible nor advisable.

Biocontrol agents never received serious consideration for their utilization especially for field application. Therefore, much more research needs to be done to explore the potential of bioagents for the management of termites infesting agriculturally important crops. Making entomopathogens as a component of an integrated approach can provide significant and selective insect control. In near future, the synergistic combinations of different practices in an integrated manner will provide a sustainable solution to the termite control.

Keywords: *Microtermes, Odontotermes, Termitidae*, infestation of termite management strategies

Effect of Bio-stimulants for Enhancing vase-life of Chrysanthemum

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ICANTFA/037

Post-harvest technology of flower is primarily focused to provide consumers with high-quality, long-lasting flowers. Cut flowers are highly sensitive to microbial contamination at the stem base or in the vase solution, which can significantly reduce their vase life. the experiment entitled "to assess the effect of bio-stimulants for enhancing vase-life of chrysanthemum" was conducted in the laboratory of floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, UBKV, in the year 2022-23 and 2023-24. Eleven different treatment combinations of bio-stimulants were used in this experiment to study the vase life namely, distilled water (control) + sucrose 2% (B_1), aloevera @ 2% + sucrose 2% (B_2), aloevera @ 4% + sucrose 2% (B_3), *Ocimum gratissimum* leaf extract @ 2%+ sucrose 2% (B_4), *Ocimum gratissimum* leaf extract @ 4%+ sucrose 2% (B_5), Lemon juice @ 2% + Sucrose 2% (B_6), Lemon juice @ 4% + Sucrose 2% (B_7), *Mentha piperita* leaf extract @ 2% + sucrose 2%(B_8), *Mentha piperita* leaf extract @ 4% + sucrose 2% (B_9), moringa leaf extract @ 2% + Sucrose 2% (B_{10}) and moringa leaf extract @ 4% + sucrose 2% (B_{11}). The data collected was analyzed for one-way ANOVA and significant variations were at probability value of 0.05 level of significance. The results showed significant difference among the treatmentschrysanthemum var. Snowball during the post harvest vase life, showed the best antimicrobial activity and recorded the minimum count of microbial colonies (43.33×10^4, 56.67×10^4 and 50.00×10^4 cfu/ml in B_7 in Y_1, Y_2 and pooled respectively), the maximum total vase solution uptake (15.76, and 15.53 g in B_7 in Y_1 and pooled respectively) of chrysanthemum var. Snowball during the post harvest period. From the above result, it could be recommended that Lemon juice @ 4% + Sucrose 2% effectively enhance the post-harvest life of chrysanthemum.

Reclaiming Time: Strategies for a Digital Detox

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ICANTFA/038

The mental health and productivity of people require the mastery of from technology in a time when devices rule our lives along with constant interruptions and digital interruptions. Reclaiming Time strategies for a Digital Detox provides readers with actual tools to cut down digital usage while developing mindfulness along with strengthening personal relationships and personal development. People experience anxiety and sleep problems besides focus impairment because they use digital platforms excessively. This publication explains how digital addiction affects human psychology and body and shows proven techniques to achieve equilibrium. Alternative digital boundaries help readers identify personal screen patterns to achieve better time management along with reduced distraction. The essential techniques for managing digital devices include being mindful with screens and planning regular device-free time along with scheduled breaks. The content explains how screen fatigue can be reduced by participation in physical activities along with spending time in nature and having personal face-to-face social interactions. The approach recommends various types of group-based programs which include workplace guidelines and family-cantered programs for enhancing digital well-being. The strategic use of technology enables people to improve their concentration capabilities and creative processes and personal relationships as well as avoid digital exhaustion. The practical guidelines in Reclaiming Time provide every group including students and families and professionals with methods to improve their technology usage. Through this approach readers gain power to re-establish direct experiences with both their own selves and their present environment as well as meaningful events.

Key Words- Sleep problems, Digital detox, Personal relationships, Digital addiction

Evaluation of *Trichoderma* isolates on soil-borne disease pathogens of maize

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ICANTFA/039

Maize (*Zea mays*) is the third most important cereal next to rice and wheat in the world. It contributes about 20 per cent share of worlds total cereal production and also known as "Queen of cereals". Among the maize growing countries, India rank 4th in area and 7th in production, representing around 4% of the world maize area and 2% of total production. Banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* and post flowering stalk rot (PFSR) caused by *Fusarium* spp are two important diseases of maize crop and huge yield loss is also caused by these two diseases. Continuous use of fungicides against the plant disease may cause several side effects to the environment, human health, crops, and beneficial microorganisms. *Trichoderma* has long been recognized as a biological agent which is a substitute to the commercial fungicides against a broad range of fungal pathogens. One of the characteristic features of *Trichoderma* is its rapid growth. It has the ability to quickly colonize and spread in various environments. Conspecuous symptoms of BLSB are cottony mycelium on the ear, ear rot and the presence of small, round, black sclerotia. In Fusarium stalk rot infected plants wilted where the leaves droopy and appear dehydrated. Despite wilting, the plants remained standing instead of collapsing. Inside the infected stalks characteristic symptom of *Fusarium* stalk rot is the presence of a whitish pink to salmon pink discoloration in the pith is seen. Both diseases were found in maize growing districts with high severity. Two isolates of *Trichoderma* TKYI and TMNP showed efficacy against *Fusarium* and *Rhizoctonia* on PDA and Corn Meal Agar. Corn Meal Agar resulted in higher colonization and inhibition percentages compared to PDA for both isolates. TMNP consistently displayed higher colonization and inhibition percentages than TKYI for both pathogens on both media types. Overall, TMNP exhibited stronger bio-control potential against *Fusarium* and *Rhizoctonia* compared to TKYI.

Key words: Trichoderma, Queen of cereals, Biocontrol, Corn meal agar

Management of Rice Root-Knot Nematode, *Meloidogyne graminicola* Through Microbial Consortia

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ICANTFA/040

An important part of the Indian national economy depends on the rice production in India. West Bengal emerges as the largest rice-producing state in India. Soil borne diseases caused by plant parasitic nematodes are one of the major bottlenecks to the crop productivity. More than 200 species of plant parasitic nematodes have been reported to be associated with rice. Rice root-knot nematode (*Meloidogyne graminicola*), rice root nematode (*Hirschmanniella oryzae*), white tip nematode (*Aphelenchoides besseyi*) and stem nematode (*Ditylenchus angustus*) are the important nematodes associated with rice-based cropping systems. Among these rice root knot nematode *Meloidogyne graminicola* is a primary pest of rice and poses a substantial threat to rice cultivation all over the world. A field experiment was conducted at Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya for two consecutive years during 2022 and 2023 for the management of rice root-knot nematode *Meloidogyne graminicola* using some microbial consortia, Biofor pf-2, Biogreen, Biotime and *Pseudomonas fluorescence* by soil application in the nursery bed.The experiment was designed in Randomized Block Design using five treatments replicated four times.The experimental result revealed that all the treatments were significantly better than untreated control with respect to plant height, root and shoot dry weight at the time of harvest. Significantly lowest root knot index (1.55) was found in the Biofor pf-2 treatment followed by the treatment treated with Biotime and Biogreen. With regard to final nematode population in main field at the time of harvest, Biofor pf-2 recorded the maximum percentage decrease in population in 200 cc soil and 5g root (35.42 % and 44.40 % respectively) with highest percentage yield increase over control (40.26 %) followed by the treatment with Biotime and Biogreen (23.81 % and 22.08 % yield increse). According to incremental cost benefit ratio T1 is the best. In addition to managing the nematodes the microbial consortia also acted as growth promoting organism.

Effect of zinc application on growth, productivity, and tuber biofortification in potato (*Solanum tuberosum*)

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ICANTFA/041

Potato is a member of the family Solanaceae is one of the most important food crops all over the world. Potato is heavy nutrient requiring crop. Zinc is the most deficient micronutrient in Indian soils (52%). Zn deficiency in edible plant parts results in micronutrient malnutrition leading to stunted growth and improper sexual development in humans and also affects multiple aspects of the human immune system. The use of Zn-fertilizers on plants that have the ability to absorb Zn and accumulate Zn in their edible sections is an alternative method to raise the concentrations of Zn in crops. This method, known as bio-fortification, promises to boost Zn concentrations in food and feed while also boosting crop yields. Keeping in mind the importance of Zinc application in potato a field experiment was conducted during *Rabi* seasons of 2021-22, 2022-23 and 2023-24 at Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal to study the effect of zinc application on growth, tuber bio-fortification and productivity of potato. The field experiment was conducted with seven treatments which were replicated thrice in randomized block design. The treatment details were – T_1: RDF of NPK (200:150:150 kg N: P_2O_5: K_2O/ha), T_2: T_1 + Soil application of Zinc @ 2.5 kg/ha, T_3: T_1 + Soil application of Zinc @ 5 kg/ha, T_4: T_1 + Foliar application of Zinc sulphate @ 2 g/liter at 25 days after planting., T_5: T_1 + Foliar application of Zinc sulphate @ 2 g/liter at 25 and 50 days after planting, T_6: T2 + Foliar application of Zinc sulphate @ 2 g/liter at 25 days after planting and T_7: T2 + Foliar application of Zinc sulphate @ 2 g/liter at 25 and 50 days after planting. Results showed that growth parameters like plant height, leaf area index, dry matter accumulation and tuber bulking rate were found maximum in T_7. So, it can be concluded from the experiment that recommended dose of NPK (200:150:150 kg N: P_2O_5: K_2O/ha) with soil application of Zinc @ 2.5 kg/ha at the time of planting and two foliar application of Zinc sulphate @ 2 g/litre at 25 and 50 days after planting is the most profitable treatment for potato cultivation and for significant increase in zinc content in potato tubers.

Key words: bio fortification, inceptisols, micronutrient, potato, yield, zinc.

Evaluation of some novel insecticide molecules against Diamond Back Moth, *Plutella xylostella* infesting cabbage under field condition in the Gangetic basin of West Bengal

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ICANTFA/042

Field experiment was conducted at Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal to evaluate the bio-efficacy of some novel insecticides molecules against Diamond Back Moth, *Plutella xylostella* infesting cabbage during *rabi* season of 2019-20 and 2020-21. Total seven treatments viz., Novaluron 10% SC, *Bacillus Thuringiensis*, Imidacloprid 17.80% SL, Spinosad 2.5 SC, Spirotetramat, Chlorpyrifos 20% EC, Chlorfenapyr 10% SC were tested in Randomized Block design. Pooled data of two year revealed that spinosad 2.5% SC was found most effective with overall efficacy of 81.22% and 76.69% and imidachloprid 17.8 SL was found least effective with 39.99% and 39.72% reduction in diamondback moth larva population after first round and second round of spray respectively. Chlorfenapyr 10% SC and novaluron 10% SC were next to follow spinosad 2.5% SC which were statistically at par at 3 days after spray in both round of spray.

The pooled data on head yield revealed that all the treatments were significantly superior untreated control (8.30 t/ha). Yield obtained from treatment spinosad 2.5 SC was highest with 16.40 t/ha. The next highest yield was obtained from plot treated with chlorfenapyr 10% SC (16.25 t/ha) followed by Novaluron 10% SC with 15.20 t/ha, Spirotetramat with 15.10 t/ha.

Key words: Bio-efficacy, cabbage, diamondback moth, new molecular insecticides, spinosad.

EFFECT OF FOLIAR NUTRITION ON GREEN FORAGE YIELD, QUALITY AND SEED YIELD IN DUAL PURPOSE LATHYRUS (*Lathyrus sativus*)

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ICANTFA/043

A field experiment was conducted consecutive 3 years during *rabi* 2021-22, 2022-23 and 2023-24 to study the effect of foliar nutrition on green forage yield, quality and seed yield in dual purpose (*Lathyrus sativus*) at Central Research farm (CRF), Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Nadia, West Bengal, India. The treatments consisted of twelve treatments of foliar nutrition; F_1: Panchagavya @ 3% (30ml per litre of water), F_2: DAP @ 2% (20g per litre of water), F_3: Urea @ 2% (20g per litre of water), F_4: KNO_3 @ 0.5% (5g per litre of water), F_5: NPK (19:19:19) @ 1% (10g per litre of water), F_6: Zinc ($ZnSO_4.7H_2O$) @ 0.5% (5g per litre of water + 2.5 g $CaCO_3$), F_7: Vermi-wash spray @ 10 % (100 ml per litre of water), F_8: Boron (Borax) @ 0.2% (2g per litre of water), F_9: Multi-nutrient spray 1% (10g per litre of water), F_{10}: Nano urea @ 1ml per litre of water, F_{11}: Water spray and F_{12}: No foliar nutrition. The treatments were replicated thrice in randomized block design (RBD). The lathyrus was sown in 20 cm X 10 cm spacing using 60 kg seed/ha. However, treatment F_1 also recorded significantly higher seed yield (1695 kg/ha), stover yield (2261 kg/ha) and Stover CPY **(**3.47q/ha. Recommended dose of fertilizer (N, P_2O_5, K_2O @ 20, 40, 40 kg ha^{-1}) integrated with foliar application of Panchagavya @ 3% (30ml per litre of water) at 40, 65 DAS (after cutting) and at 50% flowering stages, respectively to lathyrus is recommended. It has potential to produced highest green forage yield (160.8q/ha), dry matter yield (36.1q/ha) and crude protein yield (6.37q/ha) as well as highest seed yield (1695 kg/ha). It has highest net return of Rs. 65,952/-per ha with B:C ratio of 3.30. Slight increase in pH (6.71) towards neutral, and organic carbon (0.54%) was noted as compared to initial status [pH (6.67) and OC (0.52%)].

Key words**:** Foliar nutrition, green forage yield, Quality, Seed yield and Dual purpose lathyrus

Effect of Different IBA and NAA Concentration on Rooting and Survival Percent of Firethorn Cuttings (*Pyracanth Crenulata*)

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ICANTFA/044

Pyracantha crenulata, commonly known as Ghingaru or Indian Hawthorn, is a shrub native to the temperate Himalayan regions, particularly in the hills of Uttarakhand, India. Belonging to the Rosaceae family, this plant is also referred to by various names, including Himalayan Firethorn, Nepalese Firethorn, Nepalese White Thorn, Indian Hawthorn, and Chota Seb. The present investigation was carried out on the propagation of Ghingharu (*Pyracantha crenulata*) through semi-hardwood cuttings in a mist propagation chamber at Fruit Nursery, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal. The experiment was allocated within three replications, and each replication contained 15 cuttings under a completely randomized design (CRD) with nine different treatments of IBA and NAA 2000ppm, 4000ppm, 6000ppm, 8000ppm and control. In this investigation, most of the root and shoot characters of cuttings were significantly influenced by the different treatments of IBA and NAA as compared to control. The IBA 6000ppm treatment exhibited the best results concerning root and shoot characteristics, with the highest survival percent (63.52%) of semi-hardwood firethorn cuttings, followed by NAA 8000ppm (55.95%). However, the minimum survival per cent (16.233 %) was recorded under treatment control (untreated).

Keywords: *Pyracantha*; Propagation; Cuttings; IBA; NA

Assessment of heavy metal contamination in urban-periurban soils in a part of the *Terai* region of West Bengal

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ICANTFA/045

The *Terai* agro-climatic region of West Bengal features diverse land covers, including extensive croplands, scattered forests (with several national parks and sanctuaries), and tea gardens. Although the region has towns, cities, and rural areas, it lacks major industrial zones, resulting in limited research on soil pollution. This study seeks to fill this gap by evaluating heavy metals contamination in soils of urban-periurban areas (UPA) in a part of *Terai* region. The study was conducted in the Jalpaiguri district of West Bengal, India, where 50 soil samples were collected across different urban-periurban areas. Air-dried soils were analyzed for bioavailable forms of different heavy metals. UPA soils exhibited significant levels of bioavailable heavy metals, exceeding critical limits, including Zn ($\bar{x}$ = 1.88 mg kg^{-1}), Cu ($\bar{x}$ = 1.37 mg kg^{-1}), Mn ($\bar{x}$ = 2.25 mg kg^{-1}), Cd ($\bar{x}$ = 0.25 mg kg^{-1}), Fe ($\bar{x}$ = 11.36 mg kg^{-1}), and Cr ($\bar{x}$ = 4.31 mg kg^{-1}). Both Pb and Ni remained below critical limits. According to the Pi-Nemerow index, UPA soils fell into the category of moderate pollution ($\bar{x}$ = 2.58), while the pollution load index ($\bar{x}$ = 1.37) indicated a decline in soil quality. Despite the high spatial variability of heavy metals in UPA soils, the findings are concerning, as peri-urban crop cultivation (mainly vegetables) may contribute to soil contamination in croplands, potentially allowing these pollutants to enter the human food chain.

Keywords: *Terai* region, Soil pollution, Heavy metals, Urban-periurban areas, Human food chain

Organic farming in vegetables: Harbouring prospects & addressing challenges

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ICANTFA/046

Organic farming is a method of production that maintains the health of soil, ecosystems, and people. It depends on ecological processes, biodiversity, and cycles tailored to local conditions, instead of relying on inputs that have negative effects. The principles of organic farming focus on improving soil fertility, supporting biodiversity, and reducing environmental impact, all while producing food, fiber, and other agricultural products. The main objective of organic vegetable farming is to enhance the health and productivity of the interconnected communities of plants, soil, people, and animals. The quality of organic vegetable production leads to higher income for farmers. The diverse climatic conditions and a wide range of soil types in India have created significant potential for expanding organic vegetable production. In recent years, the consumption of organic vegetables has increased due to their superior taste, higher nutritional value, and reduced risk of harmful chemical residues. There is growing concern that the modern farming system is becoming unsustainable, as shown by decreasing crop yields, environmental damage, and chemical contamination, among other issues. It is now recognized that there is a need for an alternative agricultural method that operates within an eco-friendly system while maintaining and boosting crop productivity. The key challenges of organic agriculture in the country include the lack of connections between farmers and markets, as well as the absence of financial support from the government. India has the potential to become a leading organic producer due to the global demand for its agricultural products, diverse agro-climatic regions suitable for growing various crops, a large domestic market, and a long-standing tradition of eco-friendly farming and living.

Keywords: Organic farming, Vegetable production, Sustainability, Natural resource

STARTUP: THE IMPACT OF ALLIANCE STRATEGIES ON INNOVATION PERFORMANCE

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ICANTFA/047

India has the 3rd largest startup ecosystem in the world; expected to witness YoY growth of a consistent annual growth of 12-15%, India had about 50,000 startups in India in 2018; Out of these, around 8,900 - 9,300 were technology-based startups which is increasing year by year 1300 new tech startups were born in 2019 alone implying there are 2-3 tech startups born every day. Indian startup ecosystem could see 370 growth-stage startup funding deals in 2023, up only 4.5% from 354 such deals in 2022. Further, the growth-stage funding could touch $7.4 Bn in 2023, approximately 3.9% less than the $7.7 Bn raised in 2022. This study contributes to such a dynamic perspective by incorporating a time dimension in the analyses of the innovation performance implications of alliance strategies. Also, policy makers increasingly adopt an open innovation paradigm. Policy makers start recognizing that intensive collaboration between different actors is a vital element of a healthy national or regional innovation system. As a result, we do not know how the time frame of alliances might influence innovation performance. In this study, we therefore examine the impact of different time frames of alliance strategies on innovation performance. In order to do so, we collected panel data on 217 Flemish startup firms. The results show a positive association between ‘discontinuous alliance strategies with suppliers, customers and competitors and ‘incremental’ innovation performance. In addition, we find a positive impact of ‘continuous alliance strategies’ with suppliers, competitors and universities and other research institutes on ‘radical’ innovation performance. These findings encourage startup firms to balance their alliance portfolio not only in terms of different kinds of partners but also in terms of different kinds of time frames.

Keywords: Innovation, Policy makers, Portfolio, Performance, Alliance strategies.

Biochar-Based Organic Farming: A Climate-Resilient Strategy for Enhancing Soil Health, Productivity, and Farmer Profitability

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Sustainable agriculture demands innovative solutions that balance productivity, environmental conservation, and economic viability. Biochar-based organic farming emerges as a transformative approach, integrating biochar with compost and organic amendments to enhance soil health, improve crop resilience, and increase farmer profitability. Bio-charring is a relatively better option as it not only can be used as an effective soil amendment but also helps in mitigating global warming. Biochar, which is a co-product of biomass thermochemical conversion processes known as pyrolysis, is an effective way to sequester more than 10% of carbon, generate energy and improve soil fertility. The application of biochar significantly ameliorates the fertility of soil as well as the productivity of crops. It was observed that there was an increase in the biomass of *Oryza sativa L.* (rice) by 20% and *Vigna unguiculata L.* (cowpea) by 50%, owing to the application of biochar at 68 t/ ha and 136.75 t/ha. Similarly, amendment of biochar improved the biomass and yield in *Triticum durum L.* (durum wheat) by 30%.

This research provides a practical model for policymakers, agricultural entrepreneurs, and farmers, emphasizing biochar's role in carbon sequestration, sustainable land management, and climate adaptation. By adopting biochar-based organic farming, agricultural systems can transition toward higher productivity, ecological stability, and financial sustainability, ensuring food security in the face of climate change.

Keywords: Biochar-based organic farming, soil fertility enhancement, carbon sequestration, sustainable agriculture, crop productivity improvement, climate adaptation.

The physio- Biochemical Impact of Terminal Heat Stress on Wheat Varieties

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Heat stress is a major abiotic stress in bread wheat. The northwestern plain zones (NWPZ) large area was affected by heat stress in India. Climate change and increasing heat is responsible for decreasing the yield at terminal stage of growth wheat. Thus, specific selection of heat stress tolerant varieties is an essential task to battle the climate change effect. The present study aims for physio-biochemical screening of timely sown DBW90, DBW173, PBW 752, PBW 757, HD 3226 and NWPZ wheat varieties of India for their thermal stress tolerance along with heat tolerant (HD3298). The experiment was conducted in randomized block design under environmental condition. Later different physio-biochemical traits were studied in both control and stress condition. All traits exhibited significant variations among varieties under stress condition. Relative water content, chlorophyll content reduced significantly, whereas enzymatic activity of catalase, peroxidase and proline content were increased in stress plants. A tolerance matrix was prepared based on stress response of the varieties for each trait and a final tolerance score was given to each varieties. Hence, this study helps in selection of varieties for sowing better response in NWPZ for climate change.

Here showed PBW 752 and PBW 757 had minimum tolerance under heat condition as compared to other selected varieties. Therefore, the results shows DBW 90, HD 3226 could be identified as better response to heat-tolerance.

Keywords – Heat stress, biochemical parameters, chlorophyll content, catalase, peroxidase.

ENCOURAGING AGRIBUSINESS AND AGRIPRENEURSHIP IN THE DIRECTION OF FOOD SECURITY

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ICANTFA/050

Food security is a critical global challenge, demanding innovative and sustainable solutions. This research paper explores the pivotal role of agribusiness and agripreneurship in enhancing food security. It examines the key challenges faced by the agricultural sector, including climate change, limited access to resources, and market volatility. The paper then delves into the potential of agribusiness and agri-preneurship in addressing these challenges through technological advancements, improved market access, and enhanced resource management. Furthermore, it analyzes the supportive policies and interventions necessary to foster a conducive environment for agribusiness growth and encourage entrepreneurial ventures in the agricultural sector. The paper concludes by emphasizing the importance of a multi-pronged approach that integrates government support, private sector investment, and community engagement to ensure sustainable and equitable food security for all. Global Food Security Challenges: *Climate Change*: Analyze the impact of climate change on agricultural production, including extreme weather events, rising temperatures, and changing precipitation patterns. *Resource Scarcity:* Discuss the challenges of water scarcity, land degradation, and limited access to quality inputs like seeds and fertilizers. *Market Volatility:* Technological Advancements: *Precision Agriculture*: Discuss the use of technologies like GPS, drones, and sensors to optimize resource use, improve yields, and minimize environmental impact. *Biotechnology:* Explore the role of genetically modified crops, biofertilizers, and biopesticides in enhancing crop productivity and resilience. *Food Processing and Preservation Technologies:* Discuss the importance of technologies for food processing, preservation, and storage to reduce post-harvest losses and extend shelf life.

Keywords- Climate change, Investment, GDP, Food security, Market access, Contract farming

Occurrence OF Biofilm Producing, Virulent *Listeria Monocytogenes* in Meat from Animals in West Bengal, India

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Listeria monocytogenes is a Gram-positive, ubiquitous organism that causes listeriosis in animals and foodborne zoonotic infection in human. The present study was carried out to detect the occurrence, biofilm production, virulence gene profile of *L. monocytogenes* from animal(cow), animal food products (meat, dairy products) and associated environments (farm soil, sewage water, floor swab etc.). A total of 547 samples were examined which comprises of 77 genital swab of apperently healthy cows, 264 meat samples of different animal and bird species and 53 dairy products, 153 environmental samples. Eighty-three (15.17%, 83/547) *Listeria* spp. were obtained by cultural method and confirmed by *Listeria* genus-specific prs gene PCR (370bp). Of the *Listeria* positive isolates, 9(1.65%, 9/547) were identified as *L. monocytogenes* by species-specific *lmo1030* gene PCR (509 bp). Sample positivity was 5 from chevon, 2 from pork and 2 from quail meat. Virulence gene *hlyA* was detected for all 9(100%), *iapA* gene for 8(88.89%), *plcA g*ene for 5(55.56%) isolates and none of the isolates were found positive for *plcB gene*. One (11.11%) isolate was moderate biofilm producers and 4 (44.44%) were weak biofilm producer after 72 hours of incubation at 37°C by crystal violet destaining assay, they were also carrying the biofilm associated *luxS* and *flaA* genes. Geno-serotyping by PCR as per Doumith serotype scheme showed all 9 *L. monocytogenes* isolates belonged to the serogroup IVb (pathogenic type). Therefore, it is necessary to adopt the policy for hygeinic food production and implement a regular monitoring system as per food safety standards.

Keywords: lmo1030 gene, Fish, *Listeria*, *Labeo rohita*, PCR, West Bengal

AGRI STARTUPS IN INDIA- A WAY AHEAD TO SUCCESS

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ICANTFA/052

The basis of study, it is very clear that the government is very serious about the overall development of start-ups in India by creating a full-fledged start-up-ecosystem. India is making progress toward its goal of creating a robust start-up-ecosystem. The government has dedicated ministry (department) committed to assisting start-ups in order to promote and support them. Furthermore, the Indian government has introduced a slew of initiatives aimed at boosting entrepreneurship in the country and providing financial assistance to start-ups. Even in COVID-19 restrictions, Government of India is facilitating start-ups by operating its numerous program (viz., RKVY-RAFTAAR) in virtual mode. India has the 3rd largest startup ecosystem in the world; expected to witness YoY growth of a consistent annual growth of 12-15%, India had about 50,000 startups in India in 2018; Out of these, around 8,900 - 9,300 were technology-based startups which is increasing year by year 1300 new tech startups were born in 2019 alone implying there are 2-3 tech startups born every day. Indian startup ecosystem could see 370 growth-stage startup funding deals in 2023, up only 4.5% from 354 such deals in 2022. Further, the growth-stage funding could touch 740 Cr in 2023, approximately 3.9% less than the 770 Cr raised in 2022. Start-ups are critical for fostering creativity in a society. These entrepreneurs are challenging the dominance of huge corporations not simply via innovation, but also by giving simpler answers to the problems they address. Start-ups have unique ideas. They are always understaffed, never have enough hours in the day, and nonetheless have a pragmatic mindset that drives them to find new solutions to problems. These firms, via their unique approaches, have aided stressed farmers (especially small and marginal farmers) and provide solutions to Indian agriculture's difficulties.

Keywords: Startups, RKVY- RAFTAAR, Year to Year Growth.

Abiotic stress tolerance in Horticultural crops through genomics-assisted Breeding

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ICANTFA/053

Since the beginning of domestication thousands of years ago, horticultural crops such as fruits and vegetables have been the main source of minerals and vitamins for human nutrition. Their output has surpassed the 10-billion-ton threshold, indicating enormous market demand. However, they are affected by several abiotic stressors that negatively impact their productivity, including heat, salinity, cold, and drought. To overcome yield losses and preserve global food and nutritional security, significant and persistent challenges must be addressed. For crop breeders, creating productive cultivars that can withstand these unfavorable conditions is, therefore, a crucial and time-consuming task. However, the success of crop genetic modification initiatives has significantly increased with the introduction of high-throughput genomics-assisted breeding (GAB) techniques and low-cost, next-generation sequencing (NGS) technologies. For example, linkage and association mapping techniques based on marker–trait associations have been used to identify quantitative trait loci (QTLs) linked to abiotic stress tolerance. Abiotic stress-resistance genes and QTLs can thus be quickly and more accurately introduced into the vulnerable recipient parent's genetic background via marker-assisted selection, compared to traditional plant breeding techniques. . Similarly, genomic selection, which uses all available molecular markers in conjunction with phenotypic data, is the best approach for estimating breeding values and has an advantage over QTL mapping. Additionally, whole-genome sequencing using NGS-based technologies helps identify the genetic areas controlling complex traits related to stress tolerance. The information presented in this chapter, which highlights abiotic stress-related traits and studies from a variety of commercially significant horticultural crops, will be helpful for understanding the GAB methodologies used with state-of-the-art molecular technologies in crop improvement initiatives.

Keyword: Techniques and low-cost, next-generation sequencing, quantitative trait loci, marker–trait associations.

Antagonistic Activity of Salt and Temperature Tolerant Plant Growth Promoting Rhizobacteria Isolated from Tomato Rhizosphere Soil Against *Fusarium oxysporum* and *Pestalotiopsis psidii*

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ICANTFA/054

The present study was focused on Antagonistic activity of salt and temperature tolerant plant growth promoting rhizobacteria isolated from rhizosphere soil of tomato. A total of 138 isolates were isolated out of that 46 were grown on Ashby's Mannitol agar media, 46 were grown on King’s B agar media and 46 were grown on Nutrient agar media, in the laboratory of department of Agricultural Microbiology, MPKV, Rahuri, Maharashtra during year 2020-2023. Out of 138 isolates 12 isolates were selected for further studies.Out of total 12 extremely salt and temperature tolerant rhizobacteria, the highest inhibition percentage showed by *Pseudomonas furukawaii* STT-A8 (87.6 %), *Agrobacterium pusense* STT-A39 (78.75 %), Achromobacter sp. STT-A12 (77.5 %), *Pusillimonas* sp. STT-K15 (72.5 %) and *Agrobacterium pusense* STT-A24 (71.25 %), *Priestia flexa* STT-K13 (71.25 %), Bacillus *badius* STT-N22 (70 %), *Agrobacterium pusense* STT-A39 (60.00 %), *Bacillus badius* STT-N26 (60.00 %), *Brevibacterium epidermidis* STT-N28 (60.00 %), followed by *Agrobacterium pusense* STT-A24 (53.33 %), *Brevibacterium epidermidis* STT-K2 (46.66 %), *Pusillimonas* sp. STT-K15 (46.66 %) and *Bacillus* sp. STT-K24 (46.66 %) against *Pestalotiopsis psidii*. The experiment was done to check percentage inhibition of salt and temperature tolerant PGPR against *Fusarium oxysporum* and *Pestalotiopsis psidii* that would be a crucial inoculum to enhance tomato plant growth and reduce disease infestation in salty environment.

Keywords: Antagonistic activity, *Pseudomonas furukawaii, Agrobacterium pusense,*

Evaluation of efficacy of some bio-rational options for managing aphids infesting grass pea [*Lathyrus sativus*]

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ICANTFA/055

Grass pea (*Lathyrus sativus* L.) is a dual-purpose annual legume grown for its seeds for human consumption and fodder for livestock feeding. It is one of the preferred legumes in low fertility soils and arid areas because of its outstanding tolerance of dry or flooding conditions. The crop is infested by number of insect pests including some sucking pests like aphids (*Aphis craccivora*). Several synthetic pesticides have been used by farmers to mitigate the problem. However, keeping the view of adverse effect of traditional synthetic pesticides on ecosystem in mind, the present experiment was conducted at the District Seed Farm (AB Block) of Bidhan Chandra Krishi Viswavidyalaya located at Kalyani, Nadia, West Bengal during *rabi* season of 2023-24 to evaluate the efficacy of some bio-raional options against aphids in grass pea var. Prateek in Gangetic plains of West Bengal comprising eight treatments viz. T_1 (Neem seed kernel extract @ 5%), T_2 (Azadirachtin 1500 ppm @ 1.5 ml/litre), T_3 (*Lecanicillium lecanii* @ 5 g/litre), T_4 (*Lecanicillium lecanii* @ 7.5 g/litre), T_5 (*Salicylic acid* @ 0.5 mM), T_6 (Salicylic acid @ 1.0 mM), T_7 (Afidopyropen 50 DC @ 50 g ai/ha) along with one untreated control i.e. T_8 following Randomized Block Design with three replications. The results reveals that amongst all treatments, spraying of *Lecanicillium lecanii* @ 7.5 g/litre (T_4) was found significantly superior over rest of the treatments in terms of reduction of aphid population both at 1 day after treatment (14.07 per plant), 3 DAT (5.20 per plant) and 7 DAT (1.33 per plant). Moreover, all the treatments applied including T_4 are safe to natural enemies like spiders and coccinellid beetles as well as no phytotoxicity symptoms have been observed due to application of this treatment at prescribed doses. The highest gross return, net return, Benefit Cost Ratio and Incremental Benefit Cost Ratio was also recorded in T_4 which proves the economic superiority of the treatment.

Keywords: Grass pea, *Lathyrus sativus*, aphid, *Aphis craccivora*, efficacy, bio-rationals

Sustainable nutrient and eco-safe herbicide management strategies for enhancing Urd bean (*Vigna mungo*) yield

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ICANTFA/056

Achieving higher urdbean productivity in input-intensive cropping systems is often constrained by poor soil micro-flora and fertility as well as weed interference. Hence, a field experiment was conducted at AB-Block Farm, BCKV, to evaluate the impact of bio-fertilizers, herbicide-mixes, and foliar nutrition on the weed spectrum and growth of urdbean. The treatments included bio-fertilizers (Control, *Rhizobium leguminosarum*+ *Pseudomonas fluorescens*, and *Rhizobium leguminosarum* + *Stenotrophomonas maltophilia*), herbicide management (Weedy check, Propaquizafop 2.50% + Imazethapyr 3.75% ME at 125 g a.i./ha, and Fomesafen 11.1% + Fluazifop-p-butyl 11.1% SL at 440 g a.i./ha), and foliar nutrition (Water spray, 0.25% nano-urea, and 2% NPK (19:19:19)). Herbicides were applied 20 days after sowing (DAS), and foliar nutrition was provided at the pre-flowering and pod initiation stages. Seed inoculation with *Rhizobium leguminosarum* + *Stenotrophomonas maltophilia* resulted in the highest nodule number (33.31 per plant) and dry weight (48.62 mg/plant), leading to increased pods/plant (32.27), seeds/pod (5.80), seed yield (1050 kg/ha), and a B:C ratio of 2.01. Foliar nutrition with 2% NPK (19:19:19) significantly improved nodulation compared to nano-urea or water spray, recording 8.95% higher nodule number and 8.39% higher nodule weight than nano-urea spray, resulting in an 8.9% yield increase and a B:C ratio of 1.98. Thus, integrating suitable bio-fertilizers with eco-safe herbicides and a foliar nutrient management strategy can promote the successful adoption of urdbean in cereal-based systems by enhancing yield and profitability.

Keywords: Biofertilizer, herbicide-mix, foliar fertilization, seed inoculation, Urdbean, weed suppression

Microgreens: Exciting new food for Nutritional security in the 21st Century

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ICANTFA/057

Microgreens are young, tender greens that are used to enhance the colour, texture, or flavour of salads and main dishes. They can be grown in small scales and indoors, making them widely adopted by controlled environment agriculture, an indoor farming practice is particularly important for feeding increasing urban populations. Besides, microgreens are attracting more consumers' attention due to their high nutritional value and unique sensory characteristics. Diurnal increase in a population growth has led to the imbalance in horticultural food supply chain including vegetables resulting in several issues such as malnutrition and hidden hunger. Microgreens are rich in vitamins (e.g., vitamin C), minerals (e.g., copper and zinc), and phytochemicals, including carotenoids and phenolic compounds, which act as antioxidants in human body. Pre-harvest interventions, such as illumination, salinity stress, nutrient fortification, and natural substrates, influence the photosynthetic and metabolic activities of microgreens and were shown to improve their nutritional quality, while the effects varied among species. Many families in our nation still suffer from malnutrition due to unaffordability or lack of easy access to the nutritious foods. After harvesting, packaging method and storage temperature can influence the nutrient retention in microgreens. The sensory attributes and overall acceptability and liking of microgreens are primarily influenced by their phytochemical content. Microgreens are only getting popular during the last decades and research on microgreens is still at its early stage. They are a good source of vitamins, minerals, fibres and antioxidant along with low levels of nitrite content which makes them a super food for addressing overall food security, nutrition, health, income generation and ecosystem services for the human wellbeing in forthcoming days.

Keyword: Microgreen, Nutrition, Antioxidant, Preharvest, Postharvest, Health benefits.

Assessment of Soil Quality Index Based on Soil Mapping Units in Pashupathihal Sub-Watershed

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The assessment of soil quality parameters in the Pashupathihal sub-watershed (Dharwad district) revealed significant spatial and chemical variability among 46 soil mapping units (SMUs) across 12 distinct soil series. The Soil Quality Index (SQI) ranged from 0.20 (YSJmA1) to 0.76 (MVDmA2g2Ca), highlighting considerable differences in soil health. Soil depth varied between 35 and 180 cm, averaging 163.07 cm, indicating notable heterogeneity. The $CaCO_3$ content ranged from 1.37% to 14.45% (mean 6.34%), signifying moderate calcareousness. Soil pH values spanned from 7.01 to 8.96, with an average of 8.70, while high base saturation levels (82.35%–92.57%, mean 90.95%) reflected alkaline, base-rich soils. Organic carbon levels were relatively low, ranging from 2.54 to 6.77 g/kg (mean 3.75 g/kg), affecting soil fertility. EC values ranged between 0.16 and 0.43 dS/m (mean 0.27 dS/m), while the exchangeable sodium percentage (ESP) varied from 3.17% to 10.17% (mean 8.32%), indicating non-sodic soil characteristics. Bartlett's test ($\chi^2 = 293.807$, $p < 0.0001$) and a KMO score of 0.597 confirmed that the dataset was moderately suited for factor analysis. Principal Component Analysis (PCA) identified three principal components accounting for 84.82% of the variance. A radar plot illustrated variations in soil quality parameters across SMUs, highlighting superior attributes such as greater depth and higher cation exchange capacity (MGDmA2g2Ca). Cluster analysis classified SMUs into four distinct clusters (C1–C4) based on variations in pH, EC, and organic carbon, enabling the delineation of management zones. Despite significant differences among the clusters, each contributed to the development of effective soil management strategies. Soil Management Units such as MVD (127 ha, SQI 0.76) and CPT (766 ha, SQI 0.70) exhibited high SQI values, whereas YSJ (5 ha, SQI 0.20) had the lowest quality, primarily due to erosion and nutrient depletion. The BTP series, covering the largest area (2464 ha) with an SQI of 0.63, represented relatively healthy soils overall.

Keywords: Soil Quality Index, Soil Mapping Unit, PCA, Cluster Analysis, Soil Dept

Effect of Arbuscular mycorrhizal biofertilizer on Growth and yield parameters of *Kharif* Rice (*Oryza sativa*) under Submerged Conditions in Lower Indo-Gangetic Plain Zone of West Bengal

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ICANTFA/059

Arbuscular mycorrhizal fungi (AMF) possess the ability to colonize the roots of different terrestrial and aquatic plants. However, the maximum amount of works was done in terrestrial conditions while the submerged condition got very little attention. A number of research demonstrated the positive correlation between mycorrhizal fungi and the roots of rice plants. Keeping this in view, a field experiment was conducted to analyze the effect of AMF on different growth and yield parameters of rice under submerged conditions in New Alluvial Zone of West Bengal during *kharif* season in 2023. The experiment was done in randomized block design (RBD) comprised of 3 replications and 7 treatments. The treatments were - T_1 – 100% RDF, T_2 – 100% RDF + Mycorrhizal biofertilizer @ 2.5 kg ha^{-1} at basal, T_3 – 100% RDF + Mycorrhizal biofertilizer @ 5 kg ha^{-1} at basal, T_4 – 100% RDF + Mycorrhizal biofertilizer @ 7.5 kg ha^{-1} at basal, T_5 – 100% RDF + Mycorrhizal biofertilizer @ 10 kg ha^{-1} at basal, T_6 – 100% RDF + Mycorrhizal biofertilizer @ 12.5 kg ha^{-1} at basal, T_7 – 100% RDF + Mycorrhizal biofertilizer @ 15 kg ha^{-1} at basal. Mycorrhiza-treated plots performed better in growth and yield attributing characters as compared to control plot (T_1). Treatment T_5 recorded maximum plant height (116.67 cm), leaf area index (2.20), root volume (33.23 cc hill^{-1}), grain yield (4.95 t ha^{-1}) and straw yield (6.34 t ha^{-1}).

Keywords: Arbuscular mycorrhizal fungi, rice, submerged condition, mycorrhizal biofertilizer, grain yield

STUDIES ON PROPAGATION GUAVA THROUGH SOFT-WOOD CUTTING

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ICANTFA/060

The present investigation, titled "Studies on propagation guava through cutting" was conducted under shade-net condition during September 2021 to January 2022 at Research cum Demonstration Farm, college of Agriculture, Dhule, Maharashtra with the objective to study effect rooting media, growth regulators and their interaction to find growth regulator to find out the best combination of media and growth regulator for maximum root initiation, root and shoot characters and survival percentage. The experiment was set in a Factorial randomized block design (FRBD) which comprised of two factors viz. different rooting media (7 treatments) and growth regulators (5 treatments) making 35 treatment combination and were replicated three times. The results revealed that the rooting media M2 (Soil + Perlite 1:1) recorded significantly highest values for all the characters studied except days required to rooting. It recorded maximum values for success percentage (58.63 %), number of leaves per cutting at 30, 60, 90 and 120 DAP (2.36, 4.95, 9.45 and 12.63, highest fresh weight of roots (2.97 g), highest dry weight of roots (0.66 g) and highest survival percentage (35.36%). The results with respect to growth regulators were also promising and IBA at 4000 ppm (G2) registered highest values for all character's studies except the days required to rooting. It recorded maximum values for success percentage (83.13 %), 23.34 leaves per cutting at 120 DAP, number of shoots at 30, 60, 90 and 120 DAP (1.17, 1.5, 2.37 and 3.87), number of primary roots per cutting (4.30), number of secondary roots (8.34), highest fresh weight of roots (4.3 g), highest dry weight of roots (0.97 g) and highest survival percentage (54.63 %). The results revealed importance of IBA at 4000 ppm concentration along with root media Soil+ Perlite (1:1) for better leaf, shoot and root characters and also survival of the soft wood cuttings in guava.

Keywords: IBA, Plant growth regulator, rooting media. Etc

Protected cultivation of vegetable crops: Paving the way for food security and economic sustainability

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ICANTFA/061

The agricultural sector being the backbone of India's economy must continuously increase its productivity and profitability through the use of effective production technologies in order to maintain self-sufficiency, guarantee food security and export high-quality produce. Vegetables have become increasingly important in our daily diets as they are packed with nutrition. This raises the demand for their production in larger quantities with better quality. A variety of factors impede vegetable production in open fields, including high insect pest infestation pressure, fungal diseases, heavy rain, thunderstorms, excessive solar radiation and temperature and humidity levels that exceed plant growth optimums. Protected cultivation is the most sustainable way to grow vegetables in adverse weather conditions. In addition to being protected from harsh weather conditions, vegetables grown in protected areas have better form, size, and colour. The phrase "protected cultivation" encompasses a range of methods and tools, including windbreaks, irrigation, soil mulches and structures like greenhouses, tunnels, shade net houses and insect proof net houses, which modify the environment to enhance productivity throughout the year. This approach will also prolong the harvest period, increase yields, enhance quality and ensure a consistent supply of produce. It is feasible to cultivate vegetables such as cabbage, cauliflower, brinjal, beans, peas and coriander at high elevations in a protected environment. Growing high value vegetables in greenhouses in both on and off season can significantly boost financial returns from them. In addition to providing numerous opportunities for self-employment to youth, it can boost the country's economy by encouraging the sale of high-quality produce in both domestic and foreign markets. Efficient addressing of certain challenges present here is the need of the hour. This technology is the best suited to provide sustainable food security through long-term production systems.

Keywords: Protected cultivation, Vegetable production, Greenhouse, Tunnels, Shade net houses

Genomic secrets of Pigeon pea: Unlocking structural variants responsible for high protein content in pigeon pea genotypes

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ICANTFA/062

Pigeonpea (*Cajanus cajan*) is an important legume crop, playing a critical role in food security and nutritional well-being in many developing countries. The crop is rich in protein, minerals, and vitamins and is thus referred to as meat for the vegetarian population. However, this crop is not yet adequately explored at the genomic level due to incomplete genome assemblies and limited structural variant information. Some reports have indicated the existence of variation in protein content among pigeon pea varieties, and structural variation is the major hallmark distinguishing high-protein from low-protein genotypes. To address this gap, in this study, we employed a hybrid sequencing approach using Oxford Nanopore and Illumina to investigate five pigeon pea genotypes, including HY3C and ICPL87, which are high in protein content, and MC70, ICPL-13271, and MC50, which have lower protein contents. The widely assembled Asha variety has been used as a reference to enhance genome completeness and facilitate comparative genomic analysis. These assembled genotypes were aligned to the reference to identify genomic variations, followed by variant calling to detect structural variations (SVs), including insertions and deletions (indels). We identified around 7.5 million to 8.8 million genomic variants across these five genotypes. Specifically, we identified 7,792,628 SNPs and 37,320 indels in HY3C while 7,744,463 SNPs and 29,629 indels were detected in ICPL-87. Structural variations such as SNPs and indels are known to impact gene expression and protein-coding regions, thus having a major part in regulating agronomical traits like protein biosynthesis. Our findings gave an insight into the genetics of differing protein content in pigeon pea and provided a resource to breed towards improving nutritional quality. This study will help address the gap in the previously available genomic resources and contribute towards the implementation of molecular breeding strategies that will ultimately improve pigeon pea yield and resilience, thus enhancing food security for developing countries.

Keywords: Food security, Genomics, Pigeon pea, Protein content, Structural variant

Information Seeking Behaviour of Spice Growers: An Empirical Study in Kalim Pong District of West Bengal

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ICANTFA/063

India is one of the world's largest producers and exporters of spices, renowned for its diversity and quality. The cultivation of spices in India plays a significant role in agriculture, economy, and cuisine. Kalim pong district in West Bengal, India, is known for its favorable climate and diverse topography, making it suitable for the cultivation of various spices. Spice cultivation in Kalim pong district contributes significantly to the local economy, providing livelihoods for many farmers. The spices produced in Kalim pong are sold in domestic markets and sometimes exported. However, the availability of information on this subject is constrained by various factors, from research focus to regional specificity and digital accessibility. Addressing these challenges can improve knowledge dissemination and support the success of spice cultivation across the country. Thus, research has been conducted during 2024 in Kalim pong district, to study the Information Seeking Behaviour of spice growers. The study employed an ex -post facto research design and a mixed-method approach for this study. Total 200 farmers were interviewed personally with the help of a structured interview schedule. The study found the diverse information-seeking behaviours of the farmers in the Kalim pong district. It underscores the importance of interpersonal communication and mass media while revealing gaps in extension participation and contact. Further, extension services need to improve personal contact with farmers, particularly through KVK personnel and ADA, to provide direct support and information. This can lead to more effective dissemination of information to farmers and improved spice cultivation as well as better productivity in Kalim pong district.

