12th National Seminar

on

Futuristic Agriculture: Technology, Sustainability and Beyond

22th-24th May, 2025

COMPENDIUM

Organised by:

Society for Community Mobilization for Sustainable Development, (MOBILIZATION), New Delhi

Jointly with

Central Agricultural University, Imphal
ICAR Research Complex for NEH Region, Umiam, Meghalaya
ICAR-ATARI, Guwahati, Zone-VI, Assam
ICAR-ARATI, Umiam, Zone-VII, Meghalaya

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शिवराज सिंह चौहान
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सत्यमेव जयते

कृषि एवं किसान कल्याण और
ग्रामीण विकास मंत्री
भारत सरकार
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Minister of Agriculture & Farmers Welfare
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Government of India
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D.O. No. 307 /AM

संदेश

भारत के सतत विकास के लिए, कृषि क्षेत्र के योगदान की अपार संभावनाएँ हैं तथा कृषि क्षेत्र सतत विकास हेतु एक गतिमान इंजन बनने की क्षमता रखता है। यह बहुत गर्व की बात है कि विज्ञान और प्रौद्योगिकी आधारित रणनीति ने शानदार खाद्यान्न उत्पादन सुनिश्चित किया और देश में खाद्य सुरक्षा को बनाए रखने में मदद की। हालाँकि, हमें तीव्र विकास दर के लिए अभी बहुत कुछ करना है।

मुझे यह जानकर प्रसन्नता हुई कि सतत विकास के लिए सोसायटी फॉर कम्युनिटी मोबीलाइजेशन फॉर सस्टेनेबल डेवलपमेन्ट (मोबिलाइजेशन), नई दिल्ली सक्रिय रूप और लगन से विज्ञान के संचार में प्रयासरत है। मुझे हर्ष है कि मोबिलाइजेशन सोसाइटी, केंद्रीय कृषि विश्वविद्यालय (इम्फाल), उमियम, मेघालय के स्नातकोत्तर अध्ययन महाविद्यालय में 'भविष्य में कृषि: प्रौद्योगिकी, स्थिरता और भविष्य' जैसे महत्वपूर्ण विषय पर 12वीं राष्ट्रीय संगोष्ठी करने जा रही है।

संगोष्ठी के प्रस्तावित विषय जैसे; कृषि प्रसार में डिजिटल उपकरण, जलवायु-अनुकूल कृषि पद्धतियाँ, सहभागी अनुसंधान और ज्ञान साझाकरण, विपणन में नीति और शासन, कृषि खाद्य और पोषण सुरक्षा में युवाओं और महिलाओं की भूमिका सेमिनार को समावेशी बनाते हैं। मुझे विश्वास है कि मोबिलाइज़ेशन सोसाइटी, केंद्रीय कृषि विश्वविद्यालय इम्फाल एवं भा.कृ.अनु.प.-पूर्वी पहाड़ी क्षेत्र अनुसंधान परिसर, उमियम, मेघालय के संयुक्त प्रयास, समुदायों और व्यक्तियों को अपने स्वयं के साथ सामाजिक, आर्थिक और पर्यावरणीय लक्ष्यों के प्रबंधन हेतु प्रभावी सिद्ध होंगें।

मुझे विश्वास है कि यह संगोष्ठी शोधकर्ताओं, शिक्षाविदों, नीति नियोजकों, गैर सरकारी संगठनों/जमीनी स्तर के जन-संचालकों और सतत विकास तथा लोगों के जीवन की गुणवत्ता में सुधार लाने में रुचि रखने वाले छात्रों के लिए बहुत उपयोगी होगी।

(शिवराज सिंह चौहान)

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BHAGIRATH CHOUDHARY

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कृषि एवं किसान कल्याण
राज्यमंत्री
भारत सरकार
MINISTER OF STATE FOR AGRICULTURE
& FARMERS WELFARE
GOVERNMENT OF INDIA

संदेश

मुझे यह जानकर अत्यंत प्रसन्नता हुई है कि सतत विकास हेतु **सोसायटी फॉर कम्युनिटी मोबीलाइजेशन फॉर सस्टेनेबल डेवलपमेन्ट (मोबिलाइजेशन), नई दिल्ली** द्वारा कृषि विज्ञान स्नातकोत्तर अध्ययन महाविद्यालय, केन्द्रीय कृषि विश्वविद्यालय (इम्फाल), उमियम, मेघालय में **'भविष्य में कृषि: प्रौद्योगिकी, स्थिरता और भविष्य'** विषय पर 12वीं राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है।

यह सराहनीय है कि व्यावसायिक गतिविधियों में अपनी निरंतर भागीदारी के माध्यम से मोबिलाइजेशन सोसायटी ने शोधकर्ताओं और प्रसार में कार्यरत कर्मचारियों को खाद्य सुरक्षा और किसानों की समृद्धि सुनिश्चित करने की दिशा में एक प्रखर मंच प्रदान किया है। हर साल खाद्यान्न की मांग बढ़ रही है, जबकि किसान मिट्टी में कड़ी मेहनत करने के बावजूद संकटग्रस्त जीवन जी रहे हैं। इसका समाधान खेती में आधुनिक तकनीकों के अनुप्रयोग और ग्रामीण क्षेत्रों में उद्यमशीलता के विकास में निहित है।

मुझे विश्वास है कि यह संगोष्ठी किसानों और अन्य हितधारकों के व्यापक हित में कृषि विकास के विषयगत क्षेत्रों में सार्थक सिफारिशें और नीतिगत निहितार्थ लाने में सहायक होगी।

मैं मोबिलाइजेशन सोसाइटी की 12वीं राष्ट्रीय संगोष्ठी के सफल आयोजन के लिए अपनी शुभकामनाएं देता हूँ ।

(भागीरथ चौधरी)

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Dr. M. Ampareen Lyngdoh
Hon'ble Minister in-charge
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Law Department, Information & Public
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सत्यमेव जयते

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MESSAGE

Food and nutritional security are one of the major challenges faced by the country. The fusion of taste and technology will pave a new way for India, giving rise to a new future and economy. To sustain and further enhance the efforts and boost farmers' incomes, Meghalaya has made significant progress in linking its farmers with international brands to add value to their products, ensuring that Meghalaya's unique offerings gain the recognition they deserve in the global market and in the heart of Meghalaya, a green revolution 'Regeneration Meghalaya' is underway. In an era defined by rapid changes and complex challenges, it is our duty to ensure that we not only adapt but also lead with integrity and innovation. Our nation stands at a crossroads—one where the choices we make today will have a profound impact on future generations.

I am happy to learn that Mobilization Society chose Meghalaya as the venue of their 12th National Seminar. The theme of this seminar Futuristic Agriculture: Technology, Sustainability, and Beyond resonates deeply with the ongoing efforts we are making to address the most pressing challenges our society faces, particularly in the areas of sustainable development, social equity, and transformative leadership. It is only through critical thinking and shared vision that we can bridge the gap between where we are and where we need to be. Let this seminar be a springboard for actionable solutions that will not only enhance our professional journeys but also uplift the communities we serve.

I look forward to the enriching discussions that will unfold here. Together, let us embrace the opportunity to lead with purpose, innovate with passion, and act with unwavering commitment to the greater good.

(Dr. Mazel Ampareen Lyngdoh)

सत्यमेव जयते

डॉ. एम. एल. जाट
सचिव (डेयर) एवं महानिदेशक (भाकृअनुप)

Dr M. L. Jat
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 & EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

MESSAGE

I am happy to know that Society for Community Mobilization for Sustainable Development (MOBILIZATION) is organizing 12th National Seminar on "Futuristic Agriculture: Technology, Sustainability and beyond" at College of post Graduate Studies in Agricultural Science, Central Agricultural University (Imphal), Umiam, Meghalaya during May 22-24, 2025.

The Indian agriculture sector has travelled from "subsistence" to a "Vibrant" industry with the support of technological advancements in improved crop and animal varieties, various inputs and mechanization. For sustainable agriculture there is a need for optimal utilization of inputs in agriculture. In this context the issue chosen for 12th National Seminar on Futuristic Agriculture: Technology, Sustainability and beyond is very apt and timely, which may bring out policy implications for sustainable agricultural methods that will enhance productivity, environment and public health.

I hope that the deliberations in National Seminar will address the key economic, environmental and social sustainability issues amongst academia, policy makers and other stakeholders necessary to take Indian agriculture on a sustainable pathway.

I wish the Seminar a grand success.

(M L Jat)

Dated the 5th May, 2025
New Delhi

कृषि वैज्ञानिक चयन मंडल
कृषि अनुसंधान और शिक्षा विभाग
कृषि एवं किसान कल्याण मंत्रालय, भारत सरकार
चयन भवन, पूसा कैम्पस, नई दिल्ली – 110 012
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Ministry of Agriculture & Farmers Welfare, Govt. of India
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सत्यमेव जयते

प्रतिभा की खोज In search of talent
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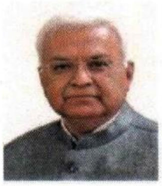
AGRICULTURAL SCIENTISTS RECRUITMENT BOARD

डॉ. संजय कुमार एफ एन ए, एफ एन ए एस सी, एफ एन ए ए एस सी, एफ सी आई एस आई
अध्यक्ष

Dr. Sanjay Kumar FNA, FNASc, FNAASc, FCISI
Chairman

Date: 06/05/2025



MESSAGE

As we navigate an increasingly interconnected and resource-conscious world, agriculture must evolve to meet the demands of a growing global population. Technology, sustainability, and innovation are the pillars of this transformation. From precision farming, smart irrigation, and AI-driven solutions to resilient cropping systems and sustainable land management, the potential for technology to revolutionize agriculture is unprecedented. The future of agriculture depends not only on advancing technology but also on leveraging these innovations to build a more sustainable, inclusive, and productive system.

We must prioritize technologies that enhance farmers' livelihoods, preserve natural resources, and ensure global food security. I commend the organizers of the 12th National Seminar of the MOBILIZATION Society on "Futuristic Agriculture: Technology, Sustainability, and Beyond" for their dedication and expertise. Through collaborative engagement, innovation, and a shared commitment to sustainability, we can shape a brighter future for agriculture.

I encourage all participants to seize this opportunity to exchange ideas, forge partnerships, and inspire solutions that will define tomorrow's agricultural landscape. Wishing you a productive and inspiring seminar.

Wishing you all a meaningful, productive, and insightful seminar.

Sanjay Kumar
(Sanjay Kumar)

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(संसद के अधिनियम द्वारा निर्मित सांविधिक निकाय)
कृषि एवं किसान कल्याण मंत्रालय
भारत सरकार

सत्यमेव जयते

Trilochan Mohapatra
Chairperson
Protection of Plant Varieties and Farmers' Rights Authority
(A Statutory body created by an Act of Parliament)
Ministry of Agriculture and Farmers Welfare
Government of India

MESSAGE

It is with great pleasure I extend my warm greetings to all participants of the Mobilization Society's 12th National Seminar scheduled on the topic Futuristic Agriculture: Technology, Sustainability and beyond at College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya. This event is expected to serve as an important platform for fostering knowledge exchange, sharing innovative ideas, and discussing advancements that play a pivotal role in shaping the future of our agrarian society. The potential of collaboration and mobilization in driving sustainable development are immense. The deliberations during the seminar will certainly contribute to further strengthening collective efforts towards building resilient and inclusive communities.

Farming in Meghalaya is organic and natural by tradition and has been practiced by the local farmers and the farming communities for ages. Located in North-east India, Meghalaya, also known as the Abode of Clouds, falls in one of the richest biodiversity areas in the world. The famed monsoons, the rich traditional festivals, and the dramatic terrain makes it suitable for exploring organic farming. Meghalaya is inhabited by many distinct tribes; most prominent being the Khasis, the Garo and the Pnars, which are mostly engaged in farming of ornamental crops.

I extend my sincere appreciation to the organizing committee, the speakers, and all participants for their commitment to making this seminar a success. I do hope that the participants will very effectively make the most of this opportunity to engage in meaningful exchanges, to learn from each other's experiences, and to work towards solutions that will benefit local communities, the agricultural sector, and ultimately the nation. May this seminar be a stepping stone towards building a more sustainable, inclusive, and resilient agricultural society in the North-East India as a whole and more specifically, in Meghalaya.

I wish all a successful and enriching seminar.

(Trilochan Mohapatra)

Date: 5th May, 2025

प्लांट अथॉरिटी भवन, एन.ए.एस.सी. काम्प्लैक्स के निकट, टोडापुर के सामने, नई दिल्ली-110012 (भारत)
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No. Message /RPCAU (VC) Date : 14 May 2025

Message

It is with great pleasure and honor that I extend my warm greetings on the organization of 12th National Seminar of Mobilization Society on *Futuristic Agriculture: Technology, Sustainability, and Beyond* at College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya. The seminar will serve as a platform for the exchange of knowledge, innovative ideas, and cutting-edge research in various subject matter fields, and I am confident that it will contribute significantly to our collective efforts in advancing the professionalism. As we navigate through an era of rapid change and technological advancements, it is crucial that we remain flexible and forward-thinking. I hope that this seminar will inspire new collaborations, generate innovative solutions, and set the stage for future advances in our profession.

Over the years, this society has played a pivotal role in fostering collaboration, sharing best practices, and addressing the evolving challenges. The abstracts and proposed presentations at this event reflect the dedication and intellectual rigor of professionals and researchers from across the country. I encourage all attendees to actively engage in discussions and network with their peers, as these interactions are invaluable in driving the future direction of research as well as extension in agricultural sciences.

I extend my best wishes to all the participants for a fruitful and enriching seminar.

Gautam

(P.L. Gautam)

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MESSAGE

As we look toward the future of agriculture, it is clear that the challenges we face—ranging from climate change and resource depletion to the growing demands of a rapidly expanding global population—require bold and visionary solutions. With advancements in biotechnology, artificial intelligence, precision farming, and renewable energy solutions, the possibilities for transforming agriculture into a more efficient, resilient, and environmentally friendly sector are immense. By embracing these technologies, we not only ensure the future of food security but also move toward a more sustainable and equitable world for all.

The National and International seminars serve as a critical platform for sharing knowledge, discussing cutting-edge technologies, and exploring sustainable practices that will shape the future of farming. The 12th National Seminar of MOBILIZATION Society on "Futuristic Agriculture: Technology, Sustainability, and Beyond"is an opportunity for all of us to engage in meaningful conversations, foster collaborations, and challenge existing paradigms in agriculture. As we look beyond the horizon, let us commit ourselves to developing solutions that will nourish both people and the planet.

I look forward to the insightful discussions and innovative ideas that will emerge over the course of this seminar, and I am confident that together, we will chart a path toward a brighter, more sustainable future for agriculture.

I wish a productive and inspiring seminar.

(Anupam Mishra)

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Message

It gives me immense pleasure to extend my warm greetings to all the participants, organizers, and esteemed guests attending the National Seminar on Futuristic Agriculture: Technology, Sustainability, and Beyond, organized by the MOBILIZATION Society.

As we navigate the dynamic and rapidly evolving agricultural landscape, it becomes increasingly vital to reflect on the role of emerging technologies, sustainable practices, and innovative strategies that will shape the future of agriculture. This seminar provides a timely and valuable platform to deliberate on how agricultural extension services can evolve to support these transformative changes—ensuring that our farmers are empowered with the knowledge, tools, and resources needed to thrive in a complex and uncertain environment.

The integration of frontier technologies—such as artificial intelligence, precision agriculture, and digital platforms—holds immense promise for enhancing productivity, optimizing resource use, and promoting sustainability. However, the real impact of these innovations will be realized only when they reach our farming communities in ways that are accessible, practical, and inclusive. Agricultural extension will play a pivotal role in bridging this gap, translating innovation into impact on the ground.

This seminar is an important opportunity for all stakeholders—scientists, extension professionals, policymakers, entrepreneurs, and farmers—to come together, share insights, and forge partnerships that will shape the future of Indian agriculture. Our collective commitment must be to build a resilient, sustainable, and technologically advanced agri-food system—one that ensures food and nutritional security while safeguarding our environment for generations to come.

I am confident that the outcomes of this seminar will contribute meaningfully to shaping forward-looking policies and strategies that strengthen our agricultural sector. I wish the seminar great success and look forward to the innovative ideas and collaborative spirit that will emerge from these deliberations.

(Rajbir Singh)

PRIYA RANJAN
Joint Secretary
&
Managing Director
National Horticulture Board

सत्यमेव जयते

भारत सरकार
कृषि एवं किसान कल्याण मंत्रालय
कृषि एवं किसान कल्याण विभाग
Government of India
Ministry of Agriculture & Farmers Welfare
Department of Agriculture & Farmers Welfare

2nd May, 2025

MESSAGE

It gives me great pleasure to extend my warm greetings to all participants, organizers, and stakeholders involved in organization of 12th National Seminar of MOBILIZATION Society on very relevant topic *Futuristic Agriculture: Technology, Sustainability, and Beyond* at College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya. The National Horticulture Board (NHB) has always been committed to advancing the growth and development of the horticultural sector in India. We believe that collaboration, innovation and shared knowledge are pillars addressing the challenges and unlocking the potential of this vital industry.

This seminar may serve as an excellent platform to exchange ideas, explore new opportunities, and strengthen the ties within the horticultural community. I encourage each one to actively engage in the discussions and work together towards a future that promises growth, sustainability and prosperity for all concerned.

I look forward to the success of this seminar and the meaningful impact of the ideas and solutions that will emerge from it.

(Priya Ranjan) 2/5/2025

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Society for Community Mobilization for Sustainable Development
(MOBILIZATION)

Dr. J. P. Sharma
Former Vice Chancellor
Sher-e-Kashmir University of Agricultural
Sciences and Technology of Jammu, J & K
President, Society for Community Mobilization for Sustainable Development (MOBILIZATION)

Message

It is with immense pleasure and pride in sharing the organization of the12th *National Seminar on Futuristic Agriculture: Technology, Sustainability, and Beyond*. This seminar brings together the brightest minds and thought leaders in the field of agriculture, technology, and sustainability to engage in meaningful discussions that will shape the future of farming, food security, and environmental stewardship.

As we stand on the precipice of a new era in agriculture, the convergence of cutting-edge technologies, innovative practices, and sustainable solutions holds the promise of transforming our approach to food production and land management. From artificial intelligence and precision farming to climate-resilient crops and resource-efficient practices, the future of agriculture is both exciting and essential for the well-being of our planet and future generations. The theme of this seminar underscores the importance of collaboration, research, and the collective drive toward building a sustainable and resilient agricultural system. Together, we can create solutions that address the challenges of today while paving the way for a brighter, greener tomorrow.

Established in 2003, the Society for Community Mobilization for Sustainable Development (MOBILIZATION) has evolved into a robust professional body having its own quarterly research journal "Journal of Community Mobilization for Sustainable Development" with ISSN 2230 –9047. Presently the Society has about 2000 Life Members including 20 foreign members. The Society has successfully organized eleven national seminars in collaboration with renowned institutions like IIT- Delhi, ICAR-IVRI, Bareilly, ICAR-, NDRI, Karnal, GBPAU&T, Pantnagar, MPUA&T, Udaipur, YSPUHF, Solan, SKUAST Kashmir etc., published books on relevant issues, besides other academic/ developmental activities. The Society fostered collaborations and innovationfor two International Conferences and continuously pushed the boundaries of what is possible. Each milestone we have reached is a result of your unwavering commitment to our shared vision. Together, we have built a legacy of excellence and camaraderie, one that will inspire future generations to continue the work we have begun. I extend my heartfelt thanks to every individual who has played a part in our success. Your contributions are what make this society truly special.

I extend my heartfelt gratitude to all speakers, participants, and sponsors for making this seminar possible. May this gathering inspire innovative ideas, foster new partnerships, and contribute to the ongoing journey toward a sustainable future in agriculture. I look forward to the enlightening discussions and insights that will emerge from this esteemed event.

(J. P. Sharma)

Preface

The Society for Community Mobilization for Sustainable Development (Mobilization Society), New Delhi, is privileged to present this compendium on the occasion of the 12th National Seminar on *"Futuristic Agriculture: Technology, Sustainability and Beyond"*, being jointly organized with Central Agricultural University (CAU), Imphal, ICAR Research Complex for NEH Region, Umiam, Meghalaya, ICAR-ATARI Guwahati, Zone-VI, Assam, and ICAR-ATARI Umiam, Zone-VII, Meghalaya, from May 22–24, 2025. This national-level seminar aims to provide a common platform for researchers, students, academicians, and policymakers to deliberate on future-ready agricultural technologies, sustainable development strategies, and innovative approaches for addressing the emerging challenges in the agriculture sector. The compendium comprises an enriching collection of abstracts and papers contributed by distinguished participants from across the country. These contributions reflect the collective wisdom and ongoing efforts of the scientific community in shaping a resilient and sustainable agricultural future.

We express our sincere gratitude to Hon'ble Vice Chancellor, CAU, Imphal, Dr. Anupam Mishra, for his invaluable encouragement, constant guidance, and unwavering support in realizing the vision of this seminar. Our heartfelt thanks are also extended to Dr. J.P. Sharma, President, Mobilization Society, for his inspiring leadership and continuous motivation throughout the planning and execution of this event.

We are thankful to all the funding partners, for their generous financial assistance, which has been instrumental in facilitating this academic initiative. We also acknowledge with gratitude the kind wishes and encouraging messages received from various dignitaries and well-wishers. We deeply appreciate the tireless efforts of all conveners, organizing committee members, and volunteers whose dedication and meticulous planning have made this seminar possible. Lastly, we extend our sincere thanks to all the participants for their meaningful contributions and active engagement, which are central to the success of this national seminar. We hope that this compendium serves as a valuable reference and a catalyst for future research and collaborative actions in the pursuit of sustainable and futuristic agriculture.

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Keynote Paper

Harvesting the Future: Transformative Agri-Visions for a Climate-Responsive, Inclusive, and Tech-Enabled World

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INTRODUCTION

Agriculture remains the bedrock of global food security, rural livelihoods, and ecological balance. However, it now faces unprecedented challenges stemming from interconnected crises: climate change, environmental degradation, socio-economic disparities, technological disruptions, and volatile global markets. These multifaceted pressures have rendered traditional, incremental approaches to agricultural development insufficient. Addressing these rapidly evolving and systemic issues necessitates not just reform but a comprehensive transformation of agri-food systems. The urgency for Transformative Agri-Visions is underscored by the escalating challenges of the 21st century. According to the Food and Agriculture Organization (FAO), up to 828 million people were affected by hunger in 2021, marking an increase of approximately 150 million since the onset of the COVID-19 pandemic . With the global population projected to reach 9.7 billion by 2050, food production must increase by at least 60% to meet future demand. However, relying on current unsustainable methods–which contribute to soil degradation, water scarcity, and biodiversity loss–is untenable. The Intergovernmental Panel on Climate Change (IPCC) warns that climate change has already slowed agricultural productivity growth over the past 50 years, particularly in mid and low latitudes. These vulnerabilities are further exacerbated by systemic inequalities. Smallholder farmers, operating on less than two hectares, constitute about 600 million individuals globally and are responsible for approximately 28–31% of total crop production. Despite their crucial role, they often lack access to essential resources such as credit, technology, and markets. Women, who comprise around 43% of the agricultural labor force in developing countries, face additional barriers, including limited land ownership and decision-making power. Without deliberate inclusion, future agricultural advancements risk perpetuating existing disparities.

In this context, agriculture stands at a pivotal juncture. Incremental changes are no longer adequate. The sector must evolve to enhance productivity, bolster climate resilience, and promote social equity. "Harvesting the Future" transcends being a mere theme; it embodies a strategic imperative. Just as the quality of a harvest depends on the choices made at sowing, the future of global agriculture hinges on today's innovations, policies, and partnerships. Our current investments- scientific, technological, and ethical- will determine whether future generations inherit abundance or adversity. Systemic transitions are thus imperative. Transformative agri-visions should adopt a holistic and inclusive approach, integrating climate-smart agriculture, regenerative practices, and ecosystem-based strategies. These methodologies aim not only to enhance resilience and productivity but also to safeguard natural ecosystems and empower marginalized communities. The integration of digital technologies such as artificial intelligence, precision agriculture, biotechnology, and blockchain is reshaping food production, management, and distribution. However, for these technologies to be truly transformative, they must be accessible, context-sensitive, and inclusive, ensuring they serve the needs of smallholders, women, youth, and indigenous populations who are often custodians of sustainability. Ultimately, transformation requires more than technological tools; it demands institutional reform, participatory governance, forward-looking policies, and sustained capacity-building. In light of this, the present paper explores strategic and technological options to reimagine and rebuild agri-food systems. It outlines a framework for transformative change that aligns agricultural development with the goals of equity, resilience, and sustainability–laying the groundwork for truly harvesting the future.

STRATEGIES FOR TRANSFORMATIVE AGRICULTURE

1. Climate-Responsive Agriculture

Need for and constraints in the climate-responsive agriculture: Agriculture is both a victim and a contributor to climate change, accounting for nearly 23% of global greenhouse gas emissions, including those from deforestation, livestock, and fertilizer use (IPCC, 2022; Kumar *et al.*, 2022). Climate variability, manifested through rising temperatures, erratic rainfall, and extreme weather events, is already impacting food systems globally (Thornton *et al.*, 2014; Haile *et al.*, 2017; Myers *et al.*, 2017). The World Bank estimates that by 2050, climate change could reduce crop yields by up to 25% in some regions, disproportionately affecting food-insecure and smallholder farming communities (Aryal *et al.*, 2022; Baptista *et al.*, 2022). As 70–80% of the world's poor live in rural areas and depend on agriculture for their livelihoods, the shift towards *climate-responsive agriculture* is critical (Tolulope *et al.*, 2025). It encompasses a wide range of solutions, including climate-smart farming systems, drought and flood-resilient practices, and carbon sequestration methods that not only mitigate emissions but also enhance adaptive capacity. Despite the evident need, the widespread adoption of climate-responsive techniques faces significant barriers. Smallholder farmers, who manage over 80% of farms globally (FAO, 2021), often lack access to timely weather forecasts, early warning systems, and climate-resilient inputs. Drought-tolerant crops and integrated flood management systems remain underutilized due to weak extension services and inadequate policy incentives. Moreover, carbon farming initiatives, though promising, face challenges in measurement, verification, and market integration, especially in developing countries. Policy coherence is another major bottleneck. While over 70% of countries reference agriculture in their Nationally Determined Contributions (NDCs), few have translated this into actionable and funded national climate adaptation plans (UNFCCC, 2022). These challenges are further exacerbated by limited investment in climate services and agro-meteorological advisory systems.

Opportunities for transition and transformation in climate-responsive agriculture: Despite these constraints, numerous opportunities exist to mainstream climate-responsive agriculture. Technological innovations such as AI-based weather forecasting, satellite-driven crop monitoring, and climate-resilient seed varieties are improving precision and response in farm management (Aijaz *et al.*, 2025). The Government of India has launched several climate advisory services and programmes aimed at enhancing the resilience of agriculture and rural livelihoods in the face of climate change. The India Meteorological Department (IMD), under the Ministry of Earth Sciences, in collaboration with the Indian Council of Agricultural Research (ICAR) and other institutions, is implementing the Gramin Krishi Mausam Sewa (GKMS) scheme to deliver Agrometeorological Advisory Services (AAS) at the district and block levels for the benefit of farmers across the country (Singh *et al.*, 2018; Kumari *et al.*, 2022). This initiative focuses on integrating real-time weather forecasts with location-specific data on climate, soil, and crops to provide actionable advisories to farmers to support in making informed decisions regarding daily agricultural operations, especially during periods of deficient rainfall or extreme weather events. By offering guidance on optimal resource use such as irrigation, fertilization, pest management, and harvesting, GKMS aims to minimize economic losses and enhance productivity. These advisories are disseminated through a variety of platforms, including SMS, mobile apps, radio, and local extension services, thereby improving resilience and efficiency in farming practices (Kumari *et al.*, 2022; Rathore *et al.*, 2025).

Additionally, the National Mission for Sustainable Agriculture (NMSA), under the National Action Plan on Climate Change (NAPCC), promotes climate-smart practices and technologies, including weather-based advisories, soil health management, and water-use efficiency. Under NMSA, the Per Drop More Crop component promotes micro-irrigation with subsidies to improve water-use efficiency. Since 2015-16, the government has also been promoting organic farming through Paramparagat Krishi Vikas Yojana (PKVY) and Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), offering end-to-end support from production to marketing. Bharatiya Prakritik Krishi Paddhati (BPKP) encourages traditional farming, while other missions like MIDH, Agroforestry, and National Bamboo Mission support climate-resilient practices. The Pradhan Mantri Fasal Bima Yojana (PMFBY) insures crops against natural disasters (PIB, 2024). The Indian Council of Agricultural Research (ICAR) leads the National Innovations in Climate Resilient Agriculture (NICRA) to study climate impacts and promote adaptive technologies. It has released over 2,500 stress-tolerant crop varieties and out of these 2177 varieties have been found tolerant to one or more biotic and/or abiotic stresses.It has developed District Agriculture Contingency Plans (DACPs) for 651 districts. Under NICRA, Climate Resilient Villages (CRVs) demonstrate adaptive practices such as intercropping, conservation agriculture, crop diversification, micro-irrigation, and agroforestry in 151 vulnerable districts. Capacity building and awareness programmes also support farmer adoption (PIB, 2024). The Digital India programme and the use of Artificial Intelligence (AI) and Geographic Information Systems (GIS) have further strengthened the dissemination and precision of climate information. Various state governments also run complementary schemes tailored to regional needs. Meanwhile, voluntary carbon markets are beginning to recognize the role of agriculture in emission reduction, offering income opportunities through practices like biochar application, agroforestry, and improved manure management. At the policy level, the emergence of frameworks such as the *Koronivia Joint Work on Agriculture* under the UNFCCC provides a platform for integrating adaptation and mitigation in agricultural policy (St-Louis *et al.*, 2018, Ramifehiarivo *et al.*, 2022). In parallel, the Department of Agriculture and Farmers Welfare runs the Sub-Mission on Nutri-Cereals (Millets) under the National Food Security Mission (NFSM), promoting millet production through incentives, demonstrations, certified seeds, water-saving devices, and training in 28 states and 2 UTs (PIB, 2024). These efforts collectively aim to reduce climate-induced risks, improve farm productivity, and support informed decision-making by farmers, though challenges persist in outreach, customization, and integration at the grassroots level. With the right mix of investment, institutional support, and localized innovation, climate-responsive agriculture can serve as both a shield against climate shocks and a pathway to sustainable development (Prasad and Kochher, 2009).

2. Digital Agriculture and Smart Farming

Need for and constraints in the smart farming: Global agriculture is under increasing pressure to produce more food with fewer resources, amid growing environmental constraints and labour shortages. Digital agriculture and smart farming, powered by technologies such as AI, IoT, drones, and big data, offer a transformative path to address these challenges (Ahmed and Shakoor, 2025). AI and machine learning can help optimize crop inputs, reduce disease outbreaks, and forecast yields, while IoT devices enable real-time monitoring of soil moisture, temperature, and pest activity (Sharma and Shivandu, 2024). For instance, precision farming using drones for aerial imaging and variable rate application has shown yield increases of 15–20% while reducing chemical usage by up to 30% (Mgendi, 2024). In India, the Digital Agriculture Mission 2021 and programs like eNAM and Kisan Sarathi demonstrate a growing recognition of the need to integrate digital tools across the agricultural value chain Despite its potential, digital agriculture faces significant hurdles in adoption, especially in low- and middle-income countries. One of the most pressing issues is the digital divide. High initial investment costs and limited access to modern infrastructure, such as reliable internet and power supply, hinder widespread adoption. Over 70% of smallholder farmers globally lack internet access or the digital literacy needed to use advanced technologies (GSMA, 2021). Furthermore, the high upfront cost of digital tools like drones, sensors, and AI-driven platforms makes them inaccessible to most smallholders. Fragmented landholdings and limited interoperability between devices and data systems further hinder implementation. Moreover, there are concerns around data privacy, ownership, and cybersecurity, as most farmers are unaware of how their data is collected, used, or monetized. Gender disparities also persist, with women farmers being 20% less likely to own a smartphone, limiting their ability to participate in digital agriculture initiatives. Additionally, the digital divide, inadequate extension services, and lack of localized, user-friendly solutions further exacerbate the problem. There is also a scarcity of skilled personnel who can manage and interpret complex data generated through smart farming tools.

Opportunities for transformation in smart farming: Despite these challenges, the growth of digital agriculture presents major opportunities for enhancing productivity, sustainability, and inclusivity in farming. India has witnessed a significant increase in the use of digital technologies in agriculture, creating strong opportunities for the transformation of farming systems. The rapid penetration of smartphones and internet connectivity in rural areas i.e., over 70% of rural India had mobile internet access as of 2023 (Statista, 2024), enables farmers to access real-time information on weather forecasts, market prices, pest alerts, and agronomic advisories if provided with accessibility (Kumar *et al.*, 2022; Sindakis and Showkat, 2024). The Government of India has introduced several policy measures and schemes to promote smart and digital farming. Government initiatives such as the Digital India Programme and BharatNet have accelerated broadband infrastructure in rural regions, laying the foundation for precision agriculture using GPS, remote sensing, IoT sensors, and AI-based decision support systems. India's Digital Mission marks a significant milestone in the country's journey toward transforming agriculture through technology, building on the broader success of its digital revolution (Sindakis and Showkat, 2024). Approved by the Union Cabinet on September 2, 2024, with an outlay of Rs. 2,817 crore, the Digital Agriculture Mission aims to create a robust Digital Public Infrastructure (DPI) for the agriculture sector (DA&FW, 2024). The mission is anchored by two key pillars i.e., AgriStack, which creates unique Farmer IDs linked to land and crop data, and the Krishi Decision Support System (DSS), which integrates geospatial, weather, and crop data to support evidence-based decision-making. Additional components include Soil Profile Mapping, a nationwide Digital General Crop Estimation Survey (DGCES), and crop mapping initiatives, targeting the creation of digital identities for 11 crore farmers over three years and conducting crop surveys in all districts by FY 2025-26. The mission is already being piloted in six states and backed by partnerships with 19 states, ensuring wide-scale grassroots implementation. It promises to enhance service delivery, simplify access to government schemes, and improve efficiency in areas like crop insurance, credit, and disaster response through real-time, accurate data. Notably, the initiative is expected to generate employment for approximately 2.5 lakh local youth and Krishi Sakhis, empowering rural communities with digital skills and opportunities. Further bolstered by an overall investment of Rs. 14,235.30 crore in allied schemes, including those for crop science, horticulture, natural resource management, and agricultural education, the mission aligns with India's vision for climate-resilient, inclusive, and tech-enabled farming (DA&FW, 2024).

The Indian Council of Agricultural Research (ICAR) and state agricultural universities are also developing and promoting sensor-based irrigation, drone applications, and digital soil health cards (ICAR, 2022). Additionally, the use of remote sensing and geospatial tools in the Pradhan Mantri Fasal Bima Yojana (PMFBY) is transforming crop insurance delivery (Pandeya, 2022). These institutional innovations create an enabling ecosystem for smart farming adoption, especially in states like Maharashtra, Punjab, and Karnataka. Startups like DeHaat, CropIn, and AgNext are actively integrating these technologies into farmer services, improving input efficiency and yield predictability (NAAS, 2022; Mandal, 2024). Emerging public-private partnerships and agri-tech startups are increasingly offering scalable and affordable digital solutions tailored to smallholder contexts. For example, platforms like Plantix use AI to diagnose crop diseases via smartphone images (Johannes *et al.*, 2017), while India's AgriStack aims to build a unified farmer database to support targeted delivery of services. Some others are leveraging AI, blockchain, machine learning, and robotics to streamline supply chains, offer precision advisory, and enable traceability in value chains (Aakula *et al.*, 2024; Silvestri *et al.*, 2025). Drones are being subsidized under government schemes such as India's Sub-Mission on Agricultural Mechanization, making precision agriculture more accessible (Padhiary, 2024). Additionally, decision support systems powered by big data analytics are enabling real-time, site-specific advice on nutrient management and pest control. Capacity-building efforts in digital literacy, like the FAO's Digital Villages Initiative, are helping bridge the knowledge gap (FAO, 2025). With appropriate policy support, inclusive design, and affordable digital infrastructure, smart farming can unlock a new era of resilient and tech-enabled agriculture.

3. Inclusive Innovation and Gender Equity

Need for inclusive innovation and gender equity in Indian agriculture: Women, who comprise over 33% of the agricultural labour force and nearly 85% of rural women who engage in farm work, often lack ownership of land and are underrepresented in extension services and technology adoption (MoA&FW, 2021). Moreover, rural youth, though increasingly educated, face barriers to entry into modern agribusiness due to a lack of mentorship, finance, and market linkage. Inclusive innovation is therefore essential to ensure that technological advancements and policy support systems reach the most disadvantaged groups, particularly women, youth, and smallholders, who are pivotal to the future of Indian agriculture. Despite policy intentions, systemic and structural barriers continue to hinder equitable participation in India's agri-food innovation ecosystem. Women farmers receive less than 5% of agricultural extension services and own only 13.9% of operational holdings (Shah, 2022). Additionally, the digital divide in rural India remains stark only 31% of rural households having internet access, and rural women are 30% less likely than men to own a mobile phone (OXFARM, 2022). Youth face hurdles such as land inaccessibility, high startup costs, and a lack of integration between agricultural education and entrepreneurial support. Marginalized communities, including Scheduled Castes, Scheduled Tribes, and landless labourers, often lack political voice and secure tenure, limiting their ability to benefit from government schemes or market opportunities. These challenges are compounded by top-down policy implementation, insufficient data disaggregation by gender or caste, and inadequate localised innovation systems.

Opportunities for advancing inclusion and equity: Despite the challenges, India has a strong foundation to build a more inclusive and equitable agri-innovation ecosystem. The *Mahila Kisan Sashaktikaran Pariyojana (MKSP)* and *National Rural Livelihoods Mission (NRLM)* have shown positive outcomes in collective farming and agri-enterprise development for women (Sathyanarayana *et al.*, 2018; Bage, 2019). Youth-led agritech start-ups are also on the rise, with over 1,500 agri-based start-ups registered under the *Startup India* initiative by 2023 (Singh, *et al.*, 2022; Deshmukh *et al.*, 2023). Moreover, social inclusion can be strengthened through participatory policy design, targeted subsidies for women and youth-led enterprises, and support for Farmer Producer Organizations (FPOs) that serve smallholders and marginalized groups. With deliberate investments in capacity-building, digital literacy, gender-sensitive research, and equity-focused governance, India can unlock the transformative potential of inclusive innovation in agriculture.

4. Sustainable and Regenerative Practices in Agriculture

Need for sustainable and regenerative agricultural practices: India's agriculture faces a critical need to shift toward sustainable and regenerative practices to safeguard long-term productivity, ecological health, and rural livelihoods. Decades of input-intensive farming under the Green Revolution model have led to alarming levels of soil degradation over 30% of India's total land area is classified as degraded (Sreenivas *et al.*, 2021). Excessive use of synthetic fertilizers and pesticides has depleted soil organic carbon, contaminated groundwater, and disrupted local biodiversity. According to FAO, agriculture contributes around 17% of India's greenhouse gas emissions, largely from enteric fermentation, rice cultivation, and fertilizer use (Chachei, 2024). In this context, practices such as organic farming, low-input sustainable agriculture (LISA), and ecological intensification offer pathways to reduce chemical dependency, restore soil health, and enhance resilience to climate stress. Agroforestry, for instance, has been shown to increase carbon sequestration and improve microclimates, while integrating circular economy principles such as waste composting and nutrient recycling can reduce environmental externalities and input costs (Ogwu and Kosoe, 2025). Despite growing awareness, widespread adoption of sustainable practices in India is constrained by several factors. Only 2% of India's net sown area is under certified organic cultivation (APEDA, 2024), and regenerative practices remain largely limited to pilot initiatives. Farmers often lack access to reliable information, technical support, and market incentives for shifting away from conventional methods. Soil health cards introduced under the National Mission for Sustainable Agriculture have seen limited behavioural impact, as many farmers still lack the knowledge or motivation to act on soil test recommendations (Reddy, 2018; Rani *et al.*, 2022). Additionally, the absence of ecosystem service valuation, lack of carbon credit mechanisms, and weak supply chains for organic produce further reduce the economic viability of sustainable approaches. High initial transition costs, especially for small and marginal farmers, and limited convergence between agriculture, forestry, and environmental policies also hinder the mainstreaming of agroecological models.

Opportunities for transitioning to regenerative systems: India is now better positioned than ever to scale sustainable and regenerative agriculture through supportive policies, innovation, and public-private collaboration. The *Paramparagat Krishi Vikas Yojana (PKVY)*, *Bhartiya Prakritik Krishi Paddhati (BPKP)*, and *National Agroforestry Policy* have laid important groundwork for promoting ecological farming (Srishailam *et al.*, 2022). States like Sikkim and Andhra Pradesh have demonstrated successful models. Sikkim became the first fully organic state, while Andhra Pradesh's Community Managed Natural Farming (CMNF) program now covers over 8 lakh farmers

(FAO, 2018). The growing global demand for organic and sustainably produced food offers export potential, while carbon farming and payment for ecosystem services (PES) can provide financial incentives for regenerative practices. Furthermore, the integration of circular economy principles like using farm residues for compost, biogas, and bio-inputs can create closed-loop, resource-efficient agri-food systems (Nguyen, *et al.*, 2025). With targeted investments in research, capacity-building, and market development, India can lead a paradigm shift toward agroecological transformation that secures both productivity and planetary health.

5. Future-Ready Agri-Extension Models

Need for innovative agri-extension models: India's agricultural extension system is undergoing a paradigm shift as it seeks to remain relevant in the face of climate change, technological disruption, and evolving farmer needs. With over 146 million operational holdings, 86% of which are small and marginal, India's diverse farming community requires location-specific, timely, and scalable advisories (Pathak *et al.*, 2022). Traditional extension approaches, often top-down and resource-intensive, are increasingly inadequate in addressing the complexity of modern agriculture, especially under volatile climatic conditions (Nedumaran and Ravi, 2019). According to a NABARD All India Rural Financial Inclusion Survey (2018), only 10.4% of farmers received information from extension officers. There is a growing need to integrate artificial intelligence (AI), data analytics, and mobile-based platforms with community-based and participatory extension models to ensure faster, inclusive, and contextual delivery of services. Models that combine human expertise with AI-enabled systems, such as precision advisories, pest diagnostics, and climate-resilient crop planning, are critical for making Indian agriculture future-ready. Despite the increasing availability of digital tools, several systemic and infrastructural challenges continue to impede the modernization of agri-extension in India. Digital illiteracy, particularly among rural women and elderly farmers, limits the uptake of mobile and AI-based services. Although smartphone penetration in rural India reached a good percentage, usage for agriculture-specific applications remains low. Additionally, fragmented institutional responsibilities, inadequate frontline staff training, and limited integration between research, extension, and market systems weaken the effectiveness of existing models (NAAS, 2022). Community-based knowledge systems, including indigenous and experiential knowledge, are often undervalued in formal extension. Furthermore, extension programs frequently lack robust monitoring, evaluation, and feedback loops, making it difficult to assess their impact and improve them iteratively

Opportunities for scalable and inclusive agri-extension: Innovative extension models in India are reshaping the agricultural knowledge delivery system to be more inclusive, technology-enabled, and demand-driven. Moving beyond traditional top-down approaches, these models emphasize participatory, market-linked, and system-based frameworks tailored to diverse agro-ecological and socio-economic contexts. Examples include the Co-Management Extension Model, which promotes community stewardship and shared decision-making, and the Farmer Income Led Extension (FILE) Model (Sharma and Gills, 2017), which reorients extension goals from production to profitability by integrating value chain development, digital tools, and financial literacy. Models like the Knowledge Value Chain Extension Model and IARI–Post Office Linkage Extension Model (IPOLEM) focus on leveraging institutional synergies and last-mile connectivity to reach marginalized farmers with real-time advisories, innovations, and services (Sharma *et al.*, 2017). Additionally, digital platforms, AI-driven decision support systems, and community-based knowledge networks are increasingly being embedded into extension strategies, creating hybrid human-digital ecosystems. The digital revolution offers significant opportunities to transform India's agri-extension ecosystem into a decentralized, data-driven, and inclusive support system. AI-powered platforms such as IFFCO's *Kisan App*, eNAM's digital market linkages, and Digital Green's community video-based extension are already showing scalable models of farmer engagement (Dixit *et al.*, 2022). Community Resource Persons (CRPs) under National Rural Livelihoods Mission and Farmer Producer Organizations (FPOs) can be leveraged as last-mile connectors to democratize extension delivery. Integrating climate-smart extension with geospatial data, weather-based advisories, and early warning systems can significantly reduce climate risks. Moreover, real-time data analytics and feedback mechanisms using IoT and remote sensing can help monitor crop conditions and evaluate extension impact. Policy-level initiatives such as the *Digital Agriculture Mission* and *AgriStack* offer a blueprint for convergence of data, services, and institutions (DA&FW, 2024). A hybrid extension model, anchored in both human and technological capacities can empower farmers with actionable insights, bridge knowledge gaps, and foster resilience across India's agri-food systems.

6. Food and Nutritional Security led Agriculture

Need for food and nutritional security in India: India, despite being a major producer of food grains, continues to face a dual burden of undernutrition and micronutrient deficiencies. According to the Global Hunger Index 2023, India ranked 111th out of 125 countries, reflecting serious concerns over child undernourishment and wasting (Yadav and Srivastava, 202). The NFHS-5 (2019–21) data shows that 35.5% of children under five are stunted and 57% of women aged 15–49 are anaemic. This highlights the urgent need to reorient agricultural strategies towards nutrition-sensitive goals. Promoting biofortified crops such as zinc-enriched wheat, iron-rich pearl millet, and vitamin A-rich sweet potato developed by institutions of ICAR and programmes like HarvestPlus can significantly bridge micronutrient gaps. Moreover, climate-resilient varieties not only withstand extreme weather but also ensure dietary continuity during shocks. Integrating agriculture with public health nutrition and reviving traditional diets rich in millets, pulses, and leafy vegetables are essential to address both food security and nutritional adequacy. While food production has increased, its alignment with nutritional outcomes remains limited due to structural and behavioural challenges. Green Revolution policies prioritized calorie-dense staples like wheat and rice, marginalizing traditional nutrient-rich crops such as millets and pulses. Despite the government's recent push like declaring 2023 as the *International Year of Millets*, their share in the average Indian diet remains low. Weak supply chains, limited access to diverse foods, inadequate storage infrastructure, and post-harvest losses (estimated at 10–15% annually) exacerbate food and nutrient insecurity. The fragmentation between agricultural and health sectors further hinders convergence in policies and programs. Moreover, lack of awareness among farmers and consumers about the nutritional value of biofortified crops and traditional foods impedes their widespread adoption. School and community nutrition programs often rely on limited food diversity, missing an opportunity to promote local, nutritious crops.

Opportunities for integrated food and nutrition strategies: India has a significant opportunity to transform its food systems into drivers of nutritional well-being through integrated, climate-smart, and culturally rooted approaches. The Poshan Abhiyaan and the Mid-Day Meal Scheme (now PM-POSHAN) can serve as platforms to mainstream biofortified and locally sourced nutrient-rich foods. Strengthening linkages between FPOs and institutional buyers like schools and Anganwadis can enhance market access for smallholders and improve dietary diversity. Policy frameworks such as the National Nutrition Strategy (NITI Aayog, 2017) emphasize the role of agriculture in improving nutrition outcomes and call for multisectoral convergence. Scaling up initiatives like the UN World Food Programme's "Farm to Plate" pilot in Odisha linking millet farmers to public food systems can offer replicable models (Garg *et al.*, 2022). The Indian Council of Agricultural Research (ICAR) has undertaken several significant initiatives to promote nutritional agriculture, aiming to combat malnutrition and ensure dietary diversity through science-led interventions. One of the flagship efforts is the development and promotion of biofortified crop varieties under the *National Agricultural Research System*. As of 2023, ICAR has released over 100 biofortified varieties of 19 crops including zinc-enriched rice and wheat, iron-rich pearl millet, and protein-rich maize–targeted to address micronutrient deficiencies affecting large sections of the Indian population. These varieties are now being integrated into government food security schemes such as the Public Distribution System (PDS) and Mid-Day Meal Scheme. ICAR has also collaborated with international agencies like Harvest Plus and national partners to scale up seed production and awareness campaigns for these crops. Beyond genetic improvements, ICAR promotes nutrition gardens, diversified cropping systems, and mainstreaming of millets and pulses to enrich household diets. Additionally, digital platforms, community nutrition gardens, and targeted extension services can raise awareness and empower rural households to make informed, nutrition-sensitive choices. These efforts are key to achieving Zero Hunger and securing the nutritional future of India's vast and diverse population.

7. Market Access and Value Chain Development

Need for market access and value chain development: The reduced level of contribution of India's agriculture sector to the GDP (18%) as compared to the supporting workforce of over 50% of the population primarily due to inefficiencies in market access and value realization. Despite being one of the largest producers of fruits, vegetables, milk, and spices globally, Indian farmers receive less than 30–40% of the consumer price, largely because of fragmented value chains, post-harvest losses, and limited access to organized markets (FAO *et al.*, 2023). With post-harvest losses estimated at Rs. 92,651 crore annually (ICAR-CIPHET, 2015), especially in perishables, enhancing cold chain and logistics infrastructure is crucial. Moreover, only about 10% of agricultural produce is marketed through digital or formal supply chains (Saha *et al.*, 2024). There is an urgent need to leverage digital platforms, Farmer Producer Organizations (FPOs), and contract farming mechanisms to integrate smallholders into efficient, transparent, and remunerative agri-value chains. Strengthening these linkages is vital not only for enhancing farmer incomes but also for enhancing food system resilience and consumer access to quality produce. Several structural and policy-related challenges hinder effective value chain development in India. A large proportion of farmers, especially smallholders who make up 86% of India's farming households (Agricultural Census 2015–16) lack direct access to markets, often relying on local traders or middlemen. While the government launched the e-NAM (Electronic National Agriculture Market) platform, adoption remains uneven, covering only 1,260 mandis as of 2023 out of over 7,000 nationwide. Inadequate infrastructure for grading, storage, and transport, especially in remote areas, leads to quality degradation and price losses. Legal ambiguity and mistrust around contract farming and weak institutional capacity of many FPOs further limit scalability. Additionally, the potential of Geographical Indication (GI) tagging and product branding for traditional crops remains underutilized, with over 400 registered GI tags in India but poor market visibility and export linkages (The times of India, 2022). Ensuring inclusivity and transparency in market reforms remains a major challenge, especially for women farmers and tribal communities.

Opportunities for building efficient and inclusive value chains: India's agri-food sector is now positioned to benefit from a convergence of digital innovation, policy support, and private sector engagement. The rise of agri-tech startups and digital platforms such as DeHaat, AgriBazaar, and Reliance Fresh has created new avenues for farmers to access markets, inputs, and advisory services directly. The government's PM Formalization of Micro Food Processing Enterprises (PM-FME) scheme and Agri-Infra Fund provide crucial financial and infrastructural support for value addition and cold chain development (Tejaswini, 2021). Contract farming, when transparently implemented with strong regulatory oversight, can offer price assurance and technology access to farmers. The emergence of 10,000+ FPOs under the Central Sector Scheme (2020) opens up pathways for collective branding, aggregation, and negotiation power. Moreover, leveraging GI tagging and storytelling around traditional foods, like Alphonso mangoes, Darjeeling tea, or Kandhamal turmeric etc. can enhance India's presence in global markets. With appropriate public-private-community partnerships, nationa can build a value chain ecosystem that is not only market-efficient but also inclusive and sustainable.

8. Integrated Farming Systems and Rural Livelihoods

Need for integrated farming systems and rural livelihood diversification: Monoculture-based farming has proven vulnerable to external shocks such as droughts, pest outbreaks, and price crashes (Belete and Yadete, 2023). In this context, Integrated Farming Systems (IFS), which combine crops with livestock, fisheries, horticulture, and agroforestry, offer a holistic strategy for income stability, ecological sustainability, and nutritional security. According to ICAR, IFS models demonstrated income increases of 2–3 times compared to conventional systems, particularly in rainfed and tribal areas. Moreover, diversification into agri-allied sectors like dairy, poultry, beekeeping, and aquaculture not only reduces dependence on a single income stream but also enhances year-round employment opportunities. In rural India, where non-farm jobs remain scarce, promoting farm-based enterprises for youth is vital for reversing distress migration and energizing the rural economy. Despite its proven potential, the adoption of IFS in India faces several operational and institutional bottlenecks. Fragmented landholdings, limited capital investment capacity, and poor access to credit and technical knowledge hinder integrated enterprise development, especially among smallholders. The lack of convergence between agriculture, animal husbandry, and fisheries departments often results in fragmented policy support and extension delivery. Infrastructure gaps, such as absence of on-farm processing units, feed supply chains, cold storage, and water management systems, further limit the profitability and scalability of integrated models. Additionally, limited training in enterprise management and value addition restricts rural youth and women from participating meaningfully in diversified agri-business opportunities. Community-based natural resource management is still underutilized, especially in managing common lands, water bodies, and grazing areas essential for multi-enterprise farming systems.

Opportunities for resilient livelihoods through integration and innovation: Our nation has immense potential to scale up Integrated Farming Systems through policy support, innovation, and community engagement. Government schemes like Rashtriya Krishi Vikas Yojana (RKVY), National Livestock Mission, and Blue Revolution offer financial and technical support for multi-enterprise farming. ICAR's network of Krishi Vigyan Kendras (KVKs) has been instrumental in demonstrating localized IFS models, such as crop-livestock-fishery integration in Eastern India or agro-horti-livestock systems in arid regions. Initiatives like FPOs, custom hiring centers, and value addition training centers provide platforms for collective marketing, input sharing, and youth entrepreneurship. Moreover, models of community-based resource management, such as Joint Forest Management and Participatory Irrigation Management, can be aligned with IFS to optimize shared resource use. Promoting on-farm value addition, rural bioenterprises, and digital tools for integrated planning and marketing can transform IFS into a cornerstone for doubling farmers' incomes and ensuring resilient rural livelihoods.

9 Education, Research, and Capacity Building

Need for education, research, and capacity building in Indian agriculture: As India grapples with the dual pressures of productivity reduction and food system transformation, revamping agricultural education, research, and capacity building has become imperative. The existing system, which largely follows a production-centric model, needs to evolve into one that is climate-resilient, technology-driven, and entrepreneurship-oriented. According to the National Education Policy (NEP) 2020, there is a call for agricultural curricula to be multidisciplinary and aligned with 21st-century challenges such as sustainability, biotechnology, data science, and artificial intelligence (Aithal and Aithal, 2020). Meanwhile, India's agricultural research spending stands at just 0.30% of agricultural GDP, well below the global average of 1% (World Bank, 2021). This is concerning, given the need for innovations in areas like water-use efficiency, carbon farming, regenerative practices, and digital agriculture. Additionally, with over 70% of rural youth seeking non-farm employment (NSSO, 2018), focused efforts to skill and attract youth into agripreneurship and rural innovation ecosystems are crucial for both employment generation and food system renewal. Despite being home to a vast network of over 75 State Agricultural Universities (SAUs) and Indian Council of Agricultural Research (ICAR) institutes, the Indian agricultural education system faces major hurdles. Curricula remain outdated in many universities, with insufficient focus on practical learning, digital tools, or business management. Rural youth and farmers often lack access to structured capacity-building programs in emerging fields like drone usage, e-marketing, or climate-smart farming. Moreover, the disconnect between research institutions and grassroots realities limits the uptake of scientific innovations. Farmer-led participatory research, while successful in some models (e.g., participatory varietal selection), is not yet mainstreamed in public research agendas. Inter-sectoral silos between agriculture, health, environment, and technology sectors further hinder integrated problem-solving (Lah, 2025). Lack of adequate funding, digital infrastructure, and trained human resources also weakens the effectiveness of outreach and extension activities.