Keywords-Kalim pong district, spice cultivation, spice growers, information utilization behavior

Weed flora and crop performance as influenced by various weed management measures in Maize (*Zea mays*) during rabi season in the new alluvial soil of West Bengal

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ICANTFA/064

Maize, the "Queen of cereals" is the third most important cereal crop in India after rice and wheat contributing around 24% of total cereal production in the country. India holds the seventh position among the maize-producing countries worldwide while China and Brazil rounded off the top corn producing countries. Being a versatile crop having wider adaptability and particularly important to the poor people for overcoming hunger and improving food security worldwide, maize coverage is increasing day by day in West Bengal. Field experiment was conducted during rabi season of 2021-22 and 2022-23 at District Seed Farm, D-Block Unit of BCKV, West Bengal in RBD with 12 treatments, namely **T_1**: Halosulfuron 67.5g/ha at 15-20 DAS; **T_2**: Atrazine + pendimethaline (0.50+0.25kg/ha) PE; **T_3**: Atrazine 1.0kg/ha PE *fb* 2,4-D1.0kg/ha LPoE; **T_4**: Atrazine +pendimethaline (0.50+0.25kg/ha) PE *fb* 2,4-d 1.0kg/ha LPoE; **T_5**: Topramezone 25.2g/ha EPoE; **T_6**: Tembotrione 120g/ha EPoE; **T_7**: Topramezone 25.2g/ha EPoE *fb* IC+HW at 40 DAS; **T_8**: Tembotrione 120g/ha EPoE *fb* IC+HW at 40 DAS; **T_9**: Tembotrione + atrazine (120+500g/ha) EPoE *fb* IC+HW 40 DAS; **T_{10}**: Topramezone + atrazine (25.2+500g/ha) EPoE *fb* IC+HW at 40 DAS; **T_{11}**: IC+HW at 40 DAS and **T_{12}**: Weedy check , replicated thrice. Experimental results revealed that better weed management and consequently the crop performance was possible with the application of **T_9** **(**Tembotrione + atrazine (120+500g/ha) EPoE *fb* IC+HW 40 DAS) followed by treatment **T_{10}**. Highest yield of 7.22 t/ha was recorded in the plots having Tembotrione + atrazine (120+500g/ha) EPoE *fb* IC+HW 40 DAS which was found to be the best treatment in the field experiment.

Keywords: Maize, herbicides, winter season, Gangetic new alluvial soils

Seasonal actual evapotranspiration, water expense efficiency, and grain yield of Chickpea under varying frequencies of irrigation

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ICANTFA/065

Chickpea is an important winter legume crop in India and popularly known as Bengal gram, or Brown gram. Chickpea is a suitable winter pulse crop for farmers to grow on residual soil moisture, i.e. with limited irrigation facilities; one to two irrigations is very much essential for terminal heat stress in drier tract. Chickpea crop is water sensitive amongst the pulse crops. It can grow leftover moisture with lifesaving water supply through irrigation during grain filling stage. Timely irrigation is important at crucial growth stages to achieving higher chickpea yield. In present study, the actual seasonal evapotranspiration, water expense efficiency and grain yield of Chickpea varieties under varying irrigation have been evaluated. The field trial was laid out at the AB block farm of BCKV, Kalyani with a split-plot design with two chickpea varieties (i) V_1- Bidisha and (ii) V_2- Purva, in the main plots and three irrigation frequencies (i) I_1-irrigate once only at 30 days after sowing (DAS); (ii) I_2- irrigate twice on 30 and 50 DAS and (iii) I_3- irrigate thrice on 30, 50 and 70 DAS replicated thrice during the *rabi* season of 2020-21 and 2021-22. The water expense efficiency was highest (1.32 kg m^{-3}) under I_1 irrigation frequency by Bidisha variety followed by Purva variety recorded highest WUE 0.95 kg m^{-3}. The maximum chickpea yield (2040 kg ha^{-1}) was harvested from Bidisha and was 23.04 % greater than Purva mean over two years in I_3 irrigation regime. Considering the output of the study cultivation of Bidisha with three irrigations can be suggested to the farmers of the region.

Keywords: Chickpea varieties, water use efficiency, seasonal actual evapotranspiration, grain yield

Effect of Foliar Nutrition of Boron and Molybdenum on Growth and yield of Chickpea (*Cicer arietinum*) in New Alluvial Zone of West Bengal

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ICANTFA/066

A field experiment was conducted to study the effect of foliar application of micronutrients on growth and yield of chickpea during rabi season of 2020-21- 2021 -22 in the new alluvial soil of West Bengal. The experiment was laid out in Randomized Block Design (RBD comprised of ten treatments vi Control (T_1), Boron at Pre-flowering Stage (T_2), Molybdenum at Pre-flowering stage (T_3), Boron at small Pod stage (T_4), Molybdenum at small Pod stage (T_5), Both Boron & Molybdenum at Pre-flowering stage (T_6), Both Boron & Molybdenum at small Pod stage (T_7), Boron at Both Pre-flowering & Small Pod Stage (T_8), Molybdenum at Both Pre-flowering & Small Pod Stage (T_9), Both Boron & Molybdenum at Both Pre-flowering & Small Pod stage (T_{10}) and replicated thrice. Dry matter accumulation of plant showed increasing trend during observation and recorded maximum at harvesting. Crop growth rate (CGR) was calculated during two intervals of growth i.e. 30-60 DAS and 60-90 DAS and higher CGR were recorded at 60-90 DAS interval.Number of nodule per plant of chickpea showed peak count during 60 DAS (41) in treatment received with both foliar application of Bo & Mo at both stages i.e. pre-flowering and small pod stage. The highest yield was obtained from the treatment (T_{10}) applied with both Bo and Mo during both stages i.e., pre-flowering and small pod stage, followed by T6 (1668 kg ha^{-1}) with both Bo and Mo application at the pre-flowering stage.

Keywords: Chickpea, Foliar Nutrition, Boron and Molybdenum, Grain yield

Inoculation of microbial consortium in soil reduces the application of nitrogen fertilizer in rice (*Oryza sativa*) production.

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ICANTFA/067

A sustainable alternative is the use of beneficial microorganisms that promote plant growth in crops. The objective of the study was to evaluate the effect of selected stains of microbial inoculants in rice production along with different doses of nitrogen fertilizer. For this purpose, pot experiment, incubation study and chemical analysis is done in regular time intervals. Treatments with specific strains significantly effects positive growth parameters like grain and stem dry matter, panicles and harvest index comparing to control plants, but the same effects were achieved in the chemical fertilizer's treatment with NPK. Grain quality was superior in inoculated treatments versus non-inoculated treatments, reaching specific increases of 33% (N). α-tocopherol (vitamin E) and globulin protein concentration increases more compared to inorganic fertilizer treatments. The strains showed that the parameters such as shoot dry weight, tillering and grain quality were superior and even similar between inoculated treatments receiving doses of 100% Nitrogen (N) (120 kg of N ha^{-1}). It is concluded that the use of selected native bacterial consortiums reduces the use of nitrogen fertilizer by up to 30%, increasing the productivity of rice cultivation. Prospectively, the use of microbial inoculants and associated approaches offers some new, cost-effective, and more eco-friendly practices for increasing rice production

Key Words: Microbial inoculants, rice yield, sustainable agriculture, organic N-fertilizer.

Varietal Evaluation of China aster (*Callistephus chinensis*) under Rajnandgaon district of Chhattisgarh

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ICANTFA/068

The experiment entitled "Varietal Evaluation of China aster (*Callistephus chinensis*) under Rajnandgaon district of Chhattisgarh" was carried out in the Department of Floriculture and Landscape Architecture at Pt. Kishori Lal Shukla College of Horticulture and Research Station, Pendri Farm, Rajnandgaon (C.G.) during the year 2019-20. The experiment was laid out in six varieties of China aster with four replications in randomized block design. Among the six varieties studied highly significant variation in growth, floral and flowering parameters were recorded among varieties. Phule Ganesh White was significantly superior amongst varieties which recorded maximum plant height (72.28cm), leaf length (10.24cm), stem diameter (10.22mm), flower diameter (6.61cm), length of flower stalk (57.90cm), weight of loose flower per plant (105.60g) and vase life (8.65 days). Significantly Arka Archana recorded earliest seed germination (3.25days), maximum plant spread in E-W and N-S direction (29.58cm &30.92cm) and number of flowers per plant (40.03) respectively. Arka Kamini was produced maximum no. of branches per plant (29.43), earliest in flowering (74.45 days) and maximum no. of leaves per plant (328.92), maximum flower duration (28.50 days) was recorded in cv. Phule Ganesh Pink. The economics of cultivation of different China aster varieties has revealed that out of the treatments in cultivation of China aster, among the cultivar Phule Ganesh White recorded higher revenue of Rs. 3,00000 and a net profit of Rs. 2,29689 with cost benefit ratio of 1: 3.26.

Keyword: Vegetative growth parameters, Plant height, Seed germination Flower diameter, Flower duration, flowering parameters, Cost of Cultivation and B:C Ratio etc.

New Education Policy 2020: A Roadmap for Holistic Education System in India

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ICANTFA/069

The New Education Policy (NEP) 2020 represents a transformative blueprint aimed at reshaping India's education system to foster inclusivity, equity, and holistic development. Developed through extensive stakeholder consultations, this policy aligns with Sustainable Development Goal 4 of ensuring inclusive and equitable quality education for all by 2030. NEP 2020 introduces a comprehensive 5+3+3+4 curricular structure, replacing the traditional 10+2 model, to address early childhood care, foundational literacy, and lifelong learning. Key reforms in school education emphasize critical thinking, multidisciplinary learning, and integration of technology to bridge the digital divide. The establishment of the National Curriculum Framework (NCF), multilingual education initiatives, and competency-based assessment systems underline a learner-centric approach. Teacher recruitment and professional development are prioritized to ensure quality and accountability in education delivery. In higher education, NEP 2020 aims to increase the Gross Enrollment Ratio to 50% by 2035 through flexible, multidisciplinary undergraduate programs and digital innovations like the Academic Bank of Credit. The introduction of the Higher Education Commission of India (HECI) streamlines governance while promoting academic excellence and research through the National Research Foundation (NRF). NEP 2020's innovative initiatives, such as the PM-SHRI scheme, NIPUN Bharat, and international academic collaborations, signify a forward-looking vision for India's education system. This roadmap strives to prepare students for a dynamic global landscape while preserving India's rich cultural heritage.

Keywords: NEP 2020, holistic development, curriculum framework, teacher development, higher education reforms

COMPARATIVE BIO-EFFICACY OF PLANT DERIVATIVES AND MICROBIAL INSECTICIDES AGAINST *Scirpophaga insertulus* WALKER ON PADDY CROP

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ICANTFA/070

The Comparative bio-efficacy of plant derivatives and microbial insecticides insecticides against *Scirpophaga insertulus* Walker on paddy crop was studied at Research cum Instructional Farm of College of Agriculture and Research Station, Mahasamund (C.G.) during Kharif, 2024. *Scirpophaga incertulas* Walker (Pyralidae: Lepidoptera) is a cosmopolitan pest to rice crop (also known as yellow stem borer or YSB) rendering extensive damage to growing stems at pre-harvest condition. Various control strategies have been adopted to check YSB; use of synthetic insecticides is a common method of pest control. The bio-pesticides are the important alternatives to minimize or replace the use of synthetic pesticides as they possess properties like toxicity to the pests, repellency, antifeedant , insect growth regulatory activities against agricultural pests. Botanicals with different modes of action may minimize insecticide resistance and pest resurgence problems while being safe and ecologically acceptable. To evaluate the bio-efficacy of Scheduled treatments against paddy yellow stem borer pre treatment observations were recorded on 10 randomly selected plants a day prior to insecticidal application while, post treatment observations were recorded at 1, 3, 5, 7, 10 and 15 days after spraying. Efficacy of each treatment was estimated in consideration of yield, extent of suppression of pest induced damage and the retention of natural enemy population. The symptoms inflicted by paddy stem borer in rice i.e. Dead Heart was found minimum in plot managed by NSKE – NSKE – NSKE (4.52 %) followed by Neem leaf Extract -Eucalyptus oil- *Beauveria bassiana* (5.16 %) and followed by Karanja leaf Extract -Neem Oil- Bacillus thuringiensis (5.24 %) and maximum Dead Heart was found in untreated control plot ie; 8.50 %. The control plot registered maximum number of natural enemies though the yield was found minimum against all treatments.

Residual Effect of Agrochemicals on Environment, Agriculture, and Human Health

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ICANTFA/071

Agrochemicals, including fertilizers, pesticides, herbicides, and plant growth regulators (PGRs), have played a significant role in modern agriculture by increasing crop productivity and reducing losses caused by pests, weeds, and diseases. However, the excessive and unregulated use of these chemicals has resulted in serious environmental degradation, biodiversity loss, soil and water contamination, and human health risks. In India, where agriculture is a major contributor to the economy and employment, the challenge is to balance food security with sustainable agricultural practices. The study explores the residual effects of agrochemicals, highlighting their impact on soil health, water pollution, air contamination, biodiversity, and human well-being. It also examines their role in declining soil fertility, increasing pest resistance, and disrupting ecosystem stability. Furthermore, it discusses existing regulatory measures and sustainable alternatives such as biopesticides, biofertilizers, and integrated pest management (IPM). The study underscores the urgent need for stricter regulations, increased farmer awareness, and the promotion of environmentally friendly alternatives to ensure long-term agricultural sustainability.

Keywords: Agrochemicals, environmental degradation, pesticides, human health risks, sustainable agriculture, soil fertility, water contamination, biodiversity loss, biopesticides, integrated pest management

Development and Evaluation of Mouthfreshner from Elephant apple (Dillenia indica L.)

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ICANTFA/072

Elephant apple (*Dillenia indica*) is an ethno-medicinally important underutilized fibrous fruit. It is acidic, sour, bitter, pungent, and astringent in its unripe stage but become sweet, sour, appetizing, and tasty when ripe. The functional activities of elephant apple include free radical scavenging, hepatoprotective, antidiabetic, anti-inflammatory and antimicrobial properties due to the presence of phenolic compounds and terpenoids. The consumption of elephant apple fruits is restricted by their seasonal availability. Therefore, to ensure the year-round availability and deliver its nutritional and therapeutic properties to human health, the fruit can be processed into industrial value-added products such as beverages, jam, jelly, pickle, chutney etc. The mouth freshener in the form of goli was formulated and standardized using the pulp of this fruit along with other ingredients like jaggery, cumin, ajwain, hing, salt, ginger powder, black pepper and amchur powder. The highly accepted mouth freshener showed the nutritional composition of carbohydrates (76.80%), protein (1.75%), fat (17.30%), fiber (2.20%), and energy (469.90 kcal). The vitamin C content was found to be 49.68 mg/100g. A comparative market analysis of certain commercially available mouth fresheners and digestive goli with almost identical ingredients revealed that the developed mouth freshener has a significant amount of protein, fiber, energy, and vitamin C. Bioactive properties in terms of total phenolic content and antioxidant activity were evaluated and obtained as 15.88 GAE/100g and 48.96 % inhibition, which was also rather good. Finally, organoleptic analysis confirmed that the developed product can be served as a sweet-sour flavoured mouthfreshing and digestive aid with some important nutritional and functional benefits.

Keywords: Elephant apple, Mouthfreshner, Nutritional composition, Bioactive properties.

Organic Farming with Residue-Free Production: Challenges and Prospects in India and Beyond

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ICANTFA/073

Organic farming has gained substantial recognition as a sustainable agricultural practice due to its focus on environmental preservation and consumer health. Central to organic farming is the goal of residue-free production, where crops are cultivated without the use of synthetic pesticides, herbicides, or chemical fertilizers, ensuring the absence of harmful chemical residues in the final product. This research paper examines the concept of organic farming with a focus on achieving residue-free production, assessing global trends, challenges, and strategies for success, with particular emphasis on India. The global organic farming area has expanded significantly, with organic farmland covering 72.3 million hectares in 2018, a 20% increase since 2013 (IFOAM, 2019). In India, the organic farming area grew from 1.2 million hectares in 2002 to 3.7 million hectares in 2018 (APEDA, 2018). Despite these advancements, residue contamination remains a challenge, primarily due to cross-contamination from nearby conventional farms, inconsistent certification processes, and limited access to organic pest control methods. This paper investigates key strategies for achieving residue-free organic production, including integrated pest management (IPM), crop rotation, the use of organic fertilizers, and other sustainable farming practices. Furthermore, it emphasizes the role of organic certification systems, regulatory oversight, and capacity building for farmers in ensuring compliance with residue-free standards. The study concludes that, while challenges persist, the future of organic farming with residue-free production is promising, with potential benefits for consumer health, environmental sustainability, and market growth. Ongoing innovation in farming practices, education, and regulatory frameworks will be essential to meet the growing demand for safe, chemical-free agricultural products.

Development and quality evaluation of Nutri Rich Bar from Elephant apple (*Dillenia indica*)

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ICANTFA/074

Elephant apple (*Dillenia indica* L.), an evergreen tree belonging to the family Dilleniaceae, is widely distributed across Southeast Asia, including India, Nepal, Bangladesh, China, and Sri Lanka. The tree produces large, greenish-yellow fruits with a tough outer shell and a tangy, fibrous pulp. Recognized for its high nutritional and medicinal value, elephant apple is a rich source of vitamin C, carbohydrates, proteins, minerals, and dietary fibre. Traditionally, the fruit has been extensively utilized in culinary applications such as curries, pickles, and beverages. Moreover, it holds significant importance in Ayurvedic and traditional Chinese medicine, where it has been used for treating digestive disorders, respiratory ailments, and skin conditions. This study aimed to develop a nutrient-dense bar incorporating elephant apple powder alongside other functional ingredients, including peanuts, sunflower seeds, pumpkin seeds, Joha rice, little millets, dates, Bhim Kol banana powder, and jaggery. Two prototype formulations—one plain and the other chocolate-coated—were developed and evaluated for their quality characteristics. The nutritional composition of the most preferred formulation, as determined through consumer acceptance studies, was found to be as follows: carbohydrate (65.43%), protein (11.25%), fat (18.29%), fibre (3.06%), energy (471.33 kcal), and vitamin C (57.46 mg/100 g. Sensory evaluation revealed that while both prototypes were well-received, the chocolate-coated variant was the most preferred among consumers. Given the rising demand for nutritionally enriched, functional snack products, this research highlights the potential of elephant apple as a valuable ingredient in the development of innovative health-focused food products.

Comparative Analysis of C3 Photosynthesis Gene Expression in contrast wheat genotypes

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ICANTFA/075

Understanding the molecular basis of photosynthesis in wheat is critical for improving crop productivity, efficiency, and resilience under changing environmental conditions. Photosynthesis is the process by which plants convert light energy into chemical energy, and for wheat, this process directly impacts growth, yield, and quality. Molecular studies of photosynthesis in wheat have provided insights into how this crop adapts to environmental stresses, such as heat, drought, and low light conditions, and how it can be genetically modified or selectively bred to enhance photosynthetic efficiency. Wheat is C_3 plant, utilizes the Calvin-Benson cycle for carbon fixation, which can be less efficient under certain environmental conditions, such as high temperatures. Molecular research has focused on improving this cycle to increase the rate at which wheat fixes carbon. The C_3 pathway, typical of most wheat genotypes, is less efficient in hot and dry climates because it is prone to photorespiration, where oxygen is fixed instead of carbon. The present study was carried out at ICAR-Indian institute of Wheat & Barley Research during crop season 2022-23. The available wheat genome data also shows the presence of C_3 photosynthetic genes in wheat and hence, some of them were also selected for expression analysis in contrast genotypes for photosynthesis. From the earlier studies by Mamrutha et al., (2019), DPW 621-50 (medium photosynthesis), EMS 98 (low photosynthesis) and M1043 (high photosynthesis). RNA isolation from leaf tissues of DPW 621-50, M1043 and EMS-98 and photosynthetically contrast genotypes identified from screening of wheat genotype in the current study was done using TRIzol method (Invitrogen, UK). The expression analysis of all DPW 621-50, M1043 and EMS-98 and photosynthetically contrast genotypes were analyzed using (Agilent Real Time System, USA) using C_3 gene specific primers and TaGAPDH was used as internal control.

PM-KISAN's Roadblocks: Addressing Gaps in Farmer Aid Delivery

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ICANTFA/076

The Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme aims to provide direct financial assistance to small and marginal farmers. However, several challenges hinder its effectiveness. The most critical issue is the discrepancy between land records in the PM-KISAN portal and actual land deeds, leading to incorrect eligibility determinations and delays in fund disbursement. Incomplete digitization of land records further complicates verification and increases errors. Additionally, the inability to correct farmer details post-submission results in permanent inaccuracies, affecting payments. Errors in Aadhaar details, dormant bank accounts, and bank mergers create further obstacles in fund transfers. Many beneficiaries also lack awareness of the eligibility criteria, leading to confusion and missed opportunities. Failed transactions often remain unresolved even after corrections, undermining trust in the system. To enhance the scheme's efficiency and inclusivity, addressing these challenges through improved land record digitization, allowing post-submission corrections, and ensuring transparency in fund disbursement is essential. Strengthening grievance redressal mechanisms will also help maximize the scheme's impact on the farming community.

Keywords: PM-KISAN, Land record discrepancies, Digitization challenges, Fund disbursement delay, Grievance redressal

Assessment of Menstrual Health Status and Cultural Practices Among Tribal Adolescent Girls of Odisha

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ICANTFA/077

Adolescence is a stage in the human life cycle that occurs between childhood and adulthood. The term 'Adolescent' comes from the Latin word 'adolescere', which means 'to grow to maturity'. Children from impoverished scheduled tribal homes do not attend school because some parents use their services to supplement their family income. As a result, providing educational opportunities is an essential component of the programme for the welfare of scheduled tribes. The current study aimed to assess the menstrual health status of tribal adolescent girls and their prevailing cultural practices in the study area. A community-based cross-sectional study was conducted among 50 tribal adolescent girls in Mayurbhanj district of Odisha. A pre-tested semi structured questionnaire was developed to collect the data on menstrual health profile and prevailing cultural practices.Out of 50 respondents, 20 (40%) were of early adolescent age (10-13 years), followed by 15 (30%) of mid-adolescent age (14-15 years), and 15 (30%) of late adolescent age (16-19 years). The majority of illiterate respondents (60%) had unsanitary menstrual hygiene practices. Adolescent girls (75%) with illiterate mothers had unsanitary menstrual hygiene practices. Respondents having joint families had sanitary menstrual hygiene practices. The current study found that education and awareness play an important role in sustaining menstrual hygiene. Reproductive health education is expected to be provided at every level. Bad cultural practices should be addressed at the community level through intervention.

Keywords: Menstrual Health, Tribal, Adolescent Girls, Cultural Practices.

Climate-Resilient Agriculture with Smart Breeding

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ICANTFA/078

Human civilization is approaching a watershed in its history as climate change becomes increasingly apparent and unavoidable. From melting glaciers that result in devastating erosion and flooding to rising temperatures that jeopardize agricultural supplies, the global repercussions of climate change are unsurpassed. Plant breeding has played a crucial role in changing agriculture throughout human history in order to feed the world's growing population. It can protect humanity from the imminent threats that agriculture faces from changing weather patterns, rapidly evolving pests, and limited resources. Utilizing wild germplasm extensively and unlocking the storehouse of genetic variety are essential components of any crop improvement endeavor. However, recent advances in high throughput phenomics, breeding, sequencing, and genomics, along with state-of-the-art genome-editing methods paired with AI, open up new possibilities.

Growth and Yield in Wheat as Influenced by Leaf Colour Chart, SPAD Meter, And Green Seeker-Based Nitrogen Management

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ICANTFA/079

A field experiment was conducted at the Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during *rabi* season of 2023-24. The experiment comprised of fourteen treatments aimed to investigate the effect of leaf color chart (LCC), SPAD meter, and Green Seeker-based nitrogen management on wheat crop and were laid in a randomized block design (RBD) which were replicated thrice. The soil of the experimental field was sandy clay loam in nature and was slightly alkaline and low in available nitrogen (221.16 kg ha^{-1}) and medium in available phosphorus (18.39 kg ha^{-1}) and potassium (146.25 kg ha^{-1}). The results revealed that LCC $\leq$ 5 showed the highest plant height (cm), dry matter accumulation (g m^{-2}), yield attributes, and yield (kg ha^{-1}) which found statistically similar to LCC $\leq$ 4 and Green Seeker threshold value of 0.8 and Sufficiency index $\leq$ 95%. Further, LCC, SPAD meter, and Green Seeker showed positive correlation with grain yield at 5% level with correlation coefficient (r) of 0.97, 0.81 and 0.91, respectively. However, maximum net returns (₹ 128160.43) and B:C ratio (2.96) was observed under LCC $\leq$ 5.

Keywords: Green Seeker, LCC, Nitrogen, SPAD, Wheat, Yield

Magnetic Field Treatment: A Sustainable Approach to Enhance Seed Quality and Growth

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ICANTFA/080

Seed and quality of seed is a basic element to determine the effectiveness of crop production. Nowadays, producing a quality of seed is definitely a challenge, faced by the modern agriculture in XXI century. Therefore, farmers, breeders, researchers should utilize smart resources of the natural environment by looking for new, safe methods to increase the quality of crop yields. One of the best approaches is seed treatment using a magnetic field as a physical factor. Magnetic field aid in the seeds physiological process, to obtain healthy seedlings, increase chlorophyll content in leaves and higher yields by breaking the seed dormancy stage. Additionally, magnetic field treatment is an eco-friendly and cost-effective technique. The main goal of this approach is to reduces the need for chemical seed treatments, making it a sustainable solution for modern agriculture. In my research, investigates the effects of different magnetic field intensities (mT) and exposure durations (minutes) on the germination parameters of soybean (Glycine max). The results found under laboratory conditions indicate that magnetic field treatment is a safe, effective, and eco-friendly method for enhancing seed germination. These findings suggest that this method has the potential for application in large-scale farming practices, offering a sustainable alternative to conventional seed treatments.

Keywords: seed; eco-friendly; seed treatment; magnetic field; germination & yields.

Crop Residue Management in Traditional and Emerging Maize Systems

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ICANTFA/081

A field experiment was carried out during 2020-21 and 2021-2022 in maize system [rice (*Kharif*) -maize (*rabi*) cropping system] at District Seed Farm (AB-Block) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal to study the effect of bio inoculants on decomposition of residue in maize systems and to study the effect of decomposed residues on nutrient availability in maize systems in new alluvial zone of West Bengal. The soil of the experimental plot was neutral in reaction and sandy clay loam in texture with medium nitrogen and potassium content and high in phosphorus content. The experiment was laid down in Strip plot Design with three replications. The four main plot (residue management) treatments viz. M1: Residue removal, M2: Residue incorporation M3: Residue incorporation + spray of microbial consortium on residue, M4: Zero-tillage + residue retention and spray of microbial consortia on residue and two sub plot treatments (nutrient management) viz. N1: 100% recommended dose of nitrogen, phosphorus and potassium , N2: 100% recommended dose nitrogen, phosphorus and 50% potassium were tested. The experimental result showed that maize grain yield and net return of maize were significantly superior with residue incorporation + spray of microbial consortium on residue over the other residue management. With aspect to the nutrient management, 100% recommended dose nitrogen, phosphorus and 50% potassium gave significantly higher maize yield over 100% recommended dose of nitrogen, phosphorus and potassium and interaction of M3 and N2 reported highest maize grain yield and net return of crop.

Impact of farm mechanization for improvement of food security

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ICANTFA/082

In India's scenario farm mechanization is still 40-50 %. The adoption of farm mechanization in Indian farming solutions is driven by number of factors such as fast-growing population, urbanization, labour shortage, Fragmentation of agricultural land, reduction of average land holding and sustainable agriculture productivity. Mechanization plays a pivotal role in commercialization of agriculture, ensuring sustainable farm productivity and improving food security. By the use of machine in agriculture mechanization have many advantages such as time saving (15-20 %), saving of input s such as seed and fertilizer (15-20 %) and also decrease in post-harvest loss, minimize crop damage maximizes the productivity of land, increase crop yield and cropping intensity. The nation's entire agriculture sector will be driven by the advancement of modern technology in four identified categories (FICCI, 2019) such as Farming as a service (FAAS), For the residue management through the machineries such as happy seeder, super seeder, seed cum fertilizer drill for the crop establishment is effective solution. By the use of climate resilient technology such as Zero tillage (ZT), laser land levelling, direct seed rice (DSR), raised bed planting it is possible to achieve sustainable agriculture development and improve the resilience of farming system. By adopting zero tillage technology in wheat sowing that improves resource use efficiency such as water saving (33 %) and mitigating greenhouse gas emission (60 %). It is found that zero tillage technology has more advantageous in terms of reduction of cost of cultivation, saving of tractor timing (60-70 %) increased gross return and net return over the conventional method of wheat sowing. Apart from this benefit of zero tillage technology immediate cost of saving is the more attraction to the farmers as compared to conventional method of sowing practice.

Key words: Mechanization. Wheat, zero tillage, food security, Sustainability

Effect of different fertigation treatments on Physiochemical parameters of broccoli (*Brassica oleracea var. italica*) in Assam condition

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ICANTFA/083

A field experiment was conducted at ICR Farm, Assam Agricultural University, Jorhat during winter season of 2020-21 to study the "Effect of different fertigation treatments to Physiochemical parameters of broccoli (*Brassica oleracea var. italica*) in Assam condition." The experiment consisted of four irrigation levels *viz.*, I_1: 1.20 Et_c (drip at 120% Et_c), I_2 : 1.00Et_c (drip at 100% Et_c), I_3: 0.8 Et_c (drip at 80% Et_c) and I_4: 0.6Et_c(drip at 60% Et_c) and four fertilizer levels *viz*. F_1: 100% recommended dose of N P and K (RD) through drip, F_2: 75% RD through drip, F_3: 50% RD through drip and F_4 : No fertilizer. The experiment was laid out in 4x4 Factorial RBD with 3 replications. The Green Magic (F-1 hybrid) variety was sown on 20th Nov. 2020, transplanted from 20th -22nd Dec. 2020 and harvested between 21th -24thMarch, 2021. During the study the highest plant height (38.90 cm) and leaf area per plant (3042.96 cm^2) were found highest in treatment combination of I_1F_1. While they were lowest in I_4F_4 with plant height (10.87 cm) and leaf area per plant (891.62 cm2). The physio-chemical characters like chlorophyll content of leaf (0.52 mg/g fw), chlorophyll stability index (86.39%), rate of photosynthesis (65.51µmol/m^2 /s), rate of transpiration (25.03 µg/cm^2 /s) and protein content (35.67 mg/g fw) were highest under I_1F_1, while lowest were found in I_4F_4 (0.22 mg/g, 26.23%, 18.19 µmol/m^2 /s, 5.10 µg/cm^2 /s and 12.43mg/g respectively). Thus, $I_1F_1$was found to be the best treatment combination for broccoli while I_4F_4 produced the poorest performance during the investigation.

Influence of harvest maturity stage on biochemical composition and shelf life of Dragon fruit (*Hylocereus polyrhizus*)

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ICANTFA/084

The present study entitled "Influence of harvest maturity stage on biochemical composition and shelf life of Dragon fruit (*Hylocereus polyrhizus*)" was conducted for two consecutive years during 2020-21 and 2021-22 under foothills of Nagaland at Seithekema-C village, Chümoukedima district, Nagaland, and post-harvest quality analysis of fruits were done at Department of Horticulture, School of Agricultural Sciences (SAS), Nagaland University, Medziphema campus, Chümoukedima, Nagaland. The experiment was laid out in Completely Randomized Design replicated five times, consisting of three harvesting stages *viz.,* H_1- 25 Days after anthesis (DAA), H_2- 30 DAA and H_3- 35 DAA. Fruits were tagged in the morning following anthesis and harvested according to the treatment requirement. Dragon fruit is a non-climacteric fruit and highly perishable in nature, thus, understanding of measurement of maturity is pivotal to postharvest handling. From the results, it was evident that harvesting stage is crucial in ensuring optimum post-harvest quality and shelf life of dragon fruit. Physiological loss in weight (PLW) was recorded highest in H3 (35 DAA) with values ranging from 1.65 to 8.05%, while minimum weight loss was observed in H2 (25 DAA) ranging from 0.86 to 4.02%. Fruits harvested at 30 DAA indicated optimum degree of ripeness and better eating quality, though storability was found better in 25 DAA, fruits at this stage or earlier have not reached optimum intrinsic and extrinsic quality and fruits may be labelled as bland and flavourless. Thus, it may be concluded that *H. polyrhizus* grown in Chümoukedima region of Nagaland reach physiological maturity between 30 to 35 DAA and optimum stage for harvest is 30 DAA.

Keywords: Maturity indices, biochemical, dragon fruit, storage.

Effect of nano urea on the distribution of nitrogen pools in Inceptisols

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ICANTFA/085

Nitrogen is a primary as well as essential nutrient for plant growth but often deficient in India. Only 30-40% of urea nitrogen is utilized by plants, while the rest is lost due to leaching, volatilization, denitrification, and runoff, reducing efficiency. Nano urea, a "smart fertilizer," enhances nitrogen utilization and minimizes environmental harm by lowering nitrous oxide emissions, a key contributor to pollution and global warming (Chen and Yada, 2011). To combat these issues, IFFCO introduced nano urea on June 5, 2021. A study on its impact on nitrogen pools in Inceptisols used French bean (*Phaseolus vulgaris* L.) as a trial crop, variety "Harsha" in a split-plot experiment. The method of application and treatment combinations were as follows: S1= Two stages application {Basal+ Early vegetative stage (EVS)}, S2= Three stages application {Basal+ Early +Late vegetative stage(LVS)} & S3= Four stages application {Basal+ Early+ Late+ Flowering stage(FS) } and F1= No N , F2= Nano urea (2 L ha^{-1} @4mlL^{-1}), F3= Granular Urea (50 kg ha^{-1}) F4= Granular Urea (37.5 kg ha^{-1}) + Nano urea (0.5 L ha^{-1} @1 mlL^{-1}), F5= Granular Urea (25 kg ha^{-1}) + Nano urea (1 L ha^{-1}@2 mlL^{-1}), F6= Granular Urea (12.5 kg ha^{-1}) + Nano urea (1.5 L ha^{-1} @1.5 mlL^{-1}). Recommended dose of P and K were applied in all plots. The results showed significant differences in Available Nitrogen, Total Nitrogen, Ammonium and Nitrate Fractions, Organic Carbon, and root volume at all growth stages. Among the methods of application, S3 (Four Stages application) performed best along with soil parameters and yield attributes of French bean. The F6 treatment recorded the best results among all combinations. The interaction of F6 and S3 showed superior results in soil parameters and yield attributes of French bean as compared to other treatments and control, demonstrating their effectiveness in enhancing soil fertility and crop yield.

Vertical Farming & Hydroponics as Urban Agriculture Solutions

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ICANTFA/086

Urbanization and population expansion have increased the need for food production in cities. Challenges to traditional agricultural methods include resource depletion, climate change, and a shortage of available land. Vertical farming and hydroponics provide creative answers to these problems by facilitating high-yield, sustainable food production in urban settings using cutting-edge technology, including precise fertilizer delivery, controlled temperature management, and LED lighting. By cultivating crops indoors, vertical farming reduces exposure to pests, illnesses, and harsh weathering precise fertilizer delivery, controlled temperature management, and LED lighting. Vertical farming reduces exposure to pests, illnesses, and harsh weather by cultivating crops indoors, guaranteeing steady and superior harvests all year long. By supplying nutrient-rich water solutions straight to the roots, hydroponics, a soilless farming method, promotes plant development. By reducing food miles, carbon footprints, and dependency on chemical fertilizers and pesticides, the combination of hydroponics with vertical farming in urban agriculture promotes environmental sustainability. Additionally, by promoting regional food production, these systems enhance metropolitan populations' access to fresh produce and food security. Notwithstanding these benefits, issues including high upfront expenditures, energy usage, and the need for technical know-how need to be resolved. The viability and scalability of urban farming solutions may be improved by developments in cost-effective technology, regulatory assistance, and the incorporation of renewable energy.

Keywords: Modern farming, soil less cultivation, sustainable food production

Nutritional benefits and market potential of value-added finger millet products

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ICANTFA/087

Finger millet, Sorghum, pearl millet, and tiny millets are among the millets that are traditionally farmed by resource-poor farmers across the nation. These are nutri-cereals, which are noted for their high fiber content and great nutritional value. Ragi or mandua, also known as finger millet (Eleusine coracana L.), is a vital minor millet that is widely cultivated in the African and Indian subcontinents. In India, especially for those from lower socioeconomic strata, it is a staple dish. Finger millet is prized for the macro- and micronutrients it contains. It has a high content of fat, protein, and carbohydrates. Dietary fibre (18%), calcium (0.38%), and phenolic compounds (0.3–3%), including epicatechin, catechin, and ferulic, salicylic, protocatechuic, cinnamic, and hydroxybenzoic acids, are among its micronutrients. Important amino acids that are typically lacking in starchy meals, such as isoleucine, leucine, methionine, and phenylalanine, are also known to be present in finger millet. The pharmacological qualities of finger millet, including its anti-diabetic, anti-tumorigenic, anti-atherosclerogenic, antioxidant, and antibacterial actions, are also highly valued. Millets are free of gluten, have a low glycaemic index, and contain phytochemicals that help prevent diseases like cancer and rectify lifestyle issues. Compound-specific genotypes in millets that can serve the pharmacy business can be found thanks to advancements in analytical techniques for the detection of different substances. Food security and agriculture's negative effects may be minimised by value-added millet products. In order to improve health consumption, the review concentrated on millet's nutritional value, health advantages, and processing methods with their value-added products.

Keywords- Millet, Value- added products, Nutritive value, Micronutrients

Genome-Wide Association Study for Identifying Key Candidate Genes Involved in Micronutrient Profiling in pigeonpea

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ICANTFA/088

Micronutrient malnutrition considered “hidden hunger,” which affects millions of populations all across the world. The consequences of micronutrient deficiencies are extensive and impact not only people's health and well-being but also societal development and economic output. Pigeonpea is a nutrient-dense legume, serving as a rich source of essential micronutrients, particularly Fe, Zn, Ca, Mg, Cu, and Mn. However, limited exploration about the genetic basis for the accumulation of these micronutrients, which hinders efforts to create nutrient-enriched cultivars. In this study, an investigation has been done to identify key candidate genes associated with high micronutrient content in a 127 diverse panel of pigeonpea genotypes. A high throughput 62K SNP "*CcSNPnks*" genic chip was employed to detect SNP markers associated with micronutrient profiling such as Fe, Mg, Cu, Ca, Mn, and Zn in pigeonpea genotypes. Micronutrient concentration was assessed using Atomic Absorption Spectroscopy (AAS). Using GWAS analysis identified 6 and 1 SNPs exhibiting a strong association with high Fe and Mn content, respectively. Identified SNPs showed an association with chr 1 (AX-165375648) for heat shock factor protein, chr 12 (AX-165389603) for cytochrome P450, chr 2 (AX-165408882) for endoribonuclease, chr 6 (AX-165383503) for serine/threonine-protein kinase TOR, and chr 8 (AX-165380255) for tRNA (cytosine (38)-C (5))-methyltransferase 2. Thereafter, GWAS analysis and identification of key genes and those identified SNPs would be validated using qRT-PCR. This validation step is crucial in establishing the functional relevance of these genes and their role in micronutrient profiling. The findings from this study will provide critical insights into the genetic architecture of micronutrient traits in pigeonpea and serve as a foundation for marker-assisted selection (MAS) in breeding program for the development of biofortified pigeonpea cultivars with enhanced nutritional value.

Keywords: Genome wide association studies, genotypes, micronutrients profiling, pigeonpea

Assessment of Sugarcane (*Saccharum* spp.) Growth and Yield under Calcareous Soil as Influenced by Different Row Spacing, Levels of Fertilizers and Genotypes

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ICANTFA/089

A field experiment was conducted to optimize the levels of fertilizers and spacing for better performance of sugarcane genotypes under Calcareous Soil during 2019-20 at Dr Rajendra Prasad Central Agricultural University Bihar. The treatment combination comprised two spacings (row to row-90 cm and 120 cm), three levels of fertilizers (100 % NPK of RDF, 125 % of NPK of RDF and 150 % of NPK of RDF) and six different sugarcane genotypes (CoLk 15466, CoLk 15467, CoP 15436, CoSe 15452, CoSe 15455, CoLk 94184) with having a total of thirty-six treatment combinations and three replications. The recommended dose of fertilizer 150:85:60 kg N: P_2O_5: K_2O ha^{-1} was applied through urea, SSP and MOP. Germination per cent was highest in treatment with 90 cm of row spacing compared to 120 cm of the row spacing. The highest germination per cent at 30 DAP (27.8%) was recorded in treatment with 150 % NPK of RDF, whereas the highest germination per cent at 45 DAP (32.4%) was recorded with 100 % NPK of RDF. At last, coming to genotype, it was concluded that at both the stages of plant growth, i.e., at 30 DAP (30.7%) and 45 DAP (34.2%), genotype CoP 15436 recorded the highest germination per cent (30.7%). Significantly higher cane yield (85.0 t ha^{-1}) was recorded in treatment with a narrow spacing of 90 cm compared to cane yield (74.8 t ha^{-1}) in treatment with wider row spacing of 120 cm. Significantly higher juice recovery was found in treatment with 90 cm spacing (64.88 %) than 120 cm spacing (63.16 %). Availability of nutrients in the soil is strongly affected by 120 cm row spacing, 150% NPK of RDF and genotype CoLk 15467 and hence proved beneficial for improving the fertility status of the soil. In the case of nutrient uptake by sugarcane plant, we concluded that 90 cm row spacing, 150% NPK of RDF and either of the three genotypes viz., CoLk 15466, CoP 15436, CoSe 15452 proved best which enabled the plant to utilize the nutrients from the soil efficiently.

Keywords: - Spacing, Levels of fertilizers, Genotypes, Germination, Cane yield.

Screening of rice cultivars for aroma at various growth stages under different dates of sowing in Konkan conditions

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ICANTFA/090

Aroma is a critical quality attribute in rice, significantly influencing consumer preference and market value. This study investigated the aroma profiles of fifteen rice cultivars, including local and released varieties grown in the Konkan region of Maharashtra, India. The research explored the impact of growth stage (seedling, flowering, maturity) and sowing date on aroma expression. Sensory evaluation was employed to assess aroma intensity. Results revealed substantial variation in aroma profiles among the tested cultivars. PR-115 consistently exhibited a strong aroma across all growth stages and sowing dates, suggesting its potential stability and suitability for the region. BM-4 demonstrated a mild scent at seedling, maturity, and after cooking, but a strong scent at the flowering stage, indicating a dynamic aroma profile influenced by developmental stage. While most genotypes displayed mild to strong aroma at flowering, a smaller subset retained aroma at maturity and after cooking, highlighting the potential loss of aroma during grain development and processing. These findings contribute to identifying superior aromatic rice cultivars adapted to Konkan's specific environmental conditions and inform strategies for optimizing planting schedules to enhance aroma and yield

Keywords: Rice aroma, Oryza sativa, Konkan, sowing date, growth stage, sensory evaluation,

Integrated Farming Systems: A Key to Sustainable Agriculture

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ICANTFA/091

Currently, farmers primarily focus on crop production, which is subject to significant uncertainty in terms of income and employment. To address this issue, it is essential to develop a strategy that enhances farm income. Integrated Farming Systems (IFS) and Sustainable Agriculture (SA) are closely interrelated concepts.

IFS involves managing a farm as a single system, incorporating multiple farming practices such as crop rotation, livestock grazing, and agroforestry. The primary objectives of IFS are to increase farm productivity, reduce environmental degradation, and promote ecological balance. Sustainable Agriculture, on the other hand, refers to farming practices that maintain or improve soil health, conserve water, reduce pollution, and produce nutritious food.

IFS is a crucial strategy for achieving sustainable agriculture. By integrating multiple farming practices, IFS helps maintain ecological balance, reduces environmental degradation, and promotes biodiversity. The integration of various agricultural enterprises, such as cropping, animal husbandry, fishery, and forestry, has significant potential to enhance agricultural economy. The main advantages of IFS include higher food production, increased farm income, sustainable soil fertility and productivity, and the availability of nutritious food. Integrated farming also helps in environmental protection, reduces production costs, and provides regular stable income through various products. A judicious mix of agricultural enterprises, suited to the given agro-climatic conditions and socio-economic status of the farmers, would bring prosperity in farming. Inclusion of biogas and agroforestry in IFS can solve energy crises, while cultivating fodder crops can provide adequate nutritious fodder for animal components. Overall, IFS has the potential to contribute significantly to sustainable agriculture, ensuring long-term food security, environmental protection, and social equity.

ORGANIC FARMING A BOON OF AGRICULTURE

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ICANTFA/092

Maintaining crop production and soil health is an important upcoming major challenge in agriculture, due to the unsupervised use of synthetic means of farming i.e. inorganic fertilizers, pesticides, herbicides, etc. human and environmental health is being seriously affected. There is a serious decline in the soil fertility which in turn is affecting the yield of the crops. Excessive and unsupervised usage of pesticides results in pest gradually getting immune to the pesticides. So organic farming is the only proper alternative to synthetic fertilizers for sustainable agriculture. The term Organic farming also known as organic agriculture or ecological farming or biological farming. Organic farming is a system of agriculture that focus on producing food without the use of synthetic pesticides, herbicides, fertilizers, or genetically modified organisms (GMOs). It relies on natural processes and techniques to maintain soil health, promote biodiversity, and minimize environmental impact. Organic farming prioritizes building healthy soil through practices like crop rotation, intercropping, compost manure, and green manure. Healthy soil is more fertile, better able to retain water, and less susceptible to erosion. Healthy soil is a living, dynamic ecosystem. It has organic matter (dead plant and animal material), micro-organisms (bacteria, fungi, and protozoa), macroorganisms (earthworms and insects), water, and air. Soil health is the capacity of the soil to function as a living system. These practices can also help to control pests and diseases, reducing the need for synthetic pesticides. Healthy soils maintain a diverse community of soil organisms that help to control plant disease, insects, and weed surfaces.

Key Word – Organic Farming, Soil Health, Environment

ROLE OF ORGANIC FARMING IN SUSTAINABLE AGRICULTURE

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ICANTFA/093

Organic seeds are a foundational element of sustainable agriculture, contributing to environmental health, food security, and biodiversity. Organic seeds are defined as seeds produced according to organic farming standards, which prohibit the use of synthetic pesticides, herbicides, and fertilizers. This approach ensures that seeds are cultivated in a manner that is environmentally sound and ecologically sustainable. These seeds are often derived from locally adapted varieties that have been passed down through generations, promoting genetic diversity and allowing for more climate-resilient agricultural systems. As climate change and global food insecurity continue to pose challenges, organic seeds offer a solution by preserving biodiversity and strengthening the resilience of farming systems. In sustainable agriculture, organic seeds play a vital role in maintaining soil fertility, supporting pest management, and fostering healthy ecosystems. By relying on practices such as crop rotations, organic manures, biofertilizers, and biopesticides, organic seed production avoids the use of harmful chemicals, reducing the environmental impact of conventional farming. However, there are challenges associated with the widespread adoption of organic seeds. Limited availability and high costs, especially in comparison to conventional seed varieties, hinder access to organic seeds for many farmers. Additionally, the lack of education and awareness about the importance of seed quality, as well as financial barriers, prevent farmers from fully embracing organic seed practices. Despite these efforts, the sector faces technical challenges in disease management, pest control, and maintaining seed quality standards. Organic seeds are essential for promoting sustainable agriculture, and continued investment in organic seed research, farmer education, and seed conservation initiatives is crucial to building resilient and ecologically sound farming systems for the future.

Keywords: Organic seeds, Sustainability, Farmers

Climate Resilient Agricultural Practices and Contribution of Extension Personnel in India

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ICANTFA/094

Climate-resilient agricultural (CRA) practices are essential for sustaining Indian agriculture amid climate changes. The study identifies key CRA practices and examines the role of extension personnel in promoting adoption in CRA practices. Findings reveal that CRA enhances smallholder resilience and their income but faces various barriers such as high costs, limited credit access, and inadequate infrastructure. Extension personnel play a crucial role, with 97% advocating for farmers and 89% issuing technical advisories, and 79% engaging in capacity building. However, challenges like inadequate training (64%), lack of efficient transportation (88%), and weak interdepartmental coordination (97%) hinder effectiveness and outreach of CRA initiatives. CRA adoption also boosts nutrition, livestock management, and women's participation. Strengthening extension services, financial support, and digital tools is vital for scaling CRA and ensuring climate adaptation in Indian agriculture.

Keywords: Climate-resilient agriculture, extension personnel, sustainable farming, climate adaptation, agricultural extension, financial constraints.

Profile of the Agriculture Assistants of the Agriculture Department in Nagpur District

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ICANTFA/095

The study entitled “Communication Behaviour of Agriculture Assistants of Agriculture Department in Nagpur district” was undertaken in ‘Hingna’, ‘Nagpur’, ‘Kalmeshwar’, ‘Saoner’ and ‘Kamptee’ Talukas from Nagpur district with sample size of 90 respondents’ agriculture assistants. The data were collected by conducting personal interview of each respondent with the help of structured interview schedule. Careful analysis, tabulation and classification of the data were done. Mean, standard deviation, frequency, percentage and correlation of the data were employed for the interpretation of the results. In the case of the personal profile of the agriculture assistants, more than half of the respondents (57.77 %) were belonged to young category (up to 35 years) and 55.55 per cent of the respondents were educated up to diploma level. Four fifth of the respondents (80.00 %) had medium service experience and majority of respondents (61.11 %) had received low number of trainings. 71 .11 per cent of respondents had medium transfer of agriculture technology facilities available at their disposal 62.23 per cent were above average level achievement motivation. Majority of the respondents (64.44 %) were satisfied with their job, followed by 34.44 per cent were unsatisfied with their job and only 01.12 per cent agriculture assistants were found highly satisfied with their job.