Opportunities for transformative learning and innovation: India stands at a unique inflection point to reimagine its agricultural knowledge ecosystem. The NAHEP (National Agricultural Higher Education Project), supported by the World Bank and ICAR, is already working to modernize agri-education through ICT integration, soft skills development, and faculty upskilling. Expanding these efforts through industry-academia collaborations, experiential learning, and start-up incubation programs can prepare a future-ready agri-workforce. The MANAGE Agri-Clinics and Agri-Business Centers Scheme, Skill India Mission, and KVK-led trainings offer scalable platforms for skilling both youth and farmers in agri-allied and tech-based enterprises. Additionally, fostering cross-sectoral partnerships between agriculture, IT, public health, and environmental sciences can fuel interdisciplinary innovation and policy synergy. Strengthening farmer-led innovation platforms, citizen science models, and community knowledge hubs will also democratize knowledge creation and dissemination. With strategic investment and institutional reforms, India can transform its education and research systems into powerful drivers of agricultural sustainability, equity, and competitiveness.

10. Policy, Governance, and Institutional Reforms

Need for policy, Governance, and institutional reforms: India's agricultural sector, demands urgent policy and institutional reforms to enhance productivity, equity, and sustainability. Existing input subsidies, particularly for fertilizers and electricity, have led to resource inefficiencies, environmental degradation, and fiscal burdens without commensurate productivity gains. At the same time, policies around land leasing, crop insurance, and export restrictions remain fragmented and often disincentivize investment and risk-taking by farmers. Strengthening Farmer Producer Organizations (FPOs) a key strategy for collectivizing smallholders is essential, especially when over 86% of Indian farmers are small and marginal. Similarly, reforming agri-marketing and trade policies is critical for linking Indian farmers with domestic and global value chains and improving price realization. Despite numerous schemes and policy announcements, effective reform implementation faces structural and institutional challenges. FPOs, though supported under the 10000 FPO scheme by the Government of India, often struggle with governance, capital access, and market linkages. Crop insurance under the PM Fasal Bima Yojana (PMFBY), while covering millions of farmers, has faced criticism due to delayed claim settlements, inadequate coverage, and low trust among farmers (Ghosh, 2018). Export bans and frequent changes in Minimum Export Prices (MEPs) for commodities like onions and wheat disrupt farmer incentives and India's image in global markets. Moreover, institutional silos between central and state agencies hinder coherent, inclusive, and timely policy execution. Governance structures often lack accountability mechanisms for inclusive development, particularly for women, tribal, and landless communities.

Opportunities for systemic reform and inclusive Governance: India has a significant opportunity to recalibrate its policy and governance frameworks for more inclusive and resilient agricultural transformation. Transitioning from input-based subsidies to direct benefit transfers (DBT) and performance-linked incentives can improve efficiency and reduce leakages. Successful land leasing models, such as those in Telangana and Odisha, provide templates for legalizing tenancy and expanding access to institutional credit. Strengthening FPOs through blended finance, digital platforms, and private sector partnerships can help them scale and compete in modern value chains. Reforms in crop insurance including weather-indexed products and digital claim processing can build trust and expand risk coverage. Aligning agri-marketing and export policies with global standards and ensuring price stability through transparent, long-term mechanisms will improve market access. Finally, enhancing governance through decentralized planning, digital public infrastructure, and community-based monitoring systems will ensure that agricultural growth is not only efficient but also equitable and climate-resilient.

CONCLUSION

In conclusion, Harvesting the Future envisions a paradigm shift in global and Indian agriculture, one that transcends traditional models and embraces transformative, inclusive, and technology-enabled solutions to confront the multifaceted challenges of the 21st century. As climate change intensifies, social inequalities persist, and technological disruptions accelerate, the need for systemic, forward-looking agri-visions becomes increasingly urgent. Integrating climate-smart practices, gender equity, digital innovations, value chain reforms, and participatory governance is no longer optional, it is foundational to building resilient, sustainable, and equitable food systems. By aligning policy, research, and grassroots action, and by empowering farmers especially women, youth, and smallholders, Indian agriculture has a historic opportunity to ensure food and nutritional security, ecological balance, and rural prosperity. The future of agriculture will be determined not just by what we grow, but by how, for whom, and with what vision we choose to sow the seeds of tomorrow.

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Lead Paper-1

Innovations in Frontline Extension for Hill Agriculture

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ABSTRACT

Hill agriculture in India offers significant potential for cultivating high-value crops such as fruits, spices, and medicinal plants, but it also faces challenges like soil erosion, marginal land holding, micro climatic conditions and poor market access. Due to the difficult terrain and poor connectivity in hilly areas, the timely reach of advanced agricultural technologies is often hindered. Innovations in frontline extension services have emerged as critical solutions to bridge the gap between research advancements and on-field adoption. The integration of big data management, artificial intelligence and machine learning-driven advisories has strengthened real-time decision-making for farmers. Digital platforms like Kisan Sarthi and Pusa Samachar have revolutionized communication, enabling timely advisories and farmer query resolution. Similarly, social media extension has played a pivotal role in knowledge dissemination, with platforms like WhatsApp advisory services and YouTube-based educational content driving engagement. Institutional interventions under NICRA villages have promoted climate resilience by establishing Village Climate Risk Management Committees (VCRMCs), Custom Hiring Centres (CHCs), seed and fodder banks, and mechanization initiatives. To address labour shortages and improve efficiency, modern mechanization through CHCs has been promoted, offering farmers access to advanced equipment for precision planting, in-situ moisture conservation, and residue management. The participatory varietal selection approach, as demonstrated by ICARDA and WARDA trials, has facilitated the adoption of region-specific, high-performing crop varieties, thereby enhancing productivity and resilience. The institutionalization of innovative extension models has been further strengthened through public-private partnerships, MoUs with government agencies, and cost-sharing mechanisms for technology dissemination that ensure long-term sustainability and scalability of interventions. Strengthening multi-stakeholder collaborations, leveraging advanced analytics, and policy support will be key to maximizing the impact of frontline extension in these challenging agro-climatic regions.

Keywords: Hill agriculture, Frontline extension, Digital Agriculture, Farmer First Programme, Participatory Research, Social Media Extension

1. Introduction

India's diverse topography includes several prominent hilly regions, each characterized by unique climatic conditions, soil types, and farming practices. These mountainous areas are ranging from the towering Himalayas in the north to the lush Western and Eastern Ghats in the south which support a variety of crops adapted to their specific environments. Hill agriculture plays a crucial role in sustaining local livelihoods, preserving traditional knowledge, and contributing to the country's overall agricultural diversity. Despite facing challenges such as difficult terrain and limited infrastructure, farmers in these regions cultivate a wide range of crops, including fruits, spices, cereals, and medicinal plants, often using eco-friendly and sustainable methods suited to fragile hill ecosystems.

The Western Himalayas, comprising Jammu & Kashmir, Himachal Pradesh, and Uttarakhand, are characterized by steep terrains where terrace farming is widely practiced to manage soil erosion and water flow. The region supports the cultivation of temperate fruits like apples, pears, plums, and apricots, along with vegetables such as peas, cabbage, cauliflower, and potatoes. Cereals like wheat, barley, and maize, as well as pulses like rajma, are staple crops, while medicinal plants such as valerian and ashwagandha are also grown (Negi, 2017; Sharma *et al.*, 2020). In contrast, the Eastern Himalayas, encompassing Sikkim, Arunachal Pradesh, and parts of Assam and West Bengal (Darjeeling), focus on organic farming and high-value crops. Darjeeling tea is globally renowned, and crops like large cardamom, ginger, oranges, kiwi, and guava are prominent. Millets and maize serve as dietary staples for local communities (Singh *et al.*, 2021; Pandey & Bajpai, 2018). Further south, the Western Ghats, stretching across Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu, support diverse agricultural practices with an emphasis on plantation crops such as coffee, tea, and rubber. Spices like black pepper, cardamom, and nutmeg flourish here, along with tropical fruits such as bananas, jackfruit, and mangoes. Paddy cultivation is prevalent in the valley regions, and agroforestry along with mixed cropping enhances environmental sustainability (Kumar & Singh, 2019). The Eastern Ghats, spread across Odisha, Andhra Pradesh, and Tamil Nadu, are known for millet and pulse cultivation including finger millet and pigeon pea alongside horticultural crops like mango and custard apple. Tribal areas continue to practice shifting cultivation (jhum), with crops like cashew and turmeric grown in some zones (Bhatt & Rawat, 2016). In the Northeastern Hills, comprising Nagaland, Manipur, Mizoram, Meghalaya, and Tripura, shifting cultivation is widely practiced, and farmers grow fruits like pineapple, orange, and banana, as well as spices like ginger and staple rice. There is a recent push toward organic farming to protect and sustain the fragile hill ecosystems (Sharma *et al.*, 2020).

The hilly region differs significantly from the plains due to its diverse terrain, unique geographical characteristics, and specific socio-economic challenges, while also offering certain advantages. In the Indian Himalayan Region (IHR), around 59% of the workforce is engaged in subsistence farming, which typically supports the population for only about 5 to 6 months annually (Saha *et al.*, 2021).

Agricultural extension services in hilly regions have traditionally been constrained by inadequate outreach, limited technological adaptation, and lack of participatory engagement with farmers. Extension services in hill agriculture in India need to be tailored to the unique challenges posed by difficult terrain. Conventional extension models often fail to address location-specific needs, making it imperative to adopt innovative approaches to knowledge dissemination. Frontline extension has emerged as a crucial mechanism to bridge this gap by integrating farmer-centric learning models, digital tools, and community-based interventions. Participatory extension approaches, such as Farmer Field Schools (FFS), on-farm demonstrations, and village knowledge centres, have proven effective in facilitating experiential learning and improving technology adoption (Saini *et al.*, 2023). Customized technologies suitable for steep slopes, terracing, and soil conservation must be promoted to reduce erosion and improve productivity (Negi, 2017). Training farmers in integrated pest management, organic farming, climate-resilient practices, and post-harvest technologies can enhance sustainability and income (Sharma *et al.*, 2020). Extension services should facilitate better market access and value chain development to help farmers sell high-value hill crops like fruits, spices, and medicinal plants (Kumar & Singh, 2019). Considering poor connectivity and remoteness, mobile apps, radio, and community information centers can deliver timely information on weather, pest outbreaks, and best practices (Singh *et al.*, 2021). Extension efforts should encourage agroforestry, mixed cropping, and organic methods to conserve biodiversity and improve resilience (Pandey & Bajpai, 2018). Building local institutions and cooperatives can strengthen collective action for input supply, credit access, and technology adoption (Bhatt & Rawat, 2016).

Innovations in frontline extension have significantly improved the transfer of knowledge and technology adoption in hill agriculture. Farmer-led participatory approaches, ICT-based solutions, and climate-smart interventions have contributed to enhanced resilience and productivity in these challenging environments. Continued investment in research, capacity-building programs, and policy support is essential for ensuring sustainable growth and food security in India's hill regions.

2. Hill Agriculture in India: Challenges and Potential Solutions

Farmers in hill regions face multiple constraints such as limited arable land, soil erosion, poor infrastructure, and inadequate access to markets and modern inputs. The steep slopes lead to high runoff and nutrient loss, reducing productivity and soil health over time. Climatic vulnerabilities like erratic rainfall and increasing temperatures further threaten agricultural sustainability in these ecologically fragile zones (Sharma *et al.*, 2020). Additionally, the high cost of transportation and lack of storage and processing facilities make it difficult for farmers to sell their produce profitably.

The predominance of subsistence farming, small landholdings, low income levels, and limited access to institutional credit significantly hinder agricultural development in hill regions. Youth migration from hills to urban areas has also led to labor shortages, further weakening the local agricultural systems and leaving large tracts of land fallow. One of the major limitations in hill agriculture is the lack of timely and location-specific extension services. The challenging terrain, poor road connectivity, and communication barriers hinder the dissemination of modern agricultural practices and technologies. Farmers often rely on traditional knowledge, which, although valuable, may not always be sufficient to cope with modern-day challenges such as climate change and market fluctuations (Singh *et al.*, 2021). Strengthening agricultural extension systems through ICT tools, community-based platforms, and mobile advisory services is essential for knowledge transfer in these regions.

Given the ecological fragility of hill ecosystems, promoting sustainable and climate-resilient farming practices is crucial. Organic farming, agroforestry, and integrated nutrient management are particularly suitable for hilly regions and can help maintain soil fertility and biodiversity (Pandey & Bajpai, 2018). For instance, the state of Sikkim has successfully transitioned to 100% organic farming through sustained policy support, extension services, and farmer training under the Paramparagat Krishi Vikas Yojana (PKVY). Replicating such models in other hill states can lead to long-term ecological and economic gains.

To support hill agriculture in India, several government schemes have been implemented with a focus on technology dissemination, capacity building, and livelihood enhancement. The National Mission on Sustainable Agriculture (NMSA) promotes climate-resilient practices, including in hilly regions, through extension support and training. The Mission for Integrated Development of Horticulture (MIDH) provides technical assistance and financial support for horticulture development, which is vital in hill agriculture. The National Innovations in Climate Resilient Agriculture (NICRA) project by ICAR focuses on technology demonstration and adaptive strategies for vulnerable hill areas. Krishi Vigyan Kendras (KVKs) in hilly districts play a crucial role in offering on-farm trials, training, and advisory services tailored to local conditions.

To harness the full potential of hill agriculture, an integrated approach is required that combines traditional knowledge with modern innovations, strengthens infrastructure, and improves institutional support. Extension services must be made more inclusive, accessible, and participatory. Investment in market access, value addition, and farmer cooperatives can improve income stability and reduce migration. By aligning policies with the unique agro-ecological and socio-economic realities of hill regions, India can make hill agriculture more resilient, productive, and sustainable (Negi, 2017; Sharma *et al.*, 2020).

3. Considerations for Successful Extension Strategy

In order to enhance agricultural productivity and resilience in the resource poor hill regions, an effective extension strategy is essential. A well-structured extension approach must consider several critical factors to ensure knowledge dissemination, technology adoption, and farmer empowerment.

A location-specific approach is essential for hill agriculture, as variations in agro-climatic conditions, soil types, and farming systems make a one-size-fits-all strategy ineffective. Tailoring extension programs to regional needs involves conducting baseline surveys to understand local farming practices and constraints, promoting region-specific crops and agronomic practices suited to moisture-limited environments, and encouraging farmer participation in designing and evaluating extension programs to ensure their relevance and effectiveness. By focusing on localized solutions, extension services can equip farmers with practical and actionable knowledge that directly addresses their challenges.

Technology transfer plays a critical role in improving hill farming systems by bridging the gap between research institutions and farmers. The successful adoption of new technologies depends on efficient transfer mechanisms, such as on-farm trials demonstrating improved crop varieties, soil conservation techniques, and water-efficient irrigation methods. Encouraging farmer-to-farmer knowledge sharing enhances the adoption of innovative practices, while ensuring that recommended technologies are cost-effective, scalable, and adaptable to resource-constrained environments increases their long-term viability. Additionally, integrating traditional knowledge with modern scientific advancements can further strengthen technology acceptance among farmers.

Reaching a diverse group of farmers, many of whom have limited access to formal education, requires effective communication channels that combine traditional and modern approaches. Community radio programs broadcasting weather forecasts, best farming practices, and government schemes in local languages can improve outreach. Mobile-based advisory services, such as SMS alerts and voice messages, provide real-time agricultural information, while community meetings and demonstrations at the village level promote hands-on learning (Burman *et al.*, 2024). By leveraging a mix of these communication tools, extension services can ensure widespread information dissemination and farmer engagement.

Collaboration with government agencies is also crucial in scaling up extension programs and ensuring farmers have access to essential resources. Extension services can play a key role in facilitating access to subsidies and credit, helping farmers secure financial assistance for inputs like seeds, fertilizers, and irrigation equipment. Promoting crop insurance schemes educates farmers on risk management strategies to mitigate the impact of climate variability, while strengthening market linkages assists farmers in connecting with wholesale markets, cooperatives, and e-commerce platforms to secure fair prices for their produce (Saini *et al.*, 2023b). A coordinated approach involving extension agents, policymakers, and research institutions can maximize the impact of government initiatives and drive sustainable agricultural development in hill regions.

4. Frontline Extension System: Challenges

The frontline extension system plays a crucial role in bridging the gap between research institutions and farmers by disseminating knowledge, innovations, and best agricultural practices. However, several structural and operational challenges hinder its effectiveness, particularly in hilly regions.

One of the major challenges is the limited availability of extension personnel at the grassroots level. In most states, extension staff are present only up to the block level, leaving a significant gap in last-mile delivery. Moreover, the existing personnel are often burdened with multiple roles, reducing their ability to focus on effective technology transfer. The extension worker-to-farmer ratio in India is alarmingly high, standing at 1:5,000, whereas in countries like China, it is 1:625 (Ragasa *et al.*, 2015). The recommended ratio for effective extension delivery is 1:1000 in irrigated areas, 1:750 in rainfed regions, and 1:400 in hilly terrains, yet India continues to face a significant shortfall in trained personnel.

The rapid pace of technological advancements in agriculture has further widened the gap between research and extension. Although new crop varieties, climate-resilient technologies, and precision farming tools are being developed at a fast rate, their adoption at the farm level remains slow due to inadequate dissemination efforts. The inefficiency of the current extension framework is reflected in the low reach of Rural Advisory Services (RAS), which cover only 6-6.8% of farmers (GFRAS, 2025). In addition to the workforce shortage, the educational qualifications and professional expertise of Village-Level Workers (VLWs) are often inadequate to meet the diverse and evolving information needs of farmers. Continuous training and capacity building programs are necessary to ensure that extension personnel remain updated with modern agricultural techniques and digital tools.

Comparisons with other countries highlight the gaps in India's extension system. In China and Vietnam, one extension worker covers 280 farm households, while in Indonesia, each worker serves about 2.8 villages (GFRAS, 2025). In contrast, India's extension personnel struggle to provide personalized guidance due to overwhelming caseloads and limited resources. Addressing these challenges requires policy interventions to promote decentralized extension models and a robust frontline extension system is essential to enhance agricultural productivity, ensure food security, and improve the livelihoods of millions of farmers across India.

Solutions to Strengthen the Frontline Extension System

To address the challenges in India's frontline extension system, customized agro-advisory services leveraging digital solutions must be prioritized. The creation of farmer databases, combined with mobile-based advisory platforms, can facilitate real-time, personalized recommendations on crop management, weather forecasts, and market trends. Digital tools can also bridge the gap in extension personnel by providing virtual training and knowledge dissemination, ensuring that farmers receive up-to-date agricultural insights despite the workforce shortage (Mukherjee *et al.*, 2025).

Agri-preneurship and business incubation can empower rural youth by equipping them with technical and managerial skills to become service providers, thereby supplementing extension efforts. Establishing cooperatives and commodity clusters, supported by technology backstopping and handholding of Farmer Producer Organizations (FPOs), Farmer Interest Groups (FIGs), and Self-Help Groups (SHGs), can strengthen local agricultural value chains and market access. Encouraging precision farming, higher Seed Replacement Rate (SRR) and Variety Replacement Rate (VRR), along with improved agronomic practices, can enhance technology adoption and productivity. Additionally, gender-sensitive extension programs must be integrated to promote women-friendly farm technologies and bio-fortified crops, ensuring inclusive agricultural development and better nutrition outcomes. Strengthening these approaches will create a more efficient, inclusive, and technology-driven extension system for hill agriculture.

5. Partnership-Based Extension Models

5.1 Branch Post Masters (BPMs)-led Extension Model

The effectiveness of agricultural extension services depends largely on their ability to reach remote and smallholder farmers efficiently. One of the promising innovations in partnership-based extension models is leveraging Branch Post Masters (BPMs) as potential extension agents (NAAS, 2022). India has a vast network of 1.55 lakhs post offices, with ~90% located in rural areas, making them an ideal vehicle for disseminating agricultural knowledge. BPMs, who are responsible for managing these rural post offices, often belong to farming communities themselves, providing them with a natural connection to local farmers. Given the decline in traditional mail services by nearly 50%, BPMs have increased their collaborative activities with financial institutions, insurance providers, and investment agencies by 15-20%, positioning them as valuable intermediaries for agricultural extension. By utilizing BPMs as community-based extension agents, the agricultural sector can benefit from a well-established network with deep rural penetration. Their proximity to farming communities allows them to serve as a reliable channel for disseminating government schemes, financial support programs. The integration of BPMs into the extension framework can bridge the gap between research institutions and farmers, particularly in hilly regions where traditional extension services struggle with outreach.

The implementation of BPM-led extension models has demonstrated several key benefits in agricultural knowledge transfer. One of the most significant advantages is its cost-effectiveness, as BPMs already have an established network and infrastructure, reducing the need for additional logistical investments. Unlike traditional extension systems that often face geographical and human resource constraints, BPMs enable rapid outreach to remotely located farmers within 4-6 days, ensuring timely delivery of essential agricultural advisories. Additionally, the model has facilitated capacity-building initiatives for both BPMs and farmers, leading to a knowledge gain of 23-36%. The success of BPM-led extension models highlights the potential of alternative extension mechanisms that rely on existing rural institutions. By formalizing BPMs as community-based agricultural extension agents, the agricultural extension system can achieve greater inclusivity, efficiency, and impact in transforming rural livelihoods.

To ensure the long-term sustainability and effectiveness of the BPM-led extension model, its integration into formal institutional frameworks is essential. A crucial step in this process is establishing a Memorandum of Understanding (MoU) with the Department of Post, which would formally recognize the role of BPMs as agricultural extension facilitators (NAAS, 2022). One of the critical aspects is providing adequate financial incentives to BPMs for their additional responsibilities. Currently, a remuneration of Rs. 6,500 per annum per BPM has been proposed, ensuring their continued participation and motivation in extension activities. To support its expansion, external funding from schemes like Rashtriya Krishi Vikas Yojana (RKVY) and Corporate Social Responsibility (CSR) initiatives can be mobilized. Additionally, a cost-sharing mechanism (such as 50% coverage of seed and postage costs) can further reduce financial constraints, making the model economically viable and scalable. With proper financial support, training, and policy integration, this innovative approach has the potential to become a nationally scalable model that complements traditional extension efforts and significantly improves technology adoption, market access, and agricultural productivity in India's hilly regions.

5.2 IARI-VOs/SAUs/ICAR Institutes Partnership Extension Model

This model is a collaborative approach aimed at leveraging the strengths of multiple research and extension institutions to enhance agricultural technology dissemination. IARI has partnership with

28 VOs spread across 14 states of India since 2010 (NAAS, 2022). This model promotes the cost-effective utilization of manpower and resources from partner institutes, ensuring that the latest innovations reach farmers efficiently. By encouraging openness in technology acceptance, this model facilitates the adoption of the best agricultural technologies, regardless of their origin, thereby maximizing the benefits for farming communities (Sharma *et al.*, 2020). One of the significant advantages of this model is its ability to integrate institutional expertise from various agricultural universities (SAUs), voluntary organizations (VOs), and ICAR research institutes. This collaboration allows for wider outreach, location-specific adaptations, and better field validation of improved crop varieties, agronomic practices, and resource-conserving technologies.

The model has primarily facilitated a one-way technology transfer process, where partner institutions have focused on disseminating improved crop varieties and production technologies to farmers. Field experiences indicate that IARI-developed technologies have shown consistently better performance across diverse agro-climatic regions, demonstrating their robustness and adaptability. The success of technology adoption, however, depends significantly on the motivation and proactive engagement of nodal officers at VOs, SAUs, and ICAR institutes, highlighting the importance of leadership in extension initiatives. A notable outcome of this partnership model has been the exceptional performance of certain varieties in non-traditional regions. For instance, Pusa Bharti (Palak) and Pusa Pragati (Vegetable Pea), originally bred for specific agro-climatic conditions, have shown remarkable yield and quality performance in Bangalore, an area not conventionally associated with these crops. The model's primary focus has been on assessing and promoting improved crop varieties, with scope for further enhancement through greater farmer feedback integration, participatory technology validation, and multi-directional knowledge exchange.

5.3 ICARDA Farmer Participatory Varietal Selection

Farmer participatory varietal selection (FPVS) is a collaborative approach that actively involves farmers in selecting and evaluating crop varieties to ensure better adaptation, acceptability, and adoption (Singh *et al.*, 2014). This approach, pioneered by institutions like ICARDA (International Center for Agricultural Research in the Dry Areas), follows a three-year systematic process that progressively refines varietal selection through multiple trials under real farm conditions.

In the first year, Farmer Initial Trials (FIT) are conducted, where a diverse range of crop varieties is introduced to participating farmers. These trials are typically preliminary and serve as an initial screening phase where farmers observe plant performance based on local environmental conditions, soil type, and climatic factors. Farmers assess traits such as drought tolerance, pest resistance, grain quality, and yield potential, providing valuable insights into which varieties show promise for further testing.

During the second year, the most promising varieties from FIT are advanced to Farmer Advance Trials (FAT). Here, the selected varieties undergo further evaluation under expanded farm conditions, allowing farmers to test them in their own fields with routine agronomic practices. This stage enables comparative assessments and provides deeper insights into yield stability, resilience to biotic and abiotic stresses, and input efficiency. Farmers' feedback in this phase helps narrow down the selection to elite varieties that show consistent performance across different environments.

The third year involves Farmer Elite Trials (FET), where the top-performing varieties are rigorously tested in larger field plots under farmer-managed conditions. This phase ensures that selected varieties not only meet scientific breeding objectives but also align with farmer preferences and practical usability.

By the end of this stage, varieties are ready for wider dissemination, seed multiplication, and eventual commercialization, ensuring that farmers have access to superior, locally adapted cultivars.

5.4 WARDA On-Farm Trial Case Study

A similar participatory selection process has been implemented by the West Africa Rice Development Association (WARDA) in on-farm trials for rice. The approach follows a three-year cycle, beginning with a centralized village plot containing about 60 different rice varieties. Farmers observe these varieties at three distinct growth stages and formally evaluate them based on key agronomic traits (Tollens *et al.*, 2013). In the second year, a subset of the best-performing varieties, as identified by farmers, is distributed for on-farm trials, while new varieties are introduced for further assessment. Farmers continue to provide detailed observations on growth, yield, pest resistance, and grain quality, contributing to a refined selection process. By the third year, the program shifts focus to assessing farmers' willingness to pay for specific varieties, estimating the technology demand, and aligning input supply chains with farmers' seed preferences. This step ensures that newly developed varieties match farmer expectations and market requirements, leading to higher adoption rates and improved food security. Farmer participatory varietal selection approaches like those of ICARDA and WARDA have proven to be effective, inclusive, and farmer-driven that enable faster diffusion of improved varieties, strengthen farmer engagement in research, and contribute to sustainable agricultural development by ensuring that new varieties meet both productivity and resilience challenges.