Innovative strategies to reduces post-harvest losses in Horticultural crops

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ICANTFA/096

Post-harvest losses are a significant challenge, particularly in rural areas where most people are small-scale farmers. Surveys by agricultural and horticulture officers reveal that fruit and vegetable losses in rural areas can reach 30-50%, leading to substantial economic losses for farmers. Key factors contributing to these losses include improper harvesting, handling, inadequate market access, storage issues, and limited farmer awareness. Other challenges involve drying, solar drying, processing, value addition, distribution, and consumption stages. Innovative strategies to address these losses focus on proper handling, cold chain systems, smart packaging, storage technologies, and advancements in precision agriculture. Policy frameworks, community awareness programs, and public-private partnerships are also critical in reducing food waste at consumer and retail levels. Reducing post-harvest losses ensures sustainable food production and distribution while improving farmers' livelihoods and supporting global efforts to combat hunger. Collaborative action among stakeholders is vital to build a resilient food system that meets current and future needs. Reducing post-harvest losses not only ensures sustainable food production and distribution but also improves farmers' economic conditions and supports global efforts to combat hunger. A concerted effort from all stakeholders is essential to create a resilient food system that provides for present and future generations.

Keywords: post-harvest losses, farmers, storage.

Precision Farming: The Future of Sustainable Agriculture Through AI and IOT

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ICANTFA/097

Matching agricultural production to human requirements has always been a fundamental challenge—one that is becoming even more critical with the projected surge in global population, shifting dietary preferences, environmental concerns, economic impacts, and socio-political challenges. Traditionally, agricultural science has relied on mechanization, agrochemicals, and genetic advancements in plants and animals. However, given the growing complexities of future food systems, emerging technologies with paradigm-shifting capabilities must be harnessed to enhance agricultural research and increase the resource-use efficiency of our crop production systems to sustain future generations.

One such transformative paradigm is Big Data Analytics and Artificial Intelligence (AI). Currently, agricultural research lags other sectors in adopting Big Data technologies, which is both a challenge and an opportunity. Agriculture is inherently complex and diverse, and conventional data management and statistical analysis tools often fall short of addressing all the nuances of agricultural value-chain development. Big Data analytics has the potential to provide deeper insights, aiding agricultural research and extending its impact through interdisciplinary collaboration. AI, in particular, is emerging as a powerful tool for solving a wide range of agricultural challenges and enabling precision agriculture.

This review explores the current state of Big Data and AI in agronomy, covering data collection methods, analytics, and practical applications. Additionally, it highlights the importance of ensuring high-quality agronomic and environmental data while addressing common misconceptions surrounding these technologies. By leveraging insights from other allied sectors, the agricultural industry can fine-tune and optimize these innovations, paving the way for a smarter, more efficient, and sustainable future for global food production.

Keywords: Big Data, Paradigm-shifting, Leveraging,

Evaluation and screening of Grass Pea (Lathyrus sativus) genotype in the Terai region of West Bengal

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ICANTFA/098

Grass pea is an annual cool-season grain legume widely cultivated in different region of world. It is a stress-resilient crop with high nutritional value, considered a promising source of traits to breed for adaptation of climate change effects. It is also reported as a suitable crop for more sustainable production systems such as intercropping. An experiment was carried out in the “Agricultural Research and Instructional Farm” in Uttar Banga Krishi Vishwavidyalaya, Pundibari, Cooch-Behar in 12 genotypes of khesari. 14 quantitative and qualitative characters along with DUS descriptors were taken for investigation to find out the genotypes as well as characters for future crop breeding programme. From the statistical analysis done in “R”, highest yield per plant (9.562 gm (G-8),9.688gm (G-10)), highest yield per plot (981.83gm)(G-10), 956.3(G-8), lowest days to maturity were found in genotype 8(BANG-307-S2)(107days) along with genotype 10(BANG-234-S1)(103daysIn 100 seed wt., moderate GCV (15.42%), very high heritability (94.69%) and moderate GAM (30.92%) were found. In yield per plant, High GCV (25.39%), very high heritability (99.10%) and very high GAM (52.07%) were found. In Pods per plant, High GCV (20.36%), very high heritability (97.46%), very high GAM (41.40%) were found. In conclusion we can recommend genotype 8(BANG-307-S2) was found to have significant desirable quantitative and qualitative characters which can be selected for future varietal trail programme.

Keywords: DUS descriptors, Genotypic correlation, GCV, heritability, Genetic advance against mean, ODAP

Utilization of Jackfruit Seed Flour in Composite Biscuits: Functional, Chemical, and Sensory Evaluation

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ICANTFA/099

This study aimed to evaluate the functional, chemical, and sensory properties of jackfruit seed flour and its potential incorporation into composite flour biscuits. Jackfruit seed flour was incorporated into the biscuit formulations at levels of 10%, 20%, 30%, and 40%, and the resulting biscuits were compared to a control (0% seed flour) for their chemical composition and sensory characteristics. Proximate analysis of the jackfruit seed flour revealed a moisture content of 15.88%, crude fiber of 2.49%, protein content of 5.78%, and a low fat content of 1.77%. The functional properties of the flour indicated a high fat absorption capacity (72%) relative to its water absorption capacity (86%), with dispersibility, solubility, and swelling power values of 33%, 2.31%, and 1.46 g/g, respectively. The incorporation of jackfruit seed flour into the biscuits resulted in a decrease in protein and carbohydrate content, while moisture, fat, crude fiber, and ash content increased with higher levels of seed flour substitution. Sensory evaluation indicated no significant differences in sensory attributes for biscuits containing up to 20% jackfruit seed flour compared to the control. However, biscuits with 30% and 40% jackfruit seed flour exhibited undesirable characteristics, such as a darker color and harder texture, leading to rejection by the panelists. These findings suggest that jackfruit seed flour can be effectively used as a functional ingredient in biscuit formulations at substitution levels up to 20%, without negatively affecting sensory properties.

Key words: Jack fruit, Biscuits, Jack seed flour, Extraction, Functional ingredients, By Products

The Soil Microbiome: A Hidden Ally for Sustainable Crop Health

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ICANTFA/100

With the world's population rapidly growing, increasing global food production is essential. However, achieving this goal while reducing dependence on inorganic fertilizers and pesticides presents a major challenge. A promising solution lies in harnessing the beneficial relationships between plants and soil microorganisms. Soil microbes—including bacteria, actinomycetes, fungi, viruses, nematodes, and protozoa—play a crucial role in maintaining soil health and supporting plant growth. These tiny organisms contribute to key biological processes such as nitrogen fixation, nutrient cycling, and organic matter decomposition, all of which enhance soil fertility. As the global population continues to rise, the demand for food production is increasing at an unprecedented rate. However, relying heavily on inorganic fertilizers and chemical pesticides to boost crop yields comes at a cost—soil degradation, water pollution, and declining biodiversity. A more sustainable and environmentally friendly approach involves harnessing the natural power of soil microorganisms to improve plant growth, enhance unprecedented rate., and reduce the need for synthetic inputs. Microbes promote plant growth through several mechanisms, including the production of essential metabolites and plant growth regulators. Some microbes even convert atmospheric nitrogen into ammonia, making it more accessible to plants. In addition to enhancing plant health, these microorganisms naturally suppress harmful pathogens, reducing the need for chemical pesticides. By fostering microbial diversity in the soil, we can support sustainable agriculture, improve soil quality, and ensure long-term food security. This review highlights the essential role of soil microbes in maintaining soil health, boosting crop production, and promoting eco-friendly farming practices.

Keywords: actinomycetes, unprecedented rate, soil fertility, microorganisms, crop production, microbes, nutrients, soil health

Water Conservation Strategies in Climate-Resilient Agriculture

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ICANTFA/101

Water conservation strategies are essential for ensuring sustainable farming, food security, and environmental resilience amid increasing global water scarcity, population growth, and climate change challenges. Sustainable agricultural practices emphasize efficient water management techniques such as drip irrigation, precision sprinklers, soil moisture sensors, irrigation scheduling, mulching, rainwater harvesting, and crop rotation. These methods optimize water use, minimize environmental impact, and enhance agricultural productivity. The adoption of drought-resistant crop varieties, advanced genetic engineering, and molecular breeding further strengthens drought resilience. Additionally, smart agricultural technologies, including IoT-based monitoring systems and automated irrigation, improve resource efficiency by enabling precise water application. Integrating biotechnological innovations such as hydrogel granules helps retain soil moisture. Natural hydrogels (cellulose-based), have less strength compared to synthetic granules, but are biodegradable and are environmentally friendly, ensuring long-term water and nutrient availability, particularly in arid and semi-arid regions. Furthermore, climate-smart agricultural strategies support adaptive water management by incorporating data-driven decision-making and real-time monitoring. Government policies and incentives also play a crucial role in encouraging farmers to adopt water-saving technologies. Continued investment in research, education, and infrastructure is necessary to scale up these innovations and promote widespread implementation. This study highlights the importance of integrating technological advancements, sustainable farming practices, and policy interventions to address growing challenges in food security and environmental sustainability. Future research should explore region-specific solutions to enhance resilience and efficiency in water use for global agricultural systems.

Keywords: Sustainable farming, Food security, Climate change challenges, Drip irrigation, Water usage, IoT-based monitoring, Hydrogel Granules.

Growth, yield and quality assessment of hybrid rice (Oryza sativa L.) varieties in kharif season

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ICANTFA/102

A field study was carried out during kharif season of 2022 at Regional Research Sub-Station, BCKV, Chakdaha, Nadia to compare the growth and yield performance of six hybrid rice varieties (PAN 802, PAN 2423, PAN 2430, PAN 2140, PAN 2150 and Arize 6444 Gold) and one high-yielding variety (Satabdi as local check) under new alluvial zone of West Bengal. The experiment was set up in randomized complete block design with seven treatments and three replications. Growth parameters namely plant height, number of tillers m-2, leaf area index, dry matter accumulation registered better in case of PAN 802 than any other tested varieties. The leaf chlorophyll content was maximum in this variety at 50 and 75 DAT. The above-mentioned growth attributes were poor in high yielding variety Satabdi, irrespective at observation dates. Among the yield attributing characters, panicles m-2 (306) and test weight (25.91 g) were highest with PAN 802, and filled grains panicle-1 (128.90) was highest in case of Arize 6444 Gold. However, all the hybrids were statistically at par with respect to panicles m-2 and test weight. The highest grain yield was achieved with PAN 802 (7.55 t ha1); however, it was statistically at par with PAN 2423 (7.33t ha-1), PAN 2140 (7.36t ha-1), PAN 2150 (7.5 t ha-1) and Arize 6444 Gold (7.4 t ha-1). The hybrid varieties namely PAN 802 and PAN 2150 produced 84.15% and 82.92% higher grain yield respectively over the high yielding variety. Among quality parameters, amylose content was more in PAN 802 (26.51%) closely followed by Satabdi (26.42%). The highest carbohydrate content (82.35%) was found in PAN 802, while the highest total soluble protein (1.72%) and crude protein (6.44%) content was recorded in Arize 6444 Gold and PAN 2150, respectively. The hybrid variety PAN 802 gave the highest net return (Rs. 57,801 ha) as well as B:C ratio (1.97). In conclusion, all the hybrid varieties exhibited better growth, grain yield and net return over the high yielding variety, but the superiority was observed in case of PAN 802.

Evaluation of the efficiency of different biocontrol agents for controlling Powdery mildew (*Uncinula necator*) of Grapes (*Vitis vinifera*)

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ICANTFA/103

Excessive and overuse of these chemicals leads to environmental pollution and are phytotoxic. Biological control is a natural control that maintains a natural balance between plant pathogenic microbes and beneficial microbes by checking the growth of harmful plant pathogens by exploiting beneficial biological control agents or antagonists against them and thus managing the plant diseases. The present field experiment was conducted in November 2024. The Chenin Blanc variety of grapes was pruned in September month. Infection of powdery mildew started in the October month. The design of the experiment was randomized block design (RBD) with seven treatments and three replications. Treatment-wise spray of bio-formulations (T1: *Ampelomyces quisqualis*, T2: *Trichoderma viride,* T3: *Bacillus subtilis,* T4: *Pseudomonas fluorescence,* T5: *Ampelomyces quisqualis* + *Bacillus subtilis,* T6: Sulphur and T7: Control) was done by using a Knapsack sprayer. Powdery mildew appearance on bunches was recorded by adopting a 0-4 scale. Only actively growing powdery mildew lesions were considered for measuring disease. In this experiment, we observed that treatment five (*Ampelomyces quisqualis* + *Bacillus subtilis*) was highly effective for controlling powdery mildew of grapes, followed by T1: *Ampelomyces quisqualis,* T3: *Bacillus subtilis,* T6: Sulphur, T2: *Trichoderma viride* and T4: *Pseudomonas fluorescence*. The results of this study suggest that the biocontrol agents (*Ampelomyces quisqualis* + *Bacillus subtilis*) have the potential to be used as an alternative to chemical fungicides for the control of powdery mildew of grapes.

Keywords: Bio-control agents, grapes, powdery mildew.

Dual-Purpose Utilization of Hybrid Maize (Zea mays L.): Leaf Defoliation for Silage Preparation and Off-Season Livestock Feeding

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ICANTFA/104

An experiment was conducted during the rabi season of 2023-24 at farmer's field in angabelia village, Gosaba Block, South 24 Parganas, West Bengal, to evaluate the effects of leaf defoliation and nitrogen (N) levels on maize (cv. NMH 1255) crop. The study was laid out in a factorial randomized block design (FRBD) with two factors: (i) leaf defoliation treatments [three levels; D0 (no defoliation), D1 (removal of lower leaves below the ear, including the ear leaf, at 7 days after 50% silking), and D2 (D1 + sequential removal of two leaves above the ear at weekly intervals)]; and (ii) doses of nitrogen [four levels; N0 (0 N), N1 (50% recommended dose of nitrogen, RDN i.e. 140:70:65 kg N:P_2O_5:K_2O ha^{-1}), N2 (100% RDN), and N3 (150% RDN)], replicated thrice. The recommended fertilizer dose of P_2O_5 and K_2O was followed for all plots. N was applied following the treatment protocols. While application of N, 40% of total N dose (for any treatment) was applied as basal and rest 60% N was equally applied in two splits, at knee-height stage (40 DAS) and at the pre-tasseling stage (80 DAS). The primary objective of the study was to evaluate and optimize leaf defoliation strategies for silage preparation while ensuring the sustainability of maize grain yield under varying N fertilization regimes. The results revealed that moderate defoliation (D1), coupled with optimal nitrogen application (N2), achieved the most favorable balance between silage biomass and grain yield. Defoliation under D1 provided sufficient high-quality biomass for silage preparation without significantly reducing grain yield, thereby demonstrating its potential for dual-purpose utilization. These findings underscore the efficacy of integrating strategic leaf defoliation and nitrogen management to enhance maize productivity for dual-purpose use, ensuring sustainable livestock feed availability and efficient resource utilization during the off-season.

Keywords: Leaf defoliation, Silage biomass, Nitrogen levels, Grain yield, Dual-purpose utilization, Sustainability, Resource optimization

Challenges in the Logistics of Agricultural Products in India: Addressing Supply Chain Inefficiencies and Wastage

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ICANTFA/105

The logistics of agricultural products in India face significant challenges that contribute to inefficiencies, high wastage, and ultimately impact food security. India, with its vast agricultural output, is the second-largest producer of fruits and vegetables globally, yet it faces alarming post-harvest losses, estimated at around 20-30% for perishables. These losses are largely attributed to poor infrastructure, inadequate cold chain facilities, lack of proper storage, and inefficient transportation systems. According to a 2020 report by the National Academy of Agricultural Sciences (NAAS), logistics inefficiencies contribute to about ₹92,000 crore ($12 billion) worth of losses annually in the Indian agricultural sector.The absence of a robust cold chain infrastructure is a significant bottleneck. India’s cold chain infrastructure only covers about 4-5% of the total requirement, leaving a large gap in the logistics process. Rural-urban connectivity also plays a crucial role in supply chain inefficiency. With poor road infrastructure, particularly in rural areas, the transportation of agricultural products from farms to markets is often delayed, contributing to spoilage. The high dependence on traditional, low-tech methods of transportation, including unregulated trucks, makes the system prone to breakdowns and mishandling. Addressing these logistical challenges will not only reduce wastage but also help improve the profitability and sustainability of the agricultural sector in India, ensuring better food security and economic stability for the country. Through this analysis, the article highlights the critical need for investment in logistics modernization, technology adoption, and infrastructure enhancement to curb wastage and enhance the efficiency of India's agricultural product supply chains

Keywords: Agricultural Logistics, Inefficiencies Supply Chain, Cold Chain Infrastructure, Post-Harvest Losses, Food Wastage.

Sustainable Mushroom Farming: Production, Value-addition and Economic viability

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ICANTFA/106

Mushroom farming represents a feasible solution to embrace sustainable agricultural practices by utilizing agro-waste as substrates for growth and converts low-economic-value byproducts into nutritional food source. Besides mushroom contribute to numerous health benefits like- anti-cancer, anti-tumor, anti-HIV-1 diabetes, heart disease, hypertension, antioxidant, ulcers, anemia, infertility, etc. due to its rich vitamin B (riboflavin, niacin), fiber content, minerals, proteins, carbohydrates and fatty acids. This study aims on production techniques involving collection and cultivation, value-added products and generating agri-business opportunities. Through an extensive field surveys and sample collection, we cataloged few samples of wild edible mushrooms such as *Leucoagaricus leucothites, Ganoderma applanatum, Schizophyllum commune, Lentinula edodes, Lentinus tigrinus, Psathyrella corrugis, Lentinus squarrosulus, etc.* and wild non-edible mushroom for their medicinal as well as industrial purposes such as *Tyromyces chioneus, Rhodofomes cajanderi, Marasmiellus candidus, Trametes suaveolens, Microporus xanthopus, Microporus affinis,* etc.; along with the cultivation techniques of *Pleurotus ostreatus* (Oyster mushroom). Post-harvest handling is crucial for quality maintenance, involves proper storage, drying, and packaging methods to extend shelf life and maintain nutritional value; involving production of value-added products such as pickle, soup, biscuit, nuggets, chips, ready-to-serve mushroom curry, etc. The findings suggest that sustainable mushroom farming can contribute to bio-diversity conservation, food security, and economic empowerment, offering significant income-generating opportunities for small-scale farmers and entrepreneurs.

Key words: Mushroom farming, Agro-waste, Economic empowerment, Food security, Value-added products.

Guava scab (*Pestalotiopsis* sp.): Identification and Characterization under Gangetic Alluvial Zone of West Bengal

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ICANTFA/107

Guava (*Psidium guajava*) is an important tropical fruit native to Southern America and the West Indies; however, the crop is now widely cultivated in many tropical and subtropical regions, including India. It is a very popular, widely adapted, and one of the most delicious and nutritious fruits. It is commonly known as the ‘apple of the tropics’ and the ‘poor man’s apple.’. Guava fruits are affected by many pathogens that cause rotting of fruits, hence severe yield reduction as well as decrease the fruit quality and marketability leading to economic loss. To know the disease scenario a field survey was conducted at the ICAR-AICRP on fruits, Mandouri, Nadia, and its surrounding districts during the years of 2022-2024. Brown, elevated, corky, necrotic lesions on the fruit's exocarp and gray/light brown lesions on the leaves with dark brown borders were the typical symptoms of the target disease. As the fruit matured, the corky lesion enlarged in size, the affected area often cracked to open the fruit. The pathogen was isolated and characterized following standard laboratory procedures. The fungus was determined to be *Pestalotiopsis* spp. by extensive microscopical and molecular analysis. Pathogenicity was demonstrated by fulfilling Koch’s postulation method using susceptible host (Cv L-49). 17 isolated were collected from different locations of 4 districts of West Bengal and 5 isolates were studied. Cultural and morphological variations were recorded on colony growth, colour, no acervulus. Conidial length, breadth, no of appendages were studies under microscope. Growth rate was studied in 7 different solid media like PDA (Potato Dextrose Agar), OMA (Oatmeal Agar), CAM (Carrot Agar), CDA (Czapek’s Dox Agar), Richard’s media, SDA (Sabouraud’s Agar), and Guava Leaf and Fruit Extract or Host Media. PDA was identified as the best media for growth and sporulation of the pathogen, followed by CAM, OMA, and host media, and the lowest growth was observed in Richard’s media.

Income and Employment in Hill Areas of West Bengal

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Women entrepreneurship plays a vital role in boosting value-added economies through agriculture and allied sector. In hill areas, women are also promoting the way of self-reliance for preserving traditional crafts and industries. Women-led businesses in disadvantageous hill region often focus on handicrafts, homestays, and food processing, leveraging local resources and cultural heritage. Considering above, the present study investigates the factors which influence female labor participation and its impact on monthly family income.To identify the factors the multiple linear regression model was selected for analysing the relationship between income and the variables such as age, education, marital status, family background, operational area, normal and peak season work participation, etc. The data has been collected from 50 female laborers through simple random sampling without replacement from Kalimpong municipality.From the result it is clear that wage rate is a significant predictor of income, with peak season wages having a positive and stronger effect, while normal season wages show a relatively weaker but still notable impact.The R-squared value indicates that 71.9 percent of the variation in income is explained by the predictors (Monthly wage rate, age, no. of family member, education, marital status, presence of children, own land area, home stayed area, area under orchard and plantation) at 1 percent level of significance. The study also explores the contribution of women in various sectors, including manufacturing, and construction, with a notable concentration of women-led businesses such as boutiques, woollen garment manufacturing, and food supply in the hill areas of West Bengal.

Despite these positive developments, women in hill region continue to face significant challenges, including limited financial support, lack of proper marketplaces, and low awareness of government schemes. To overcome these barriers, the study recommends proactive strategies such as building networks, branding products, leveraging social media for marketing, and staying informed about government schemes to enhance women's economic opportunities and independence.

Keywords: Entrepreneurship, Employment, Income, Women

A major breakthrough in seed yield and oil content in sesame (*Sesamum indicum*)

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To achieve self-sufficiency in oilseed production the present investigation is oriented towards development of high yielding varieties with higher oil content through induced mutagenesis. Twenty-three genotypes of sesame representing different parts of India were evaluated for agro-morphological and biochemical traits. Three genotypes chosen on the basis of phenotypic and seed storage protein diversity through SDS-PAGE were treated with γ-rays and ethyl methane sulphonate, (EMS), individually. Three doses of γ-rays namely 200 Gy, 400 Gy and 600 Gy and four concentrations of EMS (0.5%, 1.0%, 1.5% and 2.0%) were used to induce mutation. For its outstanding performance, this new variety was identified in 2017, released by the Central Variety Release Committee (CVRC) in 2018 and notification published in 2019. Suprava produces 26% more seed yield and 22 % oil yield than all existing varieties and recommended for its commercial cultivation in West Bengal, Odisha, Maharashtra, Chattisgarh, Telengana, Tamil Nadu and Karnataka. Conversely, CUMS-09A (Tanjila) was the best performer in multilocation Coordinated trials during 2019-20, 2020-21, and 2021-22. Hopefully, commercial cultivation of these new varieties would help in tiding over the problem of shortage of edible oils and thereby to reduce the demand-supply gap of edible oilseeds production in the country.

Keywords: EMS, gamma-rays, oil content, seed yield, sesame

Diversity and community structure of mite fauna associated with flower plants in West Bengal

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ICANTFA/110

This study explores the diversity and community structures of mite fauna associated with flower plants in West Bengal, aiming to develop a better ecologically sound strategy for mite pest management. A total of twenty-three species of Phytoseiid mites belonging to the genera *Amblyseius, Euseius, Paraphytoseius, Typhlodromips, Scapulaseius, Phytoseius, Neoseiulus, Anthoseius, Indoseiulus and Gynaeseius* were recorded during the period of investigation. Among these Phytoseiid mite, *Amblyseius largoensis* was found as dominant predatory mite species occupied 20.55 per cent of total predatory mite population followed by *Euseius alstoniae* and *Euseius ovalis* accounting 9.27 & 7.64 per cent of total predatory mite population, respectively. However, the other predatory mites belonging to the family viz. Tydeidae, Bdellidae, Ascidae, Cunaxidae, Cheyletidae and Stigmaeidae were also recorded in association with flower plants. Regarding phytophagous mites, *Tetranychus urticae, Schizotetranychus baltazari, Eutetranychus orientalis, Oligonychus indicus, Polyphagotarsonemus latus and Brevipalpus phoenicis* were recorded as destructive mite pests. Phytophagous mites are a serious concern, posing a major constraint to successful flower cultivation in West Bengal. Predatory mites were found to be effective against plant feeding mites and other soft bodied insect. So, they could be utilized as one of the important tools in IPM programme to minimum use of chemical pesticides which leads to environmental hazards.

Keywords: Diversity, mite fauna, Flower plants, West Bengal

Future prospects of food and agriculture technology for sustainable Agriculture

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Technology has played a crucial role in transforming agricultural practices, allowing for more efficient use of land, water, and other resources. For example, the development of plows, irrigation systems, and crop rotation techniques enabled societies to grow more food with fewer labourers. In the 20th century, innovations like synthetic fertilizers, pesticides, and genetically modified organisms (GMOs) further boosted yields, especially in industrialized farming. More recently, things like precision farming using GPS, drones, and AI to optimize crop management are helping farmers make better use of their resources. However, a growing population along with climate change always poses a threat between food supply and demand. Additionally, the urbanization trend is expected to accelerate in developing countries by 2050. Besides, since the living standard is expected to increase in the future, it will further increase food demand, particularly in emerging nations. Due to the continuous increase in the global population, we should be more cautious regarding nutritional values and food quality. The integration of technologies across the entire agricultural process has truly revolutionized farming. By combining advancements in sowing, crop management, and harvesting with innovations in packaging and transportation, farmers can maximize efficiency and reduce waste. Besides, this utilization of other tools such as unmanned aerial vehicles (UAVs) for crop monitoring and other beneficiary measures, such as optimizing crop yields. In addition, advanced programs based on the IoT are also used. Moreover, other advanced technologies, such as UAVs, remote and ground sensors, communication technologies, and cloud computing, are needed for sustainable agriculture. However, implementing these advanced and innovative technologies, such as the IoT, are genuinely indeed not optional. By adopting these advanced technologies, farmers will improve their agricultural resources and practices. The advancement in such advanced technologies will pave the path for sustainable agriculture.

Keywords: Sustainable agriculture, innovative technologies, crop production and artificial intelligence

Drought-Resistant Crops and Water Management: A Pathway to Sustainable Agriculture and Climate Resilience

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Climate change has intensified the frequency and severity of droughts, posing a significant threat to global food security and sustainable agriculture. Drought-resistant crops and efficient water management strategies play a crucial role in mitigating these challenges while ensuring agricultural resilience. This paper explores the importance of breeding and biotechnological advancements in developing drought-tolerant crop varieties that can withstand water stress while maintaining productivity. These crops possess adaptive traits such as deep root systems, osmotic adjustment, and improved water-use efficiency, enabling them to survive in arid and semi-arid regions. Complementary to drought-resistant crops, sustainable water management practices such as rainwater harvesting, deficit irrigation, and soil moisture conservation techniques enhance water availability and optimize its use in agriculture. Precision irrigation technologies, including drip and sprinkler systems, have revolutionized water management by minimizing wastage and maximizing efficiency. Additionally, integrating agroecological approaches, such as conservation agriculture, mulching, and intercropping, further supports water retention and soil health. Government policies and international collaborations also play a pivotal role in promoting research, adoption, and dissemination of climate-smart agricultural technologies. Incentives for farmers, investment in water infrastructure, and knowledge-sharing initiatives can accelerate the transition toward resilient farming systems. Ultimately, the synergy between drought-resistant crops and water management strategies fosters climate resilience, enhances food security, and safeguards agricultural sustainability in the face of changing climatic conditions.

Keywords: Climate resilience, Drought-resistant crops, Precision irrigation, Sustainable agriculture, Water management

Food for the future: conserving crop wild relatives

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Crop wild relatives (CWRs) have been integral to crop domestication for thousands of years. However, due to human overexploitation of plants and natural resources, they are now at risk and require protection to ensure plant evolution and sustain food production for future generations. Traditionally, CWRs have been identified using taxonomic group and gene pool concepts, which overlook the role of horizontal gene transfer (HGT). Incorporating HGT into CWR identification could enhance our understanding and utilization of these valuable resources. While the taxonomic group concept (broad sense) identifies a large number of CWRs, the gene pool concept (narrow sense) identifies fewer, limiting the number of CWRs available for breeding. Nevertheless, CWRs, including the progenitors of crops and closely related species, are invaluable for improving agricultural productivity and maintaining sustainable agroecosystems. Modern breeding techniques have facilitated the incorporation of these traits into existing cultivars. Conserving crop wild relatives (CWRs) supports post-harvest management and food security by enhancing crop resilience, storage quality, and nutritional stability. Numerous national and international initiatives, such as the "European Crop Wild Relative Diversity Assessment and Conservation Forum (PGR Forum)" and the Global Environment Facility projects, have focused on the conservation of CWRs. Recommendations for future actions include conducting gap analyses to identify CWR hotspots, marking suitable species as CWRs in botanical and conservation databases, and strengthening collaboration between plant genetic resource and conservation communities. These efforts are vital to safeguarding CWRs and ensuring their continued contribution to global agriculture.

Keywords: Conservation, Crop wild relatives (CWRs), Food Security, In-situ conservation, Taxon group and gene pool concept.

Comparative Analysis of Multiple Linear Regression and Artificial Neural Network for Potato Yield Prediction in the New Alluvial Zone of West Bengal

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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. 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) 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 tuber initiation, tuber bulking and 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. The models' performances were evaluated using the coefficient of determination (R^2), root mean square error (RMSE), and normalized root mean square error (nRMSE) etc. Among the techniques, ANN demonstrated superior predictive capability, with R^2 values ranging from 0.8 to 0.9 during calibration and validation phases, 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 SMLR models were found to perform good to poor in most cases. The findings highlight ANN outperformed SMLR across all evaluated metrics, making it a robust tool for forecasting potato yield in the New Alluvial Zone of West Bengal.

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

ECO-FRIENDLY MANAGEMENT (*IN-VITRO)* OF LEAF ANTHRACNOSE AND TWIG BLIGHT DISEASES OF NEEL (*Indigofera tinctoria*) FOR CREATING A PATHWAY TO SUSTAINABLE AGRICULTURE

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Indigofera tinctoria, commonly referred to as Neel, belongs to the family Fabaceae (Leguminosae) and is renowned for its captivating deep blue hue. The plant's origins trace back to southern Asia. With the increasing demand for sustainable agricultural practices, *Indigofera* cultivation presents an eco-friendly alternative to synthetic chemicals, offering multiple benefits for both farmers and the environment. This plant is well-suited to diverse agro-climatic conditions in India, requiring minimal water and synthetic fertilizers, making it an excellent option for drought-prone areas. In the present investigation, occurrence and symptomatology of diseases of Neel and evaluation of botanicals and bioagents *in-vitro* for managing the diseases were performed. Two diseases have been identified at New Alluvial Zone of West Bengal (22°59'21"N latitude, 88°27'18"E longitude and elevation of 9.75 m MSL): (a) Leaf & twig blight caused by *Fusarium* sp. and (b) Leaf anthracnose caused by *Colletotrichum* sp. Bioagent used in this investigation was *Trichoderma* sp. Out of 7 isolates tested through dual culture, isolate T1, T6 and T9 showed highest effectivity against *Fusarium* sp. with radial growth inhibition percentage 68.48-70.75. *Trichoderma* isolate, T2, T4 and T1 showed efficacy of 76.05 to 77.59% inhibition against *Colletotrichum* sp. Out of 6 botanical extracts tested through poison food technique *in vitro* against the pathogen *Colletotrichum* sp., where the plant extract of *Lantana camara* exhibited the highest inhibition (31.11%) of mycelium growth. The plant extract derived from Ekangi *(Kaempferia galanga)* displayed the highest inhibition percentage (64.12%) against the mycelium growth of *Fusarium* sp. Further research and government support are essential to fully realize the potential of *Indigofera* as a sustainable agricultural crop.

Keywords: *Neel, Anthracnose, Twig blight, Management, In-vitro*

ASSESSMENT OF CHEMICAL PROPERTIES OF SOIL IN KALIMPONG DISTRICT OF WEST BENGAL

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The present study was conducted to assess various soil chemical properties of different villages at different depths. Soil samples were collected from three profile depths *viz*., 0-15 cm, 15-30 cm and 30-45 cm of three different villages in Kalimpong district, which is a sub-Himalayan region in West Bengal. The samples collected were analyzed in the Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The results of the investigation revealed that soils of study area are acidic and non-saline in nature. High values of organic carbon were recorded in all the sites which varied significantly with depth. Maximum organic carbon (2.80 %) was found in Lolay village. Low to high values of nitrogen (69.60-773.40 kg ha^{-1}) were recorded which showed depth-wise decrease in all the sites. Phosphorus and potassium values did not vary significantly both due to depth and site. Phosphorus recorded high values (49.5-81.0 kg ha^{-1}) while potassium (59.5-245.0 kg ha^{-1}) recorded low to medium high values. Secondary nutrients calcium and magnesium did not exhibit significance while sulphur varied significantly with depth, all of which recorded low values. Micronutrients zinc, boron and iron were found in traces while manganese recorded low to high values and copper recorded medium to high values.

Keywords: chemical properties, depth-wise analysis, organic carbon, nutrient variability

Evaluating Machine Learning Methods to Predict Water Retention Properties of Tropical Soils

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Measuring field capacity (FC) and permanent wilting point (PWP) is labor-intensive, often yielding insufficient data for precise irrigation scheduling. Therefore, this study aimed to evaluate the performance of different machine learning (ML) models to predict volumetric water contents at 10 kPa (VWC_{10}), 33 kPa (VWC_{33}), and 1500 kPa (VWC_{1500}) for Sri Lankan soils using a soil survey dataset (N = 318). Various combinations of soil properties including texture, bulk density (BD), soil organic carbon (SOC), VWC_{10}, and VWC_{33} were used to train and evaluate Random Forest (RF), Extra Trees Regression (ETR), Support Vector Regression (SVR), K-Nearest Neighbors (KNN), and Multiple Linear Regression (MLR). The predictive accuracy of machine learning models was evaluated using the coefficient of determination (R^2) and Root Mean Square Error (RMSE). Among the tested models, Extra Trees Regression (ETR) and Random Forest (RF) demonstrated satisfactory accuracy (R^2 = 0.60–0.74, RMSE = 6.5%–4.5%) using a single input, such as sand content, outperforming MLR in predicting VWC_{10}, VWC_{33}, and VWC_{1500}. Incorporating VWC_{10} and VWC_{33} as input parameters significantly improved model performance, with VWC_{33} yielding the highest accuracy (R^2 = 0.89–0.91, RMSE = 3%–2.6%) for RF, ETR, and SVR. This underscores the ability of ensemble-based models to capture complex non-linear interactions among soil properties. Shapley Additive Explanations analysis identified VWC_{33} as the most influential predictor of PWP, while organic carbon enhanced prediction of both FC and PWP, and bulk density played a key role when combined with other parameters. The findings highlight the potential of machine learning models to accurately predict soil water retention properties using minimal input data, particularly in tropical soils with limited data availability. Future research should focus on expanding datasets and leveraging deep learning techniques to enhance generalizability of models.

Keywords: machine learning, field capacity, permanent wilting point, water retention

Approach to Extraction and Purification of Liquid Fibrolytic Enzymes and Evaluating *In Vitro* Digestibility of Pre-Treated Cotton Stalk with Different Substrate Based Fiber Degrading Liquid Enzymes at Varying Dilutions and Durations

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In the present study, paddy straw-based fibre degrading liquid enzymes were extracted, purified and quantified and evaluated to determine *in-vitro* digestibility of cotton stalk with liquid enzymes solution at different dilutions and duration. The cotton stalk was treated with rice straw, untreated cotton stalk and ozone treated cotton stalk substrate based liquid fibrolytic enzymes solution as and T_1 and T_4 : rice straw based enzyme solution @ 250 ml/kg and @ 500 ml/kg of cotton stalk, T_2 and T_5: untreated cotton stalk based enzyme solution @ 250 ml/kg and @ 500 ml/kg of cotton stalk, T_3 and T_6: ozone treated cotton stalk substrate based enzyme solution @ 250 ml /kg and @ 500 ml/kg of cotton stalk was allowed for 4, 6 and 8 hr incubation period. The results showed that the *in vitro* of dry matter digestibility (%) of cotton stalk was significantly higher ($p<0.01$) in treated with rice straw based enzyme solution in T_1 for 6 hr (66.04±0.88) and 8 hr (63.62±0.92) incubation period with 250 ml/kg and T_4 for 6 hr (67.18±2.05) with 500 ml/kg as compared to untreated cotton stalk and ozone treated cotton stalk based enzyme solution (T_2, T_3 T_5 and T_4) cotton stalk. There was significant ($p<0.01$) improvement in IVNDFD (%) in T_1 for 6 hr (78.74±1.04) with 250 ml/kg and T_4 for 6 hr (80.46±1.90) with 500 ml/kg of cotton stalk treated rice straw based enzyme solution and T_6 for 8 hr (78.91.46±1.32) with 500 ml/kg of cotton stalk treated ozone treated cotton stalk based enzyme solution as compared to other groups. It was concluded that, *in vitro* dry matter, neutral detergent fiber and acid detergent fiber digestibility (%) of cotton stalk treated with rice based liquid fibrolytic enzymes solution were significantly higher ($p<0.01$) as compare to untreated cotton stalk and ozone treated cotton stalk.

Key Words: Cotton stalk, Enzyme solution, *in vitro* dry matter digestibility, *In vitro* neutral detergent fiber digestibility, *In vitro* acid detergent fiber digestibility.

Assessment of seed and seed germination parameters of *Mimusops elangi*

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Bullet wood tree or Vovli/ Bakul (*Mimusops elengi*) belonging to sapotaceae family, has been known for its medicinal, ecological and ornamental values. It is abundantly found growing in the Western Ghats of India, mainly relished by locals for its fragrant flowers since time immemorial. The trees available on the campus and nearby locations of Goa College of Agriculture, Ela Farm, Old Goa was observed for some fruit, seed and seed germination parameters. The average fruit length (2.46 cm), width (1.46 cm), fruit weight (1.53 g), fruit weight of 100 fruits (184 g), seed length (1.75 cm), width (0.82 cm) and weight of 100 seeds (56.6g) was observed. The seeds of two-color forms, viz. brown and black was observed. The experiment to find out the effect of treatment on seed germination was conducted using treatments T1:Thiourea (2%), T2: KNO_3 (2%), T3: GA_3 (200 ppm) and Control. The seeds were soaked in the treatments for 12 hours and sown in polybags under 75% shade net conditions. The significant differences were observed amongst the treatment, wherein 75% germination was observed in seeds treated with KNO_3, followed by GA_3 (65%) and Thiourea (60%) as compared to 50% in control. The seed treatment need to be extensively studied for germination as the low germination (50 to 75%) was observed in this species. These observations would be helpful in propagation, production and nursery management of the plant.

Key words: Bullet wood tree, Pretreatments, germination rate, medicinal plant, seed

Deficit Irrigation and Modeling approach for higher yield and water use efficiency in Jute

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Jute, traditionally cultivated as a rainfed crop, is highly vulnerable to monsoon breaks, leading to water stress throughout its growth period. This study involved mapping the block-wise distribution of irrigation and net groundwater availability in the jute-growing belts of West Bengal. The research focused on optimizing deficit irrigation scheduling during the critical early and peak vegetative growth stages (April and May) using available soil moisture depletion (DASM) and crop evapotranspiration (ETc) to maximize crop productivity. The applied water treatments included 50% DASM with 50% ETc, 50% DASM with 75% ETc, 75% DASM with 75% ETc, 75% DASM with 100% ETc, moisture maintained at field capacity, farmers' practice, and control (rainfed) under surface irrigation. Among these, irrigation scheduled at 75% DASM with 100% ETc significantly improved plant height and basal diameter compared to the control treatment. The greatest canopy cover was observed at 30 days after sowing (DAS) under the 75% DASM with 100% ETc treatment, whereas the control treatment exhibited the least canopy cover. Additionally, the Leaf Area Index (LAI) at 45 DAS showed a 35% increase over the control treatment. The highest fibre yield was achieved under 75% DASM with 100% ETc irrigation schedule, followed closely by the 50% DASM with 75% ETc treatment, resulting in a 23-44% yield increase compared to the stressed control. Furthermore, water productivity improved significantly, with a 20-24% increase in water use efficiency under the 75% DASM with 100% ETc treatment, while irrigation water savings reached 51.5% compared to fully irrigated conditions. The AquaCrop model effectively simulated soil moisture, biomass, and canopy cover across various treatments. The highest model efficiency coefficients were observed under fully irrigated conditions, and a strong correlation ($R^2 = 0.93$) between measured and simulated canopy cover values validated the model's accuracy. Overall, this study underscores the benefits of optimal irrigation scheduling in improving jute yield and water efficiency.

Integrating GIS, GPS, and Remote Sensing for Efficient and Sustainable Tasar Sericulture

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ICANTFA/121

Tasar sericulture, a significant component of India's silk industry, contributes to rural livelihoods and biodiversity conservation. The tasar sericulture is a agro-forestry based industry primarily thrives in Jharkhand, Chhattisgarh, Odisha, and West Bengal, with India producing approximately 1,300 metric tons of tasar silk in 2023. However, tasar silk production faces multiple challenges, including habitat degradation, climate variability, pest infestations, and unsustainable farming practices. These factors have led to fluctuating cocoon yields and economic instability for farmers.To address these challenges, integrating advanced geospatial technologies such as Geographic Information Systems (GIS), Global Positioning Systems (GPS), and Remote Sensing (RS) has emerged as a transformative approach. GIS facilitates spatial analysis and decision-making by mapping tasar host plants (*Terminalia arjuna*, *Terminalia tomentosa*), identifying suitable areas, and assessing environmental parameters such as soil fertility, temperature, and rainfall patterns in order to expand the tasar sericulture. Further GPS ensures precise location tracking of host plant distribution, rearing sites, and resource mapping, which ultimately helps in better monitoring and management. Meanwhile, RS, through satellite imagery and spectral analysis, helps in monitoring vegetation health, predicting pest outbreaks, and assessing microclimatic conditions critical for tasar silkworm growth. Additionally, real-time data collection and predictive analytics support climate-resilient strategies, mitigating risks posed by erratic weather conditions. The integration of AI and IoT with geospatial tools further enhances decision-making, enabling automated monitoring and early warning systems for disease and environmental stress.

Keywords: Tasar sericulture, GIS, GPS, Remote Sensing, precision farming, sustainable silk production, climate resilience, pest management.

Case studies of successful agro-tourism ventures

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ICANTFA/122

Agro-tourism has emerged as a transformative approach for rural development, allowing farmers to diversify their income while offering tourists authentic countryside experiences. This study examines successful agro-tourism ventures, with a focus on YATRA Farm Tourism in Assam and Mulshi Agro-Tourism in Maharashtra, highlighting key elements that contribute to their success. These ventures stand out by providing unique, hands-on experiences such as agricultural activities, cultural interactions, and eco-friendly accommodations. Maintaining high standards in facilities, services, and visitor engagement ensures customer satisfaction and fosters repeated visits. Additionally, effective promotional strategies, including digital marketing, travel partnerships, and word-of-mouth referrals, significantly enhance their reach and appeal. Community involvement serves as a cornerstone of sustainability, as these enterprises create local employment, preserve traditional practices, and promote regional products. This integrated approach not only strengthens rural economies but also enhances the overall tourism experience. Agro-tourism, when executed strategically, has the potential to drive economic growth, support environmental conservation, and foster cultural exchange. By combining innovation with tradition and emphasizing quality and community participation, such ventures can establish a resilient and sustainable model for rural tourism. It offers valuable insights for farmers, entrepreneurs, and policymakers seeking to develop successful agro-tourism enterprises that contribute to long-term rural prosperity.

Keywords: Agro-tourism, Community Engagement, Economic diversification, Rural Development, Sustainable tourism

Precision Fertilization: Reducing Waste and Boosting Crop Yields

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The rapid increase in the global population necessitates ensuring food security through highly efficient agricultural practices. Intensive plant cultivation degrades soil quality, leading to excessive microelement fertilization. The future of agriculture lies in precise fertilization techniques that provide controlled nutrient delivery while reducing environmental issues like groundwater leaching. Nutrient release should match plant needs and uptake; this paper highlights advancements in controlled-release fertilizers for optimal growth. Despite differences in structure, all types demonstrate controlled release of microelements exploring new fertilization technologies and their environmental effects. Precision agriculture, through the use of technologies like sensors, drones, and satellite imagery, enables real-time monitoring of soil conditions and plant health. Practices like crop rotation, cover cropping, and organic amendments enhance soil structure, microbial diversity and fertility. The use of bio-based and nano-fertilizers is on the rise, offering more efficient nutrient delivery methods that enhance crop productivity, reducing environmental nutrient loss and ensuring plants receive the necessary nutrients at the right time while minimizing environmental impact. Efficient irrigation methods such as drip irrigation and fertigation provide accurate water and nutrient delivery. Pollinators, like bees, are vital for enhancing fruit set and yield, emphasizing biodiversity's importance. The modern fertilizer market introduces innovative methods for administering micronutrients and preventing hidden hunger in plants. A highly efficient unconventional approach to microelement delivery is using complex forms, which helps minimize over-fertilization and environmental impact from traditional fertilizers. Emerging agricultural trends including precise fertilization techniques like low-solubility, coated, bio-based and nano-fertilizers, designed to address these challenges more effectively.

Keywords: Environmental Impact, Nano fertilizer, Optimum growth, Precise amount, Resource utilization.

Taxonomic investigations on insect pest complex linked to cruciferous crops in Pusa Campus, ICAR-IARI, New Delhi

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A field collection was undertaken to study different insect pests associated with cruciferous crops *viz.* cabbage, cauliflower, and mustard in Pusa Campus, ICAR-Indian Agricultural Research Institute, New Delhi during November 2023 to February 2024. Over 250 specimens were collected from different fields and polyhouses of Pusa Campus, ICAR-IARI using standard protocols. The specimens were identified using different morphological characters, with special reference to their genitalia attributes. Those distinguishing characters and attributes were photographed using a Leica EC4 digital camera mounted on a Leica M205A stereo zoom auto montage microscope at National Pusa Collection, Division of Entomology, ICAR-IARI. Results indicated that crucifers were infested by a complex of fifteen different insect pests, from sowing to harvesting. Of them, in this study, eight commonly occurring insect pests belonging to five families and three orders had been briefly described with synonyms, differential diagnosis, materials examined, and remarks with special reference to their damage symptoms. Other species were also identified and reconfirmed by distinguished taxonomists. More than 30 coloured illustrations were prepared using Adobe Phtotoshop 2023, offering taxonomic insights regarding different insect pests associated with cruciferous crops. Field photographs were also provided which will help in accurate diagnosis by farmers and citizen scientists.

Keywords: Brassicaceae, cabbage, cauliflower, entomology, mustard, North India, systematics

Performance of Osmo protectants for enhancing productivity in Bt cotton under rainfed condition.

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The field experiment was conducted on Cotton in Kharif 2022-2023 with nine treatments consisting of six osmoprotectants (KNO3, Salicylic acid, Glycine betaine, Sodium nitroprusside, PPFM, Thiourea) at different concentrations was laid out in RBD at University of Agricultural Sciences, Dharwad. Among the nine treatments foliar spray of KNO3 (2%) at 80 and 100 DAS increased the chlorophyll content (2.76 mg/g f w) as compared to control and with other treatments and there was significant increase in morpho-physiological traits viz., plant height, number of branches and total dry matters. The growth parameters and biochemical parameters like total chlorophyll content, CSI and NR activity was significantly improved due to the foliar application of osmoprotectants KNO_3 2% at 80 and 100 DAS as compared to control. The biophysical parameter like photosynthetic rate also shows significance with KNO3 2% (29.16 µmol CO_2 $m^{-2}s^{-1}$) as compared to control. The treatment of KNO_3 (2%) at 80 and 100 DAS recorded significantly higher seed cotton yield (27.58 q/ha) and number of bolls per plant as compared to control. The maximum seed cotton yield was mainly attributedto its close association with yield components viz., boll number, boll weight and harvest index (HI) and other characters such as LAI and sympodial branches. Thus, it was concluded that, foliar spray of KNO3 (2%) at 80 and 100 DAS is optimum to get higher seed cotton yield.

Keywords: Osmo protectants, Chlorophyll Stability Index, photosynthetic rate, RWC, KNO3, Cotton yield.