6. Suitability of On-Farm Trials (OFTs) Based on Involvement of Stakeholders

On-farm trials (OFTs) are critical for evaluating agricultural technologies and innovations in real farming conditions. The level of stakeholder involvement, particularly that of researchers and farmers which determines the trial design, management, relevance, and potential for adoption. There are three primary types of on-farm trials:

6. 1 Researcher-Designed; Researcher-Managed Trials

These trials aim to generate precise scientific data under controlled field conditions. Researchers maintain high control over trial design, input management, and experimental protocols, ensuring replication and standardization. While these trials provide accurate scientific insights, they may not fully reflect real-world farm conditions due to standardized management practices that differ from farmers' typical practices. Farmer involvement in such trials is minimal, and the technology adoption potential remains low to moderate. However, the risk to farmers is also low, making these trials best suited for testing new technologies, treatments, or agronomic practices in a controlled setting before field-scale evaluation.

6. 2 Researcher-Designed; Farmer-Managed Trials

In this model, researchers design the trials but allow farmers to manage them under guided supervision. The objective is to assess the feasibility of new technologies under practical farm conditions, making them more adaptable to local realities. Farmers apply their own agronomic practices with some modifications based on research recommendations. This approach involves a medium level of farmer participation, with a moderate to high potential for technology adoption. While the risk to farmers is medium, these trials are best used for evaluating the practical feasibility and adaptability of new innovations before large-scale dissemination.

6. 3 Farmer-Designed; Farmer-Managed Trials

These trials are fully farmer-driven, with farmers deciding on the trial objectives, management strategies, and evaluation criteria. The focus is on determining the practical relevance and long-term adoption potential of new technologies. While this approach ensures high relevance to real-world farming conditions, it may lack scientific standardization and replication. Farmer involvement is high, leading to a strong potential for technology adoption, but the associated risk to farmers is also significant. These trials are best suited for assessing farmer preferences, understanding real-world constraints, and determining long-term adoption trends.

7. Big Data Management in Extension

Effective big data management in agricultural extension is essential for bridging data gaps, understanding farmer practices, and improving technology dissemination. Despite advancements in research and extension, systematic data collection at the field and farmer levels remains limited. The challenge lies in capturing real-time, ground-level insights to drive evidence-based decision-making. A key aspect is learning what works in agriculture by analyzing what farmers are doing and why. To achieve this, two-stage cluster sampling has been implemented using Open Data Kit (ODK), a digital data collection platform. This approach ensures randomized farmer selection, leading to comprehensive and unbiased data collection (CSISA, 2025). A standardized digital survey records 226 variables, covering major crop production practices to capture diverse aspects of farming systems. A fully randomized sample of 210 households (HH) per district enhances the representativeness of the data, ensuring reliable insights into agricultural extension needs. The adoption of near-real-time data collection tools like ODK allows for quick data processing and analysis, enabling extension systems to remain responsive to emerging trends. With structured data, researchers and policymakers can better understand regional differences, technology adoption patterns, and gaps in extension outreach, ultimately improving decision-making for sustainable agricultural development.

Big data-driven feedback management systems play a crucial role in ensuring technology development and dissemination align with farmer needs. The collected data serves as an input for the research system, helping to reorient research programs to suit the technology needs of stakeholders. This ensures that scientific advancements in agriculture remain relevant and effectively address on-the-ground challenges. Additionally, state development departments use these insights for policy formulation and large-scale technology dissemination. The ability to analyze trends in real-time ensures that policymakers can implement targeted interventions that are region-specific and data-driven. With the integration of machine learning and advanced analytics, big data enables predictive modelling across areas of interest, helping researchers and policymakers anticipate trends and develop proactive solutions. To date, over 60,000 data points and crop-cut experiments have been recorded in wheat and rice, while Large-Scale Demonstrations (LDS) in pulses and oilseeds are being carried out by 100 KVKs across India (CSISA, 2025).

8. Smart Natural Resources Management and Climate Resilient Agriculture

Effective Natural Resources Management (NRM) is essential for ensuring sustainable agricultural production, environmental conservation, and climate resilience. Traditional approaches, such as soil testing and fertilizer application, are gradually evolving towards holistic and smart solutions that integrate climate adaptation, resource efficiency, and data-driven decision-making. The NRM strategies should be guided by SMART objectives (Figure 1).

8. 1 Smart Approaches to NRM

Weather Smart: Agriculture must adapt to changing climatic conditions by leveraging weather forecasts, climate models, and adaptive farming techniques. Real-time weather-based advisories can help farmers make informed decisions on sowing, irrigation, and pest management.

Carbon Smart: Sustainable farming practices such as carbon sequestration, conservation agriculture, and

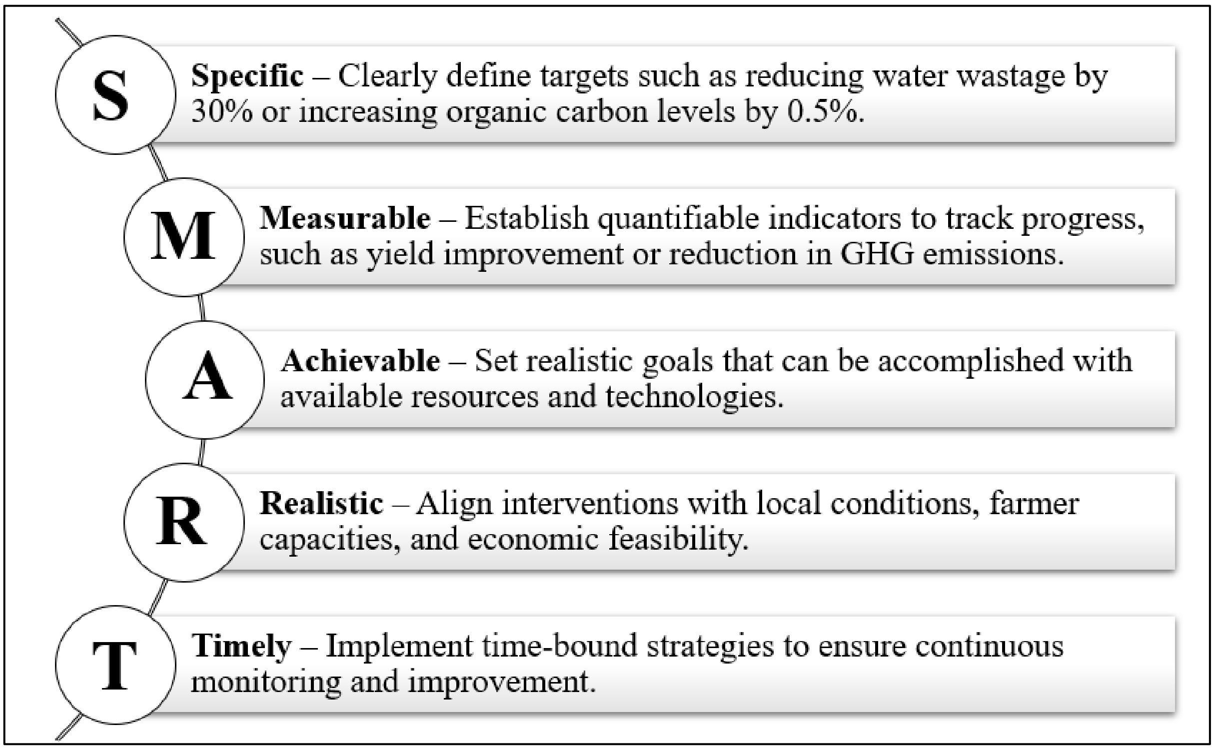

Figure 1: SMART objectives guiding the natural resource management

agroforestry help reduce greenhouse gas (GHG) emissions while enhancing soil carbon storage.

Nutrient Smart: Moving beyond traditional fertilizer-based soil management, nutrient-smart strategies focus on organic amendments, biofertilizers, crop rotations, and soil microbiome health. This ensures long-term soil fertility and productivity.

Energy Smart: The transition towards renewable energy sources, energy-efficient machinery, and conservation tillage reduces agriculture's dependence on fossil fuels and lowers production costs.

Knowledge Smart: Farmer education, capacity building, and digital extension services empower rural communities with scientific knowledge and best practices for sustainable resource use.

Water Smart: With increasing water scarcity, water-smart approaches emphasize rainwater harvesting, micro-irrigation, conservation agriculture, and real-time water management to improve water-use efficiency.

8.2 Climate Resilient Agriculture

Climate change poses significant threats to agricultural systems, affecting crop yields, water availability, soil health, and farmer livelihoods. To ensure food security and sustainable farming, the concept of Climate Resilient Agriculture (CRA) has emerged as a strategic approach to reduce vulnerabilities, enhance adaptation, and mitigate climate impacts (Kumar *et al.*, 2025).

Understanding Vulnerability to Climate Change

Vulnerability to climate change in agriculture is influenced by three key components:

Sensitivity – This refers to the degree to which an agricultural system is affected by climate-related factors, such as temperature variations, changing rainfall patterns, and extreme weather events. For instance, crops with low drought tolerance are highly sensitive to water stress.

Exposure – Exposure determines the type and extent of climate variations that impact a farming system. Regions prone to frequent droughts, floods, or erratic monsoons experience higher exposure levels.

Adaptive Capacity – The ability of farmers, communities, and institutions to adjust, innovate, and respond to climate stressors defines their adaptive capacity. Access to climate-smart technologies, resilient infrastructure, diversified cropping systems, and financial resources significantly enhances adaptability.

To assess and address climate vulnerability in agriculture, three major analytical approaches are used (Figure 2).

9. Institutional Interventions in NICRA Villages

The National Innovations in Climate Resilient Agriculture (NICRA) initiative has been instrumental in building climate resilience at the grassroots level. Through various institutional interventions, NICRA villages have adopted climate-smart agricultural practices, improved resource management, and enhanced farmer preparedness for climate variability (NICRA, 2025).

Village Climate Risk Management Committee (VCRMC): It plays a crucial role in facilitating climate-resilient interventions at the village level. It is operational in all 151 KVKs across the country (NAAS, 2022). Between 2020-2023, these committees conducted 2,037 meetings, ensuring farmer participation, decision-making, and timely implementation of

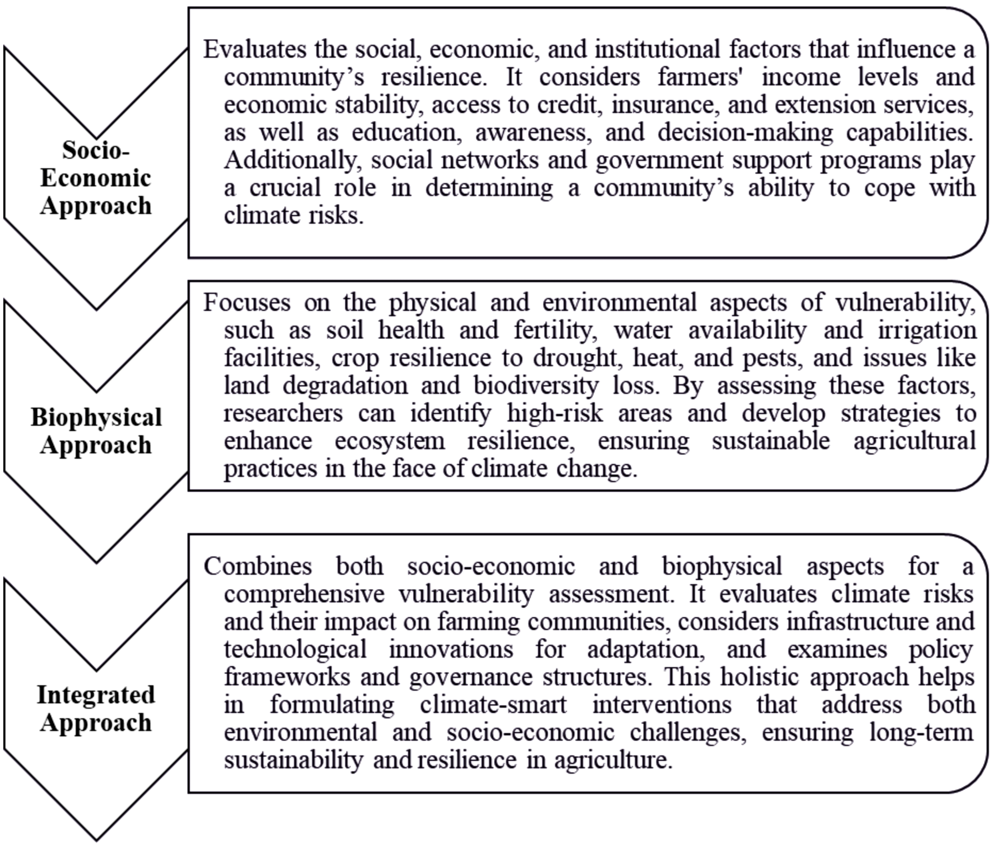

Figure 2: Approaches to climate vulnerability analysis

adaptation strategies. VCRMCs have significantly contributed to the spread of climate-smart interventions in NICRA villages, such as water conservation techniques, stress-tolerant crop varieties, and improved agronomic practices. These committees help mobilize resources, raise awareness, and ensure community-driven climate resilience planning.

Custom Hiring Centres (CHCs): To address the issue of farm mechanization access, CHCs have been established in 299 KVKs under NICRA. These centres provide small and marginal farmers with affordable access to modern farm machinery, helping them improve productivity and efficiency. During 2020-2023, CHCs accumulated deposits amounting to Rs. 95,31,083, reflecting widespread adoption and utilization by farmers. The initiative has reduced labour dependency, optimized resource use, and enhanced profitability in climate-vulnerable regions.

Small Farm Mechanization through CHCs: It play a pivotal role in enhancing small farm mechanization by providing timely access to costly agricultural machinery for small and marginal farmers. These centres enable timely sowing operations within narrow moisture availability windows, ensuring precision planting, improved germination, and better crop stand. CHCs also support crop residue recycling, water conservation, and in situ moisture retention, leading to sustainable agricultural practices.

Seed Banks for Climate Resilient Crops: Seed Banks are vital for ensuring seed security in NICRA villages. Currently, they are operational in 82 villages, where they have produced 100,084 quintals of climate-resilient seed with the involvement of 47,384 farmers. These seed banks focus on promoting drought-tolerant, flood-resistant, and heat-resilient varieties of paddy, wheat, soybean, red gram, sorghum, mustard, and millets. By ensuring timely availability of quality seeds, this intervention has strengthened farmers' adaptive capacity to climatic uncertainties.

Fodder Banks for Livestock Sustainability: To tackle fodder scarcity during climate-induced droughts and extreme weather events, Fodder Banks have been established in 34 KVKs. These banks have produced 253,255 quintals of fodder, benefiting 37,536 farmers. Besides traditional fodder crops, farmers have cultivated hybrid Napier, Berseem, fodder sorghum, maize, and oats at multiple locations. The availability of nutritious and climate-resilient fodder varieties has improved livestock health, milk productivity, and overall farmer income.

Supporting Farm Equipment Needs in NICRA Village Clusters: NICRA interventions also focus on providing technical and infrastructural support for farm mechanization. By backstopping farm equipment needs, NICRA village clusters ensure efficient resource utilization, reduced labor costs, and increased climate adaptation capacity.

10. Digital Agriculture Information Systems

The Digital Agriculture Information Systems (DAIS) have revolutionized technology dissemination by enabling real-time access to agricultural knowledge. These systems function as agri-information auto-transmission and technology hub interfaces, ensuring that farmers receive timely and accurate advisory services (Singh *et al.*, 2025). Through digital platforms, more than 5.8 crore advisories have been sent, benefiting 2.3 crore registered farmers. Additionally, over 2.5 lakh calls have been received, reflecting the increasing farmer engagement with digital extension services. By integrating mobile-based advisories, interactive platforms, and expert consultations, DAIS have bridged the gap between research institutions and farmers. These systems play a vital role in enhancing productivity, climate resilience, and decision-making by providing location-specific solutions for various farming challenges. The adoption of digital tools has streamlined knowledge exchange, making extension services more accessible and impactful for small and marginal farmers.

Kisan Sarthi Portal: Empowering Farmers through Digital Innovation

The Kisan Sarthi Portal is a comprehensive digital platform designed to facilitate real-time communication between farmers and agricultural experts (Singh *et al.*, 2025). A multilingual interface ensures accessibility for farmers across diverse regions, enabling seamless communication and knowledge dissemination. The platform facilitates two-way communication, allowing farmers to ask queries and receive expert guidance tailored to their needs. Customized agro-advisories provide location- and crop-specific recommendations, empowering farmers with data-driven decision-making. Integration with government schemes enhances awareness of subsidies, insurance, and agricultural policies, ensuring farmers leverage available resources effectively. With 24/7 accessibility, the system overcomes geographical barriers, enabling farmers to access vital information and expert support anytime, fostering sustainable and informed agricultural practices. By leveraging the Kisan Sarthi Portal, farmers can enhance productivity, manage risks, and access institutional support seamlessly (Singh *et al.*, 2025). The portal serves as a one-stop digital solution for empowering farmers through data-driven insights, technology transfer, and expert-driven advisories, contributing to sustainable agricultural development in India.

11. Social Media Extension: Pusa Samachar

In the modern era, social media has transformed agricultural extension, enabling real-time, cost-effective, and large-scale dissemination of vital information. One of the most promising initiatives in this domain is Pusa Samachar, an innovative digital extension platform by ICAR-IARI, designed to provide farmers with timely, research-backed agricultural advisories (Burman *et al.*, 2022). The initiative is structured to strengthen farm-based livelihoods through a partnership-oriented, linkage-based, and farmer-centric approach. Every Saturday at 7 PM, a new episode of Pusa Samachar is released, featuring:

- **Time-Specific Crop Management Practices**: Providing farmers with actionable insights on crop management techniques for different crops.
- **Success Stories of Progressive Farmers**: Showcasing innovative and successful farming techniques adopted by farmers across India to encourage peer-to-peer learning.
- **Pusa WhatsApp Salah (9560297502)**: An expert-driven, interactive platform where farmers can send queries and receive personalized solutions to their agricultural challenges.
- **Weather Forecasts**: Offering timely meteorological updates to help farmers plan their sowing, irrigation, and harvesting activities effectively.

The impact of Pusa Samachar is significant, with over 47,000 subscribers, 1.9+ million views, and 96,175+ hours of watch time. The widespread adoption of this platform highlights the growing trust and reliance of farmers on digital advisory services for better agricultural decision-making. The success of Pusa Samachar highlights the potential of integrating digital tools into frontline extension strategies for hill agriculture. Moving forward, expanding the scope of social media-based extension through regional language adaptations, AI-driven chatbot services, and interactive training modules can further enhance the accessibility and effectiveness of these initiatives. By leveraging the power of digital agriculture, Pusa Samachar is revolutionizing agricultural extension, ensuring that farmers in even the most challenging environments receive the knowledge and support they need for sustainable and resilient farming.

12. Results Framework (RF) for Frontline Extension in Hill Agriculture

A Results Framework (RF) is a structured visual representation that illustrates how a project or program achieves its goals. It serves as a strategic tool to help managers focus on key objectives, track progress, and ensure effective planning and implementation. In the context of frontline extension for hill agriculture, an RF is crucial for guiding interventions, optimizing resource use, and measuring long-term impact (Figure 3). The RF for frontline extension in hill agriculture follows a stepwise process that ensures systematic execution and evaluation. The key stages include:

Planning and Implementation Stages of the RF

i. Input:

This stage involves the resources and infrastructure needed to implement extension activities effectively. It includes financial resources for training, technology dissemination, and farmer support, as well as human resources such as extension personnel, scientists, and agripreneurs. Digital tools and infrastructure, including mobile-based advisory platforms, weather forecasting systems, and online learning portals, play a crucial role. Additionally, institutional support from research organizations, government agencies, and NGOs is essential for successful implementation.

ii. Activities:

The core actions undertaken to transfer knowledge and technology to farmers in hilly areas include capacity building through training programs, field demonstrations, and workshops on hill agriculture practices. Technology dissemination focuses on promoting drought-resistant crop varieties, soil moisture conservation techniques, and water-efficient irrigation systems. Digital and social media outreach, using mobile advisory services, WhatsApp groups, and YouTube platforms like Pusa Samachar, ensures real-time extension services. Stakeholder engagement through collaborations with Farmer Producer Organizations (FPOs), Self-Help Groups (SHGs), and government schemes further enhances accessibility.

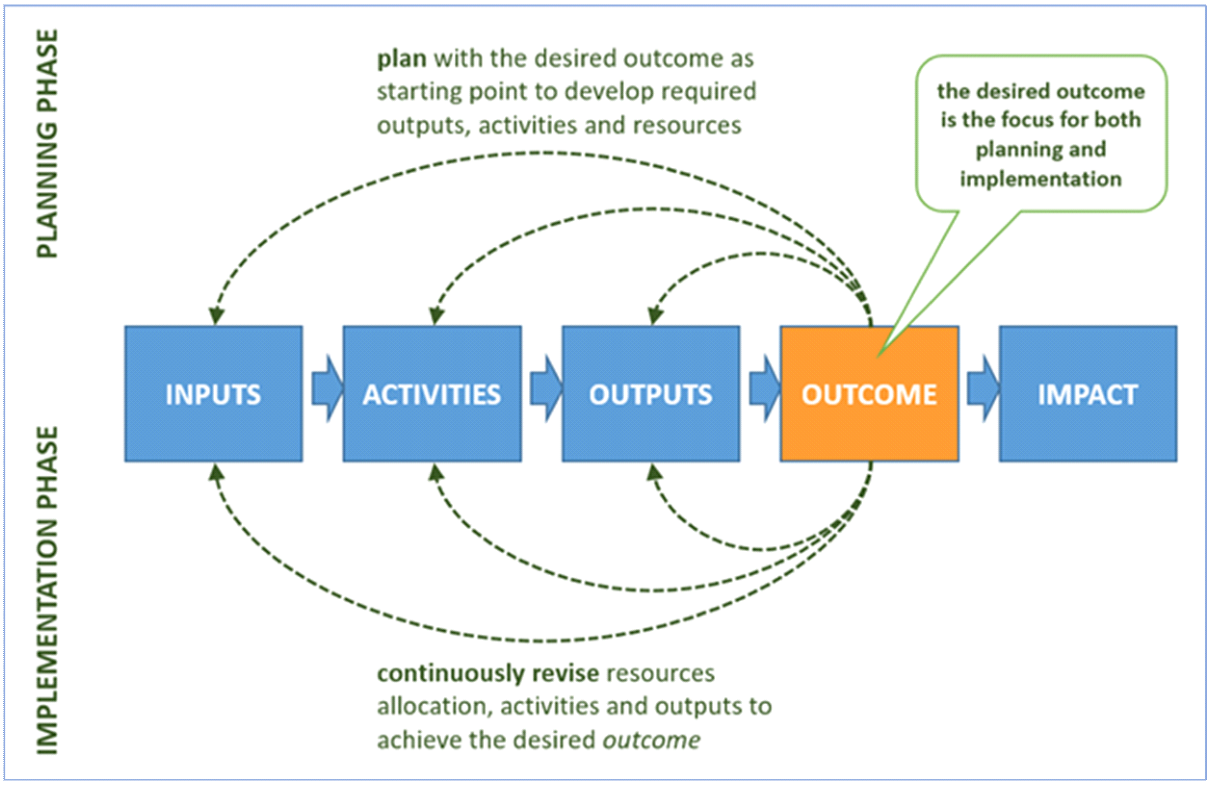

Figure 3: Results framework model for frontline extension

iii. Output:

Tangible deliverables generated through these activities include the number of farmers trained and villages covered under extension programs. Improved technologies such as precision farming tools, bio-fortified crops, and weather-based advisories are deployed, while digital adoption increases, with more farmers accessing online advisories and agri-apps. Additionally, community-based organizations like Village Climate Risk Management Committees (VCRMCs) are formed to enhance resilience.

iv. Outcomes

The short-term and medium-term changes observed among farmers include improved adoption of climate-resilient farming practices and enhanced knowledge of soil and water conservation techniques. Productivity and efficiency in resource use increase, while greater engagement with extension services and government schemes helps farmers make more informed decisions.

v. Impact

The long-term transformational effects of the program lead to sustainable hill agriculture, improved farm income, and greater food security. Farmers become more resilient to climate variability through better risk management and adaptive farming techniques. Additionally, stronger institutional mechanisms for knowledge-sharing and extension service delivery ensure long-lasting benefits for agricultural communities in hilly areas.

13. Sustainable Livelihood Development through Farmer First Programme

The Farmer First Programme (FFP) is a flagship initiative of ICAR aimed at enhancing sustainable livelihoods through farmer participatory research (Kharde *et al.*, 2019). Operating in 51 locations across 20 states, the program directly benefits 48,291 farm families in 250 villages by integrating farmers as active stakeholders in technology development, validation, and dissemination. Unlike traditional extension models, FFP emphasizes a bottom-up approach, ensuring that farmers' needs and challenges shape the research agenda. It also fosters Farmer Producer Organizations (FPOs), Self-Help Groups (SHGs), and community-led initiatives, ensuring better market access and price realization. To facilitate real-time agro-advisory services, FFP leverages digital platforms like Pusa Samachar, mobile-based advisories, and social media networks. A key component of FFP is capacity building, where farmers are trained in new-age agricultural practices, value chain management, and agri-entrepreneurship. Special emphasis is placed on women and youth empowerment by promoting gender-inclusive technologies and skill development programs. The program also strengthens linkages with government schemes and institutional support, ensuring farmers benefit from available subsidies, insurance, and financial aid. FFP's participatory approach has led to tangible outcomes such as increased productivity, diversified income sources, enhanced climate adaptation, and reduced input costs. Through co-innovation, farmer-researcher collaboration, and policy support, the FFP stands as a model for inclusive and resilient agricultural development in India.

CONCLUSION

The innovations in frontline extension for hill agriculture play a crucial role in addressing the unique challenges faced by farmers, including water scarcity, climate variability, and labor shortages. The integration of farmer mobilization, digital solutions, precision agriculture, mechanization, and policy interventions has significantly improved resource efficiency and productivity in these regions. Community-based approaches such as Farmer Producer Organizations (FPOs), contract farming, and participatory extension models have empowered farmers by enhancing their access to knowledge, inputs, and markets. The adoption of AI-driven advisory systems, satellite-based monitoring, and smart mechanization tools has revolutionized agricultural practices, enabling informed decision-making and efficient farm management. Additionally, custom hiring centers (CHCs) and conservation agriculture techniques have provided practical solutions to labor shortages while promoting sustainable farming. Moving forward, strengthening research-extension-farmer linkages, fostering public-private partnerships, and ensuring policy support will be critical in scaling these innovations for climate-resilient, economically viable, and sustainable hill agriculture.

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Lead Paper-2

Vertical Farming: Integrating IoT, Renewable Energy, and Urban Sustainability

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ABSTRACT

As urban populations grow and arable land declines, vertical farming is emerging as a sustainable solution to address food security challenges while promoting environmental responsibility. By integrating Internet of Things (IoT), renewable energy, and urban sustainability, vertical farming enables efficient, resource-conscious food production in cities. This will explores how these technologies work together to enhance crop yields, optimize resource use, and reduce environmental impacts, making urban farming more viable and sustainable. The IoT revolution in agriculture plays a crucial role in improving the efficiency of vertical farms. Smart sensors monitor key factors such as temperature, humidity, light intensity, and nutrient levels, enabling real-time adjustments through automated systems. AI-driven analytics further optimize plant growth by predicting environmental fluctuation and adjusting conditions accordingly. These data-driven solutions ensure precision farming, reducing resource wastage while enhancing crop quality and productivity. Incorporating renewable energy sources such as solar panels, wind turbines, and bio-energy solutions further strengthens the sustainability of vertical farms. These energy-efficient systems help reduce reliance on fossil fuels, lower operational costs, and enable off-grid farming solutions in urban areas. Additionally, water-saving techniques such as hydroponics and aeroponics significantly reduce water consumption compared to conventional agriculture, making vertical farming an eco-friendly alternative for cities facing water scarcity. Beyond technological advancements, vertical farming contributes to urban sustainability by transforming underutilized spaces, such as rooftops, abandoned buildings, and shipping containers into productive food hubs. This reduces the need for long-distance food transportation, cutting down carbon emissions and ensuring fresher, locally grown produce. By integrating vertical farms into urban planning, cities can promote food resilience, create job opportunities, and improve air quality through increased green spaces. It will discover successful case studies, technological innovations, and policy frameworks supporting vertical farming. By harnessing IoT, renewable energy, and sustainable urban design, vertical farming presents a transformative solution for the future of urban food production.