Value Addition through Nutritional Enhancement in Food Processing

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In the contemporary food industry, value addition through nutritional enhancement in food processing has become a significant strategy to meet the evolving needs of health-conscious consumers. With rising awareness about the links between diet and health, consumers are increasingly seeking foods that not only satisfy hunger but also offer additional health benefits. Nutritional enhancement involves various techniques that improve the nutritional profile of food products, including fortification, biofortification, and the addition of functional ingredients. Additionally, functional ingredients like probiotics, prebiotics, fibers, and omega-3 fatty acids are being incorporated into processed foods to address specific health concerns, such as gut health, heart disease, and diabetes.

This paper explores the different methods used to enhance the nutritional value of processed foods, highlighting their importance in improving public health and creating value within the food industry. The paper examines how companies have successfully applied these techniques, from fortified cereals to functional beverages, and the role of product innovation in responding to the growing demand for nutrient-rich foods. It also investigates the economic benefits of nutritional enhancement, including the potential for companies to command higher prices, foster brand loyalty, and tap into niche health-focused markets.

Finally, this paper reflects on the broader implications of nutritional enhancement for addressing global health issues, such as malnutrition, micronutrient deficiencies, and the rise of non-communicable diseases like obesity and heart disease. By offering a comprehensive understanding of the methods, benefits, challenges, and future prospects of nutritional enhancement in food processing, this paper underscores the critical role that value-added, nutrient-rich products will play in shaping the future of the global food industry.

Keywords: Value addition, Nutritional enhancement, Food processing etc.

PRODUCTION OF TRUE-TO-TYPE MICRO TUBERS FROM MICROPROPAGATED INDIGENOUS POTATOES WITH GENETIC FIDELITY ANALYSES

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Potato (*Solanum tuberosum*), the fourth-most significant food crop globally, is extensively cultivated and grown vegetatively and sexually using tubers and seeds respectively, with multiple indigenous cultivars which are cultivated in patches. Plant tissue and organ culture offers the avenue for conservation, genetic improvement, mass-scale propagation, and commercialization of these indigenous cultivars within a confined space and limited timespan. Four wild indigenous potato cultivars (Ambari local, Cooch behar local, Pilak local, and Tezu local) were used to establish monophasic cultures. Cytology based on metaphase chromosomes ensured no abnormality among micropropagated plantlets. The plants were acclimatized primarily in cocopeat with 100% survivability. After primary acclimatization, they were transferred to field under shade net house and maximum survivability of 100% was recorded in Cooch behar local, followed by Tezu, Ambari (both 85%) and Pilak local (80%). After three months, the plants were harvested. Coochbehar local produced the most number of tubers per plant (10.8) with the highest tuber weight (3.8 g). The present study, being the first for these potatoes, concludes that the developed protocols would be of high commercial importance and are suitable for producing contamination-free microtubers having genetic uniformity from mass-scale micropropagated potato plantlets.

Keywords: CDDP; DAMD; Genomic DNA; ISSR; Microtuber; Ploidy stability; SCoT

Exploring the changes in biochemical, microbial, and sensory properties of chocolate infused with *Sargassum wightii* seaweed during the storage period.

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The study aimed to investigate the changes in biochemical, microbial, and sensory characteristics of chocolate incorporated with *Sargassum wightii* over a storage period of 180 days. The research involved the formulation of control chocolate (CCH) and chocolate with ethanol seaweed extract (SC) using an optimized composition. The chocolates were packaged in aluminium foil and stored at room temperature, with analyses conducted every 30 days to assess biochemical parameters (peroxide value (PV), free fatty acid (FFA), total volatile base nitrogen (TVBN) and thiobarbituric acid (TBA) Specifically, peroxide value (PV) ranged from 0.19±0.03 to 1.99±0.05 for CCH and from 0.15±0.04 to 1.78±0.02 meq of O2/kg of sample for SC. Free fatty acid (FFA) levels varied from 0.21±0.07 to 1.93±0.03 for CCH and from 0.17±0.03 to 1.75±0.03% of oleic acid for SC. Total volatile basic nitrogen (TVBN) measures ranged from 0.055±0.02 to 0.287±0.01 mg% for CCH, compared to 0.048±0.00 to 0.256±0.04 mg% for SC. Lastly, thiobarbituric acid reactive substances (TBARS) values increased from 4.42±0.03 to 55.75±0.06 µg of malondialdehyde (MA) per kg of sample for CCH and from 4.32±0.1 to 49.52±0.03 µg of MA per kg of sample for SC. The shelf life of the chocolates (9.00±0.00-6.80±0.26 for CCH and 9.00±0.00 – 7.00±0.00 for SC) was determined based on the OAA score; the chocolate, sensorily observed seaweed chocolate remained fresh and hard without melting for up to 180 days, while the control chocolate lasted up to 170 days. Additionally, the OAA decreased with prolonged storage. The present study reveals that adding seaweed boosts chocolates' shelf life and quality more than control, offering a natural way to enhance preservation.

EFFECT OF DRYING METHODS ON PRODUCTION OF QUALITY DRY FLOWERS

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The experiment was carried out at the Vanavarayar Institute of Agriculture, Manakkadavu, Pollachi, Tamil Nadu, with the objective of examining the effect of various drying methods on the production of high-quality dry flowers, employing a completely randomized design. In this study, *Rosa hybrida* petals were subjected to seven different drying techniques: press drying, microwave oven drying, freeze drying, and embedding in silica gel, borax, sand, and shade drying as control. Observations were made on several parameters like fresh weight, dry weight, moisture loss percentage, petal length, petal width, color retention, and appearance index. The results indicated that the highest moisture loss (76%) was observed in the microwave oven drying method. A gradual decrease in dry weight was noted after drying in all methods. Drying led to a reduction in both petal length and petal width across all methods. The appearance index remained consistent in both microwave oven drying and freeze drying. Microwave oven drying demonstrated the best color retention. Ultimately, both microwave oven drying and freeze drying received a rating of 4 (good), concluding that the most effective methods for drying *Rosa hybrida* petals were microwave oven and freeze drying.

Keywords: Rose petals, Drying, Moisture loss, Colour retention, Dry flowers

Postharvest Management and Food Security

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Indian food industry has travelled a long way since the time of Independence in 1947. From the dependance on exported foods, India has now emerged as a food basket for the world. Today, India is one of the largest countries, in terms of food production, processing, supply, and consumption. India's food market is ranked 6th in the world, with 70% of sales and 5th in production, consumption, and export. India is the leading producer of fruits and vegetables, milk, sugar, pulses, spices, oilseeds etc. During the last two decades, the food consumption pattern has significantly changed that had led to the growth of a gigantic size food processing industry. The current size of Indian food retail market is valued over Rs. 68 lakh crores with a growth rate of 11%. With the rapid growth of the Indian economy, the consumption pattern of the country has also been shifted from cereals to more varied and nutritious foods including fruits and vegetables, milk, fish, meat and poultry products. In the era of extensive population growth and nutrition crisis, the cereals and grain legumes will not be able to bridge the food shortage gap. Therefore, alternative food crops need to be explored. Various fruits and vegetables including tropical tuber crops have the greatest possibility for being adopted as regular diet for supplying food in crisis situations, promoting food security, alleviating malnutrition, and providing raw materials, mainly starch to the industries. In addition, yams and cassava have phenomenal potential to play significant roles in fulfilling the multifaceted needs contributing to food security, poverty eradication and socio-economic upliftment in developing and less developed countries.

It contributes around 14 per cent of manufacturing gross domestic product (GDP), 13 per cent of India's exports and six per cent of total industrial investment. However, rapid perishability of fruits and vegetables after harvesting due to physiological, biochemical and pathological factors poses a serious problem in its postharvest utilization. In this paper, an attempt has been made to discuss the causes of spoilage and its management to reduce the postharvest losses of food, especially fruits and vegetables for promoting food security.

Eco-friendly management of invasive thrips infesting chili using biopesticides

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Chilli is an important commercial spice crop, widely used as a vegetable, spice, condiment, and in medicines. India is the leading producer of chilli, followed by China, Thailand, Ethiopia, and Indonesia, with major cultivation in Andhra Pradesh, Maharashtra, Karnataka, Gujarat, and Tamil Nadu. In which an invasive species, *Thrips parvispinus* Karny has recently emerged as a serious pest in chilli fields, causing 70-100% crop damage in some regions. Therefore, an experiment was conducted to evaluate possible eco-friendly management tactics *via* biopesticides against invasive thrips infesting chilli at the Department of Entomology, Anand Agricultural University, Anand (Gujarat), during *kharif-rabi*, 2022-23 and 2023-24. Whereas the treatments of *Beauveria bassiana* 5% WP, *Metarhizium anisopliae* 1.15% WP, and *Lecanicillium lecanii* 1.15% WP exhibited moderate control of the pest. While a treatment of aqueous tobacco dust extract proved to be the least effective, followed by neem seed kernel extract. The plots treated with azadirachtin recorded minimum fruit infestation against invasive thrips, *T. parvispinus* followed by treatment with neem oil. The highest Incremental Cost Benefit Ratio was observed in the treatment of *P. fluorescens* (1:19.83) followed by neem oil (1:19.31). Although better net realisation was observed in the treatments of azadirachtin 10000 ppm (₹ 1,67,400/ha) and neem oil (₹ 1,59,400/ha). Since *T. parvispinus* is a new invasive pest of chilli in Gujarat (India), these findings would be significantly helpful to the farmers, researchers, and students.

Keywords: Chilli, Invasive thrips, Chilli black thrips, *Thrips parvispinus* Karny, biopesticides, eco-friendly management

A Vital Role of Forest Ecosystem Services: Environmental services and Sociocultural benefits

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Mankind depends upon a variety of ecosystem services (ES) provided by forest ecosystems. Forests are vital and self-regenerating ecological units which provide a myriad of services that contribute to human survival and quality of life. ES are generated as a consequence of interaction and exchange between biotic and abiotic components of an. Ecosystem goods provisioned by the forests are the direct material benefits (e.g. fuel wood, fodder, wild edibles, minor forest products), whereas ES are the indirect benefits of a forest ecosystem (such as purification of air and water, mitigation of floods and droughts, detoxification and decomposition of wastes, carbon sequestration) The study conducted in Western Himalayan region of India by opined that provisioning services such as fuelwood, fodder, and natural fertilizers (leaf litter) provided by oak forests (Rs.5676/person/year) were more valuable than those provided by pine forests (Rs. 4640/person/year). Oak forests provided a larger variety of provisioning services to the people compared to pine forests. In Arunachal Pradesh, observed that provisioning services of forests, constitute only 21 per cent of overall ecosystem value, whereas regulation services which are the main life supporting services on the earth constitute more than 72 per cent of overall ecosystem value of the tropical forests. The study showed that indigenous trees (*Pongamia pinnata* and *Tamarindus indica*) in CAFS provided multiple benefits in comparison with exotic trees (Casuarina and Eucalyptus). Among the various services rendered by Ficus, soil quality enhancement through litter fall had the maximum aggregate score across respondents (137.25), followed by habitat services (129.00) and prevention of soil erosion (107.00). Therefore, the valuation of ecosystem services of forests is necessary for raising awareness level of stakeholders, for green or full cost accounting, land use planning and for payment for ecosystem services concept.

Key words: Self-regenerating ecological units, Forest ecosystem services, Millennium ecosystem assessment, Environmental services, Sociocultural benefits, Annual economic value, Regulatory or habitat services.

Leptin protein: A biomarker in sustainable development of agri-farming

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Leptin, a cytokine-like protein hormone, is one of the best physiological markers for body weight, food intake, energy expenditure, reproduction and marbling of meat. Information of molecular characteristics of leptin protein in different animal species is scarce. For agri farming, breed selection is necessary for sustainable development. To characterize leptin protein of diversified species, it was isolated from three different types of terrestrial and aquatic animals. Subsequently, immune biochemical characterization of the leptin protein was done at molecular level. Presently, different techniques were used for isolating leptin protein. Purification of the protein was performed by affinity column chromatography. The molecular, biophysical and serological characterization of leptin was carried out by 2D-gel, SDS-PAGE, Circular dichorism, Mass spectroscopy and Western blot. The SDS-PAGE and 2D gel analysis showed that native leptin from all the species possesses molecular mass of 16 kDa. Western blot analysis confirmed its sero-reactive property. MALDI-TOF mass spectroscopy and peptide analysis revealed the exact molecular mass of goat, mithun & rohu leptin as 15948.72 Da, 17214.26 Da & 16283.38 Da. The sero-reactive property of leptin might be exploited while preparing sero-diagnostic tool(s) to measure leptin concentration in blood, tissue that might be effective to select specific animals(s) for selective breeding purpose for sustainable development which may help the productivity of protein source to combat malnutrition and income generation of marginal agri farmer in West Bengal.

Digital Transformation and Agriculture

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The digital revolution in agriculture is reshaping the entire sector, driving gains in efficiency, transparency, and accessibility. In this paper, we'll explore how digital transformation is transforming agriculture, with a particular focus on digital platforms, blockchain technology, e-commerce, and the crucial role of cybersecurity in the rise of smart farming. Digital platforms designed for knowledge sharing and extension services have become indispensable tools for farmers, researchers, and policymakers. These platforms are pivotal in providing real-time advisories, weather updates, and market data—helping farmers make more informed decisions and boost productivity. On the other hand, blockchain technology is revolutionizing agricultural supply chains by ensuring greater transparency, minimizing fraud, and enabling traceability from the farm to the consumer. Thanks to blockchain's immutable records, trust is reinforced across the supply chain, which also supports compliance with stringent food safety regulations. E-commerce and digital marketing are also rewriting the playbook for how agricultural goods reach consumers. Farmers can now bypass traditional intermediaries and tap into broader markets, opening up new avenues for income. With online marketplaces, direct-to-consumer platforms, and social media marketing, agripreneurs are finding fresh opportunities. However, the rise of digital agriculture also raises concerns about cybersecurity and data privacy. This paper outlines both the opportunities and challenges of digitalizing agriculture, offering strategic recommendations for policymakers, agripreneurs, and industry stakeholders. By embracing digital innovations while addressing the associated risks, the agricultural sector can build resilience, enhance productivity, and stay competitive on the global stage in this new digital age.

Keywords: Digital transformation, Smart farming, Digital platforms, Knowledge sharing, Blockchain in agriculture, Agricultural supply chains, E-commerce in agriculture, Digital marketing, Cybersecurity in agriculture, Data privacy, Precision agriculture

Studies of the Occurrence and Efficacy of Some Insecticides Against *Helicoverpa armigera* on Chickpea at Alluvial Zone of West Bengal

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Chickpea (*Cicer arietinum* L.) was an important rabi pulse crop in India, according to Min. of Agri. & FW (DAC&FW), GOI (2017-18). *Helicoverpa armigera* was a cosmopolitan and polyphagous pest widely distributed in the tropics and subtropics, contributing to chickpeas' low yield. The field experiment was conducted during rabi 2017-18 and 2018-19 at BCKV, Mohanpur, West Bengal. The incidence of 0.06 larvae per five plants of *H. armigera* was observed in the 8th standard week during rabi 2017-2018, while in 2018-2019, the incidence was observed during the 1st standard week with 0.2 larvae per five plants. The gram pod borer population reached peaks of 2.2 and 0.66 during the 12th standard week and the 9th standard week during the rabi seasons of 2017-2018 and 2018-2019, respectively. Subsequently, a declining trend was noted. The experiment's data were analysed for correlation with weather parameters to assess the impact of abiotic factors on chickpea larval populations. The correlation analysis indicated that during both years, there was a positive relationship between maximum and minimum temperatures and relative humidity. The efficacy of insecticides and botanicals, namely indoxacarb 15.8% EC @ 50 g a.i.ha^{-1}, lufenuron 5.4% EC @ 30 g a.i.ha^{-1}, chlorantraniliprole 18.5 SC @ 30 g a.i.ha^{-1}, cyantraniliprole 10.26% OD @ 60 g a.i.ha^{-1}, spinetoram 11.7% SC @ 60 g a.i.ha^{-1}, *Bacillus thuringiensis,* and neem were evaluated. Chlorantraniliprole (T_3) was superior to all other treatments, with an 87.12 to 88.14 percent reduction in the larval population. Conclusion: The study demonstrated that weather parameters, particularly temperature and relative humidity, significantly affected larval population dynamics across both years. The efficacy of chlorantraniliprole application was supported by careful monitoring of weather conditions. It could be recommended as an effective approach for chickpea pod borer management and yield improvement at the alluvial zone of Best Bengal.

Keywords: *Chickpea, Helicoverpa armigera, Abiotic factors, Pest management*

AGRIBUSINESS EDUCATION, RESEARCH, EXTENSION, AND TRAINING

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Agribusiness plays a pivotal role in driving the global economy, particularly in developing nations, by supporting agricultural productivity, innovation, and sustainability. To enhance its impact, effective education, research, extension services, and training programs are essential.

Agribusiness Education: Higher education institutions globally are increasingly offering specialized programs in agribusiness management, which combine business administration with agricultural science. According to the Food and Agriculture Organization (FAO), the demand for agricultural graduates is expected to grow by 20% in the next decade, with a significant need for professionals skilled in modern farming techniques, sustainability, and market strategies.

Agribusiness Research: Research in agribusiness focuses on technological advancements, market trends, and policy frameworks to boost efficiency and profitability. Studies by the International Food Policy Research Institute (IFPRI) reveal that every dollar invested in agricultural research yields a return of $20, showcasing the critical role of research in ensuring food security and improving global trade.

Agribusiness Extension: Agricultural extension services play a vital role in disseminating research findings to farmers, especially in developing countries. The World Bank reports that agricultural extension systems are effective in improving productivity and farmer income by up to 40.

Keywords: extension, training, research, markets, agribusiness

Agricultural Marketing Infrastructure – A Critical issue faced in Indian Agricultural Practice

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ICANTFA/137

India is second largest producer of food next to China. Agriculture and allied sector make the backbone of Indian Economy as it engages more than 50% of the workforce and contributes about 21% to the country's Gross Value Added (GVA). The developments in this sector are keenly watched by policy makers, business, academia and other stakeholders. Post-harvest loss greatly affects farmers' incomes. Due to improper storage facility around 18-24 per cent of the produce are damaged and as a reason farmers are forced to sale at a low remunerative price after harvesting. Losing a portion of their yield and the degrading quality of their commodities translates to a loss of their income. To overcome this problem Govt. of India introduced Integrated Scheme for Agricultural Marketing (ISAM) in 2014 under which Agricultural Marketing Infrastructure (AMI) is a sub scheme. The paper is primarily based on literature review and delves in to review the situation of agricultural marketing infrastructure in India with their challenges and prospects. It also identifies the literature gaps and suggests the important areas for further studies.

Keywords: Gross Value Added, storage facility, Post-harvest, ISAM, AMI

From Waste to Wonder: Finishing Textiles with Lemon Peel Extract

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The primary means of colouration before the advent of synthetic dyes were natural dyes derived from sources such as roots, leaves, bark, flowers, wood, nuts, seeds, insects, and minerals. Although synthetic dyes quickly dominated the market due to their ability to meet global demands, their widespread use has raised significant health and environmental concerns, prompting researchers to focus on natural dye alternatives. This study explores the use of lemon peel extract as a natural dye for screen printing. The dye was extracted through an aqueous process and utilized as a colouring pigment in the print paste. Two different mordants ferrous sulphate, copper sulphate was applied to achieve a diverse range of hues. The printed fabrics were rigorously evaluated for colour fastness. Results demonstrated that each mordant produced distinctive shades, including dark brown with ferrous sulphate, dark brown with copper sulphate. Excellent fastness properties were observed with the combination of lemon peel extract and copper sulphate mordant, highlighting the dye's durability and potential for practical application. In addition to offering a sustainable alternative to synthetic dyes, this study showcases the versatility of lemon peel extract as a natural dye source, capable of producing a spectrum of colours through simple variations in mordants. This research contributes to the growing body of knowledge on eco-friendly textile practices and underscores the importance of reviving natural dyeing techniques to promote sustainability in the fashion and textile industries.

Keywords: Lemon, mordants, natural prints, fastness properties.

Reaching New Heights: Vertical Farming as the Future of Urban Agriculture

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The rapid growth of urban populations has intensified the demand for sustainable and efficient food production systems. Vertical farming, an innovative agricultural approach, utilizes vertical space and advanced technologies such as hydroponics, aeroponics, and LED lighting to grow crops in controlled environments. By bringing agriculture into cities, vertical farming minimizes the need for arable land, reduces water consumption by up to 95%, and eliminates the carbon emissions associated with long-distance food transportation. This integration of agriculture into urban infrastructure not only addresses food security concerns but also aligns with global sustainability goals by promoting resource efficiency and reducing waste. Vertical farming provides significant advantages, including year-round crop production, minimal use of chemical pesticides, and the potential to produce high-yield, nutrient-rich crops in compact urban spaces. These systems can be integrated into repurposed buildings, rooftops, or purpose-built structures, contributing to urban revitalization and the circular economy. Furthermore, they create opportunities for job growth, community engagement, and education, fostering a closer connection between urban residents and food systems. However, several challenges hinder the widespread adoption of vertical farming. High upfront costs, substantial energy requirements for climate control and lighting, and the need for technical expertise pose significant barriers. Additionally, the scalability of these systems and their economic viability in different urban contexts remain areas of active exploration. Innovations in renewable energy integration, energy-efficient lighting, and automation are critical to overcoming these limitations and enhancing the sustainability of vertical farming practices. This looks at how vertical farming may help with socioeconomic growth, environmental sustainability, and urban food security. It also highlights strategies to overcome existing challenges and maximize its benefits. Vertical farming represents a promising pathway toward sustainable urban living, offering a scalable solution to meet the growing needs of modern cities.

Keywords: Space Optimization, Urban Food Production, Hydroponics, Agricultural Innovation, Vertical Gardens.

Impact of Post-Harvest Losses on Global Food Security and Strategies for Mitigation

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Post-harvest management involves handling, storage, processing, and distribution of harvested crops with maintained quality and reduced losses. Quality and quantity loss after harvesting lead to post-harvest losses, significantly impacting global food security by reducing food availability and causing economic setbacks for farmers, traders, and consumers. In India, nearly 74 million tonnes of food are wasted annually, constituting 22% of the food grain production or 10% of the overall food grain and horticulture production in the 2022-23 season (ICAR). All these losses have to be mitigated through the use of better harvesting, handling, and storage techniques that avoid physical damage and moisture-related losses, improvement of cooling and refrigeration systems that ensure proper temperature maintenance, new packaging and transportation systems that avoid damage, training and capacity building of the stakeholders, and research and development of post-harvest technologies. A multi-faceted approach is necessary to reduce post-harvest losses, ensure food security, and promote sustainable agricultural practices.

Agroecology and Beyond: Pioneering New Directions in Crop Science Research

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An interdisciplinary area called agroecology, which combines ecological concepts with agricultural methods, is becoming a vital strategy for tackling the problems of sustainability and global food security. This study examines how agroecology is developing and how it is revolutionizing crop science research. Through its focus on biodiversity, soil health, and resource conservation, agroecology provides creative ways to fight climate change, build resilience, and advance sustainable food production. The field of agroecology has grown in breadth due to recent advancements in crop science research, which have integrated advanced technologies including agroforestry systems, genomic tools, and precision agriculture. By facilitating a more profound comprehension of nutrient cycling, plant-microbe interactions, and ecosystem services, these developments improve the sustainability and productivity of agricultural systems. Agroecology's emphasis on holistic methods also promotes systems thinking, which supports agroecological methods that put social justice and ecological balance first. New agroecological approaches are highlighted in this paper, such as the use of climate-smart techniques, regenerative farming, and the integration of traditional ecological knowledge into contemporary agriculture. The combination of these approaches has the potential to revolutionize agricultural systems and crop research in order to better address the complexity of the world's environmental problems. The adoption of agroecological concepts will ultimately shape crop science's future by strengthening the bonds between nature, society, and science in order to create resilient, sustainable, and just agricultural systems.

Keywords: Agroecology, Climate-Smart Practices, Crop Science, Regenerative Farming, Sustainability

Agroforestry Policies, Implementation, and Future Approaches for Enhanced Impact: A Case Study of Chhattisgarh and India

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Agroforestry, which integrates trees with agricultural crops and livestock, has emerged as a sustainable land-use practice that provides ecological, economic, and social benefits. In India, agroforestry is gaining traction as a solution to soil degradation, climate change, and economic vulnerabilities in rural areas. This paper investigates the current policies, implementation strategies, and future approaches to agroforestry in India, with a specific focus on the state of Chhattisgarh. Through an analysis of the National Agroforestry Policy (2014) and local initiatives, the study identifies key drivers and barriers to successful agroforestry adoption, including financial constraints, limited technical support, and inadequate market linkages. The paper explores the impact of agroforestry practices on farm productivity, soil health, and farmer livelihoods, while also proposing enhanced approaches for policy integration, financial incentives, research and development, and public-private partnerships. The findings underline the need for a more inclusive and adaptive policy framework to foster widespread agroforestry adoption and achieve sustainable agricultural development.

Keywords: Agroforestry, Policy Implementation, Chhattisgarh, Sustainable Agriculture, Climate Resilience, National Agroforestry Policy, Rural Development, Farmer Livelihoods, Environmental Sustainability, Public-Private Partnerships

Climate-Smart Agriculture: A Sustainable Approach to Enhancing Productivity and Mitigating Climate Change Impacts

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While the world's population is expected to grow by more than two billion people by 2050, agriculture confronts significant hurdles in meeting the food needs of over one billion people. Furthermore, as the average person worldwide becomes wealthier and eats more food and meat, food consumption patterns are shifting. Agriculture, especially in developing nations, has new challenges as a result of the heightened competition for land, water, energy, and other resources used in food production. These challenges also constitute a threat to the environment. In addition, a large portion of anthropogenic greenhouse gas (GHG) emissions (19–29%) come from numerous modern farming techniques that harm the ecosystem. Given the difficulties humanity faces in adapting and mitigating climate change, "climate-smart agriculture" (CSA) has gained much attention lately. CSA is defined by three objectives: reducing greenhouse gas emissions and increasing carbon sinks; increasing agricultural productivity to support increased incomes, food security, and development; and increasing adaptive capacity at multiple levels (from farm to nation). The relative importance of each objective varies depending on the location, with a greater emphasis on productivity and adaptive capacity in low-input smallholder farming systems in the least developed countries, for example. CSA incorporates climate change into the planning and implementation of sustainable agriculture and informs priority-setting.

Keywords: Climate-smart agriculture (CSA), greenhouse gas (GHG), food security, climate change, ecosystem, sustainable agriculture.

Role of healthy resident rhizospheric microbiome in controlling Fusarium wilt disease in tomato under saline stress.

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Fusarium wilt, caused by *Fusarium oxysporum*, which poses a significant threat to tomato (*Solanum lycopersicum*) production, with its severity exacerbated under saline stress conditions. Salinity weakens plant defences and disrupts rhizospheric microbial balance, making tomatoes more vulnerable. The experimental findings of the investigation entitled "Role of healthy resident rhizospheric microbiome in controlling fusarium wilt disease in tomato under saline stress" was carried out at the Amity Institute of Organic Agriculture Farm, Amity University Noida, Uttar Pradesh during the Rabi season of 2021-2022 to evaluate the role of healthy resident rhizospheric microbiome in controlling Fusarium wilt disease in tomato under saline stress about growth parameter. The goal of the study was to see the role and the effect of the resident rhizospheric microbiome on the germination of tomato plants on soil health as well as the in-vivo efficacy of resident rhizospheric microbiome against Fusarium wilt in tomato plants under saline stress in UP's climatic circumstances (Uttar Pradesh). Based on the findings of the conducted experimental study, it was determined that treatment T4 (Saline soil + Fusarium + Tomato), T3 (Organic soil + Fusarium + Tomato), and T2 (Saline soil + Tomato) had a high negative effect on tomato (Pusa ruby) plant growth and yield when compared to treatment T5 (Saline soil + Fusarium + Microbiome slurry + Tomato), T6 (Saline soil + Microbiome slurry + Tomato) and T7 (Organic soil + Fusarium + Microbiome Slurry + Tomato) had significantly less effect on the plant than the other treatments where T1 (Organic soil + Tomato) shows higher plant growth. As a result, microbiome slurry features the growth and development of tomatoes and it can be inferred that may be an answer to today's agricultural challenges, and that it may be beneficial in increasing soil health as well as crop development and yield.

KEYWORDS: Organic soil, saline soil, microbiome slurry, Fusarium wilt, tomato Solanum Lycopersicum (var. Pusa Ruby)

CRISPR/Cas9 genome editing of ARE1 gene for improving NUE in wheat

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The abnormal cytokinin response1 repressor 1 (ARE1) was identified as a regulator of Nitrogen use efficiency (NUE) in a genome-wide association analysis. ARE1 was identified as a suppressor of plastidic Fd-GOGAT in rice. The are1 mutant plants of rice, wheat, and barley showed improved yield and higher NUE, making it a worthy genome editing candidate. There is an urgent need for improving NUE in wheat due to its high demand of nitrogen and also traditional agricultural practices that rely heavily on nitrogen fertilizers not only contribute to reduced yields but also lead to detrimental environmental consequences. At ICAR-IIWBR, Karnal, *TaARE1* gene knockout is targeted through CRISPR/Cas9 genome editing to improve NUE in Indian wheat varieties. The gene sequence of *ARE1* from the International Wheat Genome Sequencing Consortium (IWGSC) database, confirmed its presence across all three genomic regions (A, B, and D) of wheat's chromosome seven. The guide RNA (gRNA) tailored specifically to target the *TaARE1* gene across all three genome while ensuring minimal off-target effects was designed using WheatCRISPR software. The gRNA was cloned into a Cas9 binary vector and introduced into DH5α *E.coli* cells. Confirmation of successful transformation was verified through colony PCR using U6 promoter forward and gRNA specific reverse primers and were further validated by sequencing of the amplified region. The final plasmids from confirmed colonies were then transferred into *Agrobacterium EHA 105*. The agroculture was further transformed to wheat system using immature embryo of wheat genotypes DBW187, DBW303, DBW327 and DBW371 by *Agrobacterium*-mediated transformation as per the established protocol. Putative ARE1 gene edited plants were developed, their further phenotypic and molecular characterization are under progress.

Supply Chain Optimization for Agri-Business: Enhancing Efficiency of Market Access

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Agriculture is the backbone of India's economy, with a majority of the population directly tied to farming and related activities. However, modernising its agricultural systems and fostering agribusinesses are necessary for India to ensure food sustainability and tackle upcoming difficulties. To improve the global food system, agribusiness and supply chain optimisation must be combined. Agribusiness encompasses several different industries, such as farming, raising livestock, producing agrochemicals, and processing food, all of which need efficient coordination. The efficient operation of procedures including inventory control, production scheduling, procurement, and transportation is largely dependent on supply chain management (SCM), which in turn lowers expenses, minimises waste, and guarantees on-time delivery. Modern technologies, data analytics, and cooperative methods can be used to optimise the entire "farm-to-fork" process, increasing sustainability, production, and efficiency. This optimisation ensures that premium goods reaches customers on schedule, maximises profits, and minimises waste. Additionally, by optimising production, distribution, storage, and transportation, supply chain participants can collaborate to satisfy the rising demand for agricultural goods. Achieving a sustainable food supply chain is even more crucial in light of issues like population increase, climate change, and changing consumer tastes. These issues can be addressed by adopting cutting-edge technologies and solutions, which will guarantee the agribusiness sector's continuous expansion in India and encourage sustainability for future generations.

Keywords: Agribusiness, supply chain management, sustainability, stakeholders, traditional farming.

Innovations in Irrigation: Water Conservation in Agriculture

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The largest global user of water resources is agriculture, which uses around 70% of all freshwaters. This demand is expected to grow even more as the world's population grows and so does the need for food production. In order to ensure the sustainability of farming and improve water efficiency, advanced irrigation systems are crucial. This article explores how advanced irrigation methods, such as drip and sprinkler irrigation, can reduce water loss due to deep percolation, runoff, and evaporation. Water management is also changing as a result of smart technology like satellite-based monitoring, computerised scheduling, and soil moisture sensors. Water use can be further decreased by using other strategies like mulching, deficit irrigation, and drought-resistant crops. Combining these contemporary techniques with conventional water-saving techniques can result in solutions that are suited to a range of environmental and agricultural circumstances. Despite the benefits, there are also problems, like high implementation costs, a lack of technical expertise, and unequal access to technology, especially in under resourced areas. To solve these challenges, researchers, policymakers, and farmers must collaborate to develop affordable, sustainable irrigation methods. Water conservation in agriculture ultimately requires a balanced approach that blends innovative technologies with sustainable practices to ensure food security and the preservation of freshwater resources for future generations.

Keywords: Water conservation, irrigation technologies, precision agriculture, smart irrigation, sustainable farming, freshwater management.

INFLUENCE OF SEED FORTIFICATION ON GERMINATION AND EARLY SEEDLING VIGOUR OF CHILLI

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India is one of the largest producers of chilli peppers with the production of 1.98 million tonnes and contributes 43% of total spice export quantity of the country. Chilli belongs to the capsicum genus and encompasses various species like *Capsicum annuum, Capsicum chinense, Capsicum frutescens , Capsicum baccatum, Capsicum pubescens* .There are thousands of chilli varieties worldwide varying in their characters. An investigation was conducted in the laboratory of Seed Science and Technology Programme, Department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat, Assam during the year 2022-2023.The pre-sowing seed treatments comprised of T_1-untreated control,T_2-hydropriming for 24 hours,T_3-KNO_3 priming@1% for 12hrs, T_4-KNO_3 priming @1% for 24hrs, T_5-KNO_3 priming @1.5% for 12hrs, T_6- KNO_3 priming @1.5% for 24hrs , T_7-KNO_3 priming @2% for 12hrs, T_8-KNO_3 priming @2% for 24hrs . All the priming treatments had significant effect on germination, and seed vigour characters. The seed germination parameters viz. germination percentage, days to germinate, germination index, mean germination time, seedling length, seed vigour index-I, seed vigour index-II, seedling dry weight responded well in T_3 in king chilli and capsicum variety Pongal- 2and T_5 in chilli variety Tez. Seed cubes were prepared using a combination of soil, sand, saw-dust, coco-peat, vermicompost and cowdung (1:0.5:1:0.5:1:0.25) with 230-250ml of waterper kg of medium and then shade dried for 36 hours. It was also observed that the primed seeds performed more efficiently in increasing the germination parameters than the unprimed seeds in the cubes.

Delineation of site-specific nutrient management zones for a paddy cultivated area based on soil fertility using fuzzy clustering

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Soil is crucial for biodiversity and life, significantly contributing to the provision of key ecosystem services for humanity. Crop productivity can be enhanced while reducing environmental threats from excessive fertilization by fully comprehending the spatial variability of soil properties and delineating management zones (MZs). A field investigation was carried out in Veeranam Command area in Southern India to study the spatial variability of soil properties and the delineation of MZs. Grid wise 240 soil samples collected from the study area were analyzed for pH, available macronutrients and micronutrients. The coefficient of variation of the soils varied from low (6.34%) to high (87.56%). Geostatistical analysis showed differed spatial variability patterns for the studied soil properties with spatial dependence ranged from moderate to strong and the ordinary kriging method is used to map the distribution of soil properties. MZs were delineated by performing principal component analysis (PCA) and fuzzy K-means clustering. Four PCs with eigen values more than 1 dominated 52.65% of the total variance, so they were retained for clustering analysis. Six MZs were delineated based on the two criteria modified partition entropy (MPE) and fuzzy performance index (FPI). The studied soil properties differed significantly among MZs. The input cost of every farmer has to be reduced to increase the profits in agriculture, thereby optimising the fertilizer use. Utilizing the average soil properties of each management zone as a benchmark for quantitative fertilization can be valuable, and adopting an agricultural management approach proves effective in enhancing agricultural productivity. Thus, the methodology used for MZ delineation could be used effectively for soil site-specific nutrient management for avoiding soil degradation concurrently with maximizing crop production in the study area.

Assessment of soil fertility and nutrient management strategies in an Experimental Farm: a case study using the Nutrient Index Value method

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Deficiency of Fe and Zn rank 5th and 11th, respectively among the 20 most important risk factors responsible for the development of illnesses and diseases throughout the world. The Indian agricultural soils are becoming a greater deficient of plant nutrients day by day. Zinc, cobalt, molybdenum, copper, selenium and manganese are out of 25 nutrients required for balancing of life in animal, plant and human, which are considered as micronutrients. The experiment delineated micronutrient Zinc (Zn), Copper (Cu), Iron (Fe) and manganese (Mn) availability in the soils of experimental farm of Agricultural college and Research Institute, Vazhavachanur under the Alfisols soil order of Tamil Nadu, India. Grid wise (50 x 50 m grids) geocoded surface soil samples were collected from 118 locations and analysed for various micronutrients. Available Zn in the soil varied from 0.09 to 1.69 mg kg^{-1} with an average value of 0.83 mg kg^{-1}. The major portion of the soil samples (71.2%) falls under low category while only 1.7 per cent samples were high in available Zn. Nutrient index value (NIV) of Zn availability in soil was also calculated (NIV=1.31) and found to be low. Fe availability in soil samples varied between 0.26 to 8.58 mg kg^{-1} with an average value of 4.15 mg kg^{-1}. The Fe content in 43.2 per cent of the soil samples falls under low category and 55.1 per cent of the samples were under medium category. The NIV value of Fe was found to be low. Available Cu ranged from 0.09 to 3.88 mg kg^{-1} with an average of 1.88 mg kg^{-1}. The Cu availability is high in 51.7 per cent of the soil samples and the NIV was medium. The Mn availability in the soil samples varied from 0.26 to 6.10 mg kg^{-1} with an average value of 2.92 mg kg^{-1}. The Mn content in 67 per cent of the soils falls under medium category and NIV was also medium. Thus, results revealed that soils of the experimental farm were potential Zn and Fe deficient areas. Application of Zn and Fe both as soil as well as soil plus foliar might be beneficial in enhancing the yield and quality of crops of the experimental farm.

AI and Machine Learning in Agriculture: Predicting and Improving Crop Productivity

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Agriculture is the cornerstone of the nation's development. Due to its extraordinary agricultural areas and other resources, India is known as agricultural country. Global Population is projected to reach 10 billion by 2050, amplifying the need for advanced agricultural technologies. AI powered predictive analytics assists farmers in making data-driven decisions for market demand and crop cycle. Precision farming with AI maximizes crop yield while minimizing resources use and cost. Automated tools like smart irrigation and agricultural drones enhance efficiency and address labor storage. Crop yield prediction is a decision support tool that uses machine learning and deep learning that can be used to make decision about which crops to produce and what to do in the distracting environment, machine learning algorithms are utilized in crop selection to reduce agricultural yield output losses. (Martinez et at., 2021) proposed Gaussian processes (GPs) that enable the identification of climate extremes, anomalies, and their associated causes that affect crop productivity. (Qiao et al., 2021) developed a 3-D convolutional neural multi-kernel network to capture hierarchical features for agricultural yield prediction. (Sivanantham et al., 2022) found that using orthogonal basis prediction accuracy and precision by 32% and 9% respectively. However, while the benefits are immense challenges remain. Small scale farmers often lack areas to the technologies, data infrastructure, and training needed to implement AI driven solution. In conclusion, AI and ML are transforming agriculture into smart practices, improving a sustainable future through data driven insights. Artificial Intelligence will transform the agriculture sector from traditional heuristics to completely valid, scientific decision-making to create a resilient and food secure future.

Effect of biofertilizers on growth and yield of Gladiolus (*Gladiolus grandiflorus*) var. Arka Amar

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This study investigates the "Effect of biofertilizers on growth and yield of Gladiolus (*Gladiolus Grandiflorus*) var. Arka Amar". A randomised block design with three replications was used to apply 9 different treatments, including the application of 50% and 100% recommended dose of fertilisers and bio-fertilizers (*Azospirillum*, *Azotobacter*, and PSB). Treatments under this trial was found significant for all the characters under observations except number of branching per spike. Studies revealed that 100% RDF + *Azotobacter* + PSB was found best treatment with reference to growth and flowering. Whereas some characters like initiation of spike, colour break stage, opening of first floret and so on were found optimum in 50% RDF + *Azotobacter* + PSB. Subsequently, it was observed that 100% RDF + *Azospirillum* + PSB performed maximum corm production.

Another trial was carried out to find out the best combination of preservative solutions to enhance the vase life of Gladiolus (*Gladiolus grandiflorus* L.) var. Arka Amar" as a part of the above investigation**.** The experiment was laid out in CRD with nine different combinations of sucrose, Al_2SO_4, $AgNO_3$ and citric acid including control (distilled water). The study concluded that Sucrose 2 % + $AgNO_3$ 50ppm + citric acid 100ppm was found best treatment combination for maximum vase life of gladiolus cv. Arka Amar.

Key words: Gladiolus, *Azotobacter*, *Azospirillum*, PSB, vase life, corm

EFFECT OF FOLIAR APPLICATION OF DIFFERENT SOURCES OF NUTRIENTS ON THE GROWTH OF JAMBHERI SEEDLINGS

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The present investigation, titled "Effect of Foliar Application of Different Sources of Nutrients on Growth of Jambheri Seedlings," was carried out at the Centre of Excellence for Citrus, College of Agriculture, Nagpur, during the academic year 2022–23. The study aimed to (i) evaluate the impact of foliar application of different nutrient sources on the growth of jambheri (Citrus jambhiri Lush.) seedlings and (ii) identify the most effective nutrient source for foliar application. The experiment was conducted using a Randomized Block Design (RBD) in the primary nursery and a Completely Randomized Design (CRD) in the secondary nursery, with nine treatments replicated three times. The treatments consisted of foliar applications of Nano urea at 100, 150, and 200 ppm (T1, T2, T3), Nano DAP at 100, 150, and 200 ppm (T4, T5, T6), 19:19:19 (1%) (T7), Urea (1%) (T8), and a control (water spray) (T9). The results demonstrated that Nano DAP (200 ppm) (T6) significantly improved shoot length, shoot diameter, and leaf area in both the primary and secondary nurseries. Additionally, T6 recorded the highest values for number of leaves per seedling, root diameter, root length, root volume, fresh seedling weight, dry seedling weight, and root dry weight in the primary nursery. The root-to-shoot ratio was observed to be significantly higher in Nano DAP (150 ppm) (T5). In the secondary nursery, T6 (Nano DAP 200 ppm) produced the maximum number of buddable seedlings, whereas T3 (Nano urea 150 ppm) recorded the highest number of leaves per seedling and number of shoots per seedling. However, budding success and time required for sprouting were found to be non-significant across all treatments in the secondary nursery. Overall, the study highlighted Nano DAP (200 ppm) as the most effective foliar nutrient source for enhancing the growth and development of jambheri seedlings. The findings suggest that the application of Nano DAP at 200 ppm can be a promising strategy to improve early seedling growth and nursery performance of jambheri, which can ultimately contribute to the successful establishment of citrus rootstocks.

Keywords: Jambheri seedlings, foliar application, Nano urea, Nano DAP, nutrient sources

Buckwheat: A Critical Evaluation of Its Role as a Super Crop for the Future

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Buckwheat, a pseudocereal, is emerging as a potential "super crop" due to its adaptability, nutritional value, and resilience in diverse environmental conditions. With the global population projected to reach 9.7 billion by 2050 (United Nations, 2019), and climate change posing challenges to traditional staple crops, buckwheat offers a sustainable alternative that could contribute significantly to food security and nutrition in the future. Rich in essential nutrients, including proteins (13-15% of its dry weight), amino acids, vitamins (B vitamins, vitamin E), and minerals (iron, magnesium, zinc), buckwheat is particularly valuable for addressing malnutrition, especially in regions where access to diverse food sources is limited (Feng *et al*., 2021). Its gluten-free nature also makes it an ideal crop for individuals with celiac disease or gluten intolerance, with approximately 1% of the global population affected by gluten-related disorders (Lundin and Nordin, 2019). Additionally, buckwheat is highly resilient to drought, poor soil conditions, and pests, reducing the dependency on chemical inputs and contributing to sustainable agricultural practices (Zhang *et al*., 2020). It requires minimal water, with some varieties needing only 400-600 mm of rainfall per year, which makes it suitable for regions facing water scarcity (FAO, 2020). The potential of buckwheat as a key crop in the context of global food security and nutrition, emphasizing its versatility, health benefits, and role in promoting sustainable agriculture. By leveraging its unique qualities, buckwheat could play a pivotal role in building a more resilient and nutritious global food system.

Key words: Buckwheat, Super crop, Nutritional, Drought, Resilient.

Biochar-Based Organic Farming: A Climate-Resilient Strategy for Enhancing Soil Health, Productivity, and Farmer Profitability

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Sustainable agriculture demands innovative solutions that balance productivity, environmental conservation, and economic viability. Biochar-based organic farming emerges as a transformative approach, integrating biochar with compost and organic amendments to enhance soil health, improve crop resilience, and increase farmer profitability. Bio-charring is a relatively better option as it not only can be used as an effective soil amendment but also helps in mitigating global warming. Biochar, which is a co-product of biomass thermochemical conversion processes known as pyrolysis, is an effective way to sequester more than 10% of carbon, generate energy and improve soil fertility. Biochar has several beneficial properties like it retains moisture in the soil, balances soil pH, use to make fuel, is used in metal remediation from the soil, etc. Biochar is a carbon-rich compound formed by heating biomass in a low-oxygen atmosphere. The application of biochar significantly ameliorates the fertility of soil as well as the productivity of crops. It was observed that there was an increase in the biomass of *Oryza sativa L.* (rice) by 20% and *Vigna unguiculata L.* (cowpea) by 50%, owing to the application of biochar at 68 t/ ha and 136.75 t/ha. Similarly, amendment of biochar improved the biomass and yield in *Triticum durum L.* (durum wheat) by 30%.

This research provides a practical model for policymakers, agricultural entrepreneurs, and farmers, emphasizing biochar's role in carbon sequestration, sustainable land management, and climate adaptation. By adopting biochar-based organic farming, agricultural systems can transition toward higher productivity, ecological stability, and financial sustainability, ensuring food security in the face of climate change.

Keywords: Biochar-based organic farming, soil fertility enhancement, carbon sequestration, sustainable agriculture, crop productivity improvement, climate adaptation.

Morpho-Molecular Identification of *Fusarium equiseti* and its integrated management strategies

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The aim of this study was to identify a new species of genus Fusarium associated with maize in West Bengal, India, using morphological and molecular methods and its *in vitro* management. The significance of maize cultivation is growing rapidly in India, both in terms of its socio-economic and cultural impact. Fusarium is causing serious damage to maize and is obtained from various sections of maize plant. This species is identified through a combination of morphological taxonomic keys and molecular methods by using ITS1 and ITS4 primers. *Fusarium equiseti* was identified with an identity greater than 98% and its culture is morphologically identified by National Agriculturally Important Microbial Culture Collection (NAIMCC). Genbank Accession Number (PP475463) and Cultural Accession Number (Kfe1 – isolate)- NAIMCC-F-04554 is taken. *Fusarium equiseti* is one of the most destructive pathogens. In Nadia district of West Bengal survey was done and it was found that *F.equiseti* affects maize plants, specially the leaves. This pathogen grown on OMA media for further studies. *In vitro* management of the pathogen is done using chemicals and biocontrol agents. Temperature study was also done under *in vitro* condition to observe the best temperature range for the pathogen growth and to use the data for cultural management of the pathogen. Here also the imortance of barrier cropping is discussed to avoid pathogen infection.

Sustainable Agriculture in the Changing Climate: Unlocking the Potential of Conservation Agricultural Practices

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Climate change (CC), predominantly caused and accelerated by human activities, can pose a significant hazard to global food security by jeopardising agricultural productivity through significant weather aberrations i.e. increasing global temperature, erratic rainfall, and increased frequency of extreme weather events. Amidst of the escalating climate impact, it is imperative to adopt practices and technologies that tick both the check boxes i.e. mitigating climate impact and enhancing the resilience of farming system. Conservation agriculture (CA) based on three mutually reinforcing principles: minimum soil disturbance, permanent soil cover and crop rotations has emerged as one of the best possible solutions that can reinforce several ecosystem services while contributing positively to household food security. Conservation agriculture based cropping system helps in moderating the impact of high temperature (reduces the canopy temperature by1-4℃) and enhancing irrigation water productivity (by 66-100%), thus resulting into well adaptation to heat and water stress. It helps in sequestering atmospheric carbon in soil-plant system and thereby offsets the greenhouse gas emission from fossil fuel consumption (10-15% less GHG emission as compared to traditional agriculture). This study reviews conservation agriculture and its components through the lens of climate change-food security nexus. Drawing from this holistic analysis it can be suggested that wide-scale promotion of appropriate CA practices through incorporating into national agricultural development strategy can act as a proactive solution to the challenges of food security, climate change adaptation, and mitigation in contemporary agriculture.