Keywords: Vertical farming, IoT in agriculture, Renewable energy, Urban sustainability, Hydroponics and smart farming

INTRODUCTION

The anticipated rise of the global population to approximately 9.7 billion by 2050 presents one of the most significant challenges for global food systems: ensuring food security amid shrinking arable land, urban sprawl, climate variability, and resource constraints. Traditional agriculture, reliant on extensive land use and heavily weather-dependent conditions, is increasingly proving insufficient and unsustainable for meeting the projected food demand. This urgent scenario underscores the need for innovative, resource-efficient, and space-conscious food production systems. Vertical farming emerges as a transformative solution in this context. Defined as the practice of cultivating crops in vertically stacked layers within controlled environments, vertical farming leverages cutting-edge technologies, such as Internet of Things (IoT), Artificial Intelligence (AI), and renewable energy systems, to maximize productivity while minimizing the environmental footprint. Unlike conventional farming, vertical farming does not require fertile soil or favorable weather conditions. It can be implemented in a variety of non-traditional spaces, including urban rooftops, shipping containers, warehouses, and even underground bunkers. This modality offers a radical rethinking of how food can be grown and distributed by situating production closer to consumption centers, vertical farming reduces supply chain complexities, mitigates food spoilage, and ensures year-round cultivation. Moreover, it has the potential to revitalize underutilized urban spaces and create socio-economic benefits through local employment and community-based food systems. The present study seeks to explore the comprehensive framework of vertical farming, particularly its integration with IoT technologies and renewable energy systems. By investigating both the technical and sustainability dimensions, this research aims to provide a detailed, interdisciplinary perspective on how vertical farming can contribute to urban sustainability, resilience, and food sovereignty in the 21st century.

Significance of the Study

The significance of this study lies in its interdisciplinary approach to addressing some of the most pressing global challenges: food insecurity, environmental degradation, and unsustainable urban development. As the global population continues to urbanize with over 68% projected to live in urban areas by 2050 the demand for locally grown, fresh, and safe food is intensifying. Simultaneously, traditional agriculture is grappling with diminishing arable land, unpredictable climate patterns, soil erosion, and increasing water scarcity. These converging pressures necessitate the exploration of alternative agricultural models that are resilient, resource-efficient, and adaptable to urban contexts. Vertical farming, when strategically integrated with the Internet of Things (IoT) and renewable energy technologies, represents a paradigm shift in sustainable food production. IoT enables real-time monitoring and precise control of environmental conditions (e.g., temperature, humidity, nutrient levels), thus optimizing plant health and yield while minimizing resource waste. Renewable energy sources such as solar, wind, and bio-energy can power vertical farming systems, reducing their carbon footprint and enhancing their energy independence. This study is particularly significant in the context of global efforts to meet the United Nations Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). By providing empirical and conceptual insights into the potential of vertical farming as a sustainable urban agriculture solution, this research contributes to shaping policy frameworks, investment priorities, and research agendas in urban food systems. Furthermore, this study fills a critical gap in the literature by analyzing how the convergence of vertical farming, IoT, and renewable energy can create scalable, replicable models for food production in both developed and developing regions. It provides a foundation for decision-makers, urban planners, agritech innovators, and environmentalists to collaboratively build resilient, technology-driven agricultural ecosystems.

Present Applications of Vertical Farming

Vertical farming has evolved into a practical and scalable solution addressing global food security and urban sustainability. Its key applications include:

1. **Urban Food Production:** Vertical farms are integrated into urban settings rooftops, warehouses, and containers to grow fresh produce close to consumers, reducing food miles and post-

harvest losses. Examples include AeroFarms (USA) and Sky Greens (Singapore).

2. **IoT-Integrated Smart Farming:** Advanced farms use IoT sensors and automation to monitor and optimize climate, nutrients, and lighting in real time. Spread Co. (Japan) exemplifies fully automated, data-driven vertical farming.
3. **Renewable Energy Integration:** Vertical farms increasingly utilize solar, wind, and biogas for sustainable energy needs, such as in the Netherlands and the U.S., aligning with carbon neutrality and energy efficiency goals.
4. **Retail and Supply Chain Integration:** Retailers like Infarm partner with stores to grow produce onsite, ensuring freshness, reducing logistics, and enhancing consumer awareness of sustainable practices.
5. **Adaptation to Harsh Climates:** In arid and extreme environments (e.g., UAE, Arctic), vertical farms enable food production with minimal water, contributing to regional food resilience through Controlled Environment Agriculture (CEA).
6. **Education and Research:** Universities worldwide use vertical farming for teaching, research in plant science, and AI-driven crop modeling training the next generation of agritech experts.

Future Perspectives of Vertical Farming

Vertical farming is poised to become a cornerstone of sustainable and resilient food systems. With rapid urbanization, climate change, and technological innovation, its future applications are expected to expand significantly:

1. **Smart City Integration:** Vertical farms will be embedded in smart city ecosystems, linked to data-driven networks for energy, waste, and water recycling using waste heat and greywater for resource-efficient crop production.
2. **AI and Robotics Ecosystems:** The integration of AI, machine learning, and robotics will optimize crop cycles, automate farm operations (e.g., planting, harvesting), and enable high scalability with minimal labor input.
3. **Genetic Engineering & Crop Tailoring:** Genetically modified or CRISPR-edited crops will be developed for enhanced yield, nutrition, and adaptability to controlled environments, facilitating indoor cultivation of a wider range of crops.
4. **Carbon-Neutral and Renewable-Powered Farming:** The shift to solar panels, wind turbines, and hydrogen energy will drive carbon-neutral vertical farming, particularly in urban and remote off-grid areas, supporting decentralized food systems.
5. **Crop Diversification:** Future farms will extend beyond leafy greens to include berries, tomatoes, legumes, and even compact cereals, supported by advances in LED lighting, substrates, and nutrient delivery systems.
6. **Space and Crisis-Resilient Agriculture:** Vertical farming will play a key role in space missions and disaster zones, offering compact, autonomous systems capable of producing food under extreme conditions, such as on Mars or during humanitarian crises.
7. **Rural and Inclusive Development:** Modular vertical farms can be adapted for rural deployment, especially in developing countries, creating jobs, empowering communities, and contributing to climate-resilient agriculture.
8. **Policy and Global Collaboration:** Supportive policies, subsidies, and international partnerships will be vital to scale vertical farming, harmonize regulatory standards, and ensure equitable access to technology and knowledge sharing.

Importance of Vertical Farming

Vertical farming, especially when integrated with IoT and renewable energy, offers a transformative solution to urgent global challenges in food security, sustainability, and urbanization. This study is important for the following reasons:

1. **Food Security:** It addresses the growing global demand for food by enabling high-yield urban farming using less land and water, helping feed an estimated 9+ billion people by 2050.
2. **Environmental Sustainability:** By reducing land use, chemical inputs, and carbon emissions, vertical farming offers an eco-friendly alternative to conventional agriculture, aligned with climate goals.
3. **Urban Resilience:** It supports local food production in cities, reducing reliance on long supply chains and increasing resilience to global disruptions like pandemics or climate disasters.
4. **Technological Advancement:** IoT, AI, and renewable energy systems enable smart, data-driven, and energy-efficient farming, pushing innovation in agricultural practices.
5. **Economic Development:** Vertical farming creates high-tech jobs in agriculture, sustainability, and energy, while also stimulating local economies and lowering food transportation costs.
6. **Climate Change Adaptation:** It contributes to climate mitigation by using clean energy and conserving resources, offering a model for climate-resilient agriculture.
7. **Food Justice:** By bringing fresh produce to underserved urban areas, vertical farming promotes equitable access to healthy food and improves urban nutrition.
8. **Policy Impact:** It informs governance frameworks that support sustainable urban agriculture through investment, cross-sector collaboration, and inclusive policy-making.

Types of Vertical Farming Systems

- **Hydroponics:** Plants are grown in nutrient-rich water solutions, without soil.
- **Aquaponics:** A combination of aquaculture (raising fish) and hydroponics, where fish waste is used to fertilize plants and plants filter the water for the fish.
- **Aeroponics:** Plants are grown with their roots suspended in the air and sprayed with nutrient solutions.

Depending on the intended location and the kind of crops they're meant for, vertical farms can come in a bunch of different forms.

- **Tower farms:** Tower farms use stacked layers of trays to grow crops. These systems are typically employed in the cultivation of green leafy vegetables and herbs. The biggest advantage with tower farms is that they are very modular - they can be scaled up or down to suit the requirements of a particular case.
- **Green Walls:** Green walls refers to vertical gardens that are installed on the walls of buildings. These are built with aesthetic appeal in mind and lend a pleasing natural aesthetic to otherwise ominous and grey urban settings.
- **Skyfarms**: Skyfarms are multi-story vertical farms that employ hydroponic or aeroponic growing systems to grow crops. These farms are typically situated on rooftops in urban areas where space is scarce.
- **Aquaponics**: Aquaponics is a type of vertical farming that combines pisciculture with hydroponic farming. The waste from the fish is used as a nutritional supplement for the crops.
- **Container farms:** Container farms are exactly what they sound like - vertical farms that are located in shipping containers. These systems can be transported to various locations as required and are often used to grow crops in areas where traditional farming is not possible for some reason.

- **Modular farms**: Modular farms are prefabricated vertical farming systems that can be assembled and disassembled as needed. These systems are typically used for research or demonstration purposes and can be easily tailored to suit the requirements of a particular vertical farmer.

Sustainability of Vertical Farming

Sustainability is all about using our resources wisely and reducing waste. Vertical farming is a powerful example of this idea in action. It lets us grow food in places that would otherwise be unused like rooftops, basements, or abandoned buildings. This means we don't need to cut down forests or clear more land to grow food, which helps protect the environment and biodiversity. Another big advantage is how much water vertical farming saves. Traditional farming uses a lot of water. For example, growing just 1 kilogram of lettuce traditionally needs about as much water as it takes to fill a standard freezer. In a greenhouse, this drops to roughly a bucket of water. But with vertical farming, you only need about a medium-sized pan of water. That's a huge saving especially important when we remember that about two-thirds of the world's population faces water shortages for at least one month every year, according to UNICEF. Vertical farms also produce more food from less space. In a one-square-meter area, traditional farming can grow around 3.9 kg of lettuce per year. Greenhouses can increase that to about 41 kg. But vertical farms can go even further up to 80 kg in the same area, thanks to stacking multiple layers of crops and controlling the environment more precisely. Even more impressive is that vertical farming doesn't rely on soil. It uses techniques like hydroponics (growing in water with nutrients), aquaponics (combining fish farming with plant growth), and aeroponics (spraying roots with nutrient-rich mist). These methods are very useful at a time when fertile soil is becoming scarce due to overuse, erosion, and pollution. Our modern food system is also very global. Many food products travel long distances on average about 3,200 kilometers before they reach consumers. This long-distance travel increases carbon emissions. But because vertical farms can be set up in or near cities, they reduce the need for long transportation routes. In fact, compared to traditional greenhouses, vertical farms can cut carbon dioxide emissions by 67% to 92%. There's also a benefit to our health. Since food grown in vertical farms reaches us faster, it stays fresher and doesn't need as many chemicals or preservatives to keep it from spoiling. That means it's likely to be healthier for us too.

IoT sensors and Vertical Farming

Vertical farming is predicated on artificially ensuring a tightly controlled growing environment for crops. There is practically no wiggle room in terms of natural variables and conditions such as ambient temperature, humidity and lighting. One of the pre-requisites of vertical farming is that these parameters along with other similar ones need to be monitored and adjusted in real-time to ensure that they are meeting the optimum requirements for a great yield. This is where IoT technology comes in. IoT-based connected technology is used to achieve this kind of tight control in vertical farming setups.

Now, how does that work?

IoT sensors come in a variety of purpose-built shapes and sizes - there are various sensors that are designed to sense various kinds of parameters in their environments. For instance, a number of IoT sensors are likely to be employed in your average vertical farm including temperature sensors, humidity sensors, natural light, level sensors, CO_2 sensors, NPK sensors etc. These sensors pick up measurements in real-time and relay them to the back end where enormous amounts of data are gathered and subjected to analytics, in order to plan the best interventions. IoT implementation brings certain modularity to indoor vertical top farms, allowing for various kinds of plants to be grown in the same setup, while ensuring robust health and high yields. For example, when a sensor detects that the temperature in a particular area of the vertical farm is rising above permissible levels, it actuates a command to trigger the cooling system to switch on. Similarly, if the humidity sensors in the system detect that the humidity levels are too low, the system can trigger a series of commands that would adjust the moisture content in the room. When large amounts of highly-granular data are collected and subjected to AI analytics, we are able to implement highly targeted and specific growing conditions for various plants, based on their natural requirements. This kind of a system brings about a kind of efficiency and parsimony of resources that would otherwise be unimaginable. With IoT technology we can automate many of the processes involved in vertical farming such as irrigation, fertilization and harvesting. This can slash labour costs dramatically, which adds to the economic viability of vertical farming. For example, an automated irrigation system can be set-up to water crops at specific times of the day. It can even be programmed to let out specific quantities of water and specific times for specific plants. Similar automation can be implemented for other processes involved in the conventional farming too, with a high degree of precision. Now, that's compelling stuff!

Challenges and Concerns with Vertical Farming

Vertical farming has many benefits, but it also faces some challenges. One of the biggest challenges with vertical farming is the amount of upfront investment it demands with the amount of specialized equipment and high-tech backend frameworks that are required to set up a vertical farm. This makes vertical farming a prohibitively expensive option for smaller businesses. There have also been concerns about the environmental impact of vertical farming, particularly, the large amounts of energy that are typically consumed by these setups. Artificial lighting and climate control systems typically consume a lot of energy. This also ties in with the previous point, high energy bills are something small farmers can't cope with. This makes vertical farming an elusive prospect unless you're an entity with massive means. Another issue with vertical farming is that it demands a lot of technical expertise. It's no mean feat to keep a vertical farm running. In spite of the AI and IoT wizardry taking care of a lot of the minutiae, vertical farmers are still required to have a deep understanding of various plants' environmental requirements. This can make vertical farming a daunting thing to take up if you're a newbie. Also, not all crops can be grown using vertical farming. This is another constraint. The overall conditions of a vertical farm are very different from those in a traditional agricultural setup and this means that some plants just won't grow as well. The staple crops for most of the world are grains and for instance, grains are typically not suited to be grown in vertical farms.

Energy Efficient Sensors for Vertical Farming

IoT (Internet of Things) sensors have transformed nearly every industry across the globe, and vertical farming is no exception. As our world becomes more connected, wireless sensors play a crucial role in enabling smart systems to monitor and respond to real-time conditions. In vertical farming, where every environmental factor needs to be carefully controlled, sensors are essential for monitoring temperature, humidity, CO, levels, light intensity, and more. But while sensors are necessary, traditional battery-powered sensors bring their own set of problems, especially when considering the scale and sustainability goals of vertical farming. Traditionally, these sensors rely on batteries or mains electricity. However, as the number of IoT devices grows into the billions and potentially trillions it becomes clear that using batteries is not a long-term solution. Managing that many batteries would be an environmental nightmare. Every battery eventually needs replacing and disposing of, which would result in massive amounts of toxic waste. The idea of landfills filled with billions of discarded batteries is completely at odds with the principles of sustainability that vertical farming is built upon. This is where battery-less sensors come into play. Instead of relying on traditional power sources, battery-less sensors harvest energy from their surrounding environment. They can draw power from sources such as ambient light, radio frequencies, heat, or even small vibrations. These energy-harvesting sensors have become increasingly reliable and efficient in recent years, making them a viable alternative to battery-powered devices. Not only do they eliminate the need for battery replacements, but they also significantly reduce maintenance needs. Once installed, these sensors can operate independently for long periods, without any human intervention. This is especially valuable in large vertical farming setups, where maintaining hundreds or thousands of individual sensors would otherwise be time-consuming and costly. The energy efficiency of battery-less sensors is a major advantage for vertical farming, which already struggles with high energy consumption especially for lighting, climate control, and irrigation systems. Because battery-less sensors can operate with minimal power, they help reduce the overall energy demand of the system. Over time, this translates into lower operational costs, making vertical farming more economically viable and scalable. Another important benefit is durability and reliability. With fewer moving parts and no battery degradation over time, battery-less sensors are more robust and require little to no servicing. This not only cuts down on labor but also ensures the system continues to run smoothly with minimal disruption. But perhaps the most compelling reason to adopt battery-less sensors in vertical farming is their alignment with environmental goals. Vertical farming is meant to be a cleaner, greener way of producing food especially in urban environments. Incorporating battery-less sensors supports that vision by eliminating the environmental cost of battery use and disposal. If we truly want sustainable food systems, we must also rethink the technology that supports them. Battery-powered sensors simply don't belong in a future where environmental responsibility is paramount. As the global IoT network continues to expand, it is critical that we choose solutions that don't compromise the planet's health. Battery-less sensors are not just a smart technological innovation they are an ecological necessity for the future of farming.

CONCLUSION

Vertical farming is a hugely promising technology that has significant potential to transform the way we approach food production, going ahead. The global population is slated to reach 9.7 billion by 2050. There is a very pressing need to look beyond our usual ways and embrace innovative solutions, if we are to stay on top of this enormous challenge. As the IoT revolution enters its adolescence, there is all the more hope going around that it's going to give us some much-needed answers in our quest to build a sustainable future for all life on earth. Overall, the integration of IoT technologies into vertical farming has the potential to revolutionize the way we produce and consume food, making it more sustainable, efficient, and accessible. As the world continues to face global challenges such as climate change, population growth, and resource scarcity, the need for innovative solutions such as IoT and vertical farming has never been greater. With continued research, development, and implementation of these technologies, we can work towards a more sustainable future for ourselves and for future generations.

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Lead Paper-3

A Sustainable Path Forward: Enhancing Livelihoods through Dairy Sector in Bihar

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ABSTRACT

The dairy sector in Bihar has played a pivotal role in augmenting rural incomes, ensuring nutritional security, and generating employment. Bihar, with its agrarian economy and substantial livestock population, has untapped potential to transform its rural landscape through the development of the dairy sector. The Indian dairy sector is a significant economic driver, and Bihar, despite having a large livestock population, faces challenges in milk productivity and processing. While Bihar contributes a notable share to India's overall milk production, its milk productivity and processing infrastructure lag other states. The dairy sector in Bihar plays a crucial role in rural livelihoods, but improving milk quality, promoting efficient processing, and strengthening cooperative structures are key areas for development. This paper analyses the status of the dairy industry in Bihar, compares it with national trends, explores opportunities, and challenges through a SWOT analysis, and suggests a strategic roadmap for enhancing livelihoods through this vital sector.

Keywords: Dairy sector, Bihar, Livelihoods, Rural economy, SWOT analysis, Livestock, Dairy development, Employment generation

Prologue

India's White Revolution, spearheaded by Operation Flood, established the country as the world's largest producer of milk. However, the benefits have not been uniformly distributed across states. Bihar, despite having favourable agro-climatic conditions and a strong tradition in livestock rearing, lags in organized dairy development. This paper seeks to examine the transformative potential of the dairy sector in enhancing livelihoods in Bihar and outline actionable strategies to achieve inclusive rural development. The Indian dairy industry contributes significantly to the national GDP and plays a vital role in ensuring food and nutritional security. The sector employs more than 70 million farmers, with women playing a crucial role in animal husbandry and milk production. Bihar, home to over 100 million people, has an economy heavily dependent on agriculture and allied sectors, including dairy. Despite a high cattle population, the state's milk yield per animal and organized milk processing infrastructure are below the national average. Enhancing the dairy sector could lead to income stability, employment, and empowerment of rural communities in Bihar.

Dairy Sector of India vis-à-vis Bihar

India produces over 239 million tonnes of milk annually (2024), contributing about 25% to global milk production. States like Uttar Pradesh, Rajasthan, and Gujarat lead the production due to better infrastructure, cooperative networks, and policy support. The dairy sector's value surpasses that of wheat and rice combined, underlining its economic importance. Bihar ranks among the top ten milk-producing states but has a lower per capita milk availability (around 277grams/day) compared to the national average (471 grams/day). Key dairy districts include Patna, Nalanda, Gaya, and Muzaffarpur. Institutions such as the Bihar State Milk Co-operative Federation Ltd. (COMFED) and Sudha Dairy have played a role in organizing milk procurement and marketing. However, issues such as inadequate cold chain infrastructure, low productivity of milch animals, poor veterinary services, and limited access to credit hamper growth.

Key Strategies for improvement in Dairy Sector in Bihar

A. Breeding Management

Breeding management is a cornerstone for enhancing milk productivity and the overall profitability of the dairy sector. In Bihar, low genetic potential of dairy animals is one of the primary constraints limiting milk yield. Implementing scientifically sound and regionally adapted breeding strategies can substantially uplift the dairy economy in the state.

Current Challenges in Breeding Management in Bihar

- Predominance of non-descript and low-yielding indigenous cattle
- Limited availability and access to quality artificial insemination (AI) services
- Poor conception rates due to lack of trained inseminators and heat detection
- Inadequate recording of breeding data and animal lineage
- Lack of awareness among farmers about the importance of genetic improvement
- Insufficient veterinary infrastructure and extension services

Key Strategies for Breeding Management

1. Genetic Improvement through Artificial Insemination (AI)

- Expand AI Coverage: Strengthen AI infrastructure in rural areas with mobile AI units and AI camps.
- Use of Proven Germplasm: Encourage use of frozen semen from high-yielding indigenous breeds (Gir, Sahiwal) and crossbreeds (Holstein Friesian, Jersey).
- Public-Private Partnerships: Collaborate with private AI service providers and NGOs to scale operations.

2. Breed Upgradation and Conservation

- Breed Mapping: Identify and conserve local breeds like Bachaur and Gangatiri, while promoting selective crossbreeding in suitable zones.
- Breed-Specific Strategy: Use indigenous breeds in arid or stress-prone areas and crossbreeds in high-input zones.

3. Strengthening Infrastructure

- AI Centers & Semen Banks: Establish and modernize AI centers, especially in underserved districts.
- Veterinary Support: Ensure availability of reproductive health services including pregnancy diagnosis, treatment of infertility, and deworming.

4. Farmer Training and Extension

- Conduct regular workshops for farmers on:
  - o Heat detection techniques
  - o Timely insemination
  - o Proper feeding for reproductive health
  - o Importance of culling and selection

5. Data Management and Animal Identification

- Promote digital tools and mobile apps for recording breeding and health data.

- Use ear tagging or RFID for traceability of genetic improvement and performance tracking.

6. Role of Institutions for Breeding Management

- COMFED/Sudha Dairy: Can lead AI outreach, training, and breed improvement programs for member farmers.
- Animal Husbandry Department, Bihar: Should integrate breeding policy with dairy development schemes.
- ICAR and NDDB: Provide technical support, research, and monitoring of breeding programs.

Policy Recommendations for Breeding Management

- Formulate a State Livestock Breeding Policy specific to Bihar's agro-climatic zones.
- Incentivize private AI technicians with performance-based remuneration.
- Link breeding services with livestock insurance and health programs.
- Promote community-based breeding programs with involvement of SHGs and FPOs.

B. Feed and Fodder Management Strategies for Improving the Dairy Sector in Bihar

Efficient feed and fodder management is critical to increasing milk productivity, reducing input costs, and ensuring the health of dairy animals. In Bihar, where 60–70% of the dairy production cost is attributed to feeding, addressing feed and fodder shortages can significantly enhance dairy profitability and sustainability.

Current Challenges in Bihar

- Acute shortage of green fodder (only ~20% of requirement met)
- Seasonal scarcity of dry fodder and concentrates
- Fragmented landholdings limiting dedicated fodder cultivation
- Low awareness of balanced feeding and nutritional requirements
- Poor quality of available fodder and lack of silage-making practices
- Minimal use of Total Mixed Rations (TMR) or scientifically formulated feed

Strategic Interventions for Feed and Fodder Improvement

1. Fodder Cultivation Promotion

- **Intercropping and Bund Cultivation:** Promote fodder crops (e.g., berseem, maize, sorghum) on field bunds and fallow lands.
- **Short-Duration Varieties:** Encourage multi-cut fodder varieties to increase biomass (e.g., CO-4, Hybrid Napier).
- **Agroforestry and Perennials:** Plant fodder trees (e.g., Subabul, Gliricidia) to ensure round-the-year supply.
- **Fodder Seed Banks:** Establish community-level seed banks to ensure availability during sowing seasons.

2. Feed Enrichment and Conservation

- **Silage Making:** Train farmers in low-cost silage preparation using surplus green fodder during peak seasons.
- **Urea Treatment of Straw:** Promote enrichment of paddy and wheat straw to improve digestibility and nutrient content.
- **By-Product Utilization:** Encourage use of agro-industrial by-products like mustard cake, rice bran, molasses, etc., in balanced rations.

3. Balanced Feeding and Ration Formulation

- **Ration Balancing Programs (RBP):** Introduce village-level ration balancing using software and mobile tools (e.g., NDDB's INAPH app).
- **Mineral Mixture Supplementation:** Distribute and promote mineral mixture and salt licks to address micronutrient deficiencies.

- **Use of Total Mixed Ration (TMR):** Promote mechanized TMR units and commercial feed plants.

4. Infrastructure and Support Systems

- **Fodder Banks:** Set up district-level fodder banks to store silage and hay for lean periods.
- **Custom Hiring Centres:** Provide equipment (chaff cutters, silage bags, etc.) to FPOs/SHGs on rental basis.
- **Extension Services:** Conduct training programs and demos on feed management, silage making, and use of enriched feed.

5. Institutional Roles

- **Animal Husbandry Department, Bihar:** Implement fodder development schemes and distribute fodder seeds.
- **BAIF, NDDB, ICAR Institutions:** Offer technical support, R&D in fodder crops, and field training.
- **COMFED & Dairy Cooperatives:** Integrate feed services into dairy value chains and provide inputs to member farmers.

Policy Recommendations for Feed and Fodder Management

- Integrate fodder development into MGNREGA for community fodder farms.
- Provide input subsidies for fodder seeds and silage infrastructure.
- Encourage PPPs for setting up commercial feed processing units in Bihar.
- Include feed and fodder planning in district dairy development plans.

Potential Impact of Feed and Fodder Management

- Reduce feeding costs by 20–30% through efficient practices
- Increase milk yield by 25–50% with balanced nutrition
- Improve animal health, fertility, and reduce disease incidence
- Enhance profitability and resilience of smallholder dairy farmers

C. Health Care and Management for Improving the Dairy Sector in Bihar

Effective animal health care and management are essential for enhancing dairy productivity, reducing economic losses, and ensuring the welfare of livestock. In Bihar, dairy animal morbidity and mortality rates remain high due to inadequate veterinary services, poor awareness, and limited disease control infrastructure. A comprehensive approach to animal health can significantly transform the dairy sector.