Keywords: Climate, Conservation agriculture, carbon sequestration, greenhouse gas, mitigation

COMPRESSED BIOGAS AND BIO-MANURE GREEN STARTUP: A COMPREHENSIVE REVIEW TO MAKE SMALL SCALE ENTREPRENEURSHIP

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Sustainable solutions are essential for a better, safer, and healthier future. Thus, compressed biogas plant project can be adopted. On setting up a 1000 m^3 capacity biogas plant with 100 m^3/hour biogas purification and bottling unit, 25 tons of cattle dung, 12 ton of poultry dropping, and 10 ton of agro-waste are required, Also, food waste of 10 ton is collected from municipality which was fermented anaerobically to obtain Bio-Manure and Compressed Biogas. Around 30-40% CO_2, 50-60% CH_4, 1-5% hydrogen and water vapor etc. were obtained from the anaerobic digestion through microorganisms. Energy in terms of biogas was obtained and used as power production, cooking purpose. Biogas is nontoxic, color less and flammable at igniting temperature 650-7500^{0}C of calorific value was 20MJ/m^3 and density of 1.214Kg/m^3. The taxed cost was Rs 55/Kg. Digested slurry is used as organic manure. In the year 140 ton of Compressed Biogas was generated. Remaining slurry (1/4th water will recycle and 3/4th will used as fertilizer) was used as liquid fertilizer in crop production. Its payback period was also less. It was observed that on increasing the capacity of biogas plant the payback period decreases. Plant nutrient content in digested slurry was N:P: K@1.5-2:1:1 that is higher than FYM. In the biogas purification unit, all impurities were removed and less than 10ppm H_2S was measured. At the bottling unit 100 cylinders were needed for 40 Kg purified gas. For the project, an estimate of Rs.350 lakhs of funds and an area of 1.5 acre were needed to make it financially feasible. Lastly, a slurry separator must be installed for separating liquid and solid digested slurry. Green coal could be produced from this dried sludge, and irrigation water could be replaced by filtered liquid.

Key words: compressed biogas, bio-manure, deenbandhu model.

Adapting Climate-Smart Agriculture with Precision Farming: A Path to Soil and Water Conservation.

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Climate-smart agriculture (CSA) can be defined as sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change and reducing green gas emissions. CSA offers a promising solution to enhancing agricultural sustainability and resilience, especially in water-scarce and vulnerable regions. CSA is an approach to increase the technical, policy and investment on environment to get sustainable agriculture growth for food protection under climate change. Through the use of geospatial data, precision technologies enable the monitoring of soil moisture levels, crop growth, and water requirements, allowing for more efficient water usage and reduced runoff. Additionally, the use of sensors and automated irrigation systems like drip irrigation and Variable Rate Irrigation (VRI) etc. FAO estimated that if the present production and consumption rates continues agricultural production should increase 60% by 2050 to meet the needs of food of world's population. More fruitful and more flexible agriculture requires a most important change in the way of use of land, water, soil nutrients and genetic resources management by climate Smart Agriculture Techniques. Moreover, precision farming technologies aid in the reduction of soil erosion and runoff by optimizing tillage and crop rotation practices. Climate change poses a growing threat to sustainable development. The expected effects of climate change could seriously compromise the ability of the agriculture sectors to feed the world, and severely undermine progress toward eradicating hunger, malnutrition and poverty. Action is urgently needed to prepare the agricultural sectors for the prospect of rapidly changing environmental conditions.

Key words: climate-smart agriculture, sustainability, food protection.

Effect of Different Casing Materials on Growth and Yield of Milky Mushroom (*Calocybe indica*)

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In cultivating Milky mushrooms (*Calocybe indica*) when the spawn run is completed, the crop enters the reproductive phase, during which fruiting bodies are produced. For fruiting to occur, the colonized substrate must be covered with a casing layer, which plays an essential role in the mushroom-growing process. Casing is a vital agronomic practice for mushrooms that grow on humus-rich organic matter, such as the Milky mushroom, as it triggers the transition from vegetative to reproductive growth. This layer enables gas exchange, provides mechanical support, and significantly influences the yield by offering water and structural support for the fruiting bodies. A well-structured casing layer also prevents the buildup of harmful gases on the mushroom bed's surface and must be loose enough to allow primordia emergence.

The casing materials examined in this study included Cocopeat, FYM, Soil + Sand (1:1), Vermicompost, Cocopeat + Soil + Sand (CSS) (1:1:1), FYM + Soil + Sand (FSS) (1:1:1), and Cocopeat + FYM + Sand (CFS) (1:1:1), applied after the spawn run. Early pinhead initiation occurred with the use of FYM + Sand + Soil (6 days), FYM (7.33 days), and Cocopeat + FYM + Sand (7.67 days) as casing materials. FYM as casing material resulted in the quickest fruiting body formation, the first harvest, and the highest total number of fruiting bodies.

Cocopeat + Sand + Soil produced the highest total yield (422.20 g/kg of substrate) and the most significant yield at the first harvest (234.80 g/kg of substrate) compared to other casing treatments. FYM and FYM + Sand + Soil also showed promising results regarding yield. Vermicompost, however, gave poor results for both stipe length and pileus diameter. The moisture content of the fruiting body was over 90% with all casing materials except Sand + Soil and Vermicompost. The best biological efficiency (126.79%) was recorded with Cocopeat + Sand + Soil, while FYM, FYM + Sand + Soil, and Cocopeat also showed good biological efficiency results.

Key words: Milky mushroom, casing, fruiting body, cocopeat, FYM, soil, sand.

Comparative analysis of bioethanol production from agricultural wastes using *Saccharomyces cerevisiae, Aspergillus niger,* and their co-culture

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The growing need for renewable energy sources has encouraged the use of agricultural waste for bioethanol production. This study examined waste potatoes, wheat straw, and sugarcane bagasse to determine their potential for ethanol production using *Saccharomyces cerevisiae, Aspergillus niger,* and their co-culture. The goal was to analyze the chemical composition of these materials and optimize the fermentation conditions for the highest ethanol yield. First, the chemical composition of the waste materials was tested, showing that they contain high levels of total soluble solids (TSS), making them suitable for fermentation. Then, experiments were conducted by adjusting the fermentation conditions, including the TSS levels (18°Brix, 20°Brix, and 22°Brix), pH (3.5, 4.0, and 4.5), and temperature (27°C, 30°C, and 33°C). Each waste material was tested separately with *Saccharomyces cerevisiae, Aspergillus niger*, and their co-culture to compare their ethanol production efficiency. Results showed that the combination of *Saccharomyces cerevisiae* and *Aspergillus niger* in the co-culture produced the highest ethanol yield. The best conditions for fermentation were found to be 20°Brix TSS, pH 4.0, and an incubation temperature of 30°C. Among the three waste materials, sugarcane bagasse produced the highest ethanol concentration at 6.1%, followed by waste potatoes at 5.7% and wheat straw at 4.6%. This indicates that sugarcane bagasse is the most efficient raw material for bioethanol production. The study demonstrates that agricultural waste can effectively produce bioethanol, providing an eco-friendly and sustainable alternative to fossil fuels. The results highlight the importance of optimizing the fermentation conditions to maximize the ethanol yield. Using a co-culture of *Saccharomyces cerevisiae* and *Aspergillus niger* proved to be the most effective method for the tested waste materials. These findings can help develop efficient bioethanol production processes, reducing agricultural waste while promoting clean energy solutions.

Impact of Rearing Density on the Growth Performances and Feed Efficiency of Caged Broilers under Hot Climatic Conditions

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India is a sub-tropical country with different climatic condition in different area. The Indian poultry farmer facing the problems related to summer management and heat stress and actual stocking density in hot climatic condition. To evaluate this, the study was conducted to assess the impact of different rearing densities on body weight, weight gain, feed intake, and feed conversion ratio of caged broiler chicken under the hot climate. The day-old broiler chicks were procured from hatchery and distributed in three groups namely T_1 T_2 and T_3 stock at 2 sq. ft., stock at 1.33 sq. ft. and 1 sq. ft. per bird, respectively. Chicks in each group were subdivided into eight cages to serve as replicates. Birds offered with same ration in all three groups with ad-libitum feeding. Weekly body weight, weight gain, feed intake and feed conversion ratio were determined during experimental periods. The results revealed that birds stocked at 1.33 sq. ft. per bird had significantly highest body weight and weight gain compared to 2 sq. ft. and 1 sq. ft. per bird groups. Higher stocking density led to a decrease in body weight due to increased stress and competition for resources. A moderate stocking density optimized space usage and improved growth performance. It was observed that stocking density did not showed any significant impact on feed intake and feed conversion ratio however, trend indicating that birds stock at moderate density (1.33 sq. ft. per bird) had a better utilization. It may be concluded that by the help of proper heat stress and pre-summer management practices, good performance and better feed utilization may be maintained at different stocking density.

Keywords: Broiler, Feed Efficiency, Growth Performances and Stocking Density

Effects of Dietary Inclusion of Rice Distillers Dried Grains with Soluble (DDGS) on Lipid Profile and Haematological Parameters of Broiler Chickens

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The Indian poultry industry has been largely dependent on soybean meal as a primary protein source since the previous decade. Increasing prices of soybean meal have created a crises for poultry farmers, significantly impacting their profitability. To find cheapest alternative protein source to soybean meal, the present experiment was conducted to assess the effect of rice-derived distillers dried grains with solubles (DDGS) on the serum lipid profile and hematological parameters of commercial broiler chickens. A total 2250 broiler chicks were randomly distributed in 9 dietary treatments, each treatment were sub-divided into 5 groups to serve as replicates. The birds in the control group (T_0) fed with basal diet of soybean meal were the birds in treatment groups viz. T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8 fed with the ration containing rice DDGS at the inclusion of 2, 4, 6, 8, 10, 12, 14 and 16 per cent. At the end of experiment blood sample was collected one birds per replicates for the analysis. The result revealed that a non-significant differences between the chicks fed with the ration containing rice DDGS and those in the control group diet. The results indicating that the significant differences in red blood cell (RBC) count, packed cell volume (PCV) and hemoglobin levels between the control and DDGS-treated groups, although the numerical differences were minimal. Non-significant differences in white blood cell (WBC) count and differential leukocyte counts between the control and DDGS-treated groups were observed. The findings indicated that the inclusion of rice DDGS up to 16% in broiler ration does not negatively effect on lipid profile and any hematological parameters. It may be concluded that rice DDGS can be incorporated into broiler diets at inclusion levels up to 16% without any negative effects on lipid profile and hematological parameters.

Keywords: *Broiler chicks,* Hematological Parameters, *Lipid Profile and Rice DDGS*

Innovative Approaches for Enhancing Farmers' Income

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Agriculture is the backbone of many economies, yet farmers often struggle with low incomes due to fluctuating market prices, climate uncertainties and high input costs. To address these challenges, innovative strategies integrating technology, market linkages and sustainable practices are essential. One key approach is the adoption of precision farming and smart agriculture, leveraging data analytics, IoT and AI-driven solutions to optimize resource use and increase productivity. Agroforestry and integrated farming systems help diversify income sources by combining crop cultivation with livestock, fisheries, and horticulture. Additionally, organic farming and value-added processing enable farmers to access premium markets and earn higher returns. Digital platforms and e-commerce channels provide direct market access, reducing dependency on intermediaries and ensuring better prices. Farmer Producer Organizations (FPOs) and cooperative models strengthen collective bargaining power, reducing costs and improving profitability. Crop insurance and financial inclusion programs offer security against losses, while government policies promoting minimum support prices and subsidies provide financial stability. Climate-resilient agricultural practices, such as drought-resistant crops, water conservation techniques, and renewable energy integration, ensure long-term sustainability and income security. By integrating these innovative approaches, farmers can achieve higher productivity, reduced risks and diversified income streams, ultimately leading to sustainable agricultural growth and rural prosperity. Governments, research institutions, and private sectors must collaborate to scale these solutions, ensuring equitable benefits for all stakeholders. This paper suggest that these strategies, emphasizing the need for policy support, technological adoption and capacity-building initiatives to transform agriculture into a profitable and resilient sector.

Keywords: Farmers' income, Precision agriculture and Market linkages.

Preserving Freshness: Modern Methods for Extending the Shelf Life of Pineapple

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Extending the shelf life of fresh pineapple is crucial for reducing post-harvest losses, maintaining quality, and enhancing marketability. Various techniques, including coating applications, modified atmosphere packaging (MAP), refrigeration, and antimicrobial treatments, have been explored to slow down deterioration and preserve the fruit's freshness. Edible coatings, such as chitosan, alginate, and aloe vera-based films, help reduce moisture loss and microbial growth, thereby prolonging shelf life. MAP, which regulates oxygen and carbon dioxide levels, delays ripening and prevents spoilage. Chilled storage is a commonly utilized approach, as reduced temperatures decrease enzymatic reactions and limit the growth of microbes. Moreover, both natural and synthetic antimicrobial substances, such as essential oils and organic acids, have proven successful in preventing bacterial and fungal contamination. New developments in nanotechnology and post-harvest irradiation also play a role in prolonging freshness by improving resistance to deterioration. Even with these progressions, hurdles like cost efficiency, acceptance from consumers, and adherence to regulations need to be tackled for broader implementation. Upcoming studies should aim at developing sustainable and environmentally friendly preservation techniques that preserve both nutritional value and sensory qualities. By adopting cutting-edge preservation methods, the longevity of fresh pineapple can be greatly increased, which would advantage producers, retailers, and consumers while minimizing food waste.

Keywords: Shelf-Life Extension, Fresh Pineapple, Edible Coatings, Modified Atmosphere Packaging (MAP), Post-Harvest Preservation

Methodological issues for Pricing of Unorganized Agro-based production system: A Case Study on Mango-based Post-harvest Processing

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The agricultural sector in India has undergone a significant transition from traditional farming practices to an agribusiness approach. The post-harvest agro-based enterprises primarily focuses on product diversification and value addition for present-day consumers. Only the market forces create greater opportunities for value-added products due to ever changing consumer's behavior. The science & technology enable both producers & processor into rational direction. But small-scale producers often struggle to put rational price due to the unorganized nature of works in terms of processing and marketing. The primary challenge lies in the lack of knowledge about the pricing system and often devaluates their time engagement in the supply chain. Branding and network technology also have significant impacts as well. It is evident from the result that the project is financially viable with a BCR of 1.19 & yield rate per year (FRR) of 47.10 percent. The annual cash flow is ₹5,88,364, with an annual repayment of ₹2,04,750 with same discount rate, leaving a net income margin of ₹3,83,614 per year for 20 years lifetime. The study captures a man-days generation of 100-135 in cultivation, with primary male dominance & value addition through female participation contributing 55 man-days, equivalent. The price spread between the farm value of the product and the retail has increased steadily over the years. Group activities (FPOs, SHGs, PACS, FOs) have proven beneficial, which enable producers to achieve common business objectives, mitigating risks with maximizing returns. This technique has been tried to simplify the complex pricing system, making it more accessible and efficient with the help of social capital.

Keywords: Pricing, Agribusiness, Value-addition, Income distribution

Correlation among the parameters considered for estimating the Air Pollution Tolerance Index for Trees

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Air Pollution Tolerance Index (APTI) is a measure used to estimate the tolerance of various tree species towards air pollution. It is quantified by assessing four physiological factors leaf extract pH, total chlorophyll content (TCh), relative water content (RWC), and ascorbic acid content (AA). The biochemical analysis indicated a positive correlation between high APTI values and elevated levels of the measured parameters. Leaf extract pH indicates a tree's response to acidic pollutants, with higher pH values correlating with increased pollution tolerance. TCh is a measure of a tree's photosynthetic capacity, RWC reflects the hydration status. AA an antioxidant mitigates oxidative stress induced by air pollutants. Trees with higher pH like *Ficus benghalensis* (8.04) and *Ficus religiosa* (7.0) show high APTI values, indicates positive correlation between pH and APTI. Low pH doesn't always correspond to a lower APTI observed in *Acacia nilotica* pH (4.77) but a high APTI (9.71), suggesting no clear negative correlation. *Moringa oleifera* exhibits highest RWC (135.71%) and also the highest APTI value (13.83). Syzygium cumini (64.71%) and Butea monosperma (66.67%) RWC both have relatively low APTI values of 8.06 and 7.81 respectively is somewhat negatively correlated with lower APTI values. *Neolamarckia cadamba* with a TCh of 1.158 mg/g has a high APTI(11.27), indicating the significance of chlorophyll content. *Millettia pinnata* (0.442 mg/g) has a lower APTI(8.81), and Eucalyptus alba (0.463 mg/g) has an APTI(8.91). Both show a negative correlation between low TCh and lower APTI values. There is also a negative correlation with lower AA levels seen in *Moringa oleifera*, with a low AA content (0.4 mg/g) but high APTI (13.83) an inverse relationship is not observed across all species. By understanding these correlations, planners can select trees with higher APTI for afforestation, enhancing air quality.

Keywords: Air Pollution, Tree response, APTI, correlation, urban, industrial.

CRISPR and Gene Editing in Crops

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CRISPR-Cas9 gene-editing technology has revolutionized plant biotechnology by providing a precise, efficient, and versatile method for modifying crop genomes. This breakthrough tool enables targeted insertions, deletions, and substitutions of specific DNA sequences, facilitating the development of crops with enhanced traits such as disease resistance, abiotic stress tolerance, and improved nutritional profiles. Unlike traditional breeding and transgenic approaches, CRISPR is faster, cost-effective, and more precise, often producing non-transgenic plants that align with evolving regulatory frameworks.

Recent advancements have demonstrated the successful application of CRISPR to increase crop yield, improve drought resistance in maize, and develop fungal-resistant wheat varieties. Emerging innovations, such as base editing and prime editing, are further refining CRISPR's precision and efficiency, reducing off-target effects. Despite its transformative potential, challenges remain, including regulatory hurdles, public acceptance, and bioethical concerns. Addressing these issues will be essential to harnessing CRISPR's full potential for sustainable agriculture and food security.

Keywords: CRISPR-Cas9, gene editing, crop improvement, disease resistance, abiotic stress tolerance, biotechnology, sustainable agriculture

Crop covers studies in chilli

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A three-year experimental study was conducted at the Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, to investigate the effect of different colors of crop covers on the growth, yield, quality and disease pest infestation of chilli. The experiment was undertaken in randomized block design with five treatments: T_1 - standard farmers or package of practice without cover; T_2 – absolute control without cover; T_3 - 17 GSM blue; T_4 - 17 GSM white; T_5 - 17 GSM red and three times replicate. On the basis of pooled data significantly maximum plant height (98.82cm), number of primary branches (10.03), maximum leaf area (32.55cm sq.), minimum days required to 50% flowering (46.54 DAT), maximum chlorophyll index (89.03), average number of fruits per plant (425.91), average fruit girth (4.11cm), average fruit weight (5.94g), maximum fruit yield per plant (2.53kg), maximum yield per hectare (467.01q), minimum number of thrips per three leaves per plant (6.60) and minimum number of white flies (4.95) respectively were observed in red colour crop cover. Significantly maximum benefit cost ratio (3.39) was observed in treatment T_4. From the above study, it could be concluded that the treatment T_4 (17 GSM white color crop cover) was superior among all the treatments under Vidarbha climatic conditions.

Keywords: Crop cover, growth, yield, quality, pest infestation and benefits cost ratio

ORGANIC FARMING A BOON OF AGRICULTURE

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Maintaining crop production and soil health is an important upcoming major challenge in agriculture, due to the unsupervised use of synthetic means of farming i.e. inorganic fertilizers, pesticides, herbicides, etc. human and environmental health is being seriously affected. There is a serious decline in the soil fertility which in turn is affecting the yield of the crops. Excessive and unsupervised usage of pesticides results in pest gradually getting immune to the pesticides. So organic farming is the only proper alternative to synthetic fertilizers for sustainable agriculture. The term Organic farming also known as organic agriculture or ecological farming or biological farming. Organic farming is a system of agriculture that focus on producing food without the use of synthetic pesticides, herbicides, fertilizers, or genetically modified organisms (GMOs). It relies on natural processes and techniques to maintain soil health, promote biodiversity, and minimize environmental impact. Organic farming prioritizes building healthy soil through practices like crop rotation, inter cropping, compost manure, green manure. Healthy soil is more fertile, better able to retain water, and less susceptible to erosion. Healthy soil is a living, dynamic ecosystem. It has organic matter (dead plant and animal material), microorganisms (bacteria, fungi, and protozoa), macro organisms (earthworms and insects), water and air. Soil health is the capacity of the soil to function as a living system. These practices can also help to control pests and diseases, reducing the need for synthetic pesticides. Healthy soils maintain a diverse community of soil organisms that help to control plant disease, insect and weed surface.

Key Word – Organic Farming, Soil Health, Environment

Data-Driven Farming: The Power of Precision Agriculture

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Data-driven farming, powered by precision agriculture, is transforming modern agricultural practices by integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and remote sensing. This approach enables farmers to optimize resource utilization, enhance crop yields, and improve sustainability. By leveraging real-time data from sensors, GPS mapping, and machine learning algorithms, precision agriculture allows for site-specific crop management, reducing waste and increasing efficiency. One of the key benefits of data-driven farming is its ability to monitor soil health, weather patterns, and crop conditions with high accuracy. Automated systems and predictive analytics help farmers make informed decisions on irrigation, fertilization, and pest control, minimizing environmental impact while maximizing productivity. Additionally, drones and satellite imagery play a crucial role in assessing field conditions, detecting diseases, and identifying areas that require intervention. The adoption of smart farming technologies leads to improved operational efficiency and cost savings, making agriculture more resilient to climate change and global food demand. As precision agriculture continues to evolve, the integration of blockchain and cloud computing will further enhance data security and accessibility, fostering a new era of digital farming. Embracing data-driven precision agriculture is essential for achieving sustainable food production, ensuring food security, and advancing agricultural innovation. By harnessing the power of data, farmers can make smarter decisions, increase profitability, and contribute to a more efficient and environmentally friendly agricultural ecosystem.

Keywords: Big Data Analytics, IoT in Agriculture, Precision Agriculture, Smart Farming, Sustainable Farming

COLLECTION, HARVESTING, PROCESSING, AND VALUE ADDITION OF *DIPLOKNEMA BUTYRACEA.* AN UNDERUTILIZED NTFP OF UTTRAKHAND

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Diploknema butyracea (Roxb.) H. J. Lam, locally known as Chyura, is a medium to large-sized deciduous tree widely distributed on the south-facing slopes in the sub-Himalayan region from 200 m to 1500 m. It is an underutilised multipurpose tree species distributed in the Kumaon region of Uttarakhand. The population of these trees in Uttarakhand is mainly restricted in the Pithoragarh district, particularly the areas neighbouring Nepal and the adjoining regions in Almora, Bageshwar and Champawat. Chyura seed is an important source of fatty oil. The oil is known as phulwara, which is used as a substitute for ghee and butter in cooking and burning diyas. Hence, it is famous as an Indian butter tree. The bark has tannin properties and is used for dyeing. This study surveyed representative markets and households of the Pithoragarh district to learn the processing techniques of chyura butter from seeds and the value addition of butter. To prepare chyura butter, the fruits are first harvested and collected in a basket, and their pulp is removed. The seeds obtained are then washed and sun-dried for 4-5 days. Traditionally, two methods are used. In the first method, the seeds are roasted; in another, the seeds are boiled in water for some time. The chyura oil is used for making various products like soap which are prepared through saponification reaction using lye due to its high saponin content; candles are made by mixing chyuri butter and beewax in a proportion and some fragrance. Cosmetic items like lip balm and foot crack cream are also prepared from butter. *Diploknema butyracea* is a plant with unlimited benefits for local farmers to generate livelihood opportunities. Oil is used in different fields, such as plant-based ghee production, candle manufacturing, pharmaceuticals and soap making. Existing self-help groups and NGOs can work as a bridge between local farmers to support agribusiness through things such as bee farming, better prices for honey and butter, and livelihood support.

Keywords: *Diploknema butyracea*, Livelihood, Products, Uttarakhand

Nano fertilizers - a future approach for sustainable soil fertility

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Nano-fertilizers revolutionize sustainable agriculture by improving soil fertility and reducing environmental impact. Nano fertilizers differ from conventional fertilizers, as they utilize nanotechnology to provide and release nutrients in a controlled and effective manner. Nano-fertilizers channel the high surface area and slow-release properties offered by the nanoparticles to maximize growth and yield while minimizing nutrient losses. Nano-fertilizers and their role in sustainable soil fertility and agricultural productivity In several studies, different types of micro- and nano-fertilizers were applied to different crops in various agro-ecological zones with a remarkable improvement of nutrient uptake efficiency (up to 40% increase) and significantly higher soil retention (30% reduction in leaching and volatilization losses). Nano-fertilizers promote environmental sustainability by minimizing over-application of chemical fertilizers, and thus, reducing greenhouse gas emissions and promoting. Nano-fertilizers also help promote environmental sustainability by preventing over-application of chemical fertilizers and reducing greenhouse gas emissions along with enhancing soil biodiversity. Controlled release mechanisms further balance nutrient availability with crop growth stages, preventing friendliness unfriendliness between crops and soil microbes, promoting pastoral harmony between aerobic and anaerobic soil microbes. Nano fertilizers provide significant economic advantages to farmers, as they are more profitable and require fewer inputs. Field trials showed yield increases of up to 25% in staple crops with 20% less fertilizer. Nano-fertilizers are linked to global movements such as sustainable development goals (SDGs) related to environmental protection, food security and climate change mitigation. Nano-fertilizers form an integral part of IPFN which is Resilient Farming System as they increase nutrient use efficiency optimizing environmental impacts.

Biotechnological Approaches in Vegetable and Breeding

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Vegetable and fruit production suffers from many biotic stresses caused by pathogens, pests, and weeds which require high amounts of plant protection products per hectare. Bt- sweet corn has. also proven effective for control of some lepidopteran species. Bt- fresh market sweet corn hybrids are released almost every year. Transgenic Bt- eggplant breed to reduce pesticide use is now grown by farmers. Transgenic papaya cultivars carrying the coat-protein gene provide effective protection against papaya ring spot virus elsewhere. Enhanced host plant resistance to Xanthomonas campestris pv. musacearum, which causes the devastating banana Xanthomonas wilt was achieved by plant genetic engineering. Other vegetable and fruit crops in the pipeline that have been the genetically modified to enhance their host plant resistance to insects and plant pathogens to show herbicide tolerance, and to improve features such as slow ripening that extends the shelf-life of the produce. Consumers could benefit further from eating more nutritious transgenic vegetable and fruit. Transgenic plant breeding therefore provides genetically enhanced seed embedded technology. Transgenic breeding method contributes to integrated pest management in horticulture by reducing pesticide sprays as well as improving food safety by minimizing pesticide residues.Furthermore,herbicide- tolerant transgeniccrops can help reducing plough in fields, theredy saving fuel because of less tractor use which also protects the structure of the soil by reducing its erosion.Transgenic vegetable and fruit crops could make important contributions to sustainable vegetable production and to more nutritive tritious and healthy food. Countries vary however in their market standards of acceptance of transgenic crops. Biotechnology products will be successful if cear advantage and safety are demonstrated to both growers and consumers.

Keywords: transgenic plant fruits market Nutrition, plant breeding, vegetable genetically modified

Fossil Fuels from Forests: Formation, Utilization and Environmental Impact

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Fossil fuels i.e. coal, oil, and natural gas are crucial energy sources derived from ancient organic matter, including forest biomass. The formation of these fuels dates back to the Carboniferous period, around 300 million years ago, when vast swampy forests accumulated plant material that was later buried under sediment and subjected to heat and pressure. Coal, a primary fossil fuel, originated from such forests, while oil and natural gas have partial contributions from forest biomass in certain geological settings. Today, fossil fuels remain the dominant energy source, contributing to over 80% of global energy consumption, with coal alone accounting for approximately 27% of electricity generation worldwide. However, the extraction and combustion of these resources have led to severe environmental challenges, including deforestation, loss of biodiversity, and greenhouse gas emissions. The burning of fossil fuels contributes approximately 35 billion metric tons of CO2 annually, exacerbating climate change. Additionally, mining and drilling activities cause soil degradation and water pollution, significantly impacting ecosystems. The extraction and use of fossil fuels in India have significant environmental consequences, including deforestation, greenhouse gas emissions, and pollution. Large-scale coal mining, especially in Jharkhand and Chhattisgarh, has led to extensive deforestation, destroying habitats and degrading soil quality. Furthermore, fossil fuel combustion releases harmful pollutants such as sulphur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter, severely deteriorating air quality in major cities like Delhi, Kanpur, and Kolkata. The cumulative environmental impact highlights the urgent need for sustainable energy alternatives and stricter environmental regulations. This review underscores the necessity of reducing reliance on fossil fuels and adopting sustainable alternatives to ensure long-term environmental and energy security.

Keywords: Fossil Fuel, Biomass, Sustainable Forest Management, Environmental Impact

Genotypic Variability in Wheat for Salinity Stress Tolerance: Insights into Oxidative Stress, Antioxidant Defence, Osmolyte Accumulation, Gene Expression, and Grain Quality

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Salinity stress is a significant abiotic factor that adversely affects grain yield and quality in wheat (*Triticum aestivum*). This study evaluated the genetic diversity of 20 wheat genotypes classified as tolerant, moderately tolerant, and sensitive, along with three genotypes of unknown tolerance. Various morpho-physiological, biochemical, osmoprotectant, gene expression, yield, and grain quality traits were analyzed under control (pH 8.0, EC 3.9) and saline-sodic (pH 9.4, EC 4.02) field conditions. The results revealed substantial genotypic variations in response to salinity stress. Sensitive genotypes, such as HD1941 and K9162, exhibited increased Na^+ accumulation and reduced K^+ content under salinity stress. Proline, a key stress marker, showed a significant ($p \leq 0.05$) increase, particularly in the tolerant cultivars KRL210 and KH65. Salinity stress led to a marked ($p \leq 0.05$) reduction in spike length, thousand-grain weight, and hectoliter weight, while protein content increased in sensitive genotypes, contributing to yield loss. Sensitive genotypes exhibited a significant decrease in the expression of starch biosynthesis genes, accompanied by an increase in the expression of gluten genes. Correlation analysis indicated that SOD activity, proline accumulation, and Na^+ content are reliable indicators for early-stage screening of salinity tolerance. Principal component analysis identified DBW187, DBW303, and DBW222 as salinity-tolerant genotypes with robust antioxidant defense mechanisms. These findings provide valuable insights for breeding salt-tolerant wheat by enabling efficient screening of genotypes based on key physiological and biochemical traits.

Keywords: wheat, salinity, SOD, gene expression, proline

Infrared Thermal Imaging of Eye Surface Temperature as a Non-Invasive Indicator of Livestock Stress

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Reliable, non-invasive physiological markers for stress in livestock are crucial for effective management and welfare assessment. This study examines the correlation between eye temperature (EYETi, EYETo) and key stress-related physiological parameters: respiratory rate (RR), rectal temperature (RT), Benezra's thermal comfort index (BTCI), Temperature-Humidity Index (THI), and cortisol (CORT), across different seasonal conditions. Data were collected from six growing heifers twice per season (Induced Heat Stress, Natural Heat Stress, Spring, Winter), with two measurements per season. Pearson correlation analysis determined the strength and direction of relationships between eye temperature and other physiological stress indicators. Strong positive correlations were observed between eye temperature and RT (r = 0.74), RR (r = 0.86), and BITC(r =0.89), indicating that higher eye temperature is associated with increased thermal stress. Moderate correlation was found between eye temperature and cortisol (r = 0.65), linking thermal response and endocrine stress markers. Strong correlation between eye temperature and THI (r = 0.94) suggests that as environmental heat stress increases, physiological thermoregulation may influence surface eye temperature. The strong correlations between eye temperature and key physiological parameters confirm its potential as a non-invasive stress biomarker in livestock. These findings support the use of eye temperature for early stress detection, which could enhance precision livestock monitoring and welfare management. Further research should explore its application in real-time automated stress assessment systems.

Key words: THI, BTCI,RT,RR, CORT.

Effect of different IBA concentration on sprouting and rooting of croton cuttings

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The investigation entitled “Response of different IBA concentration on sprouting and rooting of croton cuttings” was carried out at Ornamental Nursery, Floriculture and Landscape and Architecture, Dr. PDKV, Akola during September to February,2022-23 with the objectives to study the effect of IBA, on sprouting and rooting of softwood, semi hardwood and hardwood croton cuttings. The experiment was laid out in Factorial Randomised Block Design with 3 replications and 2 factors. Factor A consist of different types of cutting viz. softwood cutting, semi hardwood cutting and hardwood cutting and Factor B consist of different IBA concentrations viz. IBA-100ppm, IBA-200ppm, IBA-300ppm, IBA-400ppm and IBA-500ppm with 15 different combinations. The result of present investigation indicated that the treatment hardwood cutting recorded significantly superior results in respect of minimum days to rooting and sprouting of cuttings, maximum number of shoots per cutting, number of sprouting per cutting, length of longest sprout, number of leaves per cutting, plant height, leaf area, number of roots per cutting, length of longest root, stem girth and survival percentage. Regarding the treatment IBA-400ppm exhibited significantly superior results for minimum days to rooting and sprouting of cuttings, maximum number of shoots per cutting, number of sprouting per cutting, length of longest sprout, number of leaves per cutting, plant height, leaf area, number of roots per cutting, length of longest root, stem girth and survival percentage. Similar results were recorded in the interaction effect between types of cutting and IBA concentration i.e hardwood cutting with IBA-400ppm.

Effect of Weed Management Practices on Yield of Boro Rice in Lower Gangetic Alluvial Soil of West Bengal

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Rice is considered as the staple food for half of the world's population. In India it is grown in various regions throughout the year out of which boro season is most suitable for obtaining higher yield due to conditions like ample sunlight, controlled irrigation, well suited climatic condition and less disease and pest infestation but weeds only remain as a serious threat to optimum rice production due to its highly competitive nature with rice. Yield loss due to weed in rice field can range from 40%-60%. Some important weed species observed in rice fields are *Echinichloa spp.*, *Cyperus difformis* L., *Marselia quadrifolia* L., *Alternenthera spp*. etc. which lowers the yield of rice. Various weed management practices both through implementation of herbicides or manual operation may be carried out for complete removal of weed species existing in the field or to minimize the extent of yield loss. During the year 2022-2023 and 2023-2024 of boro season, field experiment was conducted at the experimental farm of University of Calcutta located at Baruipur, West Bengal for analyzing the effect of different chemical herbicides and hand-weeding practices on yield of boro rice which consisted of 14 treatments laid out in Randomized Block Design (RBD) replicated thrice. The treatment (T_{13}) where hand-weeding at 20 DAT and 40 DAT was done showed highest weed control efficiency and grain yield followed by treatment (T_{10}) where Triafamone 20% + Ethoxysulfuron 10 % WG @ 66.5 g a.i./ha as post-emergence (Pre-mix) was applied.

Key words: Boro rice, herbicide, RBD.

Leveraging Fungal Endophytes to Boost Abiotic Stress Tolerance in Wheat

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Endophytic fungi, which live within plant tissues without causing symptoms of disease, have gained attention to enhance plant tolerance to abiotic stresses such as drought, salinity and extreme temperatures. The positive effects of these fungi on plant health and growth can be attributed to various mechanisms, including the production of growth hormones, enhancement of nutrient uptake, and improvement of the plant's physiological responses to stress. However, the utilization of endophytic fungi in crop improvement, particularly in wheat is still limited. The present study was carried out at ICAR-IIWBR, Karnal during crop season 2023-24 under drought and heat stress conditions with three treatments control, and two endophytes treatment PMB1 and PMB2 (Obtained from UAS, GKVK, Bangalore) in widely grown wheat varieties DBW187 and DBW303. Different physiological, biochemical and yield associated traits were recorded to assess the potential of endophytes in imparting abiotic stress tolerance. Yield and yield associated traits were found to be higher in PMB2 treated plants compared to other treatments. Grain yield/plot (kg), Biomass/plot (kg), HI (%), Thousand grain weight (TGW), Grain no./spike, Grain weight /spike (g), Number of Tillers/2.5 mtr and Spike length of PMB2 treated plants was found higher followed by PMB1 and control in all conditions for both genotypes. Further validation of these endophytes with more genotypes in multilocation are under progress during crop season 2024-25.

Establishment of *in vitro* high frequency shoot multiplication protocol of *Withania somnifera* Dunal

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Withania somnifera Dunal, commonly known as Ashwagandha, is an important medicinal plant that has been used in Ayurvedic treatment and indigenous medicine for more than 3000 years. Various clinical trials show that the plant extract and its bioactive compounds are used in the prevention and treatment of many diseases for which it has a huge demand in the global market. *W. somnifera* is prone to several pests and diseases as well as continuous and large-scale production of plantlets have proved to be inadequate through conventional approach. Thus, to narrow down the huge gap between its demand and supply, alternative strategies to conventional cultivation are required. Micropropagation is the most appropriate method for production of disease-free plantlets in a large number. In this current study, *in vitro* high frequency shoot multiplication of *W. somnifera* has been achieved using internodal explants, when cultured on full MS (Murashige and Skoog 1962) medium with various types and dosages of cytokinin (i.e; BAP and Kinetin) and auxins (i.e; IAA, IBA and NAA). For prolonged maintenance of in vitro shoots, additives (i.e; Coconut water) in the media have been introduced in different concentration to minimize the adverse effects of cytokinin. Furthermore, *in vitro* rooting was initiated in an auxin- dependent (i.e; IAA, IBA and NAA) media. The rooted plantlets through sequential hardening process were then established in the field. Hence, the protocol developed for *in vitro* mass multiplication of *W. somnifera* is cost-effective and can be efficiently used for the industrial production of withanolides.

Keywords: Micro-propagation, High frequency, Additives, *Withania somnifera*,

EXPLORING MOLECULAR DIVERSITY IN FINGER MILLET: INSIGHTS FROM RAPD, ISSR, AND SSR MARKERS

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DNA markers enable precise molecular characterization of genotypes by offering more accurate insights into genetic relationships. India hosts extensive genetic diversity in finger millet. PCR-based markers such as RAPD and ISSR are particularly effective for genetic diversity studies due to their high polymorphism rates, ease of use, minimal DNA requirement, sequence independence, and automation capability. In this study, molecular analysis was conducted on seventeen finger millet genotypes. Among the four SSR markers tested, two exhibited polymorphisms. Of the seven RAPD markers, ninety-five bands were generated, with thirty-eight being polymorphic, while ISSR primers amplified an average of eighty-nine DNA bands. The number of SSR alleles ranged from one to three, while RAPD bands varied from eight (OPBE-04) to eighteen (OPBE-09). ISSR markers produced a total of eighty-nine amplified bands. The PIC values for SSR markers ranged from 0.46 to 0.65, for RAPD markers from 0.06 to 0.24, and for ISSR markers from 0.11 to 0.36. Genetic diversity analysis revealed that PYR 2 and Karunchuruttai had the highest dissimilarity index in SSR marker analysis. RAPD analysis indicated a high dissimilarity index (0.43) between GPU 28 and Karunchuruttai, while ISSR analysis showed the highest dissimilarity coefficient (0.45) between GPU 48 and PR 1506. Dendrogram analysis using the Unweighted Pair Group Method clustered the seventeen genotypes into six groups in SSR analysis, two in RAPD analysis, and three in ISSR analysis.

Keywords: Molecular Diversity, Finger millet, RAPD, ISSR and SSR

Feeding the Future: Agricultural Innovation in the Face of Global Challenges

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Climate change poses significant challenges for smallholder farmers in developing countries, crucial to global food production. Recent food crises have exposed vulnerabilities in agri-food systems, with climate change being just one factor among many contributing to food insecurity, particularly for the poor. To address this, a holistic understanding of these changes is essential. This paper reviews three case studies of agricultural innovation systems in diverse socio-economic and agro-ecological contexts, highlighting key factors for food security: multifunctionality, access to diversity, capacity building, and sustained effort. It also discusses implications for policymakers. The paper outlines a framework to explore investments aimed at poverty reduction and rural prosperity, focusing on agricultural research investments and their role in addressing development shifts over the past 25 years, such as urbanization and climate change. It introduces 18 plausible impact pathways from agricultural research to rural prosperity, assessed through bibliometric methods. The paper also redefines poverty reduction, emphasizing equity, gender, community differences, and broader measures of poverty beyond income. Conservation agriculture (CA) has been promoted to address land degradation, climate change, and food insecurity, but adoption rates remain low. This study moves beyond the adoption framework to explore dynamic, contextual decision-making, and the influence of project interventions. It emphasizes the need for investments that build on existing knowledge and highlights four factors for successful adoption: social dynamics, contextual costs, risk aversion, and practice adaptation. The Rapid Appraisal of Agricultural Innovation Systems (RAAIS) tool helps analyse complex agricultural problems and innovation capacity, offering valuable insights for strengthening agricultural systems.

Keywords: Agri-food systems, Bibliometric methods, Conservation agriculture, Decision-Making, Policymakers

Fighting Poverty, Hunger, and Malnutrition with Potential Unutilized Crops in India

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A significant increase in cultivation and consumption of potential crops in India will contribute to the efforts to eliminate hunger, malnutrition and poverty as committed in the sustainable developmental goals. It will also enable countries to increase resilience and better adapt their agricultural production systems to changing climate. The fact that most of these crops are abiotic stress tolerant and nutrient dense makes them an important resource for addressing key challenges of improving food and nutrition security. Besides these crops have great potential in sustaining the genetic resources needed to make future crops and crop production climate smart. In addition, agricultural production focused on agro-biodiversity can contribute to harnessing and safeguarding centuries-old traditions and is a powerful instrument for keeping alive the cultural identity of farmers and indigenous communities. However, to promote potential crops, there is a need to overcome major obstacles, which occur along entire value chains. This can be addressed through R&D and suitable policy frameworks. Hence, there is a need of intensive efforts to develop appropriate national strategies and policies to promote diversification of cropping systems based on the R&D outputs. This shift should also include introduction of an agro-ecology based land use classification system, which would allow for the inclusion of potential crops in the crop choice and food networks. This should be matched with identifying and prioritizing a few potential crops that have the greatest potential for success with respect to addressing food security and sovereignty, climate change adaptation and improving rural livelihoods. Through concerted action at international, national as well as at local levels, these valuable genetic resources can be transmitted on to future generations and thus can significantly contribute to humankind's well-being.

Keywords: All India Coordinated Research Network (AICRN), Genetic Resource, Germplasm, Potential Crops, Underutilized Plants

Comparative nutritional assessment of fruits of *Ficus palmata* from different regions of north India

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Throughout history, wild edible plants have been a crucial source of sustenance for human populations across all inhabited continents. The dietary use of wild fruits, nuts, seeds, and leaves is well-documented in numerous historical records. While modern diets primarily rely on a limited number of cultivated crops, the use of wild plants remains significant in many parts of the world, particularly in rural and tribal areas. In India, indigenous wild fruits play an essential role in food and nutrient security, especially for marginalized communities. Among these, *Ficus palmata* (Wild Himalayan fig or *bedu*) is an underutilized species of the Moraceae family, recognized for its nutritional benefits. . It serves as a good source of dietary fiber, antioxidants, and bioactive compounds such as flavonoids and polyphenols, which are linked to anti-inflammatory and anti-cancer properties The fruit, which is harvested between June and September, was collected from different regions of four states namely Uttarakhand, Uttar Pradesh, Punjab, and Haryana. Morphological parameters of these fruits were recorded. Biochemical analyses of the collected fruits revealed variations in nutritional components viz. total soluble sugars varied from 4.10 to 10.10 %, crude protein 3.20 %– 7.87 %), vitamin C 2.20 mg/100g to 3.55 mg/100g, fat content 1.20 % – 2.50 %, total ash 1.30 % – 2.8 %), crude fiber 19.08 % – 29.76 %, total phenolic content (52.94-65.60 mg/g), and total flavonoid content (15.74-79.39 mg/g). Thus, these findings highlight the region with superior fruits and their potential for improving nutrition.

Keywords: *Ficus palmata*, Fruit, Nutritional, Antioxidant activity, Biochemical, Underutilized

Effects of Soil Moisture on Extractable Phosphorus and Aluminium in soil-plant systems of *Terai* Agroecological region of West Bengal.

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In *Boro* rice production under continuous flooding, precision agriculture aids in optimizing water use by monitoring soil moisture, water depth, and minimizing excess losses and thus ensuring efficient soil and water conservation issues. The relative abundance of Aluminium (Al) and deficiency of extractable Phosphorus (P) in acid soil could affect production of rice. The present study aimed to explore the transport behaviour of aluminium and phosphorus in soil-plant system in pots during the *Boro* season (2022-2023) taking two rice cultivars, Uttar Lakshmi and IR 64 following factorial-CRD with 12 treatments where three levels of phosphorus (0, 45, 60 kg/ha) combined with two levels of FYM (0, 10 g/kg pot soil) and two levels of Aluminium stress (0, 250 mg/kg) were given at two different irrigation (continuous flooding and 50% soil moisture) and replicated twice. Significantly highest availability (16.80 kg/ha) and uptake (37.77 mg/plant) of phosphorus has been obtained from the treatment with 60 kg P/ha+FYM+0 Aluminium with continuous flooding for the variety IR 64 at 85 DAT and 115 DAT respectively. Aluminium treated plots exhibit significantly lower availability and uptake of phosphorus. The highest availability (10.31 kg/ha) and uptake (241.19 mg/plant) of Aluminium were recorded at 85 DAT and 115 DAT respectively from (60 kg P/ha+FYM+Aluminium) treatment with continuous flooding and the highest Al uptake with lowest availability of soil Aluminium were observed by Uttar Lakshmi, which is a Al tolerant cultivar establishing that, under Al stress condition, Phosphorus and FYM application does not always reduce Al toxicity, selection of tolerant variety with proper water management strategy are also playing important role for a better phosphorus utilization efficiency at such environment for the sustainable agricultural systems.

Keywords: Acid soil, Rice, Water conservation, Al and P uptake, Tolerant variety

Flemingia semialata as a Lac Host: Biomass Yield, Lac Production, and Carbon Credit Potential in Agroforestry Systems

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Agroforestry systems integrate trees, shrubs, and crops to enhance productivity, sustainability, and environmental benefits. Among such systems, *Flemingia semialata*, a vital host for lac insects, has garnered attention for its potential in biomass production, yield enhancement, and carbon credit generation. This study explores the role of *Flemingia semialata*-based agroforestry in optimizing biomass and lac yield while contributing to carbon sequestration. Concurrently, the lac insects hosted on *Flemingia semialata* produce valuable resin, offering economic benefits to farmers. The agroforestry system outperforms monocropping of crops in carbon sequestration, as it efficiently stores atmospheric carbon in biomass and soil, enhancing its potential for carbon credit generation. Moreover, the agroforestry practice contributes to earning carbon credits, providing an additional income stream for practitioners and promoting sustainable land-use practices. The findings underscore *Flemingia semialata*-based agroforestry as a sustainable approach to integrate ecological conservation with economic productivity. By leveraging its high biomass output, carbon sequestration potential, and lac yield, this system holds promise for rural livelihoods and environmental resilience.

Formulation and Packaging of a Fortified Ready-to-Eat Jackfruit Meal

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Jackfruit, known for its versatility and nutritional benefits, is an excellent base for creating a fortified meal that caters to health-conscious consumers and promotes food security. This study focuses on formulating and packaging a fortified ready-to-eat jackfruit meal, enriched with protein and micronutrients to address nutritional gaps. Spices and natural flavoring agents are added to improve palatability while maintaining a clean-label profile. The fortification targets key deficiencies, including vitamins A, B-complex, and iron, aligning with recommended dietary allowances. The product is packaged using aseptic technology to ensure microbial safety and retain organoleptic qualities. Advanced packaging materials with high barrier properties can prevent contamination, reduce oxidation, and enhance storage stability under ambient conditions. The microbial loads were relatively low, with total plate count, yeast, and mold counts, below safe limits throughout and no pathogens could be identified. Nutrient content, including protein, fat, and carbohydrate, demonstrated minimal variation and ensured stability. The sensory evaluation indicated high scores in the sensory attributes of taste and texture, although minor color changes did not contribute to a decline in general appeal. Accelerated storage tests also supported stability over two years. The natural preservatives in combination with aseptic packaging were initiated to be quite effective for maintaining the safety, nutritional quality, and sensory attributes of jackfruit meal over 24 months. This innovative approach offers a shelf-stable plant-based meal solution and reduces post-harvest loss, thus pushing towards more sustainable food preservation.

Keywords*:* aseptic technology, fortification, jackfruit meal, shelf-stable

Evaluation of micronutrients on the growth performance of garlic (*Allium sativum)* in the old alluvial zone of West Bengal.