Current Challenges in Bihar

- Inadequate veterinary infrastructure and shortage of field veterinarians
- Low vaccination coverage for major livestock diseases
- Poor disease surveillance and diagnostic facilities
- Limited access to preventive healthcare (deworming, mineral supplementation)
- Poor awareness among farmers about disease symptoms and timely intervention
- Traditional and unhygienic animal husbandry practices

Strategic Interventions for Health Care and Management

1. Disease Prevention and Control

- **Vaccination Campaigns:** Implement mass and timely vaccination against Foot-and-Mouth Disease (FMD), Hemorrhagic Septicemia (HS), Brucellosis, and Lumpy Skin Disease (LSD).

- **Regular Deworming:** Promote bi-annual deworming schedules using scientifically recommended anthelmintics.
- **Tick and Parasite Control:** Train farmers on ectoparasite control and promote use of acaricides and biological controls.

2. **Strengthening Veterinary Services**

- **Mobile Veterinary Units (MVUs):** Expand MVUs equipped with diagnostic kits and medicines to underserved areas.
- **Village-Level Animal Health Workers:** Train para-veterinarians and integrate them with cooperative networks for first aid, AI, and health monitoring.
- **Tele-veterinary Services:** Use mobile apps and helplines for diagnosis and consultation, especially in remote areas.

3. **Disease Surveillance & Diagnostic Facilities**

- **District Diagnostic Labs:** Establish/upgrade labs with rapid testing capability for common dairy diseases.
- **Data Management:** Implement animal health tracking using digital tools (e.g., INAPH) to monitor disease incidence and manage herd health.

4. **Nutritional and Preventive Health Management**

- **Mineral Mixture and Supplements:** Distribute region-specific mineral mixtures to prevent deficiencies like milk fever and mastitis.
- **Clean Drinking Water:** Ensure access to clean water and hygiene in animal sheds to reduce gastrointestinal infections.
- **Balanced Feeding:** Promote ration balancing to boost immunity and reduce disease susceptibility.

5. **Reproductive Health Management**

- **Regular Fertility Camps:** Conduct fertility camps for early detection and treatment of reproductive disorders.
- **Pregnancy Diagnosis:** Promote post-AI pregnancy diagnosis for reproductive efficiency.
- **Calf Care Programs:** Ensure colostrum feeding, proper deworming, and vaccination schedules for calves.

6. **Animal Shed and Hygienic Management**

- **Improved Housing:** Promote well-ventilated, clean, and dry animal sheds to prevent mastitis and foot diseases.
- **Waste Management:** Train farmers in composting and proper manure disposal to prevent disease transmission.
- **Milking Hygiene:** Encourage use of clean milking practices, udder washing, and dry hand milking or milking machines.

7. **Institutional Support and Capacity Building**

- **Veterinary Colleges & ICAR Institutes:** Conduct regular training for field vets and farmers.
- **COMFED & Cooperatives:** Integrate preventive health services (vaccination, deworming) within milk procurement chains.
- **State Animal Husbandry Deptartment:** Strengthen infrastructure, staff recruitment, and policy support for livestock health.

Policy Recommendations

- Scale up **Rashtriya Gokul Mission** and **National Animal Disease Control Programme (NADCP)** in Bihar
- Provide **free/subsidized animal health kits** to smallholders
- Introduce **livestock health cards** to track animal history
- Ensure **mandatory livestock insurance** linked with health services

Potential Impact

- Reduce animal mortality and disease outbreaks by up to 60%

- Improve milk yield through better animal health and reproductive efficiency
- Increase farmer income by reducing veterinary costs and productivity losses
- Build resilience against emerging zoonotic and climate-sensitive diseases

D. Value Addition and Processing of Milk and Milk Products for Improving the Dairy Sector in Bihar

Value addition and milk processing are critical components of a modern dairy value chain. By converting raw milk into high-value products, farmers can realize better returns, reduce post-harvest losses, and cater to a growing market for processed dairy items. Bihar, with its abundant milk production potential, stands to gain significantly from developing this segment.

Current Scenario and Challenges in Bihar

- **Low Processing Capacity:** Only a fraction of total milk produced is processed through organized channels.
- **Limited Product Diversification:** Predominantly focused on fluid milk; minimal production of high-value items like cheese, yogurt, and paneer.
- **Inadequate Cold Chain Infrastructure:** Leads to spoilage and wastage during transportation and storage.
- **Smallholder Dominance:** Fragmented production makes aggregation and scaling of value-added processing difficult.
- **Limited Market Linkages:** Poor connectivity with urban and out-of-state markets for processed products.

Opportunities in Milk Processing and Value Addition

1. Development of Milk Processing Infrastructure

- **Mini Milk Processing Units:** Promote village- or cluster-level milk pasteurization and packaging units.
- **Bulk Milk Coolers (BMCs):** Install BMCs at village collection centers to preserve milk quality and extend shelf life.
- **Chilling Centers:** Strengthen milk chilling infrastructure in dairy-intensive districts.

2. Product Diversification

- Encourage production of high-margin, culturally relevant products such as:

o **Paneer (cottage cheese)**

o **Ghee (clarified butter)**

o **Dahi (curd/yogurt)**

o **Lassi, flavored milk, and sweets** like peda, rasgulla

o **UHT milk and dairy beverages** for urban markets

3. Support for Dairy Startups and MSMEs

- **Incentivize entrepreneurs** to enter dairy processing through grants and low-interest loans.
- Promote **milk-based food startups** focused on niche or health-oriented products (e.g., probiotic yogurt, lactose-free milk).
- Establish **common facility centers** with shared processing infrastructure for SHGs, FPOs, and cooperatives.

4. Strengthening Value Chains and Market Linkages

- **Farmer Producer Organizations (FPOs):** Empower FPOs to handle procurement, processing, branding, and marketing.
- **Brand Development:** Promote regional brands for Bihar's dairy products under schemes like "One District, One Product (ODOP)."

- **E-commerce and Aggregators:** Connect producers with digital marketplaces for direct sales.

5. **Quality Assurance and Packaging**

- **FSSAI Compliance:** Train producers and processors in food safety and hygiene regulations.
- Introduce **quality testing labs** for fat/SNF content, microbial safety, and adulteration detection.
- Promote **eco-friendly and attractive packaging** to increase marketability of local dairy products.

6. **Government Schemes and Institutional Support**

- **Dairy Processing and Infrastructure Development Fund (DIDF):** Utilize DIDF for setting up milk processing plants and cold chains.
- **Rashtriya Krishi Vikas Yojana (RKVY):** Leverage funds for establishing value-addition units.
- **COMFED and Sudha Dairy:** Scale up support to smaller processing partners and enable backward linkages.

7. **Capacity Building and Technical Training**

- Train SHGs, dairy cooperatives, and rural youth in:
  - o Hygienic milk handling and processing
  - o Product formulation and shelf-life extension
  - o Branding, labeling, and small-scale packaging
  - o Business and marketing skills

Potential Impact

- Increase farmer income by 40–60% through higher value realization
- Reduce milk spoilage and post-harvest losses
- Generate rural employment in processing, marketing, and logistics
- Enhance availability of safe, high-quality dairy products in Bihar and beyond

SWOT Analysis of the Dairy Sector in Bihar:

Strengths:

- Large livestock population with a strong tradition in cattle rearing
- Availability of crop residues and agricultural by-products for fodder
- Growing demand for milk and dairy products in urban and peri-urban areas
- Presence of Sudha Dairy and COMFED for organized marketing
- Active participation of women in dairy activities

Weaknesses:

- Low milk yield per animal due to poor breeds and feeding practices
- Inadequate veterinary healthcare and breeding services
- Weak cold chain and milk processing infrastructure
- Fragmented land holdings limiting fodder cultivation
- Limited access to institutional credit and insurance

Opportunities:

- Potential for breed improvement and scientific feeding practices
- Scope for dairy cooperatives and farmer-producer organizations (FPOs)
- Government schemes like Rashtriya Gokul Mission, National Dairy Plan, and Atmanirbhar Bharat
- Increasing urban demand for processed dairy products
- Scope for integrating dairy with other livelihood activities

Threats:

- Climate change affecting fodder availability and animal health
- Market volatility and price fluctuations
- Risk of diseases and epidemics (e.g., FMD, lumpy skin disease)
- Competition from private players without farmer-centric models
- Socio-cultural resistance to adopting modern practices

Way Forward: For Bihar to harness the full potential of its dairy sector, a multi-pronged approach is essential. Key recommendations include:

Breed Improvement: Expand artificial insemination and introduce high-yielding indigenous and cross-breeds.

Infrastructure Development: Invest in cold chains, bulk milk coolers, and milk processing units.

Capacity Building: Train farmers in best practices, animal health, feeding, and milk hygiene.

Policy Support: Strengthen cooperative structures and provide incentives for private investment in rural dairying.

Credit and Insurance: Facilitate easier access to credit, livestock insurance, and risk mitigation strategies.

Research and Extension: Collaborate with agricultural universities and research institutions for technology transfer.

Gender Inclusion: Empower women through targeted schemes and ensure their representation in cooperatives.

By focusing on these areas, the dairy sector in Bihar can emerge as a powerful engine of rural transformation and sustainable livelihoods.

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Lead Paper-4

Unseen Enemies: The Global Threat of Antimicrobial Resistance and their Mitigation Strategies

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ANTIMICROBIAL RESISTANCE (AMR)

Nowadays, antimicrobial resistance (AMR) is intended as a "modern" microbial feature resulting from the unsuccessful and/or prolonged exposure to antibiotic treatments. AMR is an example of such an emerging threat with permanent humanitarian and emerging consequences if not tackled aggressively. AMR represents one of the most important human- and animal health-threatening issues worldwide. Antimicrobial resistance, is one among the most common priority areas identified by both national and international agencies, is mushrooming as a silent pandemic. With 700,000 people losing battle to antimicrobial resistance (AMR) per year and another 10 million projected to die from it by 2050, AMR alone is killing more people than cancer and road traffic accidents combined together (O'Neil, 2016). Bacterial capability to face antimicrobial compounds is an ancient feature, enabling bacterial survival over time and the dynamic surrounding. Moreover, bacteria make use of their evolutionary machinery to adapt to the selective pressure exerted by antibiotic treatments, resulting in reduced efficacy of the therapeutic intervention against human and animal infections. The mechanisms responsible for both innate and acquired AMR are thoroughly investigated. Commonly, AMR traits are included in mobilizable genetic elements enabling the homogeneous diffusion of the AMR traits pool between the ecosystems of diverse sectors, such as human medicine, veterinary medicine, and the environment. Thus, a coordinated multisectoral approach, such as One-Health, provides a detailed comprehensive picture of the AMR onset and diffusion. Economic projections suggest that by 2050, AMR would decrease gross domestic product (GDP) by 2-3.5 per cent with a fall in livestock by 3-8 per cent, costing USD100 trillion to the world (O'Neil, 2014).

The ability of microorganisms to withstand the effects of previously effective antimicrobials is known as "antimicrobial resistance". According to EARS-Net data from 2016, AMR continues to pose a major risk to European public health (ECDC, 2017). AMR is also one of the main risks to food security, development, and global health (WHO, 2015).

China accounted for 23% of the world's antimicrobial use in food animal production in 2010; by 2030, that percentage is expected to rise to 30% (Van Boeckel *et al.*, 2015). Additionally, due to the high rates of resistance of the majority of common bacteria to clinically significant antimicrobial drugs, AMR is turning into a significant healthcare issue (Shi *et al.*, 2010; Xiao *et al.*, 2011; Wang *et al.*, 2015).

With this increasing demand, the value of veterinary drugs in international market augmented from 8.65 billion dollar in 1992 to 20 billion dollar in 2010 and is projected to touch 42.9 billion dollar mark by 2018 (Hao *et al.,* 2014). Globally, animal farming relies heavily on the surplus use of antimicrobials for the improvement of animal health and greater productivity. According to Food and Drug Administration (FDA) (FDA, 2010), AMU in food animals in USA was estimated to account for 80% of the total nation's annual antimicrobial consumption. In 2012, 26 EU countries' average consumption of antimicrobials was 116.4 and 144.0 mg/kg of estimated biomass in humans and animals, respectively (Lhermie et al. 2016). Increasing population will further generate a demand for high quality livestock products. In order to match this global demand for animal proteins, AMU in food animal production will rise over 67% by 2030. Presence of antimicrobial residues in food animal products (chicken meat and milk) has been reported from different parts of India, indicating wide AMU in food animal production in India (Maron *et al.,* 2013; Kakkar *et al.,* 2013).

Out of total antibiotics using in the livestock, about more that 60% of antibiotics is using only the management of mastitis in dairy animals. Blind use of antibiotics in the treatment of mastitis and their residue in the milk are the major contributing factors in AMR. Management of AMR in both human and veterinary pathogens requires ideal and concerted action of researchers, policy makers, veterinarian(s), industrialists, and also the end users.

AMR Mechanism Employed by Bacteria

The resistance to antimicrobials is either inherited or intrinsic. For instance, in the natural resistance mechanism caused by *Pseudomonas aeruginosa*, the lower membrane permeability would be the probable reason for its intrinsic protection from numerous antimicrobials. Inherited resistance happens by securing a transposon or a plasmid that carries the genes that encode resistance mechanisms from other organisms, or via the process of chromosomal transformation.

The significant mechanisms of actions involved in the development of microbial resistance are:

- Reduction in drug binding affinity by altering drug targets.
- Modification of antibiotics causing inactivation of drugs.
- Increasing efflux or restricting uptake.
- Genetic mutations.

MASTITIS

Milk, being the most popular natural health food, is consumed globally by members of every age group. This forms the basis of establishment of dairy farming and industry. Besides milk, dairy animals are also reared for meat purpose. A complex process, mastitis, or inflammation of the mammary gland, can have a variety of causes, including physiological, traumatic, mechanical, chemical, or infectious (Ajose *et al.*, 2022; Cheng and Han, 2020; Cobirka *et al.*, 2020; More *et al*, 2022; Ruegg, 2021). In dairy cows, bacterial mastitis is the most prevalent type. The virulence of the pathogen and the cow's capacity to generate a quick and efficient immune response both affect how severe the inflammatory response is (Cheng and Han, 2020). While a minor inflammatory reaction results in neutrophil influx in the gland without any discernible changes, a more severe response results in apparent

Table 1: AMR mechanism

ANTIBIOTIC	TARGET
β-Lactams	Penicillin-binding proteins (PBPs)
Vancomycin	D-Ala-D-Ala terminus of peptidoglycan precursors
Macrolides (Erythromycin Class)	Bacterial ribosomes (50S subunit)
Tetracyclines	Bacterial ribosomes (30S subunit)
Aminoglycosides	Bacterial ribosomes (30S subunit)
Fluoroquinolones	DNA gyrase and topoisomerase IV

symptoms of inflammation, either locally or globally (Cheng and Han, 2020; Cobirka *et al.,* 2020).

Three criteria-clinical appearance, length of the infectious process, and mechanism of infection transmission-are used to classify mastitis (Ajose *et al.,* 2022; Ruegg, 2021). Observable changes in the milk, udder inflammatory symptoms (edema, discomfort, heat, redness), and systemic symptoms such as fever, dyspnea, anorexia, and prostration are all indicators of clinical mastitis (Ruegg, 2021). These symptoms can be used to categorize severity into three degrees (Fredebeul-Krein *et al*., 2022). Just the changes in milk qualities are what define Grade 1, milk changes and indications of udder inflammation are part of Grade 2, and systemic symptoms including fever, dyspnea, anorexia, and prostration are part of Grade 3. Depending on when the symptoms appear and how long they last, clinical mastitis can also be categorized as hyperacute, acute, or chronic (Fredebeul-Krein *et al.,* 2022). Rapid start and severe but transient changes are hallmarks of both hyperacute and acute mastitis, which are frequently brought on by bacteria that are present in the production environment (Jamali *et al*., 2018). Permanent alterations in the quality of milk and fibrosis of the mammary tissue are linked to chronic mastitis. While pathogens with a high therapeutic cure index may not need antimicrobial treatment because of the possibility of spontaneous resolution, antimicrobial therapy is advised for clinical mastitis cases caused by pathogens with a low rate of spontaneous cure (Fredebeul-Krein *et al.,* 2022; Jamali *et al.,* 2018; Ruegg, 2021).

According to the pathogen transmission, mastitis is typically categorized as either contagious or environmental (Cheng and Han, 2020; Cobirka *et al.,* 2020, Morales-Ubaldo *et al.,* 2023). When cows come into close contact with environmental pathogens-mostly bacteria-found in their surroundings, they can develop environmental mastitis (Cheng & Han, 2020; Cobirka *et al*., 2020; Morales-Ubaldo *et al*., 2023). The teat canal, which is open for one to two minutes to two hours following milking, is how these pathogens enter the udder (Cheng & Han, 2020; Cobirka *et al*., 2020). Transmission of infectious mastitis happens during milking, by contaminated mammary quarters, by the hands of the milkers, and through fomites in milking unit liners. Enterobacteria (e.g., *Escherichia coli, Klebsiella spp., Serratia spp.*) and other opportunistic bacteria (e.g., *Coagulase-Negative Staphylococcus (CNS), Streptococcus uberis, Streptococcus dysgalactiae, Lactococcus spp., Trueperella pyogenes, and Pseudomonas spp.*) as well as fungi, yeasts, and algae such as *Prototheca spp.* are frequently responsible for environmental mastitis (Bronzato *et al*., 2017; Rodriguez *et al*., 2018). According to Morales-Ubaldo *et al.* (2023), *Staphylococcus aureus, Streptococcus agalactiae, Corynebacterium bovis, and Mycoplasma spp.* are linked to contagious mastitis.

ACTION PLANS ON AMR

Since 2015, political commitment and international action against AMR has grown. Beginning in May 2015, the World Health Assembly resolution WHA68.7 (WHA, 2015) adopted the GAP on AMR (WHO, 2015), developed by FAO, WHO and OIE. The GAP emphasized the need for a "One Health" approach to combat AMR by involving all sectors of government and society and strengthening coordination between FAO, WHO and OIE. Most of FAO's work on AMR to date has been implemented through extra-budgetary funds via donor-funded projects. Despite information gaps on antimicrobial use (AMU) and the impacts of AMR in food and agriculture – particularly in low- and middle-income country (LMICs) – FAO's support to tackle AMR has gained a momentum that needs to be maintained and built upon to strengthen the resilience of agriculture and food systems. The main objective of the Global Action Plan on AMR (GAP) is assisting Members in the development and implementation of multisectoral One Health NAPs. The GAP also presented key actions for addressing AMR. To respond to this challenge and realize the four betters: better production, better nutrition, a better environment and a better life, FAO has established two main goals for its work on AMR:

1. Reduce AMR prevalence and slow the emergence and spread of resistance across the food chain and for all food and agriculture sectors.
2. Preserve the ability to treat infections with effective and safe antimicrobials to sustain food and agriculture production.

The ***five objectives*** of the FAO Action Plan on AMR 2021–2025 are designed to help focus initiatives at every scale towards meeting the above goal and vision. These objectives are:

1. Strengthening governance and allocating resources to accelerate and sustain progress.
2. Promoting responsible use to keep antimicrobials working.
3. Increasing stakeholder awareness and engagement to foster changes.
4. Strengthening surveillance and research to support evidence- based decisions.
5. Enabling good practices to prevent infections and control the spread of resistant microbes.

KEY ACTIVITIES FOR 2021-2025

Activities are aimed at global, regional, national and local levels and span sectors, including terrestrial and aquatic animals, crops and the environment.

1. Outcome-1: Increased awareness of AMR risks in food and agriculture sectors and engagement in changing practices

- Awareness-raising, risk communication and behaviour change insights are developed
- Initiatives to increase awareness and engagement are supported and implemented

2. Outcome-2: Strengthened evidence through multisectoral surveillance and research on AMR, AMU and antimicrobial residues

- Laboratory capacity for generating high-quality data and metadata on AMR and antimicrobial residues is improved
- Surveillance, monitoring and research for AMR, AMU and antimicrobial residues is supported
- Epidemiology resources and capacities are developed

3. Outcome-3: Good practices to minimize the incidence of infections and spread of AMR are adopted by food and agriculture stakeholders

- Guidance for implementation of good practices for minimizing and containing AMR is made accessible
- Interventions effectively promoting good practices for minimizing and containing AMR are developed and implemented

4. Outcome-4: Antimicrobials are used responsibly by food and agriculture stakeholders

- Guidance and resources for responsible AMU are developed and shared
- Initiatives for enabling responsible AMU are developed and implemented

5. Outcome-5: Strengthened governance and resource allocation to minimize and contain AMR sustainably in food and agriculture

- Policies and regulatory frameworks for AMR containment are supported
- Research on innovation and incentives in food and agriculture is supported
- Partnerships and multisectoral collaborations are implemented and supported

MITIGATION STRATEGIES

Due to AMR, there is an urgent need to adopt to alternative methods for the management of bovine mastitis. About 68% antibiotics in veterinary practices are used for the mastitis control/ treatment (Kuiper *et al.*, 2016). In 2015, 27% of the intramammary antibiotics were used for clinical mastitis (CM) therapy, whereas 73% animals were kept on dry cow therapy (DCT). The high prevalence, the low cure rate of the highly economic and sometimes deadly disease is an alarming call for all the dairy sector, Veterinarians and policy makers. Though, India is a leader of milk production, yet the challenge for milk quality, early diagnosis, treatment, prevention and control of bovine mastitis continues to knock the doors of veterinarians.

Role of mitigation strategies are very important for management of diseases in farm practices as it help in:

1. Judicious use of antibiotics in treatment of mastitis.
2. Frequent treatment protocol decisions after considering all factors.
3. To find out alternative approaches.
4. Potential mastitis prevention measures.
5. Prevent antibiotics residue in milk/ meat.
6. Timely review of strategies and their effective alternative.
7. Awareness among dairy farmers.

One of the effective mitigation strategies for tackling mastitis and AMR is known as 3 "R" i.e., Reduce, Replace and Rethink. It says to reduce the consumption of antibiotics, replace the antibiotic therapy with alternative measures such as herbal, vaccination etc, and rethink about the livestock system by implementing farming practices that prevent the introduction and spread of diseases.

ALTERNATIVE METHODS FOR TREATMENT OF MASTITIS

To prevent the infection from spreading from cow to cow and to lessen damage to the glands that make milk, it is critical to identify and treat mastitis as soon as possible.

The afflicted cow must be fully milked as the initial step in the mastitis treatment process. The milk ought to be discarded properly.

- ANTIBIOTIC THERAPY - During the dry period, antibiotics are often given as a prophylactic strategy against mastitis. Among cattle animals, antimicrobial dry cow treatment is permissible as a preventative approach. When choosing antibiotics to treat clinical mastitis, consideration should be given to the patient's medical history, etiology, antibiotic sensitivity profile, and—above all—recommended therapeutic principles.
- PROBIOTICS - Probiotics are becoming more widely used in the management of many inflammatory illnesses and disorders. Although several microorganisms have been tested for probiotic function, the majority of probiotic species are lactic acid bacteria (Dhama *et al.* 2017). Because of their strong immunomodulatory action, lactic acid bacteria can prevent mastitis when administered as feed supplements, teat dips, and intramammary inoculations (Pellegrino *et al.* 2017; Yu *et al.* 2017; Rainard and Foucras 2018).
- HERBAL TREATMENT - Since herbal therapy has no negative side effects, it is a potential option for treating mastitis. A subspecialty of veterinary medicine called ethno-veterinary medicine treats illnesses using herbal remedies (Tiwari *et al.* 2018). Medicinal plants can be employed as an adjuvant or substitute therapy for the treatment of cow mastitis. Mastitis can be treated with them as an immunomodulatory, antibacterial, and anti-inflammatory drug (Mushtaq *et al.* 2018). They can also be used as a replacement to antibiotic and anti-pyretic agents that are generally used in the treatment of mastitis (Muluye *et al.* 2014).
- NANO – PARTICLE BASED THERAPY - Another field that is currently evolving as a drug delivery method for antimicrobial agents and other medications is nanoparticle technology (Gomes

and Henriques 2016). Positive findings have previously been obtained from the evaluation of various nanoparticle types for the treatment of mastitis (Castelani *et al.* 2019; Kalinska *et al.* 2019; Orellano *et al.* 2019; Pinheiro Machado *et al.* 2019). The antibacterial activity of the active drug will be improved by nanoparticle formulations by increasing its absorption by phagocytes (Gruet *et al.* 2001).

- STEM CELL THERAPY - The cow mammary epithelial cells' stem cells are crucial to preserving the health of the udder. According to Sharma and Jeong (2013), these stem/progenitor cells can be used to treat mastitis-related structural and cytological abnormalities in the cow udder. Because mesenchymal stem cells can create certain molecules that suppress bacterial growth, they have anti-bacterial activity (Yuan *et al.* 2014; Cahuascanco *et al.* 2019). Mesenchymal stromal cells generated from bone marrow exhibit in vivo antibacterial efficacy against methicillin-resistant S. aureus in a rat model. Either boosting the innate immune response or encouraging the development of specific anti-microbial peptides results in the increased bacterial clearance (Yuan *et al.* 2014).

- DRY COW THERAPY AND LACTATION THERAPY - The two antibiotic treatment procedures used to treat mastitis are dry cow therapy and lactation therapy. Using antibiotics to treat mastitis during lactation is known as lactation therapy (Tiwari *et al.* 2013). Because of its low efficacy and high cost of therapy, this therapeutic approach is not very useful (Pyorala 2009). Dairy cows are treated throughout the dry season as part of dry cow therapy. The goal of dry cow therapy was to eradicate current IMIs and manage any new infections that emerged during the dry season (Berry and Hillerton 2002; Derakhshani *et al.* 2018). In order to control mastitis at the herd level, this time frame is crucial. This is due to the fact that IMIs have greater cure rates when treated during a dry time (Halasa *et al.* 2009; Cameron *et al.* 2015).

- ACOUSTIC PULSE THERAPY - A portable device that generates pulsating pressure waves is used in acoustic pulse therapy (APT), commonly referred to as shock wave therapy. These waves can disrupt the scar tissue of chronic wounds, causing revascularization, by penetrating the deeper tissues. A statistically substantial portion of the mastitis cattle (70.5%) in a trial that used APT for subclinical mastitis were able to resume their regular milk output, as contrast to the control group (18.4%). Although this treatment seems promising, more research is needed to standardize it, including investigations on the sorts of infectious agents implicated. Additionally, APT may be used in conjunction with class IV laser and interferential therapy to assess the possibility for healing.

- TEAT SEALANTS - The opening of teat canal before calving is an important predisposing factor responsible for the occurrence of heifer mastitis. The risk of developing subclinical and clinical mastitis in heifers can be reduced by using internal teat canal seal ant during pre-calving period (Parker *et al.* 2007). Internal teat sealant (ITS) when used in combination with antibiotic dry-cow therapy significantly reduced the SCC along with improved prevention of subclinical mastitis (Golder *et al.* 2016).

- NATIVE SECRETORY FACTORS - Lactoferrin (Lf), a natural whey protein of mammary gland origin, carry many biological functions. Among various functions, limited anti-bacterial and anti inflammatory activities are prominent that can aid in treating mastitis. Anti-bacterial effects of Lf arise through iron binding required for bacterial growth, besides, being cationic in nature. Its weak anti-bacterial activities can be potentiated in combination with several antibiotics like penicillin G (Petitclerc *et al*. 2007). A study demonstrated that Lf increases the inhibitory activity of penicillin up to 4-fold in most penicillin-susceptible S. aureus strains. The potentiated inhibitory activity of Lf increased from 4 to 16-fold in penicillin-resistant strains. Apart from utilization along with the antibiotics, the bovine lactoferricin gene (LFcinB) has been cloned into PiggyBac Transposon vector. Such a vector clone has been transfected into the bovine mammary epithelial cells resulting in three-fold increase in LFcinB secretion.