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An on-farm trial was conducted at a farmer's field in Muglishpur village, located in the Kumarganj block of Dakshin Dinajpur district, West Bengal. The objective was to observe the effects of micronutrients on garlic (Allium sativum L.) performance over two consecutive years, 2020-21 and 2021-22. The trial was designed using a randomized block design (RBD) with nine replications, supervised by the Dakshin Dinajpur KVK. Four technology options with different micronutrient combinations were evaluated: Zinc at 0.2%, Boron at 0.2%, a combined application of Zinc and Boron (Zn 0.2% + Bo 0.2%), and a control group with no micronutrients. The results revealed significant differences among the various technology options regarding yield and its contributing factors. The highest yield of 16.18 tonnes per hectare was obtained from the combined application of Zinc and Boron at 0.2%, followed by Boron alone at 0.2%, which yielded 14.77 tonnes per hectare. The trends for the number of leaves per plant, number of cloves per bulb, individual bulb weight, and cost-benefit ratio aligned with the yield results. Notably, the combination of these micronutrients (Zn and Bo) also resulted in the shortest time to bulb maturity, taking an average of 117.08 days. In contrast, the lowest yield of 8.544 tonnes per hectare was recorded in the plots where no micronutrients were applied. Therefore, the most effective technology was the combined application of Zinc and Boron (0.2%) along with the recommended doses of major fertilizers.

Keywords**:** Boron, Garlic**,** Micronutrients, Yield, Zinc

Genome Wide Association Studies in *indica* MAGIC lines of rice (*Oryza sativa*) for grain yield

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Rice is a primary food source for over 3.5 billion people, particularly in Asia and is a significant contributor to the economies of many countries, providing livelihoods for millions of farmers and workers. The present investigation "Genome wide association studies (GWAS) in *indica* MAGIC lines of rice (Oryza sativa L.) for grain yield" was carried out during *kharif*, 2017 at Regional Agricultural Research Station, Maruteru, West Godavari District of Andhra Pradesh state located at 81.440 E longitude, 26.30 latitude and 5m above mean sea level. A subset of 395 *indica* MAGIC lines and its genotypic data was used as an experimental material for this study. The experimental material was laid out in Augmented randomized complete block design in the field. Six popular varieties *viz*., Sahabhagi Dhan, Rasi, IR64, MTU 1010, CSR36 and MTU 1075 were used as check varieties replicated six times. Phenotypic data was collected on yield trait *viz*., grain yield per plant (g). The genotypic and phenotypic data was used to perform GWAS in TASSEL software which identified significant marker-trait associations in graphical Manhattan plots. The analysis revealed twelve significant SNP sites by both General Linear Model (GLM) and Mixed Linear Model (MLM). From the twelve SNP sites, three marker sites were found significantly associated with three yield QTLs *viz.,* qGY6-1, qGY6 and qGY10 on chromosomes 6 and 10. Genomic summary of SNPs shows the highest contribution of nucleotide Guanine 28.45% in the whole genome of the populations. The identified markers can be used to pyramid multiple desirable traits, leading to the development of elite rice varieties with improved performance and adaptability.

Urban Farming in the Farm-to-Fork Era: A Sustainable Solution for Food Security in Megacities

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By 2050, India's urban population is projected to surge, with a staggering 55% of the country's total population expected to reside in cities. Urban farming is a crucial response to the challenges posed by rapid urbanization, population growth, and the fragmentation of agricultural land. It provides sustainable solutions to food security and environmental sustainability by utilizing underused urban spaces such as rooftops, vacant lots, and public areas to grow fresh produce. This practice not only enhances access to high yield – high quality nutrient dense food, reduces reliance on industrial agriculture, minimize carbon footprint and fosters community engagement but also offers economic benefits by generating income, creating jobs, and stimulating local economies. Furthermore, urban farming promotes environmental sustainability through resource conservation, including water and energy efficiency. However, challenges such as economic viability, limited arable land, insufficient investment, restrictive policies, and comprehensive knowledge hinder its growth. To bridge these gaps, strategies like implementing IoT based Smart Agrotech Systems, offering education and training, fostering community networks, and supporting policy reforms are essential. Technological innovations, such as automated irrigation systems, climate control, and vertical farming, can enhance productivity and reduce labour costs. By securing the necessary resources, including funding, infrastructure, and technology, urban farming can thrive, contributing to a more resilient, sustainable, and self-sufficient urban food system. With the right support, urban farming can play a pivotal role in ensuring food and nutritional security for growing urban populations while promoting environmental stewardship.

Keywords: Carbon Footprint Reduction, Environmental Sustainability, Food Security, Urban Farming, Vertical Farming

Government policies for sustainable agriculture in India

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The goal of sustainable agriculture is to meet society's food and textile needs in the present without compromising the ability of future generations to meet their own needs. Practitioners of sustainable agriculture seek to integrate three main objectives into their work, a healthy environment, economic profitability, and social and economic equity. Every person involved in the food system—growers, food processors, distributors, retailers, consumers, and waste managers can play a role in ensuring a sustainable agricultural system. There are many practices commonly used by people working in sustainable agriculture and sustainable food systems. Growers may use methods to promote soil health, minimize water use, and lower pollution levels on the farm. Making agriculture more productive, sustainable, and remunerative and climate resilient by promoting location specific integrated farming systems; soil and moisture conservation measures, comprehensive soil health management, efficient water management practices and mainstreaming rainfed technologies. The Central and state governments have initiated several measures to promote sustainable agricultural development. Pradhan Mantri Krishi Sinchayee Yojana aims to provide irrigation facilities and promote efficient water usage in agriculture, leading to higher crop productivity and Paramparagat Krishi Vikas Yojana encourages organic farming practices and sustainable agriculture, minimizing the use of chemicals and promoting soil health. The Indian government's policies and initiatives in sustainable agriculture are designed to enhance farmers' income, ensure food security, and promote eco-friendly farming practices. These efforts aim to achieve long-term agricultural sustainability while improving the livelihoods of farmers across the country.

Keywords: Sustainable agriculture, Organic farming, Integrated farming system

Government Policies and Planning for Sustainable Development of Agriculture: A Case Study of Chhattisgarh and India

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Agriculture plays a vital role in the Indian economy, providing livelihood to a significant portion of the population. However, challenges such as soil degradation, climate change, water scarcity, and economic instability have led to the need for sustainable agricultural practices. This paper examines the government policies and planning frameworks aimed at promoting sustainable agricultural development in India, with a focus on Chhattisgarh, an agriculturally rich state in central India. It reviews key national policies such as the National Mission for Sustainable Agriculture (NMSA), Pradhan Mantri Fasal Bima Yojana (PMFBY), and state-specific initiatives like Chhattisgarh's Agricultural Policy and water conservation programs. The paper assesses the effectiveness of these policies in fostering climate resilience, enhancing productivity, and improving farmers' welfare. It also identifies gaps in policy implementation, including limited financial support, infrastructure challenges, and lack of farmer awareness. Based on these findings, the paper proposes strategies for improving the effectiveness of agricultural policies, including increased financial incentives, technological innovation, and stronger public-private partnerships. The study highlights the need for integrated and adaptive policy frameworks to ensure the long-term sustainability of agriculture in India.

Keywords:
Sustainable Agriculture, Government Policies, Chhattisgarh, Agricultural Development, National Mission for Sustainable Agriculture, Climate Resilience, Farmer Welfare, Policy Implementation, Water Conservation, Rural Development

Harnessing Omics Technologies for Horticultural Crop Improvement

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The advent of omics technologies has revolutionized horticultural crop improvement by providing comprehensive insights into the genetic, molecular and biochemical underpinnings of plant growth, development and stress responses. Genomics, transcriptomics, proteomics, metabolomics and phenomics collectively enable the identification of key genes, pathways and regulatory networks associated with desirable traits such as higher yield, enhanced nutritional quality, disease resistance and abiotic stress tolerance. High-throughput sequencing and genome-wide association studies (GWAS) have facilitated the discovery of genetic markers and quantitative trait loci (QTLs), accelerating marker-assisted breeding and genome editing initiatives. Transcriptomics elucidates gene expression dynamics under specific environmental or developmental conditions, while proteomics and metabolomics provide insights into protein functions and metabolic pathways essential for trait expression. Advances in phenomics, driven by imaging technologies and machine learning, enable precise phenotypic characterization, bridging the gap between genotype and phenotype. Integrating multi-omics data through bioinformatics and systems biology approaches allows for holistic crop improvement strategies. This paper highlights omics technologies applications, challenges and prospects in horticultural crop improvement, emphasizing their potential to meet the growing demands for sustainable and resilient horticultural production systems.

Agritourism: A Catalyst for Rural Prosperity

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Innovative ways that combine tourism and agriculture, such as horti-tourism and agri-tourism, give tourists immersive experiences while boosting the local economy in rural areas. By maintaining traditional farming methods, encouraging environmental preservation, and creating alternate revenue streams for farmers, these industries support sustainable rural development. With an emphasis on decorative horticulture, therapeutic plants, and environmentally friendly landscaping, horti-tourism focuses on garden-based attractions including botanical gardens, flower festivals, and greenhouse tours. Through direct consumer interaction with farming, both sectors raise public knowledge of local food production and sustainable agriculture. These tourist methods support cultural preservation, employment in rural areas, and biodiversity conservation. By encouraging sustainable land use and reducing environmental damage, they also aid ecotourism. Through virtual farm tours and direct reservations, farmers may now reach a larger audience thanks to developments in digital marketing and internet platforms. To guarantee long-term sustainability, however, issues including seasonal variations in demand, infrastructure constraints, and the effects of climate change must be resolved. To overcome these obstacles and increase the sector's resilience, farmers, tourism organizations, and local communities must fortify their partnerships. To sum up, horti-tourism and agritourism are essential to the environmental sustainability and economic diversification of rural areas. They promote sustainable development and cultivate an appreciation for farming customs by fusing agriculture with experiential tourism.

Keywords: Agri-Tourism, Eco-Tourism, Farm-to-Table Experiences, Horti-Tourism, Sustainable Rural Developme

Effect of Edible Coatings Chitosan and Calcium Gluconate on Sugars and Ascorbic Acid Content of Mango (Mangifera indica)

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ICANTFA/195

An experiment was conducted to study the effect of edible coatings chitosan and calcium gluconate on ascorbic acid and sugars of mango (*Mangifera indica*) at College of Horticulture- Rajendranagar, SKLTSHU, Siddipet district, Telangana. The experiment was conducted in a Completely Randomized Design with six treatments, and three replications which includes T_1 - Dipping in 1% edible chitosan coating, T_2 - Dipping in 2% edible chitosan coating, T_3 - Dipping in 2% calcium gluconate, T_4 - Dipping in 1% edible chitosan coating + 2% calcium gluconate, T_5 - Dipping in 2% edible chitosan coating + 2% calcium gluconate, T_6 – Control and observations were recorded at every three days interval up to end of shelf life. Among different treatments highest total sugars (11.95 %) were recorded by T_2 - dipping in 2% edible chitosan coating, followed by T_1 - dipping in 1% edible chitosan with highest ascorbic acid content (31.22 mg 100g-1) and T_6 – control (untreated fruits) recorded the rapid changes *i.e.*, increase and decrease in sugars and ascorbic acid as it ripens fast. Post-harvest coating of mango fruits with chitosan has resulted in increased sugars and ascorbic acid content compared to calcium gluconate and control.

Keywords: Mango, edible coating, chitosan, calcium gluconate.

Impact of Domestic Processing on underutilized Nutrient-rich soybean

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Soybean (Glycine max (L.) Merrill) is one of the most multipurpose legume crops in the world. It contains 36 per cent protein which provides all the essential amino acids needed for human health. Its seeds 30 percent carbohydrates and appreciable amounts of dietary fibre, vitamins and minerals. Soybean has lecithin, which is helpful for brain development. It is also rich in unsaturated fatty acids, low in saturated fatty acids and a source of omega-3- fatty acids. The mineral fraction of soybeans contains several types of minerals, the most important of which are potassium, phosphorus, magnesium, calcium, and iron which perform essential functions in the body. Besides the diverse essential nutritional constituents like minerals, vitamins, micronutrients, etc., soybean seed also contain a considerable amount of anti-nutritional constituents. The removal of anti-nutritional compounds from the soybean is a mandatory requirement prior to its consumption otherwise it creates serious health hazards. Different type of processing treatments has been given to the soybean at household level from ancient times to make them suitable for human consumption. Different processing treatments include soaking, heating, roasting, fermentation, germination, cooking, etc. which are used for value additions and to enhance bioavailability and reduction of antinutritional factors. The result revealed that soaking treatment significantly ($p \leq 0.05$) increased the antioxidant activity of soaked flour than control flour. Phytic acid content of control flour had significantly ($p \leq 0.05$) higher than that of soaked soybean flour. There was a significant ($P \leq 0.05$) increase in mineral contents after processing treatments of soybean. Therefore, the processing treatments were quite effective in increasing the nutritional value as well as the bioactive components and decreasing the antinutritional components.

Key words: Soybean, Anti-nutritional factor, Soyabean processing and Anti-oxidant activity

Impact of Organic Farming on Human Health

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This review summarises existing evidence on the impact of organic food on human health. It compares organic vs Conventional food production with respect to parameters important to human health and discusses the potential impact of organic management practices with an emphasis on EU conditions. In the last decade, the production of organic cultivation and organic food has increased steadily in the world, despite the lower production of organic food. Organic food has lower pesticide residues; consumption may Reduce the risk of allergic disease and of overweight and obesity, reducing the risk of chronic illness, and hormonal imbalances, but the evidence is not conclusive due to likely Residual confounding, as consumers of organic food tend to have healthier lifestyles. Organic food consumption may reduce the risk of allergic diseases and obesity, but organic cultivation doesn't involve any practice of conventional food production. In organic agriculture, the use of pesticides is restricted, while residues in Conventional fruits and vegetables constitute the main source of human pesticide exposures. Epidemiological Studies have reported adverse effects of certain pesticides on children's cognitive development at current levels of Exposure, but these data have so far not been applied in formal risk assessments of individual pesticides.Differences in the composition between organic and conventional crops are limited, such as a modestly higher Content of phenolic compounds in organic fruit and vegetables, and likely also a lower content of cadmium in Organic cereal crops. On the behalf of greater concern is the prevalent use of antibiotics in conventional animal production as a key driver of antibiotic Resistance in society; antibiotic use is less intensive in organic production.Overall, this review emphasises several Documented and likely human health benefits associated with organic food production, and application of such Production methods is likely to be beneficial within conventional agriculture, e.g., in integrated pest management.

Keywords: Agricultural crops, Food safety, Nutrients, Organic food, Pesticide residues

Improved Statistical Measures for Varietal Selection in Multi-Environmental Experiments

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An important step in a crop improvement program is to assess the performance of improved varieties in multi-environmental (multi-location, multi-year, or both) trials for identifying promising varieties (genotypes) for large-scale propagation. If possible, the breeder would like to have genotypes, which show high performance for yield and other agronomic traits over as a wide range of environmental conditions as possible. However, in actual practice, the genotypes perform differently in different environments. Leading to the alteration of their rankings in these environments. This causes difficulty in the identification of superior varieties. In order to overcome this difficulty an attempt is usually made by the plant breeder to reduce the GE interaction, i.e. dependence of the genotypic ranking on environmental conditions through special breeding techniques like resistance breeding. Since only a minor part of the GE interaction can be attributed to controllable environmental determinants, much reduction in the interaction cannot be achieved. The most practical alternative then would be to attempt to produce progressively better adapted populations to the existing or specific subsets of environments. For the final choice of varieties for general/specific adaptation, apart from the mean performance the stability characteristics of the trial genotypes have to be given due consideration. Moreover, their definitions are many and varied even within the confines of GE interaction. For a proper application of the stability analysis and its interpretation it is essential that these concepts and definitions are understood clearly. Keeping this in view we now turn to the elucidation and measurement of these parameters. It is observed that till date the cultivars are judged mostly on the basis of high yield and the stability of performance of the cultivars has not been given due consideration while judging the genotypes real merit. This can be done with no additional cost involvement. The importance of going for such simultaneous selection for yield and stability is explained in Articles.

Keywords: Multi-Environmental Trials, Stability, G × E interaction, biological parameters, agronomic performance, non-parametric stability methods, Combined Stability Index.

Sowing Date Variability and Its Influence on Growth, Yield, and Water Use Efficiency of Cowpea in New Alluvial Zones 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 cowpeas 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. 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 D_3, which declined by 7% at D_2. The lowest LAI (2.50) was recorded at D_1. Among the variety, the highest LAI (3.3) was produced by Bidhan Barbati 1, which was 30% lower under Bidhan Sadabahar, irrespective of the variety, the highest (381.5 mm) and lowest seasonal evapotranspiration (SET) (226.7 mm) value was recorded respectively under D_2 and D_3. The variety achieves 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.

Enhancing Sustainable Agriculture by Synergistic Effects of Antifungal Metabolites and Growth-Promoting Rhizobacteria in Maize

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ICANTFA/200

Among 204 isolates obtained from maize rhizospheric soils, 57 demonstrated significant efficacy in suppressing the mycelial growth of *Fusarium verticillioides*. Dual culture assays identified isolates MRB5 and MRF8 as the most effective, achieving inhibition rates of 45.7% and 41.3%, respectively. The antifungal activity of these isolates was attributed to the production of both diffusible and volatile metabolites. Screening revealed that all isolates were capable of ammonia production, with 12 also producing hydrogen cyanide (HCN). Furthermore, the isolates exhibited plant growth-promoting attributes, including the ability to solubilize phosphorus (P) and zinc (Zn), and to synthesize indole-3-acetic acid (IAA), gibberellic acid, proteins, exopolysaccharides, and siderophores. These properties collectively enhance nutrient availability, root development, and stress tolerance, thereby contributing to improved plant health. Based on their potent antagonistic characteristics, four isolates—MRB5, MRF8, MRP4, and MRL3—were selected for greenhouse trials to assess their efficacy in managing seed rot and seedling blight in the maize variety PMH14. The results demonstrated a substantial improvement in seedling emergence rates, with MRB5 and MRF8 achieving 80% emergence, compared to 60% in the untreated control. This study underscores the potential of these rhizobacteria as promising biocontrol agents, effectively managing fungal pathogens while promoting plant growth, thereby advancing sustainable agricultural practices.

Keywords: Rhizobacteria, Biocontrol agents, maize rhizospheric soil, sustainable agriculture

A Review on Possibilities of Intercropping with Oil Palm Plantation in Tripura under NMEO-OP Scheme

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ICANTFA/201

Oil palm (*Elaeis guineensis*) is identified as the world's leading edible oil-producing plant and well established as a perennial plantation crop in tropical countries, originally from Malaysia and Indonesia. oil palm is typically planted in a triangular or hexagonal pattern with a spacing of 9 m x 9 m x 9 m, resulting in row spacing of approximately 7.5 m. The economic life span of the plant is around 30-35 years and stand per hectare is around 143-150 plants. During the initial three years after planting, while the palms are still in their prebearing stage, there are ample amount of free space available inside young plantations, farmers can grow locally suited crops in the interspaces. Therefore, following suitable intercropping systems plays a crucial role for implement a sustainable and successful agricultural future. if crop choices or timing differences in crop life cycles are not managed correctly, then two crops can compete with each other for water, nutrient and other resources with negative yield results. For instance, okra, Turmeric, Ginger, Chilli has been recommended as a most profitable intercrop during the initial phase of oil palm. The practice of intercropping, especially with leguminous crops, can improve soil fertility by fixing nitrogen, which is vital for the growth of oil palms and other crops. This reduces dependency on chemical fertilizers and promotes organic farming practices. The Tripura government has set a target of bringing 7000 hectares of land under palm oil cultivation by 2026-27 financial year. The Central government had increased import duty on oil palm, thus doubling farmers' income accepted in Tripura. It is also enlightening the farmers about the right time to harvest the crop and select suitable intercrop. Adopting oil palm plantation with intercropping systems can significantly enhance agriculture in Tripura. It offers a sustainable approach that improves soil fertility, increases farmer income should lead to overall rural development and economic growth in Tripura. The state could become a leader in diversified, sustainable farming practices, setting an example for other regions with similar agricultural challenges.

Development of paddy straw-based bio-composite packaging material for food

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This study focused on developing bio-composite rigid packaging from agricultural residues as a sustainable alternative to conventional plastic packaging used for fresh produce. Growing environmental concerns regarding non-biodegradable materials such as PET, LDPE, and PP have spurred interest in biodegradable polymers sourced from agricultural waste. Paddy straw, an abundant agricultural byproduct, was chosen for its potential, and its properties were improved through alkaline pulping before being incorporated into a biopolymer matrix. The alkaline treatment process parameters—alkali concentration, temperature, and time—were optimized using Response Surface Methodology (RSM), with evaluations based on pulp yield, pH, ash content, lignin content, tensile strength, and browning index. The optimized alkaline treatment (14% alkali concentration, 53°C, 240 minutes) enhanced lignin and hemicellulose removal and modified the cellulose structure, making paddy straw more compatible with bio-polymer integration. A 30% PSP concentration was identified as optimal for the bio-composites. Mushrooms stored in PSP-PVA, PSP-PLA, and PSP-PBAT packages maintained better quality for 6, 8, and 8 days, respectively, outperforming PVC (4 days) and EVOH (6 days). However, PSP-PVA packages absorbed more moisture and degraded faster than PSP-PLA and PSP-PBAT during storage. In summary, PSP-PBAT and PSP-PLA bio-composite rigid packaging show promise as eco-friendly alternatives to PVC/EVOH for packaging fresh produce like white button mushrooms.

Study the Cultural, Morphological characteristics, and Pathogenic variability of *C. truncatum* isolates causing Anthracnose of chilli.

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Chilli (Capsicum frutescens) is a globally significant crop, extensively cultivated for its dual roles as both a culinary staple and a valuable medicinal resource. Rice based cropping system is the tradition of the Konkan region. The humid climate favors the incidence of various diseases like powdery mildew, anthracnose as well as fruit rot. The present investigation revealed that in the roving survey conducted in four districts of Konkan region. The collected isolates were serially numbered as CC1-CC10. The colonies of all the 10 isolates under study, exhibited mostly cottony or fluffy mycelium with distinctly regular margins. The observations on morphological features of the selected 10 isolates of C. truncatum divulged that the mycelium was septate, conidiophores short and unbranched. On average, conidia measured 24.83 µm X 4.40 µm to 12.22 µm X 156 µm (l X b). The acervuli were round to elliptical in shape and recorded a diameter range of 122.21µm to 192.09 µm. The average length of setae was within a range of 16-52 µm. The isolate CC6 (Roha) was the most virulent as it infected all the test plants recording 100 per cent disease incidence within 8 days of inoculation.
Keywords- C. truncatum, mycelium, conidia, acervuli, etc.

Precision Agriculture and Smart Farming: The Future of Agriculture and Environmental Sustainability

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Precision Agriculture employs technology to measure and analyze variations in field conditions, helping farmers make more accurate decisions about crop management. Smart farming extends this concept by incorporating advanced technologies like the Internet of Things (IoT), Artificial Intelligence (AI), Drones, Robotics for intelligent farming practices. These advancements not only increase productivity and profitability but also promote environmental sustainability and enhance decision making processes. Despite this immense potential, the adoption of these technologies presents numerous challenges, including technological barriers, high implementations costs and data privacy concerns. Future prospects for these technologies promise further advancement, Recent trends in agriculture with the potential to significantly influence global food security. The development and adoption of these technologies, necessitate careful consideration of ethical issues and supportive policy frameworks. To fully realize the potential of precision agriculture and smart farming, it is essential to address these challenges. These includes formulation of policies promoting necessary infrastructure, such as reliable internet access in rural areas, education and training programs for farmers. Strict ethical standards must be enforced to safeguard farmers data privacy and ensure cybersecurity with appropriate measures. Precision agriculture and smart farming can play a significant role in revolutionizing agriculture, boosting global food security and promoting sustainable agricultural practices in the face of ever-increasing global population.

Keywords: Artificial Intelligence, Decision Making, Drone Technology, Global Food Security, IoT, Precision Agriculture, Smart Farming, Sustainable Agriculture

Brief Explanation of Soil Health and Nutrient Management

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Soil health is fundamental to sustainable agriculture, influencing crop yields and environmental quality. A thriving soil ecosystem, teeming with diverse microorganisms, plays a crucial role in nutrient cycling, disease suppression, and overall soil fertility. Advancements in plant genetics and biotechnology offer innovative solutions for improving nutrient uptake efficiency and stress tolerance in crops, reducing reliance on synthetic fertilizers. Precision nutrient management, utilizing technologies like GPS and sensors, allows for site-specific fertilizer applications, optimizing nutrient use efficiency and minimizing environmental impacts. Effective soil conservation practices, such as cover cropping and contour farming, are essential for preventing erosion and maintaining soil structure. Addressing soil contamination with pollutants like heavy metals and pesticides is crucial. Remediation strategies, including chemical, physical, and biological approaches, are necessary to mitigate their detrimental effects on soil health and the environment. Preventing the transfer of soil pollutants into the food chain is paramount for human and environmental health. By integrating these multifaceted approaches, we can enhance soil health, optimize nutrient management, and promote sustainable agricultural practices for a healthier planet and a more secure food supply.

Keywords: Food safety, Microbiome, Nutrient management, Pollution remediation, Precision agriculture, Soil conservation, Soil health, Sustainable agriculture.

Effect of light emitting diodes (LEDs) in morphological growth in microgreens

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ICANTFA/206

Microgreens or vegetable greens are just germinated plants harvested cotyledon leaf stage/ one set leaves stage/ and are important as a nutrition supplement. The photoreceptors and cryptochrome of distinct light wavelength spectrum exhibit morphogenesis and metabolic activity in the growing microgreen plant. The photoreceptor phytochrome absorbs 600-750 nm (red, far-red light), 530-700 nm (green); cryptochrome, phototropins, zeitlupe family protein absorbs 530-700 nm green, 390-500 nm blue, 320-390 nm UV-A, UVR8- ultraviolet resistance locus 8 absorbs 290-315 nm UV-B and regulates plant morphogenesis and physiological activities in the growing microgreen plant. The phototropin regulates leaf uniform, phototropism, stomata opening & closing and chloroplast relocation. The zeitlupe family protein regulates regular metabolism and flower activity in the growing plant. The photoreceptor ultraviolet resistance locus 8 (UVR8) regulates etiolation inhibition, flavonoid synthesis in the growing microgreen plant with controlled climatic factors in the closed system. The microbial emergence in growing media, cold water treatment, regrowth improvement after first stage harvesting, storage system and shelf life are required to screen in the microgreen plant under closed and open system. The details of physiological, genetic and molecular pathways of specific light spectrum on phenotypic characters and yield of crop plants need further investigations under closed system.

Keywords: light emitting diode, morphology, photoreceptors, cryptochrome, microgreens

Revolutionizing Agriculture: The Power of Smart Farming

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With a projected 10 billion people on the planet by 2050, sustainable development will face many obstacles, especially in maintaining food security in the face of diminishing agricultural land and a shrinking rural labour force brought on by urban migration and land conversion for residential and industrial uses. On the other hand, cutting-edge technologies like automation, mobile internet, the Internet of Things, and artificial intelligence (AI) are starting to emerge as game-changing remedies. Precision farming is made possible by the Internet of Things (IoT), a key component of smart agriculture that allows for real-time monitoring and data-driven decision-making. By combining sensors, automation, and machine learning algorithms, agricultural efficiency is increased overall, crop yields are increased, and resource utilisation is optimised. Precision pest control, irrigation management, weed detection, planting, harvesting, and other vital tasks are made easier by technologies like automated machinery, agricultural robots, and unmanned aerial vehicles (UAVs). AI-driven predictive models allow for preventive responses by anticipating hazards like pest outbreaks and weather variations. Furthermore, accurate resource allocation is made possible by IoT and wireless communication technologies, which maximise productivity while minimising waste. With exceptional accuracy, drones and sensors track crop health, environmental conditions, and soil health, while satellite remote sensing provide high-resolution imagery to aid in decision-making, even on tiny farms. A paradigm shift in agriculture is represented by these developments taken together, which provide resilient, efficient, and sustainable farming methods to meet the world's expanding food need while preserving the environment.

Keywords: Sustainable agriculture, IoT, sensors, automation, drones, artificial intelligence, crop monitoring, resource optimization.

Impact of Organic Fertigation on Soil Organic Carbon and Biochemical Parameter of Common Beans

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ICANTFA/208

The increasing demand for sustainable agricultural practices has led to the exploration of organic fertigation as a means of enhancing soil fertility. This study investigates the impact of organic fertigation on soil organic carbon (SOC) and the biochemical parameters of common beans (Phaseolus vulgaris). Field trials were conducted during Rabi season of 2021-22. Using organic fertigation treatments, and various parameters such as SOC, and plant biochemical markers (chlorophyll content) were measured. The experiment was laid out in Randomized Block Design with five treatments and three replications. In this investigation, the results revealed that application of FYM + vermicompost + vermiwash + Drip irrigation (T4) significantly increased the plant height(26.9 cm after 60 days of sowing), number of leaves (19.8 after 60 days of sowing and number of branches (4.33 after 60 days of sowing) and the highest chlorophyll content was recorded in T1 (28.92µg/cm2) which was treated only vermicompost and the highest soil organic carbon (SOC) was recorded in T4. Results indicated a significant increase in soil organic carbon and improved biochemical parameters in beans treated with organic fertigation, compared to control plants. These findings suggest that organic fertigation could enhance soil health and bean productivity, promoting sustainable farming practices.

KEY WORDS: Organic Fertigation, Vermicompost, FYM, Vermiwash, Beans, growth, Chlorophyll, Soil Organic Carbon, Drip irrigation

Management Strategy for Weeds of Sesame in Coastal Ecosystem

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ICANTFA/209

Sesame (*Sesamum indicum* L.), the "Queen of oilseeds," has a long history in agriculture due to its high oil content and drought resilience. Its seeds are rich in essential oils and antioxidants, making it valuable for food and non-food industries like cosmetics and pharmaceuticals. India, a leading producer, is particularly dependent on sesame cultivation. Field trial was therefore conducted during the *pre-kharif* season (2024) at Agricultural Experimental Farm, Institute of Agricultural Science, University of Calcutta, Baruipur, West Bengal to evaluate the impact of weeds management strategy of sesame in coastal ecosystem. The experimental field was laid out in a Randomized Block Design (RBD) having ten treatments with three replications using the sesame variety, CUMS-17 (Suprava). Consisted treatments were Weedy check (T_1), @750 g a.i./ha as PE *fb* Propaquizafop ethyl 10% EC @ 100 g a.i./ha at 20 DAS as PoE (T_6), Metolachlor 50% EC @ 750 g a.i./ha as PE *fb* Quizalopfop ethyl EC @ 50 g a.i./ha at 20 DAS as PoE (T_7), Metolachlor 50% EC @750 g a.i./ha as PE *fb* Propaquizafop ethyl 10% EC @ 100 g a.i./ha at 20 DAS as PoE (T_8), Quizalopfop ethyl 10% EC @ 50 g a.i./ha at 20 DAS as PoE (T_9), Propaquizafop ethyl 10% EC @ 100 g a.i./ha at 20 DAS as PoE (T_{10}). Therefore, sesame cultivation should be adopted with Pendimethalin 30% EC 750 g a.i./ha as a pre-emergence herbicide (PE*) followed by* Propaquizafop ethyl 10% EC @ 100 g a.i./ha as a post-emergence herbicide (PoE) at 20 DAS in coastal ecosystem.

Keywords: Ecosystem, management, sesame, herbicide, effects.

Seed yield of green gram in response to GA_3 foliar application

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To find out the effect of foliar application GA_3 on seed yield and quality of Green gram an experiment was conducted with the Phule Chetak variety of Green Gram. This variety was sown in field in Mecheda, Purba Medinipur, West Bengal following Randomized Block Design (RBD). Foliar application with 25, 50, 75, 100, 125, 150 and 200ppm GA_3 were performed at 30 and 45 DAS to investigate the treatment influences. Ten plants in each subplot were marked randomly at the initial stage of crop growth & were harvested finally for making observations on average plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod, seed yield per square meter & test weight. Treatment influences were found to be significant in most of the cases. Best treatment influence in increasing the plant height, primary branches per plant, pods per plant & seeds per pod were noted with the spraying of GA_3 150ppm. Among the other field parameters best result with GA_3 200ppm (which was also at par with GA_3 150ppm) can be observed in case of yield per square meter & test weight of the harvested seeds. Results indicate that foliar application of plant growth regulator has beneficial effects in terms of increasing the quality & productivity of Green gram. In conclusion it can stated that foliar spraying with GA_3 with 150ppm and 200ppm at 30 DAS and 45 DAS can be recommended to the farming community for better seed productivity as notable improvement can be identified over untreated control group.

Mechanization of Selroti Processing: Preserving Tradition through Modern Technology

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Selroti, a traditional rice-based fermented bread from the Sikkimese Nepalese population, is firmly ingrained in the region's cultural and culinary traditions. Selroti is traditionally prepared by hand, which requires a labour-intensive procedure of batter preparation, fermentation, and deep frying. While conventional methods maintain authenticity, they are time-consuming and can limit manufacturing capacity. Mechanization of Selroti processing addresses these issues by giving a more efficient approach to create the delicacy without sacrificing quality. Automated methods for combining rice flour, water, and other materials to make a uniform batter are part of the process' automation. In order to ensure consistent cooking and better product quality, robotic fryers maintain a constant temperature, while controlled pouring of batter through nozzles mounted on robotic arm may be utilized to shape the batter into uniform rings. Preserving its distinctive traditional texture, flavour, and sensory qualities is one of the primary goals. To reproduce these characteristics, the automated procedure has to be precisely calibrated. Furthermore, striking a balance between the product's originality and production size is still crucial. While guaranteeing the preservation of the rich cultural legacy of the Sikkimese population, automation may boost Selroti production, increase its availability, and reach new markets by fusing contemporary technology with traditional methods.

Keywords: Selroti, Automation, Traditional Food, Sikkimese Nepalese Community

Medicinal uses and value-added products of Apple ber

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Apple Ber (*Ziziphus mauritiana* Lamk.) belonging to the family “Rhamnaceae”. It is considered as an underutilised crop. Ber fruit is normally eaten fresh highly nutritious, rich in ascorbic acid, carbohydrates and contain fairly good amount of vitamin A and B complex, minerals like calcium, phosphorus and iron. Predominant phenolics found in Ber relates to its major antioxidant activity, reducing power activity and scavenging of free radical activity. The fruit pulp has high sugar content (sucrose, glucose fructose and starch); it is, therefore, high in carbohydrates, which provide energy. Therefore, Apple ber fruit can be used in the treatment of liver diseases according to their function and also used in cancer treatment. Fruit has great medicinal value, considered to purify blood and aid digestion. Apple ber fruit is mainly eaten fresh and in a dehydrated form. The fruits are greatly seasonal and available in plenty at particular times of the year. During peak season, the price decreases and their surplus amount in the market may result in the spoilage of large quantities, to avoid this spoilage; the fruits can be processed into various products like Apple ber fruit powder, murabba, preserve, candy, jelly, jams beverages, wine, pickle etc. These value-added products contribute significantly to the therapeutic as well as nutritive value.

Keywords: Apple ber, nutritive value, antioxidant activity and preserve.

Status and Distribution of Phosphorous in the Acid Soils of Chandel District, Manipur

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An experiment entitled “Status and Distribution of Phosphorus in the Acid Soils of Chandel District, Manipur” was conducted at Collage of Agriculture, central Agricultural University, Imphal during Rabi season, 2022-23. Twenty soil samples were collected from different locations of Chandel district, Manipur for this experiment. All the investigated soil samples were acidic in nature with a mean value pH 5.40. The mean EC, OC,CEC, Bulk density, Available N kg ha-1 and Available K kg ha-1 were 0.18 dSm-1, 1.62 g kg-1, 19.05 [Cmol(p+)kg-1], 1.57 g cm-3, 321.02 kg ha-1 and 211.12 kg ha-1, respectively. Six extractants were tried viz. Bray P1, Bray P2, Mehlich P1, Mehlich P3, Troug and Olsen reagent to assess the available phosphorus(P) status of the soils. The extractable P in the soils was found to be following decreasing order : BrayP2> MehlichP1> Bray1> Troug> MehlichP3> Olsen. For thesoil studied the amount of Inorganic P fractions was in the order: Reductant Fe P> Red P> Al P> Occl. P> CaP.Among the extractants used, Bray P2 reagent extracted more phosphorus than the other reagents. All the extractants were significantly correlated with the physico-chemical properties of soils with varying degree,however, the sand content of the soils was negatively correlated with all the extractants. The pot experiment was also conducted during during Rabi season, 2022-23. Lentil (Lens culinaris). Hul-57 was sown as the test crop in the earthen pots. The treatments consisted of 0, 40 and 60 kg P2O5 with three replication. According to graphical procedure of Cate and Nelson (1965), the critical level of extractable phosphorus of soil were 20 ppm for Bray P1,16.1 ppm BrayP2 and 17.5 ppm Mehlich P1 phosphorus depending upon the method of phosphorus extraction. For estimating the critical

limit of phosphorus in the 40 days lentil plant the data was subjected to Cate and Nelson (1965). From the graphical approach the critical limit of lentil plant was found 0.28 per cent phosphorus. Keywords: Soil properties, P fractions, critical limit, uptake.

Microbial and Sensory Evaluation of Foam Mat Dried Apricot and Plum Powder for Food Application

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This study evaluates the microbial stability and sensory characteristics of apricot and plum powders produced via foam mat drying, aimed at determining their suitability for use in functional food applications. The fruits were processed by foaming and drying under controlled conditions to optimize quality. Microbial analysis was conducted to assess the safety and shelf life of the powders, focusing on total plate count, yeast, and mould growth, while sensory evaluation was carried out to evaluate colour, aroma, texture, and taste attributes. The results showed that foam mat drying preserved the microbial safety of both apricot and plum powders, with no significant microbial growth observed during storage under standard conditions. Sensory evaluation revealed that both powders retained desirable characteristics, with apricot powder showing a slightly higher preference for flavour and texture, while plum powder offered a unique tartness and pleasant aroma. Overall, the study confirms that foam mat drying is an effective method to produce apricot and plum powders with good microbial stability and appealing sensory attributes, suitable for incorporation into a variety of food products.

Key Words: Foam mat drying, functional food, tartness, shelf life, microbial stability

Minimum Support Price (MSP) in India: Challenges and Reforms

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The Minimum Support Price (MSP) is a government-mandated price floor for certain agricultural products. It aims safeguard farmers from sharp price decline, particularly during larger harvest when market price might fall down below its production costs. The MSP is announced before the sowing season for specific crops, that provides farmers guaranteed income for their produce. However, MSP have suffered criticism for its negative effects as well. Some of the negative effects such as trade and market distortion, overproduction of certain crops (example: Paddy, Wheat, Pulses etc), burden over government for subsidy etc. Additionally, MSP is not necessarily benefited to the farmers as it does notreach to the farmers, resulting in failure of selling their crops. Now, The Agriculture Produce Market Committee (APMC) Act, enacted in 1960s plays very important role in the agricultural marketing system of India. Basically, APMCs has contributed to the development of agri-markets. Even though APMC is not a standalone solution but can be partial solution to the challenges associated with MSP. The APMC reforms such as allowing farmers to sell outside and promoting private sector participation resulting in increased competition in agri-market, improved price for farmers etc. Additionally, APMCs serve as the medium by disseminate market information to farmers, helping them to make decision about when and where to sell. Overall APMCs cannot be a panacea, but a part of solution for MSP related issue. Other issues such as expanding procurement, expanding and improving market structure, reforming APMC regulation are also needed to be addressed to resolve the chaos and benefit farmers.

Keywords: MSP, APMC, Market distortion, Agri-markets, Policy reform

Mitigating Global Food and Nutritional Insecurity: Role of under-exploited fruits and vegetables

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Fruits and vegetables are essential for maintaining a balanced diet, providing important nutrients, vitamins, minerals, and antioxidants that support overall health. They help boost immunity, promote digestive health through fiber, and prevent chronic diseases such as heart disease, diabetes, and certain cancers. Including them in your diet aids weight management, offering low-calorie, filling foods. Health guidelines typically recommend at least 400g (about 5 servings) per day, with some suggesting 100g per meal. These foods also fill nutrient gaps, offering vitamins like Vitamin C and A that may be missing from other food groups, promoting a variety of essential nutrients. Traditional or indigenous crops, which have evolved through years of cultivation and natural selection, are also important. They can improve agrobiodiversity and the nutrition of impoverished populations. Underutilized indigenous fruit crops like ber, kair, aonla, and phalsa and vegetables like Spine gourd, Water spinach, Malabar spinach, Tree Tomato are rich in minerals, antioxidants, and phytonutrients compared to many commercial fruits. In India, these crops are conserved at ICAR-NBPGR and its centers, preserving 1,717 varieties, with 1,127 accessions maintained by research institutions. These efforts promote the use of these crops for sustainable agriculture. By 2050, global consumption of processed and animal-source foods must drop by over 50%, while plant-based food consumption should increase by over 100%. Neglected legumes, rich in protein, amino acids, and healthy fats, offer an affordable, sustainable alternative to meat, supporting healthier, plant-based diets

Keywords: - Antioxidants, Cultivation, Diabetes, Indigenous, ICAR-NBPGR,

Moringa: A Resilient Solution for Climate Mitigation and Carbon Reduction in Global Agriculture

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Moringa oleifera, often referred to as the "miracle tree," holds immense potential to address global agricultural, nutritional, and climate challenges. As the world faces the dual crises of climate change and a growing population, sustainable solutions for carbon reduction and resource efficiency are urgently needed. Moringa's rapid growth, resilience to harsh conditions, and low water requirements make it an ideal crop for climate-vulnerable regions, promoting sustainable land use while sequestering carbon and mitigating environmental degradation. Nutritionally, moringa is a powerhouse, rich in protein, vitamins, minerals, and essential amino acids, making it a vital tool for combating malnutrition and enhancing food security. Its leaves, seeds, and pods can fortify diets and improve immune health, particularly in developing nations where nutritional deficiencies are widespread. Beyond its nutritional value, moringa's seeds offer natural water purification properties, providing affordable solutions for clean drinking water, while its medicinal benefits support health initiatives. Crucially, moringa plays a significant role in climate mitigation. When integrated into agroforestry systems, it enhances soil quality, promotes biodiversity, and contributes to carbon sequestration, making it a key player in sustainable agricultural practices. By reducing the need for resource-intensive crops and improving soil health, moringa helps lower the carbon footprint of farming systems. To meet the demands of a growing population while addressing climate change, the adoption of resilient crops like moringa is essential. This presentation highlights moringa's multifaceted benefits, emphasizing its potential to strengthen global food systems, support economic growth, and contribute to a low-carbon, sustainable agricultural future. Moringa stands as a testament to nature's ability to provide innovative, adaptable solutions for combating climate change and fostering a healthier planet.

Keywords: Sustainable Agriculture, Agroforestry Systems, *Moringa oleifera*, Miracle Tree, Carbon Sequestration.

Infrared-Induced Structural and Biochemical Transformations in Kodo Millet: Enhancing Processing and Nutritional Quality

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Kodo millet, a drought-tolerant and nutrient-dense grain, is gaining attention as a potential staple food. However, its dehusking remains challenging due to the tightly bound husk and dense fibrous layers. This study investigates the impact of infrared (IR) treatment on the structural and chemical properties of Kodo millet, analyzed using Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and Fourier Transform Infrared Spectroscopy (FTIR). IR treatment significantly improved the dehusking efficiency to 72.08% and the head rice yield to 71.71%. SEM analysis revealed that IR treatment induced subtle disruptions in the cell structure of unhusked Kodo millet, increasing surface porosity and forming microvoids. These structural changes facilitated dehusking by creating cracks and increasing husk brittleness, leading to easier removal compared to untreated millet. XRD analysis indicated that IR treatment partially disrupted the crystalline regions of Kodo millet, shifting its structure toward a more amorphous form, as evidenced by broader peaks in the XRD pattern. This transformation suggests alterations in the internal crystallinity, which may influence the millet's functional properties. FTIR spectra further revealed significant chemical modifications in IR-treated millet, including increased intensities in hydroxyl (O-H), aliphatic hydrocarbon (C-H), and carbonyl (C=O) groups. These changes indicate a rise in phenolic and flavonoid content, potentially enhancing the millet's antioxidant capacity and bioavailability. Overall, the combined findings from SEM, XRD, and FTIR analyses demonstrate that IR treatment not only enhances the structural characteristics of Kodo millet, making it more suitable for milling, but also improves its nutritional profile by increasing bioactive compounds. These results highlight

the potential of IR treatment to optimize both the dehusking process and the nutritional value of Kodo millet, paving the way for its broader utilization in millet-based food products.

Keywords: DE husking efficiency, SEM, XRD, FTIR, microstructure changes

Design, development and optimization of seed metering roller for fenugreek seed

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The metering rollers of 9 cell, 61 mm diameter and 17 mm width were designed for fenugreek seed. Drawing was created in Pro-E software and rollers were printed using 3d printer. For fenugreek seed three roller of different cell size (4.5×2.25 mm, 5×2.5 mm and 5.5×2.75 mm were fabricated. The speed of sticky belt was set at three levels: 1.5, 2 and 2.5 km/h for fenugreek seed. The applied parameters for planting of fenugreek seed were optimized numerically usung response serface methodology (RSM) for the desirability having equal weightage and importance to both and dependent parameters. The combination of peripheral speed and cell size of seed metering roller with the highest desirability was selected. The optimized values of the cell size, and peripheral speed were 5.5 mm (R_3 roller) and 0.09 m/s, respectively. The overall desirability of dependent parameters was found to be 0.97. The models obtained for different independent parameters were found significant at 1% level of significance. Coefficient of determination (R^2) was ranged from 0.95 to 0.99.The predicted value of Peripheral speed ,missing index, Multiple index, Quality of feed index, degree of variation, cell fill percentage, seed spacing and seed rate was found to be 1.15 (%), 9.44 (%), 91.71(%), 14.50 (%), 93.23(%), 10.31 cm and 10.75 (kg/ha), respectively for fenugreek seed.

Agri-Business and Market Development

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ICANTFA/220

Agri-business advancements and changing market patterns are emerging which lead to the transformation of the agriculture sector. The focus of this paper is on factors such as agripreneurship, market orientation, agri-finance, and organic agriculture trends that enable growth and harmony in the sector. There are emerging agribusiness startups which aim at increasing economic activities in rural areas, creating jobs, and fostering innovation as a whole. Technology together with sustainability business strategies are being implemented by new agribusiness ventures. Alongside emphasizing productivity, profitability, market orientation with value chain development are also equally important for enhancing efficiency and value addition to agricultural products. To achieve better market competition, value chains need to be strengthened using technology in logistics and stakeholder collaboration. Agri-finance and investment options are becoming more popular as agricultural businesses become more appealing to financial institutions and venture capitalists. In regard to farmers' sustainability, there should be accessible credit insurance and literacy programs which can improve resilience. As for the products of organic and fair-trade agriculture, the consumer's willingness for purchasing environmentally friendly products drives these trends.

Keywords: Agri-business, Market development, Agripreneurship, Startup ecosystem, Market orientation, Value chain development, Agri-finance, Investment opportunities, Organic agriculture, Fair-trade agriculture, Sustainable practices, financial inclusion, Innovation in agriculture, Rural economic growth, Global competitiveness

Physico–Chemical Properties of Wild Jujube (*Ziziphus oenoplia*) Fruits as Influenced by Pre- and Post-Harvest Conditions

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The investigation entitled "Physico-Chemical Properties of Wild Jujube (*Ziziphus oenoplia* L.) Fruits as Influenced by Pre- and Post-Harvest Conditions" provides valuable insights into the nutritional quality and potential health benefits of Kanteikoli fruits, focusing on the effects of storage and the collection of fruits from different locations in Odisha. Study Period was 2020-2022. The experiment was conducted in PG Laboratory, Department of Horticulture, Siksha 'O' Anusandhan University, Bhubaneswar, Odisha. The study uses Randomized Block Design (RBD) with 9 treatments (T1-T9) and 6 replications and collection sites were Bhawanipatna, Kamthana, Bharatpur with three storage durations: Fresh (0 weeks), 1-week storage, 2-week storage. The fruits were analyzed for ascorbic acid, phenolic compounds, sugars, and other biochemical parameters. Bharatpur-sourced fruits exhibited higher levels of ascorbic acid & phenolic compounds, suggesting better antioxidant properties compared to samples from Bhawanipatna and Kamthana. Vitamin C content (ascorbic acid) declined with increased storage duration, consistent with known degradation during storage. Fresh fruits retained the highest nutritional values across all locations. The fruits have high antioxidant content and nutrient density highlight their role in promoting health and combating oxidative stress-related diseases. It evaluates the fruits' role in enhancing food security and

addressing malnutrition. Wild jujube fruits present promising avenue for nutritional enhancement and therapeutic applications. Continued research and development could unlock their full potential, contributing significantly to both public health and agricultural innovation.