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Lead Paper-5

Climate Smart Agriculture for Long-term Sustainability of Agri Food System

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In present context, climate change is a reality and its impact on Agriculture are enormous. Increasing atmospheric temperature, increasing weather aberrations and extreme weather events are serious worries foe achieving sustainability in agri food system. Increased temperatures, droughts, floods, and erratic weather patterns affect crop productivity. Further, heat stress reduces yields of staple crops (wheat, rice, maize), shifts in growing seasons and zones challenge traditional farming practices. However, there are number of best management practices, which have been classified as climate smart practices because these help in achieving sustainability in yield, build resilience and help in mitigation of GHGs. A set of agronomic management practices can help maintain balance among ecosystem components while ensuring the provision of essential ecosystem services (Rathore *et al.*, 2024). These practices include crop diversification, organic farming, integrated farming systems, agroforestry, and climate-smart agriculture. They contribute to lower greenhouse gas emissions and reduce carbon, water, and energy footprints, thereby supporting the proper functioning of ecosystem services (Rathore *et al.*, 2021). To effectively address emerging agricultural challenges, the following approaches are particularly relevant: integrated farming systems (IFS), optimal soil health management, agroforestry systems (AFS), efficient resource recycling, and climate-smart agronomic practices. Permaculture, biodynamic agriculture, organic farming, and conservation agriculture (CA) rooted in agroecology, therefore agro-ecological approaches are the essence of BMPs (Rathore *et al.*, 2022).

The Integrated farming system (IFS) is the integration of compatible agri and allied activities where complementarity and synergy of resource use ensure the enhanced resource use efficiency, lesser ecosystem disservices and higher income to the farmers. Further, the increasing biotic and abiotic stresses especially in changing climate scenario are serious challenges for sustainability of agri food system. Therefore, this is high time to diversify the production system. More number of compatible enterprise with complementarity in interaction will certainly going to enhance the total farm productivity and the farm profitability. Integrated Farming System (IFS) is based on holistic an innovative approach for improving the productivity of existing systems in totality and enhancing the profitability of existing systems with need based induction of suitable components. Vertical expansion in small farms is possible by integrating appropriate farming system components requiring less space and time and ensuring periodic income to the farmers. The IFS includes field crops, pulses, oilseeds, vegetables, livestock like dairy, poultry, goatary, and agri-horti system with dominant cropping systems. The IFS is considered as an approach to meet the multiple objectives of poverty reduction, food security, competitiveness and sustainability of small and marginal farmers. The approach aims at increasing income and employment from smallholdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself. The significance of the IFS approach is supportive in enhancing productivity to meet the multiple demand of food, feed, and fuel and fiber requirement of the ever-increasing population. However, these integrated farming systems will be required to be tailor-made and designed in such a manner that they lead to substantial improvement in energy efficiencies at the farm and help in maximum exploitation of synergies through adoption of close cycles. Even in difficult, risk prone agro ecology of North Eastern Hill Regions, the integrated farming system (IFS) has been found an effective agronomic intervention for enhancing system productivity, profitability and higher resource use efficiency (Rathore and Bhatt, 2008).

Based on the consideration of small and marginal farmer's condition, ICAR-IARI, New Delhi have designed a one ha. Model of IFS for irrigated situation, which has proved potential in enhancing and doubling the farmers' income in a sustainable manner. Based on above consideration an IFS model has been developed at ICAR-IARI, New Delhi for irrigated situation, which has proved potential in enhancing and doubling the farmers' income in a sustainable manner. The enterprises of the model are crops, livestock, poultry, duckery, fisheries, boundary plantation, agroforestry, apiculture, horticulture etc. These components are integrated in such a way that a farmer can get year round income and employment. Generally farmers of Northern India are practicing rice-wheat (11.4 m ha), maize-wheat, rice-potato-mungbean etc. where they are earning up to 1.5 lakh rupees per year. However, by adopting IFS model, on an average they can get more than 4.16 lakh rupees per year as net profit. Besides this, they can also get nutritious food for their family and round the year employment. The highest net income (1.80 lakh/year) was obtained from livestock enterprises with 70 m2 area. Second enterprises i.e. crop from which we got net income of Rs. 1.34 lakh per year followed by fisheries enterprises (net income 0.37 lakh/year). The highest sustainability in IFS was due to the more diversified enterprise integration and higher net income within the system against single cropping system (Shyam *et al.*, 2022). In a study at research farm of ICAR-IARI under Trans IGP. Integrated crop management in IFS also a potential option for enhancing overall productivity and resource use efficiency (Anamika *et al.*, 2024). The higher greenhouse gas intensity (GHGI) was reported in maize-wheat cropping system (MWCS) with 0.252 kg CO2 eq/kg MEY, followed by rice-wheat (0.198 CO2 eq/kg MEY) cropping system (RWCS). However, a significantly lower GHGI was recorded in diversified system including cereals, legumes, and oilseeds along with livestock (0.070 CO2eq/kg MEY). Hence, diversified IFS is climate smart practice, which ensure sustainability, build resilience and mitigate the GHGs.

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Lead Paper-6

Innovative Extension Approaches for Revitalizing Agriculture in Jammu and Kashmir

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INTRODUCTION

In the post independence era, Indian agricultural extension system has been struggling with regard to strategic planning, The extension system faces the challenges of serving a very large clientele with structural complexity and functional diversity. There is a very wide gap vis-a-vis extension workers to farmer ratio (1:1100) with contact intensity of one hour/ farmer/ year. Critical analysis of the existing system recognizers defects in realistic base level information and lack of continued real time impact assessment at the backend; discrete operation of schemes, poor coordination and cohesiveness among the extension players, low level of public confidence and lack of real time connectivity at the execution level, as the major impediments in realizing the bio-economic potential of agriculture and allied sector. UT of Jammu & Kashmir is bestowed with highly fertile lands and abundant water resources. However geo-physical and climatic variability leads to diverse agro climatic Zones, warranting a robust and versatile extension system. A robust technology enabled agricultural informatics, AI based analysis and reporting system with real time farmer-extension agents interface shall constitute the basis of strategic planning for a proactive agriculture extension system. The extension policy propounded is essentially a cluster approach, with real time regional analysis of the climate and agro-ecology information for promoting the niche agriculture under given agro climatic conditions; and synergizing the interventions under various agriculture development schemes tailored to various agro climatic zones. This shall facilitate holistic development and sustainable bio-economy. This however warrants restructuring and strengthening of agricultural extension. The key features of the proposal include a bottom-top approach with establishment of Panchayat level "Kissan Khidmat Ghar", revitalizing the "Block- level Extension Advisory Committee", promoting KVKs as the hub of convergence of services at District level and establishment of Business orientation centres at SKUAST-K & J with reinforced coordination for planning and execution of AES. Cyber extension including RS-GIS driven agro-advisories and ICT based virtual contacts and communication systems facilitating an enabling environment fostering real-time problem redresses. Other important interventions include capacity building of professionals, skill development of youth for promoting entrepreneurship and generating employment, awareness programmes promoting secondary agriculture and Public Private Partnership and remodelled students rural exploration programme for outreach intensification. Research in extension warrants special consideration for identifying Technology and Service Gaps, Technology adoption and Impact Assessment. Looking into the technological gaps the project was initiated with following Vison, Mission and objectives

Vision:- To foster smart technology driven seamless innovative, implementable and inclusive agri-extension services for empowering farmers educated youth to realize the sustainably progressive bio-economy.

Mission:- A dynamic Agri.-extension system using IoT enabled real time big data for farm centric planning and re-orientation of resources to foster sustainable and profitable agriculture with significant increase in the share of agricultural GDP.

Objectives

1. Holistic planning and execution of Production to Profitable agriculture with Ares. Commodity Specific Extension Approach based on agri. knowledge system (JK As stack platform).
2. Convergence of functional extension resources and approaches for Participatory planning and decentralized decision making to promote remunerative agriculture.
3. To provide seamless agricultural extension services with perfect outreach a dynamic contact across the value chain and real time resource person-clients interaction.
4. Capacity building in agricultural extension and skill development for entrepreneurship development and employment generation.

Project Components

I. Establishment of "Kissan Khidmat Ghar" at Panchayat level for seamless agricultural extension services

In order to extend quality services to farmers' door steps, it is proposed to extend Andhra Model of "Rythu Bharosa Kendras" to UT of J&K by establishing the "Kissan Khidmat Ghar" at panchayat level. This shall establish a sustainable and seamless agricultural extension outreach to the farmers by serving as a ground level convergence point for synergizing the extension efforts of multitude of stake holders and provide self – employment to 2000 youth in first phase. So far as 200 KKG has been established. These KKG provide one-stop centre serving the agriculture and allied sectors, acting as an information and knowledge hub equipped with modern ICT tools, including kiosks for direct farmer access to a wide range of services such as input supply, technology updates, and market information. This centre aims to foster effective and economical value chain management through a public-private partnership model. It will be staffed by village-level workers from various departments associated with agriculture and allied sectors, supported by contractual personnel. The centre will be led by the senior-most Agricultural Assistant or an equivalent official possessing at least a diploma in agriculture or a related field, who will serve as the in-charge of the Krishi Kiosk and Guidance (KKG) Centre. To promote self-employment, each KKG will engage one technical facilitator who will provide end-to-end services to farmers for a nominal fee. A robust Management Information System (MIS) will be implemented to ensure transparency and accountability in service delivery, as well as efficient sharing of both discrete and consolidated data with the parent departments and local administration. Furthermore, the centre will maintain strong linkages with Krishi Vigyan Kendras (KVKs), line departments, and agricultural universities, working in close coordination with Panchayati Raj institutions to foster a collaborative public-private-panchayat partnership.

Key Functions of KKG

- Execution of direct services in agriculture and allied sector as per mandate of respective Departments viz. health services (soil, plant, animal, etc.) including monitoring, surveillance, clinical diagnosis, laboratory testing and treatment/ prophylaxis; Artificial insemination in cattle; Consultancy services, etc.
- Input booking/ delivery and market intelligence services
- Capacity building and skill development with technical backstopping for Departments, KVKs and Agricultural Universities.
- Facilitating custom hiring services.

- Shall facilitate generation of baseline information for policy planning and review of Operational schemes at block and higher levels.

II. KVK as Central hub of Convergence at District

For holistic development of agriculture in the Union Territory of Jammu and Kashmir, For implementation of these projects/schemes, There is a pressing need for Krishi Vigyan Kendras (KVKs) to have all essential supporting facilities consolidated under one roof to ensure seamless service delivery and holistic development of the agricultural sector. These facilities should include dedicated centres for information dissemination, advanced agricultural technologies, processing units, certification and testing-especially for niche products like honey-along with adequate storage infrastructure. In addition, provisions for branding, value addition, and marketing of finished products must be integrated to empower farmers and enhance their market competitiveness. To ensure sustainability, the KVK should also serve as a hub for continuous capacity building and handholding support for Farmer Producer Organizations (FPOs), particularly after project-based interventions are phased out. Bringing all these elements together within the KVK framework will enable it to function as a comprehensive, one-stop solution centre for farmers and stakeholders in the agriculture and allied sectors. For strengthening the research and extension in the region it is necessary to strengthen the KVKs and their infrastructure. So in order to accomplish that, 29 civil works has been under process.

The key features of KVK as a district level facilitation centre are:-

- To act as facilitation centre for complimentary and supplementary support to various projects implemented through different Departments/ agencies. The common/central demonstration units, facility centres, etc. that cannot be extended to individual KKG shall be developed in KVKs.
- To act as resource centre for end-to-end solutions. The facilities for all the products in terms of certification, packing, branding and marketing shall be created in KVK'. This shall provide for collectivization and hence a better market control.
- To act as centre for capacity building for different agri. & allied-enterprises, all type of capacity building programmes including skill trainings, vocational trainings awareness programmes required for effective implementation of the developmental programmes will be conducted at the KVK's.
- To test and validate high value low volume crops in non-traditional areas, High value, low volume crops like saffron, lavender, kala zeera, pecanut, chestnut etc, which are grown under niche areas will be tested validated and demonstrated in non traditional areas by providing seed/planting material and training interventions.
- To develop potential based agro-tourism models in KVKs. Krishi Vigyan Kendras are well located to attract tourists. The infrastructure in these KVKs will be further strengthened to develop model of agro-tourism to provide demonstrations to farmers and build their confidence. The provisions will be made for construction of guest houses, tourist vehicles etc. so as to provide comfortable stay to tourists. Schools from all over the state and outside the states will be the targeted clientele for this intervention.
- To facilitate impact assessment of developmental schemes under different sectors in a cohesive and coordinated manner.

III. Cyber Extension/Multimedia

Cyber Extension refers to the use of information and communication technology (ICT), especially digital tools like the internet, multimedia content, and mobile applications, to enhance the dissemination of knowledge, particularly in fields like agriculture, education, and rural development. It represents a shift from traditional, face-to-face methods of communication to modern, technology-driven approaches.

In the context of rural development and social sciences, cyber extension allows researchers, educators, and government agencies to reach wider audiences with timely and relevant information. For example, farmers can access weather updates, market prices, best farming practices, and government schemes through mobile apps or online platforms. Multimedia elements-such as videos, animations, and interactive modules-make complex information easier to understand, especially for populations with low literacy levels. These tools enhance learning, encourage community participation, and empower individuals with the knowledge they need to make informed decisions.

Overall, cyber extension and multimedia improve the effectiveness, speed, and reach of communication strategies in social science research and outreach, making them powerful tools for social change and sustainable development.

The project is helpling in strengthening cyber extension through:

- Establishment of Community radio station in SKUAST Jammu namely "Radio Kissan SKUAST Jammu". Established Radio Kissan SKUAST Jammu has been established on 20 Nov, 2024 with aerial range up to 10 km radius along with that mobile app has been launched which offers worldwide connectivity of CRS.
- One more Community radio station yet to be established in KVK Samba.
- Technological centre at SKUAST Jammu yet to be established for augmenting documentation and production of high quality agri-extension/ technology Vedios/documentaries.

IV. Students Rural Exploration Programme

A novel and innovative approach for continued exposure of the graduates, post graduates and doctoral students to in-situ Real Challenges in agriculture and allied sectors shall provide a unique opportunity for students to immerse themselves in the social and economics realities of rural areas. The programme aims to bridge the gap between theoretical knowledge and practical experience, fostering a deeper understanding of rural life and its challenges in general and agriculture in particular.

Objectives

- Students Rural Internship
- Minimizing expert deficit at grassroot
- Extended outreach for services at doorstep
- Generation of primary agricultural data at farmers' level
- Promoting real-life learning process among students for capacity building in creative and critical thinking
- Inculcating ethical and social values for better public relations
- Promoting leadership qualities and team work culture in addressing real-life problems.
- Promoting a dynamic system for continued assessment of potential resources, ITKs, Technology interventions vis-à-vis SWOT analysis for furthering the development.
- Optimal use of human resources for widening the SKUAST-Jammu outreach to the farming community.
- Total number of students to be covered under students rural exploration programme are 1327, for graduate students are 953, for post graduation 217 and Ph.D. 157.
- Total number of Block to be covered in Jammu Region 148, Panchayats 2105 and villages 4615.

Goals

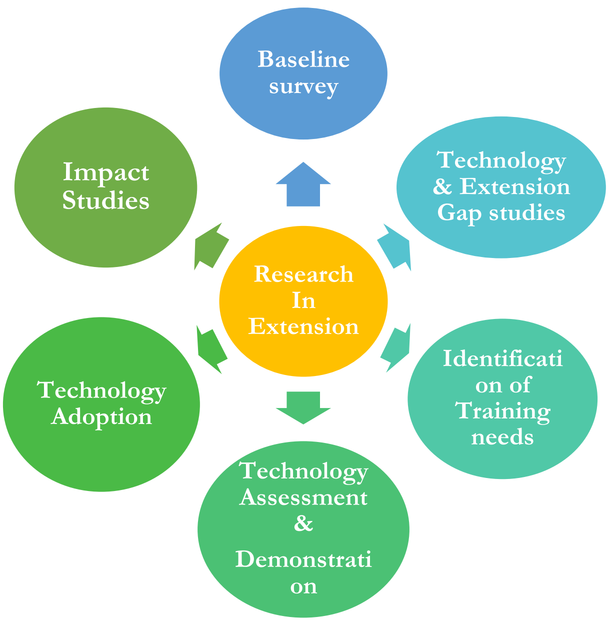
- Reaching out to farmers at panchayat level and extended coordination with extension agencies

- To create baseline data related to farming of whole Jammu region
- To aware students about the farming situation of whole Jammu region

V. Research in Extension

Research in this project component, as we collecting data from all districts of Jammu region. It will collect the data regarding the farming, extent of reach of government intervention and about the other information related to agriculture/farming. It will help govt. in policy making. The following research projects are under progress.

1. Impact of Agriculture input use on productivity of major cereal crops of the Jammu region.
2. Impact evaluation of different Government interventions in agriculture sector.
3. Determinants of income diversification in family farm households for livelihood security in J&K.
4. Yield gap analysis of field crops in Jammu region of J&K.



VI. Capacity Building and skill development

Capacity building of farmers is essential to improve their knowledge, skills, and access to resources, ultimately leading to more sustainable, productive, and profitable farming. Here's why it's needed:

1. **Adoption of Modern Techniques:** Modern agriculture involves advanced techniques like precision farming, integrated pest management, and climate-resilient practices. Many farmers, especially in developing areas, are unaware of or untrained in these.
2. **Climate Change Adaptation:** Farmers need to adapt to changing weather patterns, droughts, floods, and other climate-related risks. Capacity building helps them implement resilient practices to protect crops and livelihoods.
3. **Sustainable Resource Use:** With growing pressure on land, water, and biodiversity, training helps farmers use resources efficiently and sustainably, reducing environmental degradation.
4. **Improved Market Access:** Capacity building can teach farmers how to grade, package, and market their products better, enabling them to access local and global markets and get fair prices.
5. **Increased Income and Livelihood Security:** When farmers apply better practices, yields and quality improve. This translates into higher income and better food security for their families.
6. **Empowerment and Decision-Making:** Educated and skilled farmers can make informed decisions about crops, inputs, finances, and investments, reducing dependency on middlemen or external actors.
7. **Digital Literacy:** With growing use of mobile apps and digital tools for weather forecasts, market prices, and online training, farmers need capacity building to use these effectively.

8. Capacity Building

- To develop the skill and knowledge of farmers, 41 trainings has been organised at different institution of SKUAST Jammu and also 6 trainings programme for capacity building of officials from agriculture experts.
- 40 interview programme has been recorded and telecasted through Doordarshan studio Janipur, Jammu under the Programme name "Sadhi Dharti Sadhe Lok". Special features of these programme was that these were recorded in regional (Dogri) and Hindi language. Experts from different field of agriculture were invited in these interview.

Strategy of work

- Step I Call for Mission Mode Projects
- Step II Screening & Evaluation
- Step III Facilitation / Execution
- Step IV Report / Impact

CONCLUSION

The HADP project was initiated in 2022. This project converges all the department and research institutions related to Agriculture and allied activities on single platform which will ultimately help the farmers in easiest possible way and create the sense of collective responsibility. This project covers all the aspects of farming as mentioned in different components and whole work has been streamlined through online process. So that empowered farmers can adopt climate resilient practices and move towards Sustainable and advance farming.

Lead Paper-7

Climate-Smart Socio-Technical Innovations Bundling: A Framework for Widespread Adoption of Resilient Farming

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Developing countries with agrarian economy have been facing challenges arising from climate change causes and consequences. The altered patterns of climate are affecting the yield potential of crops thereby affecting agricultural production, farmers' income, and livelihoods. The 13th Sustainable Development Goal (SDG) of the United Nations on 'Climate action to combat climate change and its impacts,' emphasises the importance and urgency of addressing the effects of climate change in developing nations (FAO, 2017). It is projected that climate change would have the most detrimental effect on agriculture, the primary source of income for small and marginal farmers in developed nations (Azadi *et al.*, 2021). Building the ability of small and marginal farmers will be crucial to global food security over the next decade (FAO, 2020). World Bank (2018) reported that 800 million South Asian population are at risk of experiencing a decline in their standard of living and incomes due to rising temperatures and more erratic rainfall hampering the agriculture production system. Millions of low-income smallholder farmers, particularly those who rely on agriculture for a living and an income in South Asia, would be directly impacted by a reduction in productivity leading to food supply shortages and price increases.

Climate Smart Agriculture (CSA) is being promoted to combat the climate change issues and their effect on agriculture. CSA can transform the current agricultural system to support food security and safeguard it during increased climate vulnerabilities; therefore, need of present-day agriculture is to transform into CSA establishing a sustainable agricultural production system and stable food-secured system (Das *et al.*, 2022a). Farmers have differential awareness, knowledge, and perceptions towards climate change and thus their responses differ to combat climate change impacts (Karki *et al.*, 2020; Ramborun *et al.*, 2020). Climate change adaptation strategies are being formulated in the agriculture sector; however, consistency of those with the farmers' preferences has been the concerns in developing countries (Khanal *et al.*, 2018). Climate change mitigation measures are often hampered by farmers' awareness, knowledge and attitude towards climate change and its impact on agriculture & vice-versa (Tzemi and Breen, 2019). Thus, the Climate-Smart Socio-Technical Innovations Bundling through Climate Smart Extension (CSE) approaches will be key to widespread adoption of the CSA interventions. Combining different types of socio-technical innovations is a promising way forward to achieve household resilience and gender equity, especially if the correct kinds of social and technical innovations are combined and channelled into contextualized activities and interventions for better outcomes in agri-food systems (Johnstone *et al.*, 2023). A tailored approach is needed as what works in one place may not work in another, and therefore the bundles may vary as climate impacts and socio-cultural contexts vary with space and time (Chakona *et al.*, 2024).

Climate Smart Agriculture

The CSA integrates the climate change issues into the planning and development of sustainable agricultural production systems. The concept of CSA is given by Food and Agricultural Organization of the United Nations (FAO 2013). CSA is defined as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals." According to FAO (2013), there are three pillars of CSA- (i) increasing agricultural productivity to support sustainable livelihoods (ii) adaptation and capacity building to bring out resilient agricultural systems (iii) mitigation by reducing the GHGs emissions to a safe level. The domains of CSA are food security, adaptation, and mitigation

While CSA is based on current knowledge, technologies, and sustainable agriculture concepts, it is distinct in several aspects. First, it is explicitly committed to combating climate change. Secondly, CSA evaluates systematically the synergies and trade-offs between productivity, adaptation, and mitigation. Lastly, CSA intends to seize new funding opportunities to close the investment gap.

CSA encourages coordinated actions by farmers, researchers, the private sector, civil society, and policymakers toward climate-resilient pathways through four main action areas: (1) building evidence, (2) increasing local institutional effectiveness, (3) fostering coherence between climate and agricultural policies, and (4) linking climate and agricultural financing. Thus, CSA varies from business-as-usual approaches as it emphasises the capacity to deliver flexible, context-specific solutions supported by creative policy and finance initiatives (Lipper *et al.*, 2014).

Progress of CSA and CSE in India

National Innovations on Climate Resilient Agriculture (NICRA) was launched by ICAR in 2011 to develop different climate resilient technologies and transfer the same to different vulnerable districts of India. Several leading projects under The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) are continuing, one of them being Climate Smart Villages (CSVs). Climate Change Knowledge Network in Indian Agriculture (CCKN-IA) is another initiative of MoA & FW launched in 2013 that is focused on ICT enabled approaches for knowledge exchange on climate change in Indian context. ICAR has implemented National Innovations on Climate Resilient Agriculture (NICRA) from 2011 to promote various resilient technologies to different vulnerable districts of India. India's take on climate change and climate smart agriculture has been encouraging but not sufficient. Despite initiatives of national and international agencies to promote CSA in India, there is still low adoption of such interventions (Aryal *et al.*, 2018). The adaptation strategies remain unique to a particular setting and blanket suggestion for its up-scaling and out-scaling has remained an issue even decade after the introduction of NICRA. Therefore, the climate change adaptation policies must be integrated with climate smart extension and advisory services (EAS). Under NICRA of ICAR, 151 Climate Smart Villages are addressing vital challenges like drought, flood, soil related problems, etc. These climate smart villages are aimed to become: weather smart, water smart, carbon smart, nutrient smart, energy smart, and knowledge smart. The number and kind of interventions implemented are largely determined by the resources available, vulnerability status and involvement of communities. Village Climate Risk Management Committee (VCRMC) is constituted to manage both climate smart technical and institutional interventions in a climate smart village (Singh, 2020).

Integrated Approach to Promote CSA through CSE

Extension education, research as well as advisory services need to focus on the agriculture, water resources/ irrigation, climatic vulnerability, and socio-economic scenario of a climatically vulnerable region to screen, prioritise and promote location specific CSA interventions (Figure 1). The scenario analyses may

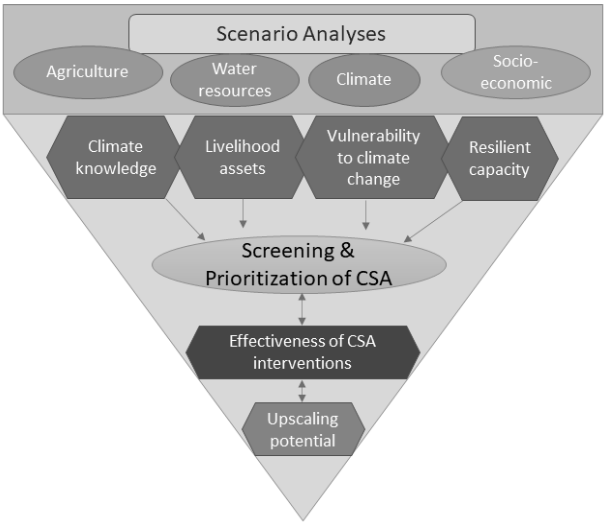

Figure 1: Extension research and advisory services to promote CSA

like to consider time series data on various parameters over the space and time to identify climatically vulnerable as well as resilient regions with the help of different indexes. Depending on the availability of data, scenario analyses may be undertaken at the grassroot level starting from the district level.

Following the scenario analyses, farm household level analyses will be important with respect to the farmers' climate knowledge including the causes and consequences of the climate change, livelihood status as determined by physical, social, human, financial, and natural assets holdings of farm households, farmers' vulnerability to climate change in terms of exposures to various climatic events (cyclone, flood, drought, heatwave, etc.) and their impacts, and resilient capacity of farm households depending on their access to basic services, assets, social safety nets and adaptive capacity. These farm households' attributes act as the determinants of adoption of CSA in a region.

An inventory of CSA interventions in terms of scientific technologies, indigenous technical knowledge, information and communication technologies, and institutional innovations will initiate the screening and prioritization process through assessment of effectiveness of the CSA interventions and their upscaling potentials. The involvement of farmers in the assessment process will take care farmers' preferences influencing the better adoption of CSA interventions. An integrated approach of extension education, research and advisory services will be able to design and deploy climate smart socio-technical innovations bundling in terms of both technological and institutional innovations through an effective partnership of all stakeholders, which will provide diversified livelihood options to the farm households and better insulation against the vulnerability to climate change in a specific agro-ecosystem.