KEYWORDS: Anti-microbial, Antioxidant, Nutritional, Therapeutic, Wild ber

Nutrition and Gut Health, Animal Science Research Priorities

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The intricate relationship between nutrition and gut health is a critical area of research in animal science, with profound implications for animal growth, disease resistance, and overall productivity. Optimal gut health is essential for nutrient absorption, immune function, and microbiome balance, directly influencing animal performance and welfare. Recent advancements highlight the role of probiotics, prebiotics, and precision nutrition in modulating gut microbiota to enhance feed efficiency and resilience to diseases. Research priorities in this field include understanding host-microbiome interactions, developing sustainable feed additives, and mitigating the impact of dietary changes on gut integrity. Emerging technologies such as metagenomics and metabolomics offer novel insights into microbiota composition and function, paving the way for targeted nutritional strategies. This article emphasizes the need for interdisciplinary approaches to address gut health challenges in livestock and companion animals, ensuring sustainable animal production and improved welfare outcomes.

Keywords: Metagenomics, Metabolomics, Sustainable, Welfare.

Optimizing Drying Methods for Enhanced Nutrient Retention in Broccoli & Cauliflower

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Cauliflower and broccoli are key cruciferous vegetables with a major impact on the Indian agricultural economy and nutritional security. Globally, India is the 2nd largest cauliflower producer and an emerging broccoli producer. Despite the production, India struggles to feed its entire population with such healthy treats, primarily due to post-harvest losses during handling and storage. A viable option to handle such losses includes drying. Dried broccoli and cauliflower are easy to handle and can be stored for a prolonged period in the expanse of some nutrient loss. Such treats can be rehydrated with warm water and savored in numerous delicacies. In this investigation, the blanching conditions for drying broccoli and cauliflower were optimized for increased shelf life with minimal loss i.e., higher retention of nutrients after rehydration. Hot water blanching treatments in varying temperatures (80-100°C) and durations (1-4 minutes) were evaluated for drying characteristics and post-rehydration biochemical attributes of broccoli and cauliflower. Blanching broccoli at 100°C for 3 minutes (Treatment T3) and cauliflower at 100°C for 4 minutes (Treatment T3) yielded the highest retention percentage, facilitating efficient drying with minimum nutrient loss. Whereas, in cauliflower the treatment T3 showed the highest biochemical constituent recovery in titratable acidity (89.29%), reducing (128.16%) & non-reducing sugars (383.33%), and ascorbic acid (80.28%). Furthermore, sensory analysis revealed superior colour, texture, flavour, and overall acceptability for the treatments blanched at 100°C for 3 minutes in broccoli and 4 minutes in cauliflower. Shorter blanching durations at lower temperatures resulted in suboptimal drying

and diminished quality. These findings provide valuable insights into optimizing blanching protocols for the drying broccoli and cauliflower.

Adaptive Strategies for Extreme Weather Events and Contingency Crop Planning in Pant Nagar, Uttarakhand, Under a Changing Climate

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This study explores the impact of extreme weather events and develops adaptive crop planning strategies for the Tarai region of Uttarakhand under a changing climate. Utilizing 41 years of daily weather data (1981–2021) from Pantnagar, the analysis focused on rainfall patterns, drought occurrence, heatwaves, cold waves, and probabilities of dry and wet weeks through a Markov chain model. Statistical analysis was conducted using Weather Cock software, with Mann-Kendall and Sen’s slope estimation applied R studio for trend detection. The findings revealed an average annual rainfall of 1552.31 mm distributed over 57 rainy days, with 85% of rainfall occurring during the monsoon season. August recorded the highest rainfall, with significant contributions from the 23rd to 39th Standard Meteorological Week. Drought occurrence probabilities were 71% for no drought and 29% for moderate drought, with no severe drought observed. Heavy rainfall events were concentrated in the monsoon, accounting for 92.89% of recorded occurrences. The study underscores the erratic nature of extreme weather events attributed to climate change, emphasizing the need for adaptive measures. A contingency crop plan was developed to minimize the impacts of droughts, extreme rainfall, and temperature anomalies, ensuring sustainable agricultural practices in the region.

Keywords: Extreme weather, crop planning, rainfall trends, climate adaptation, Pantnagar.

INNOVATION IN WHITE JUTE SEED PRODUCTION THROUGH PLANT GROWTH REGULATORS AND PINCHING APPROACHES

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Quality seed is the crucial feature to comprise identical field emergence with high seedling vigour liable for ideal cultivation. Hence, the upgrading of seed quality is the leading theme in crop advance through great exploitation of inherent ability of the cultivar. The seed production of Jute specifically *capsularis* type may be troubled due to irregular weather condition like rainfall, temperature etc. predominantly in aspect of seed quality. A field trial was steered on nine varied genotypes of White Jute (*C. capsularis*) viz.$\mathbf{V_1}$ (JRC-212), $\mathbf{V_2}$ **(**Monalisa) , $\mathbf{V_3}$ **(**JRC-532), $\mathbf{V_4}$ **(**JRC-321), $\mathbf{V_5}$ **(**JRC-698), $\mathbf{V_6}$ **(**JRC-517),$\mathbf{V_7}$ **(**CIN-27), $\mathbf{V_8}$ **(**CIN-21) and $\mathbf{V_9}$ **(**CIN-73) through foliar application of plant growth regulators under standard and detopping mode to revise the productivity and quality of seed in a higher way. Seven treatments like $\mathbf{T_1}$ (30 ppm NAA + detopping), $\mathbf{T_2}$ **(**100 ppm GA3 + detopping), $\mathbf{T_3}$ **(**200 ppm Paclobutrazol + detopping), $\mathbf{T_4}$ **(**30 ppm NAA), $\mathbf{T_5}$ **(**100 ppm GA3), $\mathbf{T_6}$ (200 ppm Paclobutrazol) and $\mathbf{T_7}$ (Control, without treatment) were employed to confirm the promising consequence on produced seed of Jute cultivars. The field trial followed split-split plot design with two replications under suggested agronomic practices listed for the jute crop. $\mathbf{V_5}$ **(**JRC-698) showed a prominence for most of the characters with an exemption in 1000 seed wt. where $\mathbf{V_1}$ and $\mathbf{V_2}$ were the greatest. The treatment, **T3** exposed uppermost significant impact on seed through positive sign in plant growth and yield attributing parameters with seed quality. The advanced performing was also observed in $\mathbf{T_1}$ treatment particularly in yield attributes with discrete lead in 1000 seed wt. accountable in cooperation of qualitative and quantitative aspects. **T3** followed by **T1** treatments can be used for seed production of white jute principally in participation of $\mathbf{V_5}$ genotype. The outcomes of existing observation may be considerable for upgrading the seed production of jute in new alluvial zone of West Bengal.

Keywords: White Jute, Plant growth regulators, Pinching, Seed production.

Optimizing planting time for enhanced seed yield and quality in African Marigold (*Tagetes erecta*) under the mid-hill region of Himachal Pradesh

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The rising demand for marigold seeds in India, driven by large-scale cultivation, necessitates the development of effective strategies to enhance seed yield and quality. This study aimed to optimize planting time for marigold seed production under mid-hill conditions in Himachal Pradesh. A field experiment was conducted using a randomized block design with three replications, evaluating two marigold cultivars, 'Pusa Narangi Gainda' (V_1) and 'Pusa Basanti Gainda' (V_2), across five planting dates at 15-day intervals; 10th July (D_1), 25th July (D_2), 10th August (D_3), 25th August (D_4), and 10th September (D_5). The results revealed that planting date had a significant impact on seed yield and quality parameters across both cultivars. Pusa Narangi Gainda' planted on 10th September maturing the earliest (115.16 daysNotably, the 10th July planting of 'Pusa Narangi Gainda' produced the highest number of seeds per head (244.07), followed closely by 'Pusa Basanti Gainda' (233.22) under the same planting schedule, demonstrating the influence of planting time on seed productivity. Among all treatments, the earliest planting (10th July) with 'Pusa Basanti Gainda' resulted in the highest seed yield and quality, achieving the maximum seed yield per head (0.64 g), 1000-seed weight (2.58 g), and seed yield per plant (19.92 g), making it the optimum planting time for commercial seed production. Additionally, regression analysis revealed a strong correlation between seed weight per head and 1000 seed weight, with seed yield per plant, with an R^2 values of 0.913, and 0.809, respectively, indicating their significance as predictors of seed yield. Overall, the study emphasizes the importance of optimizing planting time and selecting the appropriate cultivar to enhance marigold seed yield and quality. These findings provide valuable insights for farmers and seed producers, offering an effective approach to maximizing profitability in the mid-hill regions of Himachal Pradesh.

Key words: African Marigold, Planting Time, Seed yield, 1000 seed weight.

Screening of azotobacter, bacillus, and pseudomonas species for biofertilizer production

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The increasing need for sustainable farming methods has led researchers to search for beneficial bacteria that can replace chemical fertilizers. This study focused on three types of plant growth-promoting bacteria—Azotobacter, Bacillus, and Pseudomonas—to examine their ability to support plant growth. Soil samples were collected from the rhizospheres of wheat, maize, and rice crops at the SDMVMS College of Agricultural Biotechnology, Aurangabad. The bacteria were identified based on physical and biochemical characteristics. Azotobacter exhibited strong nitrogen-fixing ability, as confirmed by the detection of ethylene gas and ammonia. Bacillus and Pseudomonas were tested for phosphate solubilization, which helps plants absorb phosphorus from the soil. Among them, Pseudomonas had a slightly higher solubilization rate. All three bacteria were also tested for the production of indole-3-acetic acid (IAA), a natural plant hormone that promotes root growth. Azotobacter produced the highest amount of IAA. Additionally, the bacteria were evaluated for their antifungal properties against Fusarium oxysporum and Rhizoctonia solani. Bacillus exhibited the strongest antifungal activity by inhibiting the growth of these plant pathogens. The results suggest that Azotobacter, Bacillus, and Pseudomonas have great potential as biofertilizers. They can naturally improve soil fertility, enhance crop growth, and protect plants from diseases. Using these beneficial bacteria offers an environmentally friendly alternative to chemical fertilizers, supporting sustainable agricultural practices. treatment (T1) recorded the lowest values for all parameters, with plant height at 50 cm, 6 branches per plant, 2.0 g dry weight, 10 pods per plant, 4.5 cm pod length, 800 kg/ha seed yield, and 1300 kg/ha stover yield. These findings suggest that a combination of *Azotobacter*, *Bacillus*, and *Pseudomonas* biofertilizers can significantly enhance green gram growth and yield. This sustainable approach reduces the dependence on chemical fertilizers while improving soil health and productivity. This study highlights the potential of biofertilizers in promoting environmentally friendly agricultural practices and increasing crop yield.

Post-harvest storage infrastructure and management: A critical component of food security

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Post-harvest storage infrastructure and management plays a vital role in maintaining crop quality, reducing losses, and ensuring food security. Effective management of storage infrastructure is crucial to prevent physical, biological, and chemical damage of crops. Agriculture is a key pillar of India's economy, contributing 17% of country's GDP (Gross Domestic Product) and employing more than half of its workforce. However, Indian farmers face a major challenge due to the lack of proper storage facilities. While the government purchases food grains from the farmers, there is often not space to store them properly. As a result, millions of tonnes of food grains are lost each year due to inadequate storage and infrastructure facilities. Post-harvest losses in India ranges between 10% and 25%, with the highest losses occurring in horticulture, livestock, and fisheries. Addressing this issue requires significant investment in modern agricultural markets, quality certification systems, warehouses, and cold storage facilities. In conclusion, efficient post-harvest storage infrastructure is vital for food security and sustainable agriculture. It is essential for policymakers, farmers and stakeholders to prioritize investments in storage solutions and management practices to minimize waste and maximize food availability.

Keywords: post-harvest storage, Gross Domestic Product, infrastructure management, food security, sustainable agriculture, crop losses, food quality.

Post-Harvest Management: A Pillar of Food Security and Sustainability

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A key element of food security is post-harvest management, which makes sure that agricultural products are wholesome, safe, and accessible for consumption. Food supply is reduced significantly worldwide as a result of post-harvest losses, especially in underdeveloped nations where waste and spoiling are caused by improper handling, insufficient storage, and ineffective transportation. Good post-harvest practices can increase shelf life, cut waste, and boost farmers' profits. These include better cold chain logistics, storage infrastructure, and sophisticated food processing methods. It is possible to maximize supply chain efficiency and guarantee that food reaches consumers in the best possible condition by integrating contemporary technologies like blockchain for traceability, IoT-based monitoring, and AI-driven predictive analytics. By mitigating food wastage and curbing greenhouse gas emissions, sustainable post-harvest strategies not only fortify global food availability but also contribute significantly to ecological conservation. Enhancing post-harvest handling and storage at the grassroots level necessitates strategic policy reforms, substantial investment in rural infrastructure, and targeted educational programs for farmers. Moreover, strengthening market linkages and fostering value addition through advanced agricultural processing can stimulate economic growth while alleviating seasonal food deficits. The execution of holistic post-harvest interventions aligned with sustainable development imperatives demands a concerted effort from governmental bodies, scientific communities, and key industry stakeholders. By tackling post-harvest issues with creativity, capacity-building, and calculated investments, food security will be greatly improved and wholesome food will continue to be available and reasonably priced for expanding populations. A robust and effective post-harvest management system is essential to creating a world food system that is sustainable.

Keywords: Food Security, Food Loss Reduction, Post-Harvest Management, Supply Chain Optimization, Sustainable Agriculture

Prospects of underexploited vegetables for nutritional security

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Vegetables are the important components among horticultural crops in the diversification of agriculture to provide food and nutritional security for the ever-growing population of the country. India has a wide variety of climate and soils in which more than hundred types of vegetables are grown, but maximum emphasis has been given to a limited number of vegetables only. Kerala is known for its vast resources of underexploited vegetables which are the store house of nutrients and phyto-chemicals and some are having medicinal uses also. Consumption of these crops has significant health promoting effects. These are considered as protective foods since they can reduce the risk of many chronic diseases such as cardiovascular problems, cancers and various other degenerative diseases . Importance of nutritional quality of underexploited vegetables in human health has been reported . Underexploited cucurbit crops include sweet gourd, ridge gourd, smooth gourd, snap melon etc. High content of protein is reported in spine gourd among cucurbits. Crops like chow-chow and pointed gourd have specific adaptability to certain areas. Protein rich underexploited legumes include jack bean, sword bean, winged bean, dolichos bean etc. KAU has released high yielding varieties in some crops namely ìRevathyî in winged bean; ìHarithamî and ìDeepthiî in ridge gourd. Cruciferous vegetables are rich in sulphur containing glucoside called glucosinolates and sprouting broccoli has the powerful anticancer components ever detected. Most common among them are chekkurmanis, water leaf, water convolvulus, basella etc. Varalakshmi and Rao reported higher antioxidant capacity in green leafy vegetables. Underexploited crops have certain features like adaptability to low-input agriculture, resistance to pests and diseases, contribute to food and nutritional security and provide environmental services. Attempts should be made to bring underutilized vegetable crops out of the shadows into mainstream as these crops are efficient in producing edible dry matter, rich in nutrients and can definitely be utilized as alternate sources towards achieving the goals of food and nutritional security.

Improving food availability and reducing waste through post-harvest management

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Post-harvest management plays a critical role in improving food availability and reducing waste, particularly in regions where food insecurity remains a challenge. A significant portion of global food production is lost or wasted between harvest and consumption due to poor handling, inadequate storage, inefficient transportation, and a lack of proper processing techniques. Addressing these challenges through effective post-harvest management can enhance food security, increase farmers' incomes, and contribute to sustainable agricultural systems.One of the major reasons post-harvest losses occur is through inadequate handling and storage. Inadequate drying, exposure to pests, and contamination by microorganisms cause degradation and reduce nutritional value. Improvements in storage facilities through hermetic bags, silos, and temperature controls would greatly minimize losses. Other preservation methods are cold storage and processing, like drying, fermenting, and canning. Investment in rural infrastructure, including roads and market linkages, ensures that harvested produce reaches consumers in good condition, minimizing losses during transportation. Optimizing the food distribution system will be achieved through smart storage solutions, blockchain for supply chain transparency, and mobile applications connecting farmers to markets. Governments and stakeholders should invest in research and policy frameworks that support efficient post-harvest strategies and incentivize the adoption of best practices. With concerted efforts, reducing post-harvest losses can contribute to a more resilient and sustainable food system, benefiting both producers and consumers worldwide.

Keywords: - food availability; reducing waste; storage; transportation; post-harvest losses; nutritional values; food processing; alternative markets; lowering environmental impacts.

STUDY ON THE IMPACT OF CONSERVATION AGRICULTURE PRACTICES ON SOIL MICROARTHROPODS POPULATION IN RICE-BLACK GRAM-MUSTARD CROPPING SEQUENCE

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An experiment was conducted at Balindi Research Complex Farm of Bidhan Chandra Krishi Vishwavidyalaya, West Bengal, during Rabi, pre-kharif and kharif season starting from October 2018 to March 2020 to evaluate the impact of conservation agriculture practices on soil microarthropod population under rice-black gram-mustard cropping sequence. Varieties of rice, black gram, and mustard were Ajit, Sulata, and B9 respectively, used during the experimental period. There were total of 15 tillage treatments after combining three main plot treatments (conventional tillage, reduced tillage, zero tillage) with 5 sub plot treatments (100% NPK, 50% NPK with 100% residue, 75% NPK with 100% residue, 100% NPK with 50% residue & 75% NPK with 50% rice stubble i.e. crop residue), among them highest soil micro arthropod population was recorded under zero tillage treatment plot M3S3 (with 75% NPK and 100% residue) @ 3.01/10 gm of soil followed by M3S2 (with 50% NPK and 100% residue) @2.38/10 gm of soil, then treatment plot M2S3(reduced tillage with 75% NPK and 100% residue) @ 1.81/10 gm of soil and all time lowest mean soil micro arthropods population was observed under treatment plot M1S1 (Conventional tillage practices with 100% NPK application) i.e. 0.57/10 gm of soil followed by M1S2 (Conventional tillage practices with 50% NPK and 100% residue retention) @ 0.72/10 gm of soil. Highest arthropod population was observed at 90 DAS followed by 60 DAS, in black gram (1.57/10 gm of soil) followed by rice (1.55/10 g of soil) and lowest was recorded under mustard ecosystem i.e. 1.49/10 gm of soil. Mites (2.26/10 gm of soil) and springtails (2.14/10 gm of soil) were most abundant group and together comprises of about 60 % of total soil micro arthropod fauna found during the experiment. Zero tillage (1.52) and reduced tillage (1.51) plots have highest mean Shannon-Wiener diversity index in comparison with conventional tillage system (1.49).

Role of smart sensors in soil health monitoring

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Maintaining soil health is essential for sustainable agriculture as it directly affects crop productivity, environmental conservation, and food security. Traditional methods of soil assessment are often slow, labour-intensive, and lack real-time data. The introduction of smart sensors has revolutionized soil monitoring by enabling continuous, real-time analysis of key parameters such as moisture levels, temperature, pH balance, salinity, and nutrient content. These sensors leverage advanced technologies like the Internet of Things (IoT), wireless sensor networks (WSN), artificial intelligence (AI), and remote sensing to efficiently collect, process, and transmit soil data. Embedded in the soil and integrated with cloud-based platforms, smart sensors allow farmers and researchers to monitor soil conditions remotely. This real-time data enhances precision agriculture by optimizing irrigation, fertilizer application, and land management, ultimately increasing crop yields while conserving resources. A significant benefit of smart sensors is their ability to detect soil degradation and contamination at an early stage. Issues such as excessive chemical fertilizer use, erosion, and salinity buildup can be identified promptly, enabling timely corrective actions. Moreover, these sensors support climate-resilient farming by helping farmers adjust to environmental changes through data-driven strategies. Despite their many advantages, adopting smart sensor technology in soil health monitoring presents challenges. High installation costs, maintenance requirements, lack of digital infrastructure in remote areas, and complexities in managing large volumes of data are barriers to widespread implementation. Their integration into precision agriculture enhances efficiency, promotes sustainability, and helps safeguard soil fertility. As technological innovations continue, smart sensors will play an increasingly critical role in maintaining agricultural productivity and environmental sustainability. Encouraging broader adoption and investing in cost-effective solutions will be crucial in maximizing the benefits of this technology for modern farming practices.

Keywords: Precision Agriculture, Real-time data, Smart sensor, Soil health Monitoring, Sustainability

Precision Farming: - An Innovative Approach to Double Farmer's Income

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Precision farming (PF), which involves the utilization of modern technologies to assist in farming practices, is emerging as a better way of increasing yields as well as protecting the environment and managing food production sustainability. Making use of other complex technologies such as Global Positioning System (GPS), Geographic Information Systems (GIS), Artificial Intelligence (AI), drones, Internet of Things (IoT), Decision Support Systems (DSS) and Information Communication Technology (ICT), PF encourages the application of agricultural chemical products, water and other farming inputs based on the specific needs of the fields in order to increase irrigation efficiency and avert losses. This is because climate change and other related extreme weather phenomena is witnessed frequently and is getting more severe in its destruction, which makes the agriculture of India, one of the prime earning sectors within the country, more vulnerable. Drones in particular have recently turned out to be one of the most effective gadgets used in data gathering high quality images imaging processes with the purpose of proactively managing diseases. The use of drones for pesticides and fertilizers also helps in enhancing the welfare pest control of the plants with a reduced chemical environment. The use of drone technology is gaining momentum in the agricultural industry in India. American consulting firm reports that there will be new agricultural drones coming on the market as the forecasted agricultural market will reach 121.43 million dollars by 2030. This gives a positive outlook to the future of precision farming in India in that it presents a viable solution towards agricultural practices that are sustainable and suitable for economic and environmental concerns.

Keywords

Precision farming, SSM (site-specific management), global warming, drone technology

Pre-emergence application of Diclosulam 84 WDG: a new approach to weed management in summer groundnut (*Arachis hypogaea*)

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The field experiment was conducted during three consecutive summer seasons of 2022 to 2024 at Regional Research Station (latitude: 22°46´N and longitude: 87°01'E with an altitude of 81m above mean sea level) Bidhan Chandra Krishi Viswavidyalaya, Jhargram, West Bengal to evaluate the efficacy and economics of pre-emergence application of Diclosulam 84 WDG in different combination on weed management of groundnut under irrigated condition. The experiment comprising in a Randomized Complete Block Design (RCBD) with ten different weed management treatments replicated thrice. The different weed management treatments were T_1: Diclosulam 84 WDG @ 20 g a.i. ha^{-1} as pre emergence (PE), T_2: Diclosulam 84 WDG @ 25 g a.i. ha^{-1} as PE, T_3: Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} as PE, T_4: T_1 followed by hand weeding (HW) at 30 and 60 days after sowing (DAS), T_5: T_2 followed by HW at 30 and 60 DAS, T_6: T_1 followed by Quizalofop Ethyl 5% EC 50 g a.i. ha^{-1} as post emergence at 30 and 60 DAS, T_7: T_2 followed by Quizalofop Ethyl 5% EC 50 g a.i. ha^{-1} as post emergence at 30 and 60 DAS, T_8: T_3 followed by Quizalofop Ethyl 5% EC 50 g a.i. ha^{-1} as post emergence at 30 and 60 DAS, T_9: Weed free check and T_{10}: Weedy check. The groundnut cultivar TG-37A used in the experiment received 20:60:40 kg N, P_2O_5 and K_2O ha^{-1} irrespective of treatments. Result revealed that pod yield of groundnut increased about 55.2-62.6% with pre-emergence application of Diclosulam 84 WDG followed by post emergence application of Quizalofop Ethyl 5% EC over weedy check, where the B:C ratio was increased a tune of 32.9-37.6% due to application of Diclosulam 84 WDG followed by post emergence herbicide. Though, the highest pod yield, gross and net return was found from the weed free plot (T_9) but due to its tremendous treatment cost it had not produced the highest B:C ratio. The different weed management practices of groundnut produced 21.87 to 74.81 % higher pod yield over weedy check or control during summer season.

Keywords: Summer groundnut, weed management, diclosulam, herbicide

Preparation of Fish Snacks by incorporating *Pangasius Surimi* Powder

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Minced meat technology targets the production of surimi and surimi-based products having unique textural properties and high nutritional value. Surimi is concentrated myofibrillar protein, extracted from fish flesh by washing minced meat with cold water to remove fat and other water-soluble contents, is then mixed with a cryoprotectant like sugar or an alcohol to get surimi. Surimi could be converted to a dried form, surimi powder offering advantages in commerce, like ease of handling, lower distribution costs, more convenient storage and usefulness in dry mixes application. Due to high nutritive qualities and excellent sensory properties (tender flesh, sweet taste, absence of fishy odor and spines); *Pangasius* meat can be used as a raw material for development of surimi powder. Thus, the objective of the study was to determine the incorporation rate of the surimi powder in preparation of fish snacks. Fresh pangas was used to prepare surimi powder (dried in 60^{o}C drying temperature). Different percentages of surimi powder (SP), i.e., 0% (SP 0); 5% (SP 5); 10% (SP 10) and 15% (SP 15) were used for incorporation during the preparation of snacks by mixing the dry ingredients with water in a commercial mixer followed by frying in hot vegetable oil (190^{0}C) for 100 to 120 seconds till the light brown color appeared and finally ready for further analysis and sensory evaluation. The highest expansion was recorded as SP-15 (11.31±2.38%) and SP-10 (47.00±0.00%) for area expansion and volume expansion (p>0.05) respectively. Overall acceptability scores reveal that (SP-10) (6.08±0.30) was best acceptable. Thus, the standardized 10% incorporation level was most effective with good quality standards and may be further developed into "ready to use" labelled product in near future.

Keywords: *Pangasianodon hypopthalmus,* surimi, surimi powder, fish snacks, value addition

Profitability Assessment in Agricultural Production and Marketing of Agricultural Enterprises

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2021 research in the Bemetara district in the plain region is a study on the impact of self-help groups (SHGs) on various aspects of their operations. Jai Satnam SHG, established in 2008, is an NRLM SHG supported by the government through the National Rural Livelihood Mission. The SHG produces around 5040 packets of sanitary pads annually, with a total cost of Rs 15.00 per packet. The SHG is organized at three levels: President, Secretary and Members, as well as 2021 research in Gariaband district in the plain region focused on the use of organic pesticides, which are beneficial to the environment and free of cost. Agneestra, Brahmastra and Dravya Jeevamrit are produced in large quantities, with the organic pesticides yielding the highest profit. 2021 research in Kanker district in the south region shows the success of Radha SHG in producing an average of 542 kg/acre of lac, with a total net profit of Rs 15.00. 66810.97/acre in the first year and the average gross return was 103744.97/acre. And 2021 research in Raigarh district of the northern region shows better business performance in the production of various commodities by Radha Krishna Mahila SHG, with a combined net profit of Rs 21985, Rs 118457.5, and Rs 12712.

Keywords- SHG, region, organic, production, impact

Soil Pollutants and Their Impact: Strategies for Effective Remediation

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Heavy metal pollution is one of the serious problems that contaminates the environment through various means due to the growth of industries in several countries. Removal of heavy metal contaminants from the environment has been achieved using different techniques, including physical, chemical, and biological methods. However, these techniques face some limitations such as cost, time, and consumption of resources, logistical issues, and mechanical complexity. With the rapid growth of industrialization and agriculture, soil pollution with potentially toxic elements and organic pollutants has recently emerged as an increasingly serious environmental concern. Scattered literature has been employed to critically analyze the different natural and anthropogenic sources, hazards, and potential remediation practices for several of the contaminants identified, which are mainly organic in nature, like arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb), copper (Cu), etc. that are more frequently found in contaminated soils. Remediation practices, including both chemical and phytoremediation techniques, are discussed in this chapter. The immobilization, soil washing, and vitrification methods of chemical remediation are relatively expensive and hazardous to the environment. They are, therefore, not applicable for large-scale soil remediation activities. Phytoremediation, on the other hand, has been recognized as an environmentally friendly and feasible technology for the restoration of contaminated soils. However, very limited efforts have been directed towards demonstrating this technology under field conditions. Soil contamination with heavy metals requires remediation to reduce these risks, promote the availability of land resources to agricultural production processes, enhance food security, and solve land tenure problems resulting from changes in patterns of land uses.

Keywords: Heavy metal pollution, Soil remediation, Phytoremediation, Environmental contamination, Toxic elements.

Agroforestry and Soil Fertility: The Role of Tree-Based Systems

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In light of escalating issues including nutrient depletion, soil degradation, and climate change, sustainable land management techniques are now essential to sustaining agricultural output. The integration of trees with crops and livestock, known as agroforestry, presents a possible answer by improving nutrient management and soil health. Tree-based systems use processes including nitrogen fixation, litter deposition, and root-soil interactions to enhance soil structure, boost organic matter content, and promote nutrient cycling. In order to maintain long-term soil fertility, these systems also control soil moisture, encourage carbon storage, and lessen nutrient runoff and erosion. Furthermore, nutrient availability and soil resilience depend on the diversity and activity of soil microbes, which are improved by agroforestry. Tree-based systems have shown notable improvements in soil physical, chemical, and biological qualities in a variety of agroecological conditions, including semi-arid, degraded, and tropical settings. Case studies from Roraima, Brazil, demonstrate how efficient tree management techniques combined with conventional agroforestry methods can restore soil fertility. However, despite these advantages, obstacles including low awareness, financial limitations, and a lack of policy backing prevent agroforestry from being widely adopted. The multifaceted role of agroforestry in climate-smart agriculture is the subject of current research, but there are still unanswered questions about its long-term impacts on soil health, nutrient dynamics, and the integration of new technology. In order to maximise agroforestry techniques, guarantee sustainable soil fertility management, and improve agricultural resistance to environmental problems, these gaps must be filled.

Keywords: Agroforestry, soil health, nutrient management, climate-smart agriculture, soil fertility, sustainable land management.

Diversified Crop Rotation for Sustainable Farming

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The agriculture sector plays a crucial role in addressing the productivity dilemma because of rising food demand and decreased crop yields brought on by population growth. A practical approach to agricultural land management has been spurred by a growing interest in creative and effective farming methods, particularly in-view of the issues of soil erosion made worse by human activity and unsustainable farming methods. Crop rotation is one method of sustainable farm management that aims to increase soil organic matter and decrease soil erosion. A helpful strategy in sustainable agriculture is crop rotation, which restores plant nutrients and prevents the multiplication of insects and pathogens. A well-chosen crop rotation plan can preserve soil fertility over the long term, decrease trade-offs between crop viability and environmental effects, and interrupt the weed and disease cycle process through intrinsic nutrient recycling. The paper also highlights the difficulties, barriers, and factors affecting the Diversified Crop Rotation adaption and application in the agricultural production system.

Keywords: Diversified Crop Rotation, nutrient recycling, crop rotation, sustainable agriculture, plant nutrients.

Innovative Fertilizers and Soil Amendments for Sustainable Agriculture

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Soil quality is crucial for plant growth, yet approximately 30% of Indian soils are degraded due to the overuse of fertilizers and mono-cropping, and in turn, it affects climate change. With growing global food demands and the need to safeguard environmental health, modern technologies in agriculture, such as biotechnology and nanotechnology, are essential. These innovations can help minimize the ecological impact of chemical fertilizers and improve agricultural waste management. Innovative fertilizers with controlled nutrient release and bio-formulation using bacteria or enzymes and the use of harvesting residues as coatings are emerging as key solutions. Healthy soil is non-renewable, and sustainable agriculture relies on proper soil management. This paper highlights trends in nanomaterials, organic farming, and precision agriculture, which puts more emphasis on the importance of diversifying soil nutrients, soil fertility, and structure, especially in developing countries.

Keywords: Innovative fertilizers, biotechnology, nanotechnology, sustainable agriculture, precision agriculture.

Revolutionizing Precision Agriculture Powered by Smart Farming using Hybrid AI Models

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Precision Agriculture (PA) is a modern farming technique that is transforming the future of agriculture by providing smart, data-driven solutions to its challenges. By utilizing a Hybrid AI Model—a combination of various models—this approach integrates insights from multiple factors, including soil, weather, and crop data. The goal is to optimize farm management, conserve resources, and promote sustainable practices. The Hybrid AI Model will identify trends in numerical data which includes seasonal changes and forecast future conditions along with their impacts by analyzing time-series patterns. It will optimize planting and irrigation strategies by mapping spatial layouts, such as field structures and crop arrangements. Additionally, the model will take into account natural behaviors like soil and water dynamics by incorporating physical principles. This integration enables real-time monitoring, accurate predictions, and resource-efficient decision-making. This processed data is then fed into the Hybrid AI Model, which uses it to make even more accurate predictions and optimize farming strategies. As a result, farmers receive real-time insights and precise guidance to make informed decisions quickly, whether they are in the field or managing their farms remotely. It enhances yields, reduces costs, and minimized environmental impact by integrating automation, remote sensing and advanced decision-support systems, revolutionizing Precision Agriculture and empowering farmers with data-driven, sustainable farming solutions for a smarter future.

Keywords: Precision Agriculture (PA), Hybrid AI Model, Smart Farming, Data-Driven Solutions, Satellites

Leveraging Technological Innovations for Strategic Decision-Making in Post-Harvest

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The post-harvest phase of food production is a crucial point where efficiency, quality, and timely decisions are vital. Advanced technologies are transforming decision-making in this phase, providing insights into their applications, benefits, and future possibilities. Post-harvest management involves complex decision-making, influenced by factors like crop condition, environment, market trends, and logistics. Traditional methods often fail to provide timely, accurate data, leading to inefficiencies and quality loss. However, emerging technologies are enabling more precise and efficient operations, helping stakeholders make better decisions with greater accuracy. The Internet of Things (IoT) is a key technology in improving post-harvest decision-making. It allows real-time monitoring across the supply chain using sensors to track factors like temperature and humidity. This helps in optimizing storage conditions and providing valuable data insights for better decision-making. Artificial Intelligence (AI) and machine learning (ML) also play a significant role by analyzing historical data and recognizing patterns. AI systems can predict market trends, optimize inventory, and foresee quality issues, leading to more proactive decisions. Additionally, AI automation enhances tasks like sorting and packaging, improving efficiency and consistency. Blockchain technology offers an immutable ledger for tracking the origin and quality of products, ensuring transparency, consumer trust, and regulatory compliance, thus supporting a more sustainable food supply chain.

In conclusion, technologies like IoT, AI, ML, and blockchain are revolutionizing post-harvest decision-making, allowing stakeholders to optimize resources, reduce waste, and enhance sustainability in the sector.

Keywords: Advanced technologies, Artificial intelligence (AI), Blockchain, Internet of Things (IoT), Machine learning (ML), Post-harvest operations.

CARBON SEQUESTRATION IN SUSTAINABLE AGRICULTURE

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The concentration of greenhouse gases (GHGs), especially carbon dioxide (CO_2), has increased very rapidly, reaching approximately 419 ppm in 2023, compared to pre-industrial levels of 280 ppm, leading to increased global warming and calling for immediate action. Soil carbon sequestration is a promising way of lowering atmospheric CO_2 levels. Globally, soils store approximately 2,500 gigatons (Gt) of carbon, which is three times the amount in the atmosphere (about 830 Gt) and four times that in terrestrial vegetation (about 560 Gt). Agricultural soils, particularly those that are slightly degraded or actively managed, have the potential to sequester between 0.9 and 1.85 Gt CO_2 per year, making them a critical tool for climate change mitigation. The capacity of soil to sequester carbon depends on climate factors such as temperature, moisture, and CO_2 levels. However, edaphic factors, including soil texture, structure, porosity, compactness, mineral composition, and microbial activity, are also essential in the carbon sequestration process. The land-use system, conservation of plant residues, and application of agrochemicals significantly influence soil organic carbon (SOC) stocks—either by altering the quantity of carbon entering the soil or by modifying soil aggregation and decomposition rates. In addition to reducing GHG emissions, soil carbon sequestration provides multiple benefits for agriculture. Increasing SOC levels by just 1% can enhance soil water retention by 20,000 gallons per acre, which is crucial for drought resilience. Higher SOC content improves soil aggregation, water-holding capacity, and biological activity, thereby minimizing soil erosion and degradation. Therefore, integrating soil carbon sequestration into sustainable agricultural systems not only strengthens climate resilience and preserves long-term ecological integrity but also enhances soil health, food production, and farm incomes—making it a win-win strategy for both agriculture and the environment.

Keywords: Sequestration, Climate change mitigation, Ecosystem integrity, Land use practices, Climate resilience

Effect of container and storage condition on longevity of wheat seed

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The present investigation entitled, "Effect of container and storage condition on longevity of wheat seed" was conducted during 2020-21 at Seed Technology Research Unit (STRU), M.P.K.V., Rahuri. The experiment consist of four varieties *viz*., Godavari (V_1), Panchavati (V_2), Tapovan (V_3) and Trimbak (V_4), two storage condition *viz*., Ambient storage (S_1) and Storage at low temperature (20^0C) (S_2), Five storage container such as Gunny bag (C1), Cloth bag (C_2), Polythene bag (C_3), HDPE bag (C_4) and Pro-grain bag (C_5) and three seed type age fresh seed (A_1), Rvd Ist seed (A_2) and Rvd IInd seed (A_3).

The study revealed that, among the varieties, significant differences were observed. The seed quality parameters *viz.*, germination percentage (88.04 %), root shoot length (32.30 cm), seedling dry weight (0.300 g) vigour index I (2844.33), vigour index II (23.72), Electrical conductivity (0.444 dSm^{-1}) and field observation *viz*., field emergence (75.55 %) was better in respect of variety Godavari followed by Panchavati, Tapovan and Trimbak. Among the storage condition, storage at low temperature (20^0C) i.e. cold storage, condition was formed better for seed longevity of wheat. The seeds stored in polythene bag were better for maintained the better seed quality parameters (germination (88.16 %), (root-shoot length (32.29 cm), (seedling dry weight (0.30 g), (vigour index I (2849.41), (vigour index II (25.51), and low electrical conductivity (0.240 dSm^{-1}) up to 12th months under cold storage conditions.

Among storage containers, seeds stored in polythene bag showed good storability followed by pro-grain bag and HDPE bag. However lowest quality performance was observed from gunny bag storage container. Seed quality parameters *viz.*, germination percentage (93.20 %), root-shoot length (32.16 cm), seedling dry weight (0.29 g), vigour index I (2967.53) and vigour index II (26.32) were formed better in the fresh seed. However, electrical conductivity was recorded higher in Rvd IInd aged and Rvd Ist. The wheat seeds can maintain the 85.68 per cent germination percentage at the age of 34th months which is above IMSCS (85%).

Using Soil Sensors to Improve Crop Management and Productivity

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Improving agricultural productivity, crop management, and crop output all depend on soil management. Soil management strategies directly include soil sensors. It approaches soil health, temperature, pH, moisture content, and nutrient levels. Sensors have easy access to the electromagnetic spectrum and can use a wide variety of technologies. Their sole goal was to increase productivity without causing any disruptions to the environment. In order to produce better harvests in the future, contemporary technology is widely desired. It achieves high profitability while using fewer inputs. Soil nitrogen, phosphorus, and potassium are accessible through nutrient sensors. This technique makes use of a variety of sensors, including soil moisture, temperature, and nutrient sensors. Particularly in agriculture and water resource management, soil moisture sensors are used extensively.They give farmers precise information on soil moisture so they may manage crops more effectively and waste less water. The physical and biological characteristics of soil, such as water and nutrients, can be measured and tracked more easily with the use of soil sensing. Soil organic carbon can also be tracked using the new sensing techniques. These days, there are new technologies that use lasers, LEDs, thin film filters, tiny electromechanical structures, etc. Farmers can limit the usage of pesticides and fertilizer by using soil sensors to identify trouble spots. This improves sustainable agricultural development and lowers soil contamination.

KEYWORDS: Soil sensors, precision agriculture, nutrient monitoring, soil moisture, sustainable farming.

Habitat Diversification for Sustainable Pest Management

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With increasing global strains in agriculture, sustainable pest management is vital for environmental health and food security. Habitat diversification bolsters ecosystem resilience and reduces reliance on chemical pesticides. Agricultural intensification and monoculture practices have diminished habitat diversity, negatively impacted biodiversity and increasing crop vulnerability to pests. Diverse habitats, featuring hedgerows, cover crops, intercropping systems, and non-crop refuges, support a variety of plant species and create ecological niches for natural enemies. These environments offer alternative food sources, overwintering sites, and shelter for predators and parasitoids, enhancing their survival and pest suppression efficiency. Landscape engineering methods like agroforestry, trap cropping, and the push-pull strategy further enhance functional diversity in agroecosystems by manipulating pest behaviour and population dynamics. The presence of flowering plants and perennial vegetation increases resources for pollinators and beneficial arthropods, strengthening pest control services. Complex landscapes foster greater biological control than simplified systems due to enriched spatial structure and biodiversity, which influence pest-natural enemy interactions. Effective habitat diversification requires strategies tailored to local ecological conditions, crop varieties, and pest complexes. By promoting ecological balance, habitat diversification supports long-term food security, environmental sustainability, and agricultural productivity. Its integration into integrated pest management (IPM) frameworks highlights the importance of blending ecological principles with agricultural practices for effective pest control and biodiversity conservation.

Keywords: Habitat diversification, sustainable pest management, biodiversity, ecosystem resilience, integrated pest management, landscape engineering.

Post-Harvest Management: Key to Food Security

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Post-harvest management encompasses a critical set of practices that significantly impact global food security. By effectively managing agricultural produce after harvest, we can minimize losses, ensure the availability of nutritious food, and enhance the sustainability of the food system. Key aspects of post-harvest management include the implementation of advanced technologies such as controlled atmosphere storage and cold chains to preserve perishable produce and extend shelf life. Optimizing the food supply chain is crucial, requiring efficient transportation networks, improved infrastructure, and seamless logistics to move produce from farm to fork swiftly and cost-effectively. Furthermore, minimizing post-harvest losses, including spoilage, damage, and waste, is paramount. This necessitates the adoption of best practices throughout the supply chain, such as proper harvesting techniques, careful handling during transportation and storage, and the development of innovative value-added products from damaged or surplus produce. Finally, advancements in food preservation and processing technologies play a vital role. Techniques such as irradiation, high-pressure processing, and traditional methods like drying, freezing, and fermentation contribute to enhancing food safety, extending shelf life, and increasing the diversity of available food products. By effectively addressing these critical aspects, post-harvest management contributes significantly to enhancing food security, reducing food waste, improving the livelihoods of farmers and consumers, and ultimately fostering a more sustainable and resilient food system.

Keywords: Cold chain, Food preservation, Food processing, Food security, Post harvest losses, Supply chain management, Sustainable agriculture.

TRANSFORMING AGRICULTURE: THE ROLE OF DRONES AND SATELLITE IMAGING IN PRECISION FARMING

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Agriculture is experiencing a technological revolution through the adoption of precision farming techniques, where drones and satellite imaging play crucial roles. It provides real-time, high-resolution data that supports crop productivity enhancement, resource optimization, and efficient decision-making processes. Drones provide extensive data for soil condition analysis, identification of diseases and crop health issues, and optimum application of fertilizer and pesticides. As these drones offer accurate information on the level of growth, farmers can use precise treatment to reduce costs and the negative impact on the environment. Drones equipped with satellite imagery can offer long-term and holistic study on vegetation health, soil moisture, and climatic conditions. The influence of the knowledge used in yield prediction and water resource management is significantly reduced through controlling the effects of climate change. The combination of remote sensing and artificial intelligence can make these technologies more accurate and user-friendly. Even though the advancement of automation and data analytics has made these technologies more accessible, they still face challenges such as large capital inputs, complex data processing, and regulatory limitations. Traditional farming is being transformed into a data-driven, sustainable, and efficient enterprise through the integration of drones and satellite images. This is important to the food security issue in the world, as the demand for food continues to rise. Smart agriculture technologies can be used in making informed decisions that increase yields without waste resources and that would be proof against future climate concerns through the use of drones and satellite imagery.

Keywords: Precision Farming, Drones and Satellite Imaging, Crop Health Monitoring, Resource Optimization, Climate Change Adaptation.

Tourists and Agriculture: Integrated approach

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Agri-tourism presents a compelling synergy with multifaceted benefits for both farmers and tourists. This approach transcends conventional tourism models, offering immersive experiences that connect visitors with the roots of food production, cultural heritage, and rural landscapes. For farmers, agritourism represents a vital avenue for income diversification, reducing reliance on fluctuating commodity markets and creating direct marketing opportunities for their produce. It empowers them to showcase their sustainable practices, educate consumers about the origins of their food, and build stronger relationships with their communities. Furthermore, agritourism facilitates the preservation of traditional farming methods and cultural heritage, safeguarding these practices for future generations. Tourists, in turn, gain access to unique and enriching experiences beyond typical sightseeing. They can participate in hands-on activities like harvesting crops, learning about traditional crafts, and interacting with farm animals. This direct engagement fosters a deeper appreciation for the effort involved in food production and promotes a better understanding of the connection between agriculture and the environment. Agritourism also offers opportunities to connect with rural communities, experience local culture firsthand, and enjoy the tranquillity of rural landscapes. It provides an alternative to traditional tourism, promoting sustainable travel practices and supporting local economies. The potential for agritourism to contribute to sustainable agriculture is significant. By showcasing environmentally friendly farming practices, it encourages responsible land management and promotes biodiversity. It also creates a platform for educating visitors about the importance of sustainable agriculture and its role in ensuring food security. This integration of tourism and traditional farming offers a powerful tool for rural development, cultural preservation, and the promotion of sustainable agricultural practices, fostering a mutually beneficial relationship between farmers, tourists, and the environment.

Keywords: Agri-Tourism, Sustainable tourism, Agricultural entrepreneurship, Local economic development, Community-based tourism

Integrating QTLs and Resistance Genes for Improved Stress Tolerance in CO 51 Rice Using Marker-Assisted Pyramiding

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Marker-Assisted Backcross Breeding (MABB) was utilized to improve the rice variety CO 51 for resistance to drought, submergence, blast, and bacterial blight (BB). This enhancement involved the introgression of specific QTLs and resistance genes, including drought-related QTLs qDTY1.1 and qDTY2.1 from the donor Apo, qDTY12.1 from Way Rarem, the Sub1 submergence tolerance gene from FR13A, blast resistance genes Pi9 and Pi54, and the BB resistance gene xa13 from 562-4, into the genetic background of CO 51. A total of 26 advanced breeding lines at the IMF5 generation (Inter-Mated Filial) were developed and genotyped using foreground markers. These lines were evaluated for drought tolerance, resistance to blast and BB, yield potential, and grain quality. Background selection with 72 SSR markers resulted in recurrent genome recovery rates ranging from 90.00% to 95.71%. Of the 26 backcross inbred lines (BILs), 23 lines, including BIL #55X2-9-1-4-10, BIL #55X2-9-1-4-11, and BIL #55X2-9-1-4-13, showed exceptional resistance to drought, blast, and BB compared to the recurrent parent. This study demonstrates the efficiency of MABB in pyramiding multiple QTLs and resistance genes, effectively addressing both abiotic and biotic stresses while achieving high recurrent genome recovery. These advancements significantly enhance the stress resilience of rice, paving the way for the development of robust varieties.

SECTORIAL IMPROVEMENTS FOR DOUBLING FARMER'S INCOME

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Agriculture is the largest enterprise in the country. An enterprise can survive only if it can grow consistently. And growth is incumbent upon savings & investment, both of which are a function of positive net returns from the enterprise. The net returns determine the level of income of an entrepreneur, farmer in this case. This explains the rationale behind adopting income enhancement approach to farmers' welfare. Revenue and profit are often used interchangeably by the average person, profit being an outcome of revenue. Objectives of doubling of farming income is to increase production and productivity of crop, strong measures will be needed to harness all possible sources of growth in farmers' income within as well as outside agriculture sector within the sector farmers has to concentrate on reducing cost of production, Resource use efficiency, Increase in cropping intensity, Diversification towards high value crops and higher price realization by farmers needs to be achieved through various price realization market reforms like e-NAM and various provisions of APMC Act. Concerted and well-coordinated efforts are required to be made between the Centre and the States, policy direction to ramp up physical connectivity from farm to consumers and easing certain regulatory restrictions are required and also greater access to more markets hedges against selling risks, and adds opportunity to produce more. Outside agriculture sector includes shifting cultivators from farm to non-farm occupations, and improvement in terms of trade for farmers or real prices received by farme

Keywords: DFI, APMC, e-NAM

The influence of cool chain management on the shelf life and quality of Horticultural Products

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The influence of cool chain management on the shelf life and quality of horticultural products is critical in ensuring food security and reducing post-harvest losses. Effective cool chain infrastructure plays a vital role in maintaining the freshness, nutritional value, and marketability of perishable horticultural produce. However, many regions, particularly in developing economies, face significant challenges in implementing efficient cold chain systems. The impact of cool chain management on the quality and longevity of horticultural products, highlighting key components such as pre-cooling, refrigerated transportation, and controlled storage conditions. It explores the role of temperature regulation in minimizing spoilage, microbial growth, and physiological degradation, which are major contributors to post-harvest losses. Furthermore, the study discusses the economic benefits of an optimized cool chain system, including higher farmer incomes, reduced food waste, and improved consumer access to fresh produce. It also identifies existing bottlenecks, including inadequate cold storage infrastructure, lack of refrigerated transport facilities, and high operational costs. Case studies from India and other developing nations illustrate how the absence of an integrated cold supply chain leads to significant wastage and financial losses. To enhance food security and sustainability, it suggests policy interventions, investment in cold chain infrastructure, and the adoption of innovative technologies such as IoT-enabled monitoring and solar-powered refrigeration. Strengthening the cool chain system is imperative for ensuring a resilient horticultural supply chain, ultimately contributing to economic growth and global food security.

Keywords: Cold Chain, Food Security, Postharvest, Preservation, Sustainability.

SOIL HEALTH CARD: AN APPROACH TOWARDS SUSTAINABLE AGRICULTURE

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Soil provides ecosystem services critical for life; it acts as a water filter, a growing medium, provides habitat for billions of organisms, contributing to biodiversity, provides essential nutrients to our forests and crops, and helps in regulating the Earth's temperature as well as many of the important greenhouse gases. Thus, the year 2015 was declared as INTERNATIONAL YEAR OF SOIL (IYS) by the 68th United Nations General Assembly on December 20th ,2013 after recognizing December 5th as WORLD SOIL DAY. On this basis the Govt. of India has launched a nation-wide program namely the SOIL HEALTH CARD SCHEME (SHCS) on 19th Feb. 2015 aiming to provide SOIL HEALTH CARD (SHC) to 14cr . farmers of the country. SHC provides first-hand information on 12 soil parameters viz., Boron, Zinc, Iron, Copper, Manganese, Nitrogen, Phosphorus, Potassium, Sulphur, pH, Electrical conductivity, Organic carbon. It also contributes to an increase in the farmer's income with an aim of in Doubling the farmers income. Therefore,a well-monitored SHC ,consisting of crop wise recommendations of nutrients and fertilizers, is important for farmers.

Keywords: Soil management, international year of soil science, soil nutrient status, sustainable agriculture, farmer income.

Problems arising due to over-mechanization in farming practices

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Mechanization in agriculture has significantly increased productivity, efficiency, and profitability. However, excessive reliance on mechanization poses several long-term disadvantages that can impact the environment, economy, and social structures. This abstract highlight key concerns associated with over-mechanization in farming.

Soil Degradation: Heavy machinery compacts the soil, reducing aeration and water infiltration, leading to lower soil fertility. Loss of Biodiversity; Large-scale mechanized farming often promotes monoculture, which depletes soil nutrients and disrupts ecosystems. Water Resource Depletion: Mechanized irrigation systems can lead to the overuse of groundwater, causing water scarcity. Increased use of fuel-based machinery contributes to greenhouse gas emissions and environmental pollution. Automation displaces farm laborers, thus leaving a significant portion of the rural population unemployed. Lack of employment opportunities drives rural populations into urban areas, thus increasing the congestion of urban centers. Mechanization favors big agricultural firms, leading to an inequality gap between landowners and small farmers. Mechanization negates local farming methods that can ensure sustainability. Mechanized agriculture usually involves more chemical application than necessary, endangering human lives. Higher dependency on large equipment increases the likelihood of farm-based injuries and death. Most farming machinery relies on fossil fuels, contributing to resource depletion and climate change. Intensive mechanization can permanently damage soil structure, reducing long-term agricultural productivity. If machinery-dependent farming faces disruptions (e.g., fuel shortages or supply chain breakdowns), food production may decline.

Keywords: - heavy machinery; monoculture; automation; inequality gap; sustainability; soil infertility; accidents; farming face disruptions

Spirulina Synergy: Pioneering Post-Harvest Strategies for Global Food Security

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This study enlightens the pivotal role of post-harvest management in enhancing the food security potential of spirulina, a highly nutrient dense microalga. Specialized emphasis is placed on advanced post-harvest technologies and storage solutions that preserve the beneficial compounds of spirulina, focusing upon the extension period of its shelf life. Novel drying methods, cold storage innovations, and advanced packaging technologies are discussed as key strategies to mitigate quality degradation during storage, transportation and packaging. The research significantly highlights an optimized food supply chain management and logistics framework. Reducing post-harvest losses and waste is addressed through the implementations of precision harvesting techniques, efficient monitoring systems, automated sorting systems and improved handling practices. Such measures are crucial for maintaining high yields and ensuring that the nutritional value of spirulina is not compromised through the supply chain and thereby contributes as an accessible compact food source to the consumers. Moreover, the nutritive value of the superfood spirulina boosts the immune system and stands effective for few chronic diseases. Its rich nutritional profile plays a considerable role in detoxification and enhances resistance to various diseases. Furthermore, the exceptional complete plant-based protein source incorporation in a vegan dietary in the form of spirulina provides sustainable alternatives to animal-derived sources. The study puts forward recent innovations in the food preservation and processing industry, such as encapsulation and freeze-drying technologies, which have been shown to significantly enhance the stability and bioavailability of spirulina’s active compounds. These advances are crucial for the development of spirulina-based products that meet the need of modern food security systems, ensuring a stable, high quality, and nutritious food supply in the face of growing global demands.

Keywords: Spirulina, Post-harvest Management, Food Security, Nutrition, Globalization.

Study on genetic parameters in post-rainy sorghum landraces

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Sorghum is a climate-resilient crop due to its unique characteristics. It's drought-tolerant, heat-tolerant, and water-use efficient, making it suitable for warm and tropical regions. Its genetic diversity provides a rich source of traits for breeding and improving climate resilience. Studying genetic parameters in sorghum for grain yield-related traits is crucial for identifying genetic sources of variation, estimating heritability and genetic gains, and developing effective breeding strategies to improve grain yield and stability, ultimately enhancing food security and sustainability. Field experiment involving 97 post-rainy (rabi) sorghum landraces was conducted at the Indian Institute of Millets Research (ICAR-IIMR), Hyderabad (Telangana) during 2020-21 to estimate genetic parameters for grain yield, its component traits, and other agronomic traits. Significant variation between genotypes was noticed for all the 12 traits studied. CSV-216R (114g), Malegaon local (104g), CSV-29R (97g), IC345199 (92g) are the genotypes which yielded highest among all the genotypes in terms of grain yield per plant. Estimates of heritability varied from 25% (number secondary branches on central primary branch of panicle) to 94% (panicle length). Grain yield per plant, test weight, panicle weight, panicle length and number of grains on central primary branch of panicle have shown high estimates of heritability and genetic advance which suggests that these traits were being controlled by additive gene action and can be improved through simple selection. Seed hardness, number of green leaves and number of grains per panicle have shown moderate heritability values whereas the remaining trait i.e., number of secondary branches on central primary branch of panicle had shown low heritability values.

Sustainable Agriculture: Crop Management & Climate Resilience

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Agriculture, which is essential to human survival, incorporates all scientific disciplines for the production of food, feed, fuel, fodder, and lumber. Agro systems are heavily reliant on climatic and natural phenomena. Due to their dependency, they are more susceptible to biotic (such as pests, illnesses, etc.), abiotic (such as drought, heat, and nutrient deficits, etc.), and socioeconomic factors that have varying frequencies and intensities of impact. To create resilient crops, it is essential to comprehend the genetic and biochemical reactions to these challenges. However, a large portion of the greenhouse gas emissions that cause climate change are caused by agriculture, which poses a serious threat to human survival. Long-term food security requires an interdisciplinary strategy that incorporates sustainable practices, resource management, and climate change adaption and mitigation options. According to the research, climate change can be lessened and natural habitats preserved through sustainable agriculture. Although sustainable agriculture is a transdisciplinary model that incorporates adaptation techniques and resources to increase the resilience of agro systems, it is also still hotly contested in the scientific community and lacks a consensus definition.

Keywords: Sustainability, cropping systems, abiotic stresses, climate adaptation, stress-tolerant crops, soil fertility

Boosting Agroecosystem Resilience Through Crop Rotation

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Crop rotation diversity is a crucial strategy for enhancing the resilience and advantages offered by agroecosystems. This approach promotes ecological interactions and synergies by rotating a range of crops, including oilseeds, legumes, and cereals. Rotations can increase biodiversity, enhance soil health, and reduce the load of disease and pests by utilising a variety of crops in the farming system. This approach, in turn, improves sustainable agricultural productivity by promoting ecosystem services including pollination, water retention, and nitrogen cycling. Addressing climate change while producing enough agricultural products on a limited amount of arable land to satisfy the demands of food, feed, fuel, fibre, and industrial applications is one of the most difficult problems of our day. Varying crop rotations can also lead to increased resilience to changes, including climate change. Diversifying crop rotation is a good way to build more resilient, sustainable, and environmentally friendly agroecosystems. However, farmers will need to use a variety of management techniques and diversify crop rotations in order to fully utilise the potential of ecological intensification.

Keywords: Crop rotation, climate change, agroecosystem, nutrient cycling, crop diversification

Soil and Water Conservation Interventions for Climate Change Mitigation

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Soil and water conservation (SWC) practices are essential for mitigating climate change by enhancing soil health, increasing carbon sequestration, and improving water use efficiency. Climate variability threatens agricultural sustainability, making the adoption of effective SWC strategies crucial for resilience. Key agronomic practices such as cover cropping, crop rotation, conservation tillage, mulching, and intercropping play a significant role in reducing soil erosion, enhancing organic matter, and maintaining soil moisture balance. These interventions not only contribute to greenhouse gas mitigation but also improve soil fertility and agricultural productivity. Additionally, integrated nutrient management, precision irrigation, and agroforestry further enhance sustainable land use by reducing surface runoff, improving infiltration, and promoting biodiversity. Conservation tillage minimizes soil disturbance, aiding in carbon sequestration and reducing energy consumption in farming operations. Cover cropping and mulching protect the soil surface, preventing degradation and enhancing microbial activity, which supports long-term soil fertility. The combination of these techniques fosters ecosystem resilience and promotes sustainable intensification. Despite their benefits, the widespread adoption of SWC practices faces several challenges, including knowledge gaps, financial constraints, and policy limitations. Limited access to resources and extension services hinders farmers from implementing these measures effectively. Strengthening research, extension support, and financial incentives is essential to encourage the large-scale adoption of these techniques. Moreover, integrating SWC into climate-smart agricultural policies can enhance food security, sustain ecosystems, and build climate-resilient agricultural landscapes. This study highlights the importance of investing in agronomic SWC interventions as a cost-effective and sustainable approach to addressing climate change and land degradation. By adopting these practices, policymakers, researchers, and farmers can contribute to climate mitigation while ensuring long-term agricultural sustainability.

Keywords: Agronomic practices, soil and water conservation, climate change mitigation, sustainable agriculture, carbon sequestration.

Smart Irrigation Systems: Optimizing Water Use for Sustainable Agriculture

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Water is one of the most important but becoming more limited inputs, and sustainable agriculture depends on the effective management of natural resources. Increasing crop output while maximising water consumption has become a critical challenge as climate variability increases and global food demands rise. In this regard, smart irrigation systems stand out as creative fixes that incorporate cutting-edge technologies to improve water efficiency and promote sustainable farming methods. These systems use wireless communication networks, weather forecasting services, and precision monitoring tools to control irrigation with exceptional accuracy, especially during intermittent wet spells. The combination of cloud computing, NI CompactRIO controllers, affordable Wireless Sensor Networks, and Internet of Things-embedded devices is demonstrated by a Smart Farm prototype, in which soil moisture, temperature, and climate sensors are all seamlessly connected to a single control system. By automating decision-making, machine learning algorithms improve irrigation techniques even further, providing small-scale farmers with significant advantages. According to field assessments, intelligent irrigation can increase crop yields by more than 10% while maintaining accurate soil moisture control. Nonetheless, there are still issues, such as a lack of study on wider agricultural implications, unclear nomenclature, and little interdisciplinary collaboration. Future research should focus on deep learning applications, water-energy dynamics, network interactions, irrigation techniques under stress, and the scalability of these systems across various agro-climatic zones. These developments highlight how intelligent irrigation technologies may revolutionise water conservation and build robust, sustainable agriculture systems.

Keywords: Smart irrigation, sustainable farming, water efficiency, precision agriculture, machine learning, climate resilience.

Growing Green: Sustainable Agriculture for a Resilient Planet

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In a time of environmental problems, improving climate resilience and guaranteeing food security depend heavily on sustainable agriculture. This essay examines the ideas and methods of sustainable agriculture that support long-term productivity, resource efficiency, and ecological balance. Through the integration of regenerative agriculture, organic farming, and agroecology, farmers can improve soil health, lower their carbon footprint, and support biodiversity. Global food systems are seriously threatened by climate change, which can result in water scarcity, soil erosion, and extreme weather events. Precision farming, conservation tillage, and crop variety are a few examples of sustainable agriculture practices that can be used to improve sustainability and productivity while reducing negative effects. Furthermore, there are useful methods to improve resilience against environmental stresses through cutting-edge solutions like agroforestry, climate-smart irrigation, and organic soil additives. This study emphasizes the part that stakeholders, farmers, and legislators play in advancing sustainable agriculture through funding green technologies, educating the public, and enacting favourable legislation. A healthier earth and a decrease in greenhouse gas emissions can be achieved by the agriculture sector by switching to environmentally friendly farming practices. Adopting sustainable agriculture is ultimately not just required, but also a calculated move to protect future environmental health and food security. By committing to sustainable practices, we can guarantee that farming will continue to be resilient and productive, sustaining livelihoods and protecting natural ecosystems.

Keywords: Agroecology, Climate Resilience, Food Security, Regenerative Farming, Sustainable Agriculture

Sustainable Sequins: Exploring the Potential of Seaweed-Based Materials

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One of the major issues facing the globe today is plastic pollution, and the major cause of this problem is petroleum-based plastics, which take thousands of years to break down and disappear from the environment. The increasing need to reduce the usage of plastics made from petroleum has inspired researchers to seek novel natural resources that possess the same properties as plastics but are also biodegradable and safe for the environment and human health. An abundant and renewable marine resource, seaweed shows promise as a substitute for petroleum-based plastics in several applications including the fashion industry. In addition to being affordable and biodegradable, materials are sustainable and renewable, and their synthesis processes can eliminate hazardous waste and chemicals.

Even though eco-friendly resources and eco-friendly technologies were used to manufacture the apparel, petroleum-based plastics were still used for the embellishments. Seaweed bioplastic sequins offer a sustainable substitute for traditional plastic sequins and pave the way for a more ecologically friendly future. The development of bioplastic sequins is still hindered by a lack of technologies. To overcome the obstacles and realise all the possibilities of this innovative technology, more research and development is essential. In order to reduce plastic waste and encourage circularity in the fashion sector, this study intends to show the potential of seaweed bioplastics as an environmentally friendly and sustainable substitute for sequin manufacture. The findings contribute to the growing field of bio-based materials and offer a practical solution for minimizing the environmental footprint of embellishments in textiles and other applications.

Sustainable Skies: The Role of Vertical Gardens in Urban Renewal

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Urbanization has led to increasing challenges in maintaining green spaces, combating air pollution, and ensuring food security. As cities expand, traditional horizontal gardening becomes less viable, necessitating innovative solutions. Vertical gardening emerges as a sustainable practice that integrates greenery into urban landscapes, addressing environmental, social, and economic concerns. Vertical gardens, also known as living walls or green facades, offer a transformative approach to urban renewal. By utilizing vertical surfaces such as building exteriors, balconies, and rooftops, they maximize greenery in limited spaces. These installations improve air quality by filtering pollutants, reducing the urban heat island effect, and enhancing biodiversity. Additionally, vertical gardens contribute to energy efficiency by insulating buildings, lowering cooling and heating costs. Beyond environmental benefits, vertical gardening plays a crucial role in social and economic development. Incorporating green walls into urban infrastructure fosters mental well-being, creates aesthetically pleasing environments, and encourages community engagement. Moreover, urban farming through vertical gardens enhances local food production, reducing dependency on imported produce and promoting food security in densely populated areas. The integration of vertical gardens into urban planning requires collaboration among architects, policymakers, and environmentalists. Cities worldwide are recognizing the potential of vertical gardens in revitalizing neglected spaces, promoting ecological balance, and improving overall quality of life. As the world faces rapid urbanization and climate change, vertical gardening stands as a vital strategy for fostering resilient and sustainable cities. By redefining urban landscapes, vertical gardens pave the way for greener, healthier, and more livable environments, truly embodying the essence of sustainable skies.

Keywords: Vertical Gardening, Sustainable cities, Green facades, Urban heat, Traditional horizontal gardening, Living walls etc.

Sustainable Innovation in Sugarcane Cultivation

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Sugarcane is one of the important crop for biofuel, sugar, and energy production. However, its cultivation faces challenges such as water scarcity, soil degradation and pest or disease incident. To address these issues, innovative practices are being adopted in sugarcane cultivation. New cropping system, introducing inter-cropping sugarcane with legumes, improve soil fertility and reduce the need for synthetic fertilizers. Crop rotation with nitrogen –fixing plants such as pules (chickpea) and oilseeds (soybean) which enhance soil health, reduces pests or diseases, and promotes biodiversity. These practices contribute to maintaining high yields. Integrated pest and disease management (IPDM) plays a crucial role in reducing crop losses. Biological control agents (BCA), resistant varieties and eco-friendly pesticides are being used to manage pests like borers and white grubs, while fungal and bacterial diseases are mitigated through precision monitoring. Improving irrigation, such as drip and surface irrigation, optimizes water usage and improves sugarcane growth, especially in water-scarce regions. These techniques reduce water wastage, enhance nutrient absorption, and lead to higher sucrose content in sugarcane. Sustainable livestock integration within sugarcane farming systems maximizes land use efficiently. By incorporating livestock, farmers can utilize sugarcane by-products as fodder; while animal waste enriches soil organic matter, reducing the use of synthetic fertilizers. These sustainable practices not only enhance sugarcane productivity but also promote environmental conservation, reduce input costs and improve farmer livelihoods. the integration of modern technologies and eco-friendly farming methods ensures long–term resilience and profitability in sugarcane cultivation, addressing both economic and ecological concerns.

keywords: IPDM, Soil fertility, BCA, Cropping system, Sustainability.

A Metabolomic Perspective: Identification of Key Metabolites Influencing Rancidity Development in Pearl Millet

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Pearl millet (Pennisetum glaucum) is a climate-resilient cereal that has the immense potential to address food and nutritional security challenges by 2047, when the global population is expected to reach more than 9 billion. Known as the food of the future, pearl millet thrives in arid and semi-arid areas where other staple crops fail because it can withstand heat, drought, and poor soil conditions. Pearl millet is rich in carbohydrates, proteins, lipids and many other macro and micronutrients which empowers it as a Nutricereals. However, its high lipid content makes it highly susceptible to rancidity, leading to deterioration in flour quality, reduced shelf life, and generation of off-flavors. In this study, six pearl millet varieties which are categorized as high-rancid and low-rancid will be analysed during storage at 0-day, 5-day, 10-day, and 28-day by using non-targeted metabolomics to identify key metabolites associated with rancidity, including fatty acids, glycerophospholipids, glycerol lipids, sphingolipids, flavonoids, alkaloids, and terpenoids. LC-MS were employed to detect compositional changes linked to lipid degradation, enabling the characterization of metabolic shifts and providing insights into the biochemical mechanisms underlaying rancidity. This will reveal the novel insights into utilising metabolomics for understanding rancidity-related biochemical processes, and pathways ultimately facilitating precision breeding strategies for developing low-rancid pearl millet varieties.

Key words: High-rancidity, LC-MS (Liquid Chromatography-Mass Spectrometry), Lipid metabolites, Low-rancidity, Pearl millet, Rancidity, Untargeted-metabolomics.

Genetic Diversity and Trait Associations in Cucumber: An AI-Driven Approach

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Cucumber (Cucumis sativus L) is a tropical vegetable crop with high economic and medicinal value. Rich in antioxidants like β-carotene and ascorbic acid, it helps reduce diabetes mellitus and several skin problems. This study investigated genetic diversity and key traits influencing yield, disease resistance, and nutraceutical content in cucumber genotypes from West Bengal, India. Twenty-nine genotypes were evaluated for 18 qualitative and 14 quantitative traits. Significant genetic variability was observed, particularly in fruit shape, color, and yield. Cluster analysis using Mahalanobis D^2 statistics grouped genotypes into distinct clusters. Multiple Linear Regression (MLR) analysis revealed that fruit weight, fruit count, and fruit length were significant predictors of total yield (R^2=0.834). Artificial Neural Networks (ANN) identified peduncle length, fruit girth, and fruit color at maturity as key predictors of ascorbic acid and β-carotene content. These findings provide valuable insights for cucumber breeding programs in West Bengal, helping breeders select and develop superior genotypes with improved yield, disease resistance, and enhanced nutritional quality.

Keywords: Characterization, cucumber, MLR, ANN, Artificial Intelligence

CRISPR/Cas9 BASED GENOME EDITING IN WHEAT: A COMPREHENSIVE REVIEW

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Bread Wheat/Common Wheat (*Triticum aestivum*, AABBDD, 2n=6X= 42 chromosomes), is one of the staples and most consumed cereals across the globe. With the ever-increasing population and limited cultivable land, improving agronomic traits to enhance wheat production, especially through mutation breeding, has substantiated to be a challenge, mainly because of the large genome with high repetition. To help ease out matters, Clustered Regularly Interspaced Short Palindromic Repeat (CRISPR/ CRISPR-Associated Nuclease (Cas) genome editing technologies have offered an effective and promising solution for the precise manipulation of genomes of crops by detecting target sequences of DNA using the sgRNA sequence of CRISPR complex and thereafter, cleaving the targeted DNA sequence (causing Double-Strand Breaks) using the Cas9 protein(nuclease). Presently, Crispr gene editing technologies have been able to generate various genome modifications in wheat, including indels, precise nucleotide substitutions and insertion or deletion of larger DNA fragments. Improving grain weight to enhance yield of wheat has been achieved by CRISPR/Cas9 through targeting the gene TaGW2 which functions to regulate grain weight using Particle Bombardment method. Likewise, TAGW7 gene has also been targeted by CRISPR/Cas9 genome editing technology, resulting in a reduction of grain length and increase in the grain width and weight that ultimately improves the yield trait of wheat. Thus, the CRISPR genome editing system has been powerful and highly efficient in producing transgene free and homozygous wheat mutants.

Examining Technological Gap in Sugarcane Cultivation: A Study from Haryana

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Sugarcane is a vital cash crop in Haryana, especially in districts like Yamuna Nagar, Kaithal, and Rohtak. However, the adoption of advanced production technology among sugarcane growers remains limited, hindering productivity and profitability. This study aimed to assess the technological gap and identify the key constraints in adopting sugarcane production technology. Data were collected from 120 sugarcane farmers using structured interviews in 2023. The technological gap, calculated as the difference between recommended practices and actual adoption, averaged 30.19%. The highest gaps were observed in pest (38.06%) and disease management (36.67%), while irrigation practices showed the least gap (21.95%). Education was positively correlated with technology adoption, while income, social participation, and innovation also significantly influenced adoption levels. Farmers reported facing medium to high levels of constraints. Major barriers included high labor costs, transportation expenses, labor shortages during peak seasons, and high prices of plant protection chemicals. These challenges highlight the urgent need for targeted interventions, such as affordable inputs, enhanced pest management strategies, and improved supply chain mechanisms. By addressing these issues, this study emphasized the potential to bridge the technological gap and empower farmers to enhance sugarcane productivity in Haryana, ultimately contributing to the sustainability and profitability of the sugarcane industry.

Keywords: Technological gap, Constraints, Sugarcane production, Adoption challenges, Haryana farmers

Role of Cover Crops in Enhancing Soil Health and Nutrient Cycling

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Cover crops refer to plants cultivated to enhance soil fertility, reduce erosion, enhance protection of the soil, and contribute to nutrient cycling. They contribute a significant role in enhancing the diversity of microbial populations and soil health. Selection of cover crops is based on the primary reasons they serve. These include improving nutrient availability and suppressing weeds. The major factors that influence the choice of cover crops relate to weather conditions and sowing time. Leguminous and non-leguminous crops are also included. Recently, cover crops have also been recognized for their contribution towards the mitigation of climate change and enhancement in availability of nutrients, especially exchangeable ones like Mg^{2+} and K^{+}. These multi-functional crops improve soil quality by enhancing its physical, chemical, and biological properties, raising organic matter content, releasing available nutrients, suppressing pests, and controlling weeds. However, cover crop-soil nutrient interactions are complex and necessitate careful management to optimize effectiveness. Understanding such dynamics is very important for appropriate, site-specific fertilization strategy setting. Efficient management options will be necessary in developing a context-specific cover cropping system that will maximize both soil health and agricultural productivity.

Keywords: Cover Crops, Soil Health, Nutrient Cycling, Microbial Diversity, Climate Change Mitigation.

Genetic variability studies in wheat (*Triticum aestivum*)

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The current study entitled, **"**Genetic variability studies in wheat (*Triticum aestivum*)" was undertaken to obtain information on important genetic parameters in a set of thirty-six genotypes and four checks. The study was carried out to analyze genetic variability, correlation, and direct and indirect influence of various attributes on seed yield among all genotypes grown in randomized block design with two replications accomplished during *rabi* 2023-2024 at Wheat and Maize Research Unit, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. High heritability coupled with high genetic advance as per cent mean was observed for days to 50% heading, number of productive tillers per plant, spike length, number of grains per spike, biological yield per plot, 1000 grain weight, harvest index and grain yield per plot. Therefore, heritability of these characters is due to additive effect and selection might be effective for improvement of these characters. Based on mean performance, genotypes IC 539250 (0.96 kg/plot), EC 445278 (0.68 kg/plot), IC 416098 (0.68 kg/plot), EC 445427 (0.64 kg/plot) and EC 444951 (0.60 kg/plot) exhibit higher grain yield and were found as promising genotypes. The grain yield per plot showed positive significance correlation with number of productive tillers per plant, number of grains per spike, biological yield per plot and harvest index. Therefore, these characters are considered as yield contributing characters for improvement of yield. The path coefficient analysis revealed that number of productive tillers per plant, number of grains per spike, biological yield per plot and harvest index exhibited positive direct effect and significant positive genotypic correlation with grain yield per plot. Therefore, direct selection for these characters would be easy and would be rewarding improvement in yield of wheat. It could be concluded that in breeding programme aiming to improve the grain yield in wheat, more weightages should be given to effective number of productive tillers per plant, number of grains per spike, biological yield per plot and harvest index.

(**Keywords:** Wheat**,** Variability, Heritability, Genetic advance as per mean, Correlation and Path coefficient)

De-Stressing Farm Women; A Step Towards Em (Powering) Them

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According to the 2021-2022 Periodic Labour Force Survey (PLFS), women make up 62.9% of the agricultural workforce. In rural India, about 80% of women work in agriculture. Women make up about 33% of cultivators and 47% of agricultural laborers. With increasing rural-to-urban migration by men, Indian agriculture is experiencing "feminization," where women take on key roles as cultivators, laborers, and entrepreneurs. They often face a heavy workload and significant stress due to the demanding nature of farm work combined with their domestic responsibilities, including childcare and household chores, with limited access to resources and support, leading to physical and mental stress or health concerns. The physical and mental stress experienced by farm women can significantly impact sustainable agriculture by leading to decreased productivity, poor decision-making, reduced resilience to environmental challenges, and potentially neglecting important farm practices that contribute to long-term sustainability. The number of studies related to the stress and well-being of women in farming are still relatively small thus, research has been conducted in Coochbehar and Alipurduar districts of West Bengal, to study the level of stress of the farm women as well as the factors contributing to it. The study has also generated measures to reduce the stress level among the farm women. The study employed a ex post facto research design and stratified simple random sampling technique for the study. Family structure has a significant positive association with the stress level of the farm women. The study suggests fostering social connection, providing support networks, addressing specific stressors through education and various adaptation strategies. By addressing these stressors, women's participation in agriculture can be strengthened, fostering both economic empowerment and gender equality in the sector.

Keywords: Agriculture, farm women, stress, factors

Roots to Robots: Blending Ancient Wisdom with Precision Agriculture for a Sustainable Future.

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Agriculture is at a crossroads. Climate change, soil degradation, and resource depletion are threatening agriculture. While modern precision agriculture offers technological advancement, traditional farming wisdom holds priceless sustainability lessons. But abandoning age-old wisdom for high-tech solutions is not the answer either. The future of farming lies in merging the roots of tradition with the intelligence of technology—a perfect blend of ancient farming techniques and precision agriculture (PA). Methods like organic composting, rainwater harvesting, intercropping, and natural pest control have conserved soil fertility, as well as biodiversity. Fine-tuning moisture content in soils, AI algorithms can predict possible outbreaks of pest infestation, drones assess crop health issues, and planters and reapers, linked through GPS sensors, can efficiently sow and reap the crops instead of replacing their wisdom, the data can fortify them-for fine-tuned old techniques towards efficient implementation for a climatologically unpredictable region. The challenge is, however, the accessibility and affordability of PA among small-scale farmers. Most high-tech farming methods are not feasible because of costs, lack of awareness, and poor infrastructure. Localized innovations at low costs, mobile advisory services, and training programs have to empower the farmer to put modern tools alongside traditional practices. The farmers will be able to produce more with fewer resources, protect the health of soil, and face climate change when intuitive ancestral knowledge is combined with real-time digital precision. Agriculture's future doesn't belong solely to old wisdom or new technology but to the seamless integration of both, which will ensure farming remains productive yet sustainable for generations to come.

Keywords - Climate change, Precision agriculture (PA), Traditional farming, Sustainability, Natural pest control, AI algorithms, Drones, GPS technology, Small-scale farmers, Mobile advisory services.

Transforming Agriculture: Carbon Farming as a Catalyst for Sustainable Development and Climate Change Mitigation

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Agriculture is capable of adding to and, at the same time, offsetting climate change. An innovative approach known as "carbon farming" integrates multiple sustainable agriculture practices to enhance the retention of soil carbon and mitigate greenhouse gas emissions. Some of the important methods in this situation which can be applied to capture atmospheric CO2 and store it in the soil include application of biochar, agroforestry, conservation tillage, cover crops, alternating wetting and drying (AWD), and soil organic carbon (SOC) management. These techniques not only slow the effects of climate change but also boost microbial diversity, increase soil fertility, and optimize water management, which makes agriculture more adaptable to harsh weather. This paper, therefore, has outlined some of the major environmental, financial, and social benefits, including improved soil health, climatic resilience, water saving, and income-generating opportunities via carbon credits. It also explores how carbon farming is being put into practice, key monitoring metrics, barriers to farmer uptake, legislative gaps, financial constraints, and the role of international carbon markets in promoting sustainable farming practices. This article discusses the introduction of cutting-edge technology such as soil carbon modelling, remote sensing, and blockchain-based carbon credit trading systems for the improvement of efficiency and transparency in carbon farming projects. Transforming agricultural landscapes into carbon sinks represents this potentially powerful approach, in concert with sustainable agriculture, food production, and long-term environmental stability. Widespread diffusion of such practices would support the achievement of global climate goals, promote rural economic development, and work toward food security for future generations.

Keywords: Carbon farming, Sustainable agriculture, Soil carbon sequestration, Climate change mitigation, Carbon credits.

Building Climate- Resilient Farms: Strategies for Sustainable Agriculture

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Climate–Climate-resilient agriculture (CRA) encompasses the integration of adaptation, mitigation, and various agricultural strategies. Fluctuations in temperature and rainfall patterns have adverse effects on crop productivity, posing a threat to food security in India. Sustainable agriculture is a farming approach which improves the quality of the environment and the foundational resources that agriculture relies on. Maintaining and enhancing soil quality can be accomplished through practices such as after harvesting, and recycling agricultural waste in the field. By integrating traditional knowledge and modern techniques. CRA can provide a promising pathway to improve productivity, resilience and carbon sequestration. Various practices like conservation tillage, balanced nutrient application, crop residue management, crop rotation, weed management and organic farming boost soil fertility, combat degradation, and promote long-term productivity. Through the adoption of technological advancements, Indian agriculturists have the opportunity to strengthen their adaptability, lessen uncertainties, and guarantee food sustainability amidst changing agricultural scenarios. AI-driven decision support systems utilize climate analytics, soil condition insights and crop performance data to improve decision-making processes. Provide seasonal advisory on climate impacts on yields and changes in food availability within national and international production to enable value chain actors to set transparent and competitive food prices for both domestic markets and food exportation. Use proper harvest equipment and conduct training on harvesting methods and best timing to minimize losses caused by falling of fruit and food spoilages. Using community lands for fodder production during droughts and floods, enhancing fodder and feed storage techniques, employing feed ingredients and micronutrients to enhance resilience to heat stress, along with providing preventive vaccinations are some interventions in the livestock and fisheries industry. Furthermore, incorporating CRA practice into India's broader economic and development goals requires harmonizing agricultural strategies with national economic agendas, poverty alleviation programs, and sustainable targets.

TURMERIC AND TAMARIND THE POTENTIAL HURDLES IN FISH PRESERVATION

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In order to extend the shelf life of perishable Croaker fish, the current study intends to ascertain the microbiological and sensory profile of Croaker fish fillets treated with both turmeric and tamarind simultaneously. This will help to validate the hurdle concept and achieve a synergistic effect, which requires more energy from microorganisms to break through all the barriers. The proximate composition of Croaker was found to be Protein (16.20±0.18%), Fat (2.77±0.04%), Moisture 79.23±0.17%) and Ash (1.66±0.01%). The TPC value, gradually decreased from Control (5.524±0.006 log cfu/g) with increased concentration of turmeric and tamarind respectively to get the synergistic effect and finally the T8 treatment recorded lowest TPC score (4.92±0.01 log cfu/g) which may be due to synergistic antimicrobial effect of highest concentrations of turmeric (6%) and tamarind (4%). At rates of 0%, 2%, and 4%, respectively, TPC levels dropped inversely in relation to the additional tamarind concentrationT5 had the smallest Staphylococcus count (3.91±0.01 log CFU/g). Every treatment, including control, falls within the safe range of Staphylococcus that is suitable for human consumption. The count of Salmonella sp. was zero, and the fungal count in all treated samples, including the control, was zero or very low. At rates of 0%, 2%, and 4%, respectively, the pH dropped inversely in relation to the amount of tamarind supplied. According to the pH and microbiological evaluation, T5 and T8 both showed the best preservation effect results. Because of their combined antibacterial properties, turmeric and tamarind may be used as a natural method of preserving fish.

Key words: Turmeric, Tamarind, Microbial count, Croaker, Seafood borne pathogen

STUDIES ON DISTRIBUTION, REGENERATION STATUS, AND UTILIZATION PATTERN OF *Terminalia chebula Retz*. IN SIRSI FOREST DIVISION OF UTTARA KANNADA DISTRICT OF KARNATAKA

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The present study was conducted in five natural populations of Terminalia chebula Retz. Distributed habitats in dry deciduous, moist deciduous and semi-evergreen forests of the Sirsi Forest division of Uttara Kannada district in Karnataka. In every natural population, 5 quadrates of 20m×20m, size plots were randomly laid out to study the population status and vegetation diversity of the tree species. In each quadrat, nested quadrats of 1m×1m, size were laid out to study the regeneration status of Terminalia chebula distributed forest. The entire study area's tree species comprised 68 Species representing 53 genera and 28 families. All the sites are dominated by the Terminalia chebula tree in its natural population according to the ranking of IVIThe highest IVI of Terminalia chebula regeneration in the Hulekal range (27.42), followed by Janmane (22.06), Banavasi (15.04), Sirsi (15), and Siddapur (13.47). The Shannon-wiener index of the regeneration layer ranges between 3.03 to 2.81. Simpsons index values varied from 0.06 to 0.08. Evenness index values were found between 0.10 to 0.12. This study also documented utilization patterns of the tree by participatory discussion method through a questionnaire survey. A total of 85 families from 22 different villages of Sirsi Forest Division were surveyed and 15 different using patterns and 7 various medicinal usages were documented which are used for a variety of purposes by the local people of this region.

Keywords: Community structure, regeneration status, Species diversity, Importance Value Index, Family Importance Value, Shannon-Wiener index, Simpsons index, evenness index

Urban Tourism Synergy with Agri Horti Cultural Practices

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Indonesia's booming tourism sector, fueled by its natural beauty and cultural diversity, presents both opportunities and challenges, particularly in agrotourism development as a sustainable alternative. This research explores the untapped agrotourism potential in Dante Mararih Hamlet, South Sulawesi, focusing on horticultural resources and public awareness. Using qualitative methods like observation, interviews, and documentation, the study reveals significant agro-tourism potential in the area, which can provide economic benefits through local commodities, cultivation activities, and natural beauty. However, public awareness is low, requiring efforts to align perceptions and optimize resources like human resources, infrastructure, and agro-industry. A broader reflection on urban landscapes highlights the value of interstitial spaces, which often go unnoticed but hold potential for urban cohesion. These spaces can facilitate ecological processes, social interaction, and community development. The integration of urban agriculture into such spaces can help cities become more self-sufficient, support sustainability, and preserve resources. Farming multifunctionality in peri-urban landscapes, seen in Europe, enhances social, aesthetic, and environmental functions. In Chieri Municipality, Italy, a study of farm multifunctionality across three categories—crops, vineyards, and horticulture—identified strategies for promoting sustainability, such as enhancing rural farm networks, promoting local food, and integrating farms into tourism. Urban agriculture also plays a critical role in promoting sustainable food systems. Research on urban gardens and family tourism highlights their potential as attractions that engage families with local food and foster sustainable urban development. These studies advocate for a holistic approach to landscape design, combining production, leisure, and protection for sustainable urban landscapes.

Keywords: Agrotourism, Multifunctionality, Peri-urban landscapes, Holistic approach, Sustainability

Value Addition of Roselle (*Hibiscus sabdariffa*) Calyxes: Standardisation and Storability of Jam and Tea

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Roselle (*Hibiscus sabdariffa*) is a tropical shrub rich in antioxidants that offers significant potential for enhancing rural livelihoods in India through its cultivation and production of value-added foods and beverages. Various post-harvest products can be made from this nutraceutical significant crop. In this investigation, the development and storage stability of two value-added products *viz.*, roselle jam and roselle tea were studied. The products were evaluated for their physicochemical properties and sensory attributes for over 120 days of ambient storage. Roselle jam was prepared with varying added sugar (500-1250g per Kg roselle pulp) for its process standardization while the Roselle tea was prepared by treating with varying blanching time (0 to 90 secs). The Jam exhibited good stability in over 4 months in terms of pH (initial: 3.40, final: 3.37) and maintained an acceptable sensory quality throughout. However, average vitamin C content of all the treatments decreased from 3.89 mg/100g to 3.10 mg/100g, and the mean anthocyanin content declined from 48.44 mg/100g to 26.65 mg/100g. In case of Roselle tea stored for about 4 months, a slight increase in its average moisture content (0.90% to 1.02%) and a decrease in the mean vitamin C content from 31.50 mg/100g to 19.27 mg/100g was observed. The overall acceptability of the tea decreased from 7.36 to 5.55 on a 9-point hedonic scale. Roselle jam prepared with 1250g added sugar per 1000g pulp had the highest nutrient retention during storage along with the highest consumer acceptability. Whereas Roselle tea prepared after steam blanching for 90 seconds showed significantly better biochemical and sensory attributes during storage. This research provides valuable insights into the processing and shelf-life of roselle-based products, contributing to the development of sustainable and profitable value chains for this underutilized crop in India.

Variability of narrow-leaf lupin RILs lines in terms of proportion of seed coat and pod walls

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Narrow-leaf lupin *(Lupinus angustifolius)* is a bean crop with applications in the food and feed industry due to its fat protein, fiber content, and rich chemical composition. In legumes, an important parameter is the proportion of seed coat and pod walls whose content affects seed quality parameters. Over the years, recombinant inbred lines resulting from crossing the Graf variety (well-yielding and high proportion of the seed coat) and the AU mutant (Low yielding and low seed coat proportion) have been analyzed. Tests in terms of seed coat and pod wall proportion of 131 lines were performed in 2023 and 2024. Recombinant lines were characterized by pod wall participation in 2023r max 45.7%, min 18.3% and in 2024r max 41.7%, min 18.8% while seed coat participation in 2023r max 26.7%, min 19.4% and in 2024r 26.0%, min 15.1%. Some lines showed these traits as stable not variable in years other lines showed a large difference in years. The results indicate a wide range of analyzed characteristics. The variation indicated possibilities for further selection for genotypes possessing improved traits of pods and seeds

BSF LARVAL FRASS: AN ORGANIC APPROACH FOR ENHANCING PLANT GROWTH AND IMPROVING SOIL HEALTH

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Black soldier fly larval frass is a natural and sustainable by-product of black soldier fly larvae (BSFL) production. It is essentially the solid waste or excrement left behind by these larvae as they feed on organic materials like food scraps. BSFL frass has gained significant attention as a valuable biofertilizer due to its rich nutrient composition and beneficial properties for plants and soil. BSFL frass is a good source of essential plant nutrients including 1.7% Nitrogen, 0.8% Phosphorus, and 1.3% Potassium. It also contains micronutrients like iron, zinc, copper, and manganese. It is having high waste degradation efficiency (65-78%). It is a rich source of organic matter, which improves soil structure, water retention, and aeration. Frass contains chitin, a natural biopolymer that can stimulate plant growth, enhance nutrient uptake, and act as a natural defense against certain pests and diseases. It often contains beneficial microorganisms that can help suppress plant pathogens and improve soil health. Nutrients in frass are released gradually, providing a sustained supply to plants. BSFL frass can be directly applied to soil as a fertilizer or mixed into compost. It is particularly beneficial for vegetable gardens, flower beds, and agricultural fields. BSFL frass helps to reduce organic waste by converting food scraps into a valuable resource. It offers a sustainable alternative to synthetic fertilizers, reducing environmental impact.

Key words: BSFL, Organic, Bio-fertilizer, Nutrients, Soil health.

Irrigation production efficiency and water footprint of mustard crops under moisture Deficit conditions

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A two-year (2020 to 2022) research conducted at Prayagraj (Uttar Pradesh, India) in IRS farm of Sam Higginbottom University of Agriculture, Technology and Science to assess the Irrigation production efficiency and water footprint of the mustard crop (Varuna T-59) under moisture Deficit conditions The experiment was plotted in random block design. This research work included 5 treatments with three replications. Under soil-water-limited conditions, irrigation volume is lowered by 20%, 40%,60%, and 80% of the design depth of irrigation (60 mm) in the second, third, fourth, and fifth treatments, respectively. However, in the first treatment, full irrigation depth is provided without any stress. Under soil water limiting conditions, Maximum growth parameter, yield attributes height(162.5cm), number of leaves (36), number of branches (23), dry matter accumulation (40 g/ plant), Maximum leaf area index (5.3), length of siliqua (5.3cm), number of seeds around 16 per siliqua, 1000 seed-weight (5.3g), stover yield, (7 t/ha), the maximum yield (2.25 t/ha), biological yield (9.26t/ha) and harvest index (24.35%) were recorded with 216 mm depth of water at 40% moisture deficit. Highest irrigation production efficiency(1.33Kg/m^3) calculated under soil-water limiting conditions with 72mm depthof water at 20% soil moisture depletion, while Maximum values of Water Footprint (2164.3 l/Kg) calculated with 360 mm depth of water at 0% soil moisture depletion. Version 6.1 of the FAO aqua crop model was used to validate and simulate the water productivity, biomass yield and yield of mustard for all irrigation scheduling. This model accurately simulates grain yield, biomass, and water productivity under for all irrigation scheduling of moisture deficit irrigation may be due to its good fit and good collinearity with observed data.

Keywords: Soil-water-limited condition, grain yield, biomass, water productivity, Water footprint, benefit-cost ratio, and Aqua Crop model.

Wildlife Health, Conservation, and Management

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Wildlife health, conservation, and management are crucial for maintaining biodiversity, ecosystem balance, and sustainable coexistence between humans and wildlife. The increasing threats of habitat destruction, climate change, poaching, and emerging diseases pose significant challenges to global wildlife populations. Effective conservation strategies integrate scientific research, policy frameworks, and community participation to ensure the protection of species and their habitats. Wildlife health management involves disease surveillance, rehabilitation programs, and veterinary interventions to mitigate the impact of infectious diseases and human-wildlife conflicts. Conservation initiatives such as protected areas, sustainable land-use planning, and wildlife corridors help maintain genetic diversity and ecological resilience. This paper explores the interconnectedness of wildlife health and conservation, emphasizing the importance of adaptive management approaches and collaborative efforts in safeguarding global biodiversity.

Keywords: Biodiversity, Threats, Management, Conservation, Approach, Efforts

Within and between seed sources variation in germination traits of *Albizia procera*

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Albizia procera Benth., commonly known as White Siris or Safed Siris, is a large, fast-growing deciduous tree from the Fabaceae family. Analysis of variance revealed significant differences ($p < 0.0001$) among seed sources and trees within the seed source for all germination traits except germination percentage, mean daily germination, and germination index. Among seed sources, Navsari exhibited the highest germination performance with values such as germination percentage (85.33 ± 7.18), mean daily germination (2.67 ± 0.22), and germination index (2373.33 ± 202.46). Conversely, the Dang seed source showed the lowest germination percentage (73.89 ± 7.90) and germination index (2056.22 ± 212.90). Significant differences were also observed within seed sources for traits such as germination rate index, peak value, germination value, and mean germination time. Notably, individual tree analysis identified NRM11 as the top performer for germination percentage (90.00%) and germination index (2536.67), while DG13 and DG09 showed the lowest values for germination percentage (66.67%) and germination index (1865.00), respectively. These findings underscore the importance of selecting high-performing seed sources, such as Navsari, for restoration projects, as local provenances often demonstrate superior adaptation to site-specific conditions. This supports the use of local seed sources to enhance the success of ecological restoration initiatives.

Keywords: *Albizia procera;* germination percentage, mean daily germination; peak value.

Response of different IBA concentrations on sprouting and rooting of croton cuttings

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The investigation entitled "Response of different IBA concentration on sprouting and rooting of croton cuttings" was carried out at Ornamental Nursery, Floriculture and Landscape and Architecture, Dr. PDKV, Akola during September to February,2023-24 with the objectives to study the effect of IBA, on sprouting and rooting of softwood, semi hardwood and hardwood croton cuttings. The experiment was laid out in Factorial Randomised Block Design with 3 replications and 2 factors, Factor A consist of different types of cutting viz. softwood cutting, semi hardwood cutting and hardwood cutting and Factor B consist of different IBA concentrations viz. IBA-100ppm, IBA-200ppm, IBA-300ppm, IBA-400ppm and IBA-500ppm with 15 different combinations. The result of present investigation indicated that the treatment hardwood cutting was recorded significantly superior results in respect of minimum days to rooting and sprouting of cuttings, maximum number of shoots per cutting, number of sprouting per cutting, length of longest sprout, number of leaves per cutting, plant height, leaf area, number of roots per cutting, length of longest root, stem girth and survival percentage. Regarding the treatment IBA-400ppm exhibited significantly superior results for minimum days to rooting and sprouting of cuttings, maximum number of shoots per cutting, number of sprouting per cutting, length of longest sprout, number of leaves per cutting, plant height, leaf area, number of roots per cutting, length of longest root, stem girth and survival percentage. Similar results were recorded in the interaction effect between types of cutting and IBA concentration Le hardwood cutting with IBA-400ppm.

A Vital Role of Forest Ecosystem Services: Environmental services and Sociocultural benefits

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Mankind depends upon a variety of ecosystem services (ES) provided by forest ecosystems. Forests are vital and self-regenerating ecological units which provide a myriad of services that contribute to human survival and quality of life. ES are generated because of interaction and exchange between biotic and abiotic components of an ecosystem (de Groot *et al*., 2012). Ecosystem goods provisioned by the forests are the direct material benefits (e.g. fuel wood, fodder, wild edibles, minor forest products), whereas ES are the indirect benefits of a forest ecosystem (such as purification of air and water, mitigation of floods and droughts, detoxification and decomposition of wastes, carbon sequestration) (Singh, 2012). Forest ecosystems are responsible for providing a wide range of goods and services to human beings, sustaining their livelihoods and survival. ES service concept has been proposed as a meaningful framework for natural resource management, and it holds concomitant benefit and consequence for the forest product sector. In the first major study.In the Millennium Ecosystem Assessment (Anon, 2005), ES have been categorized into: Provisioning services (food and water); Regulating services (flood and disease control); Cultural services (spiritual, recreational and cultural benefits; and Supporting services (nutrient cycling that maintains the conditions for life on Earth). In a basic "*Payment for Ecosystem Services*" (PES) transaction function, if a payment (a landowner) of the value of conserved ecosystem services surpasses the expected economic benefit from conversion, that makes forest conservation the economically desirable choice

Keywords: Self-regenerating ecological units, Forest ecosystem services, Millennium ecosystem assessment, Environmental services, Sociocultural benefits, Annual economic value, Regulatory or habitat services.

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