Scenario Analysis for CSA & CSE

Promotion of appropriate location-specific CSA interventions require an analysis of scenarios of agriculture, water resources for irrigation, socio-economy and climatic vulnerability of the regions. It would reflect the resilience of the region's agriculture to the climate change as well as climate induced natural disasters. A composite agricultural scenario index (ASI) can be constructed considering 10-15 years data on 10-15 parameters to depict the district-wise agricultural scenario (Ghosh *et al.*, 2017a, Das *et al.*, 2020). It is assumed that the greater the ASI value, the greater the resilience exhibited by a district during a disaster year relative to other districts that experienced the same occurrence. Resilience of agriculture depends not only on the sustainability of agricultural-related parameters as measured by ASI, but also on socio-economic condition, climatic vulnerability, and water resources for irrigation; therefore, the socio-economic index (SEI), season-wise climatic vulnerability index (CVI), groundwater development index (GWDI), surface irrigation index (SII), and overall irrigation scenario index (ISI) can be worked out (Ghosh *et al.*, 2017a and 2017b). Using Arc GIS Desktop Basic Software, index maps are generated to illustrate the comparative agricultural, socioeconomic, climatic vulnerability, and water resources/ irrigation scenario of the districts in a given state. The performance of agriculture is factored by irrigation availability; therefore, irrigation availability develops better resilience to agriculture in the event of climatic aberrations.

Farmers' Participatory Prioritization of CSA and Its Drivers

The major challenge for CSA addressing location specific climate change issues is identification, prioritization, and upscaling of available CSA interventions in diverse agro-ecosystems. The decisions made by policymakers often fail to be realistic and functional without listening to the voices of the farmers (Azadi *et al.*, 2021). The challenges to promote adaptation to climate change can be met through involvement of stakeholders, where opinion of farmers, the primary stakeholder is of pivotal importance. As adaptation bears a better observability compared to mitigation, it becomes more alluring for small scale farmers to adopt the CSA practices underlining adaptation.

Enhancing the need and capacity to manage climate risk, which is a core adaptation strategy, necessitates a rise in the climate knowledge of decision makers so that they are more aware of climate impacts on various systems and how to use management options to intervene, thereby mitigating negative impacts and capitalising on opportunities. Lack of climate knowledge in the society creates a wider gap between policy formulation and policy implementation. Inadequate climate knowledge can not only weaken the adaptation strategies but it may also misguide mitigation efforts in this dimension. Therefore, assessing climate knowledge through location specific development of climate knowledge test encompassing causes and consequences of climate change is the stepping stone in providing EAS for CSA (Das *et al.*, 2022b). It is important to unravel the determinants of climate knowledge of the stakeholders including the farmers that would be precursor to formulate location-specific as well as clientele-specific capacity building programmes and EAS (Das and Ghosh, 2020).

The prioritization of CSA interventions by the farmers as adaptation options following an integrated approach will enhance the acceptance of those; one such location-specific framework to consider farmers' inputs in prioritization and upscaling of CSA is suggested that consider productivity, income, resilience and mitigation to determine effectiveness of CSA practices, and technical feasibility, cost of technology, gender inclusivity, and synergy with government plans as the parameters to determine upscaling potential of CSA interventions (Das *et al.*, 2022a). Delineation of livelihood indicators as drivers of CSA would help in policy advocacy to promote CSA. Government support in terms of financial assistance, subsidies, and insurance, climate smart EAS, adequate institutional infrastructure, and effective partnerships between the stakeholders would enable farmers to adopting CSA innovations, building sustainable farm livelihoods and improving resilience to climatic change.

Climate-Smart Socio-Technical Innovations Bundling

Socio-Technical Innovations Bundles (STIB) ensures need of different combinations of institutional and technological innovations. This concept works in conjunction and not in isolation as socio-institutional & technological innovations are dependent on each other. Bundling innovations brings "context-specific" social empowerment as well as technical empowerment. External drivers such as population growth, climate variability, and changing income patterns have made this integrated strategy increasingly essential. The main objectives of STIB include fostering gender equality, enhancing resilience and empowerment, and promoting sustainable livelihoods. By addressing both technical and social dimensions, STIB builds stronger, climate-resilient communities. Several mechanisms promote the adoption and scaling of STIB, including extension and advisory services, government policies, safety net programs, and the establishment of forward and backward market linkages.

Socio-technical innovation bundles generally comprise several key elements. First, there are technological and technical innovations such as improved seeds and crop varieties that are flood/drought-tolerant, pest-resistant, or high-yielding; affordable and efficient irrigation methods like drip irrigation or rainwater harvesting; digital tools like mobile applications, remote sensing, and Geographic Information Systems (GIS) for precision farming and market access; and climate-smart agricultural practices including conservation agriculture and intensification. Second, social and institutional innovations play a crucial role, including the formation of farmer cooperatives to improve access to markets, resources, and training; microfinance and credit initiatives designed for smallholders, especially women; and gender-sensitive extension services that offer technical support and knowledge exchange. Third, cultural and behavioural innovations focus on community participation to ensure that innovations align with local values and needs, alongside programs that promote gender equity by encouraging women's leadership, resource access, and decision-making roles in agriculture. Finally, policy and regulatory innovations involve creating supportive government policies that drive sustainable farming practices, safeguard the rights of marginalized groups, and establish enabling regulatory environments with standards and certifications that promote sustainability.

Importantly, selecting and integrating the right combination of innovations for any given situation is primarily a social process requiring collaboration—often more challenging to achieve than generating scientific solutions (Gartaula *et al.*, 2023). Barrett *et al.* (2020) emphasized the need for context-specific bundles that bring together technologies, policies, knowledge, social institutions, and cultural norms, noting that no single innovation is universally applicable. Generic, "one-size-fits-all" bundles often overlook the unique needs of groups like women farmers, who make up nearly half of the agricultural workforce but are frequently underserved (Pasha *et al.*, 2023). Additionally, isolated innovations often lead to partial successes in the agri-food sector, underscoring the need for complementary interventions developed through broad, inclusive stakeholder engagement. This collaborative process

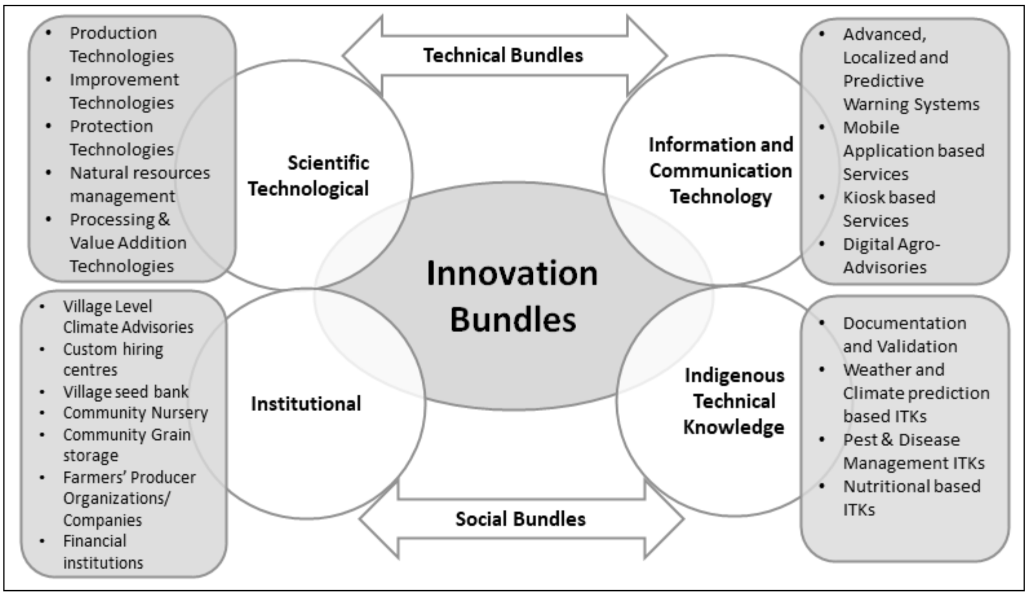

Figure 2: Bundles of Climate-Smart Socio-Technical Innovations

is crucial for designing the right bundles for the right people at the right time, enabling meaningful, large-scale impact (Chakona *et al.*, 2024).

Climate-Smart Socio-Technical Innovations Bundling refers to the strategic integration of multiple technologies, practices, and social interventions designed to enhance climate resilience and promote sustainable development (Figure 2). Instead of relying on a single solution, bundling combines innovations like drought-resistant seeds, renewable energy systems, precision farming tools, community-based insurance schemes, and capacity-building programs to address the complex challenges posed by climate change. This approach acknowledges that technical advancements alone are insufficient without supportive social structures, inclusive governance, and local empowerment. By blending technical bundles (like tolerant crop varieties and digital advisories) with social bundles (such as community-driven climate knowledge systems), STIB aims to significantly reduce the vulnerability of communities to climate change while enhancing their adaptive capacities (Figure 3). It promotes multi-stakeholder partnerships and facilitates necessary trade-offs, ensuring that innovations are not only technically sound but also socially acceptable and impactful. By aligning technological solutions with social needs and behaviours, Climate-Smart Bundling fosters greater adoption, scalability, and long-term impact, especially in vulnerable communities where environmental and socio-economic stresses are deeply intertwined.

CONCLUSION

Building climate-smart farm communities requires the promotion of CSA through CSE. Scaling up CSA will undoubtedly necessitate altering the behaviour, methods, and agricultural practises of millions of agricultural producers, who must become more knowledgeable about the effects of climate change in order to adopt more climate-smart strategies. EAS have long functioned as a link between research and agriculture, providing farmers with information about new technologies. However, the effective expansion of CSA requires CSE methods that extend far beyond the modification of farm-level agronomic techniques. In fact, it necessitates the identification, bundling and promotion of suitable techniques/technologies, social

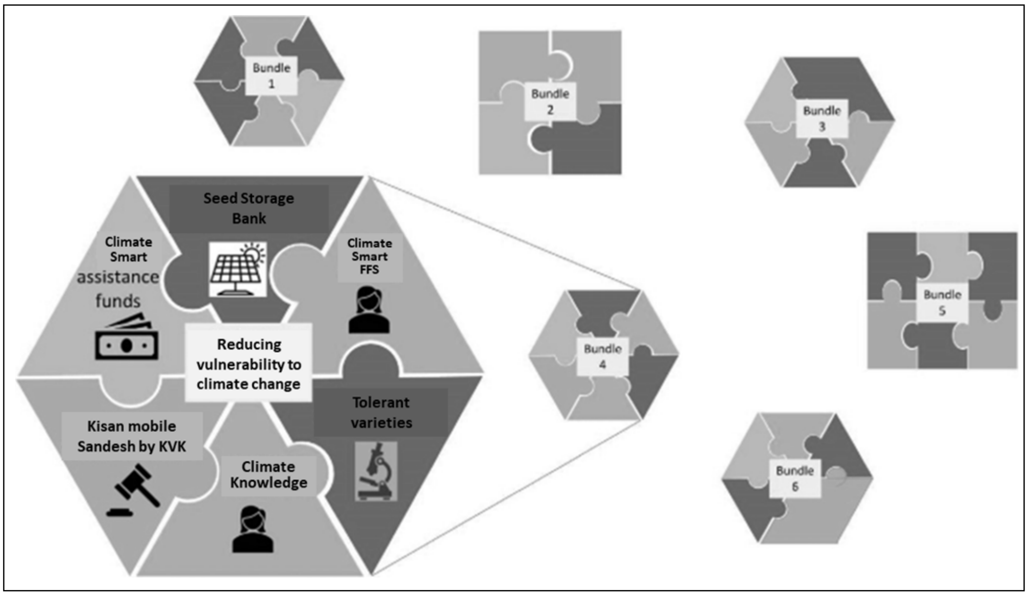

Figure 3: Example of climate-smart socio-technical innovations bundle (following Barrett *et al.*, 2022)

innovations and/or models (new, improved, or adapted) within enabling settings, and it must include constructive institutional structures, policies, and financial investments. Thus, climate smart extension needs to be pluralistic in nature meeting the multifarious needs of farmers in a climatically vulnerable region. Approaching climate change issues in an integrated manner would facilitate the links between sustainable development policy and emerging climate policy on resiliency and adaptation. Climate smart extension requires to focus on climate smart socio-technical innovations bundling through good partnerships to provide farm households a better resilience to climate change in a climatically vulnerable agro-ecosystem.

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Lead Paper-8

Strengthening Agricultural Extension through Effective Policy Framework: A Case of Extension Systems Management (XSM) Division of ICAR-NAARM

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ABSTRACT

Emerging challenges in agriculture necessitates building the capacity of stakeholders of National Agricultural Research Education and Extension (NAREES). ICAR-National Academy of Agricultural Research Management System (NAARM), Hyderabad regularly builds the capacity of stakeholders of NAREES on emerging issues and thereby facilitates change management through training programmes, research and policy advocacy, higher educational programmes and promoting entrepreneurship in agriculture in six thematic areas. Extension systems management is one such thematic area and the Division of Extension Systems Management (XSM) of ICAR-NAARM facilitates change management in National Agricultural Extension System (NAES) of the country. Research and policy advocacy is one of such initiatives of the Division. This paper discusses about the focus, strategy, stakeholders and policy strategies of XSM Division in four thematic areas in a strategic framework established specifically for the Division.

Keywords: Agricultural extension, Policy, Extension systems management, ICAR-NAARM

Trends in Indian Agriculture

Indian Agriculture needs to grow at a rate of 3% per annum in order to feed the growing population with their income in 2050 (Anonymous 2015). The increasing food demand and decreasing natural resource base, force the land productivity to be enhanced by four times, water productivity by three times and energy efficiency by two times. Continuous fragmentation of land holdings results in increase of proportion of small-holder farmers and decrease in rural labour force availability. Here arises, a need for better technology that not only brings enhanced productivity and profitability to the majority small and marginal farmers, but also its suitability to be integrated with the emerging agribusiness and food supply and value chains. Ironically, the emerging climate change events adversely affect agricultural production and its sustainability. Therefore, the need of the hour is to employ more knowledge-based pathways guiding agriculture towards sustainability by meeting the challenges of climate change, monsoon variability, degradation of natural resources, biotic and abiotic stresses and more importantly market challenges (Srinivasarao *et al.*, 2016; Srinivasrao *et al.*, 2020). Thus, these new challenges necessitate a major shift in the agricultural research and its management from traditional input-centric orientation to innovative knowledge and process-centric orientation.

The National Agricultural Research, Education and Extension System (NAREES) in the country under the Ministry of Agriculture and Farmers Welfare (MoA & FW) strives to address the emerging issues in agriculture through its need-based research, education and extension efforts throughout the country. The huge infrastructure of NAREES through 113 research institutes of Indian Council of Agricultural Research (ICAR); 76 state agricultural universities (SAUs)/ Agricultural Universities (AUs)/ Central Agricultural Universities (CAUs) and 731 Krishi Vigyan Kendras (KVKs) address the demands of stakeholders of agriculture such as farmers, input industries, non-governmental organizations (NGOs), farmers' producers' organizations (FPOs) etc. Here arises a need for a central organization that keeps vigil on the emerging demand process and guide the organizations of NAREES towards change management. The ICAR-National Academy of Agricultural Research Management (NAARM) is one such organization that regularly enable smooth transition towards change management in agriculture through its capacity building programmes.

Operative Environment of ICAR-NAARM

Markets increasingly drive the production system in Indian agriculture. Even by 2050, more than one-third of the Indian population might depend on agriculture for their livelihood security. Amidst such scenario, a shift in agricultural paradigm from production-orientation to market-orientation with agribusiness and consumers on one hand and environment and eco-system on the other hand of management is inevitable. In spites of achievements of NAREES in bringing food self-sufficiency through green revolution, it has been frequently criticized for its capacity in terms of leadership, governance, investments, human resources, their competencies to meet the contemporary challenges of agriculture and often compared with vibrant private R&D system of the country. Thus, the prevailing socio-political and innovation regulatory system encourages meaningful partnership between public–private R&D organizations. NAREES can address these challenges through innovations in research, education, and extension and agri-business management, adequately supported by holistic policy measures. Accordingly, NAREES has to plan and implement capacity strengthening measures, partnerships, linkages and collaborative strategies to accelerate innovation towards bringing sustainable agricultural development.

Opportunities for ICAR-NAARM to Address Agricultural Challenges

ICAR-NAARM has been continuously striving to build the individual and institutional capacities of NAREES. Considering the pluralistic nature of the innovation system in agriculture, leadership and governance factors needs to be given significance from the innovation management point of view. Thus, innovation, leadership and governance are three domains (Figure 1) offer ample opportunities for ICAR-NAARM to play an effective role in transformation of NAREES.

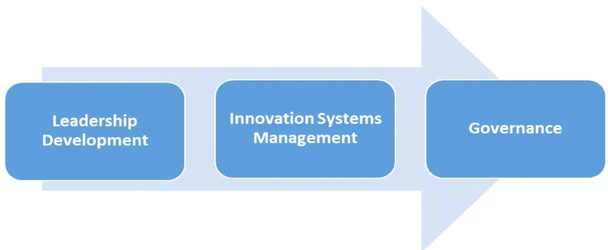

Figure 1: Critical Management Domains of ICAR-NAARM

Competency Framework Adopted by ICAR-NAARM

Human resources are the most valuable resources in any organization. Hence, developing them is a priority. ICAR-NAARM will strive to strengthen capacity of individuals towards innovations and organizations towards organizational learning and change. ICAR-NAARM will adopt a Competency Framework in developing the competencies (Figure 2) of scientists of NAREES.

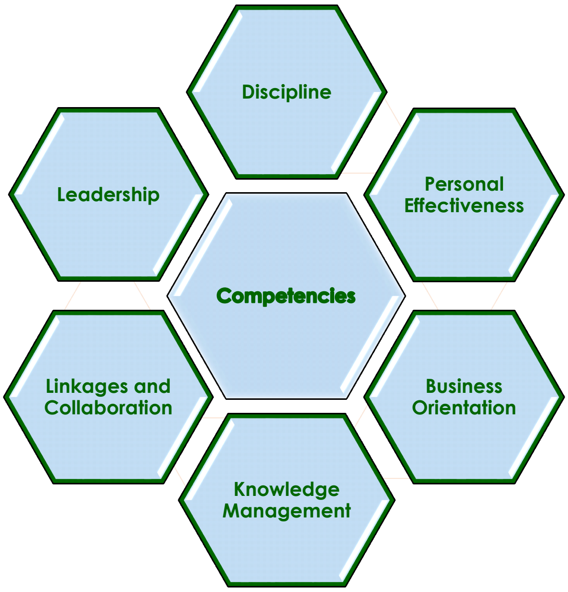

Figure 2: Competencies addressed by ICAR-NAARM

Research and Policy Advocacy Activities of ICAR-NAARM

Though, ICAR-NAARM has been recognized as a Premier capacity building organization, the scientists of the academy also undertake research projects, extramural projects, consultancy, contract research programmes, policy studies, sponsored research programmes and organize policy events such as workshops, seminars, symposia etc., in order to recommend policy strategies on emerging and important issues on agriculture, in the form of research reports, policy briefs, occasional papers, research papers, status papers, strategy papers etc. As ICAR-NAARM is recognized as one of the think tank policy institutes of ICAR, preparation of policy documents is also given adequate weightage apart from capacity building, educational programme and outreach activities in thematic areas such as agricultural research systems management, information and communication management, human resource management, agri-business management, education system management and extension systems management.

Research and Policy Advocacy through "Extension Systems Management" in a Market-driven Environment

In the modern era of agriculture, information plays a vital role. Timely dissemination of information to the needy farmers assumes significance from the stakeholders, especially, from the farmers' point of view. Hence, effective management of extension systems across agriculture and allied sectors, assumes importance. The transformation of agriculture to be a business-oriented enterprise, means a lot in order to re-align the approaches and methodologies to be adopted by the extension systems in the country. Hence, innovative models and strategies to be adopted and up scaled across sectors, are to be documented and communicated to the stakeholders of the extension systems in the country. Hence, a Division namely "Extension Systems Management (XSM)" was exclusively established. In that way, the core research areas under of the Division are, extension policy and management, institutional innovations, knowledge sharing and management including that of digital extension and gender mainstreaming.

Key Thematic Areas for Research Policy Advocacy for XSM Division

The following are the key thematic areas of "Extension Systems Management" Division within the strategic framework (Table 1):

- Extension Policy, Planning and Management
- Innovations in Agricultural Extension for Inclusive and Sustainable Agricultural Development including Market-oriented Extension
- Information and Communication Technologies (ICTs) and Knowledge Management & Sharing
- Gender Empowerment

Sub-themes of Extension Policy, Planning and Management

Theme on Policy, Planning and Management addresses the leadership and governance aspects of ICAR-

Table 1: Strategic Framework for XSM Division of ICAR-NAARM

<table>
<tr><th>Vision, Mission, Objectives</th><th>Thematic areas</th><th>Sub-thematic areas</th><th>Strategy</th></tr>
<tr>
<td rowspan="4">Vision
The Extension Systems Management (XSM) Division will be a unique enabler for facilitating continuous learning and innovation in the National Agricultural Extension Systems in India and the world.
Mission
To enhance leadership, governance and innovation capacities of NAES through capacity strengthening, education, research, consultancy and policy advocacy.
Focus
Extension Systems Management for Sustainable Livelihood Security and Farmers' Empowerment
Strategy
Enhance operational, adaptive and generative capacity for frontline agricultural extension systems to address emerging challenges
Enhance capacities for use of ICTs to provide customized knowledge, skills and solutions for social networking</td>
<td>Extension Policy, Planning and Management</td>
<td>• Capacity development of individuals and organizations of NAES with focus on Frontline Extension
• Developing Quality Assurance Protocols in Extension
• Performance assessment of NAES
• Mapping of agricultural extension service providers
• Documenting and institutionalizing "Best Management Practices" for enhancing effectiveness of NAES
• Strengthening extension systems in allied sectors
• Enabling "convergence and synergy" in Pluralistic Extension System (including schemes and programmes)
• Customized extension models for less-endowed and dis-advantaged areas
• Models for empowering resource-poor farmers
• Methodologies for evaluation and impact assessment
• Partnership in extension services
• Reforms in extension curricula
• Agricultural Innovation Systems–Role of Extension
• Promotion of para-extension services
• Meta analysis of research in extension</td>
<td rowspan="4">• Establishing national linkages and International collaboration
• Organizing need-based refresher courses, EDPs and MDPs for professionals of frontline extension system with focus on KVK professionals
• Adopting interdisciplinary approach
• Establishing collaborative field laboratories
• Assessing and documenting critical success factors
• Action research (as a major activity across the themes)
• Facilitating and guiding network research projects on important thematic areas
• HRD of XSM faculty and staff
• Providing consultancy services
• Collating available evidences and experiences from micro-studies (Meta-analysis)
• Write-shop for synthesizing experiences and formulating road-maps
• Use of Expert Resources (consultants, visiting faculty, community of practice, etc.)
• Preparing and communicating policy papers
• Regional Centre of Excellence in Extension Systems Management for South Asia</td>
</tr>
<tr>
<td>Institutional Innovations in Agricultural Extension for Inclusive and Sustainable Agricultural Development / Market-oriented Extension</td>
<td>• Promotion of producer organizations
• Facilitating rural producer-driven market interventions
• Addressing value-chain management
• Promoting agribusiness and agri-entrepreneurship
• Climate change and NRM Extension
• WTO and Agricultural Extension</td>
</tr>
<tr>
<td>Information and Communication Technologies (ICTs) and Knowledge Management & Sharing</td>
<td>• Documentation of experiences and knowledge sharing through publications and policy fora
• Mass media (Electronic and print media)
• Critical factors of innovation spread
• Repository of extension outputs of commodity-based research institutes
• M-extension
• Interpretation, validation and sharing of agricultural knowledge
• Identifying research priorities and sharing with SAUs as research agenda of M.Sc. and Ph. D programmes
• Capturing success stories of frontline demonstrations
• Establishing digital media for a for participatory knowledge management
• Use of social media for knowledge management
• Management of Indigenous Technical Knowledge (ITKs)</td>
</tr>
<tr>
<td>Gender Mainstreaming</td>
<td>• Collating gender studies and experiences and sharing
• Undertaking gender analysis; developing tools and methodologies
• Facilitating gender sensitive extension approaches
• Household food and nutritional security
• Urban agriculture and edible greening</td>
</tr>
</table>

NAARM strategy. The sub-themes identified are as follows:

1. **Capacity development of individuals and organizations of NAES with special focus on Frontline Extension:** Having individual and organizational components of National Agricultural Extension System (NAES) as the stakeholders, XSM division has to develop the capacity of them through structured programmes designed based on appropriate needs of the stakeholders with focus on frontline extension system comprising of KVKs, extension wings of ICAR institutes and SAUs.
2. **Developing Quality Assurance Protocols in Extension:** Ensuring quality in extension services is a pre-requisite for extending broad-based and effective services to the farming community. Quality of extension services rendered by components of NAES needs scrutiny, so that appropriate protocol strategies may be recommended for ensuring quality of services of NAES.
3. **Performance assessment of NAES:** Performance of frontline extension system needs to be assessed in order to establish appropriate feedback mechanism and suggest idealistic models.
4. **Linkages and collaboration in Extension:** The NAES has many components such as ICAR institutes, SAUs, KVKs (frontline extension system), development departments (mainstream extension system), NGOs, private sector etc. (private extension system). However, these components are poorly linked. Hence, in-depth studies on convergence models like ATMA would help in identifying mechanism to address this issue.
5. **Mapping of agricultural extension service providers (Inventory of ESPs):** There are many models of agricultural extension service providers catering to the needs of stakeholders of NAES. An inventory mapping the profile and activities of such service providers may help in planning and implementing effective capacity building & policy advocacy programmes in strengthening the activities of these service providers.
6. **Documenting and institutionalizing "Best Management Practices" for enhancing effectiveness of NAES:** Many models of extension are very much successful at the field level due to best practices followed by the extension agencies. Success stories of such models need documentation and wider dissemination.
7. **Strengthening extension systems in allied sectors of agriculture:** Extension systems in agricultural allied sectors (Ex. Animal husbandry, fisheries etc.) are not fully developed and yet to function at higher take-off stage. These extension systems need thorough and in-depth analysis and policy interventions for further strengthening.
8. **Enabling "convergence and synergy" in Pluralistic Extension System (including schemes and programmes):** Many schemes are being implemented for the benefit of farming community with huge investment (Ex. RKVY, NHM, NFSM, NPS etc.). Utilization of such schemes needs to be studied and strategies for effective utilization of such by the targeted beneficiaries need to be recommended.
9. **Customized extension models for less-endowed and dis-advantaged areas:** Less-endowed, dis-advantaged, far-flung areas, areas with inadequate natural resources and poor accessibility need adequate emphasis in order to address inclusive growth in general and agricultural development in particular. In such areas, there are models that are emerging to address the developmental needs of farmers and rural community. These extension models need in-depth analysis and policy interventions are to be recommended for enhancing the efficiency and effectiveness as well as scaling-up and replicating them in similar areas.

10. **Models for empowering resource-poor farmers:** The benefits of agricultural advisory services and various development as well as welfare programmes reach to the resource rich farmers. However, such benefits are not reaching the resource-poor farmers in the areas that have poor accessibility. Hence, strategies for formulating customized extension models that empower and address the resource poor farmers are to be suggested.
11. **Methodologies for evaluation and impact assessment of extension systems:** XSM division of ICAR-NAARM needs to develop and communicate effective methodologies for evaluation and impact assessment of extension models and such methodologies.
12. **Partnership in extension services (Public-Public; Public-Private and Private-Private models):** The broad-based needs of stakeholders of agriculture cannot be met by individual models of extension system. Hence, there is a need for developing and strengthening effective models on public-public; public-private and private-private extension services to serve the stakeholders in an effective and efficient manner.
13. **Reforms in extension curricula:** There is a need for having demand-driven and uniform curricula for the courses of Agricultural Extension being offered at under graduate, post graduate and doctorate levels. Hence, the existing curricula need in-depth analysis and appropriate reforms need to be recommended.
14. **Agricultural Innovation Systems (AIS)–Role of Extension:** Interactions among a wide range of stakeholders within an Agricultural Innovation System (AIS) is needed to put new knowledge into wider use. Agricultural extension services can and should play a much wider role in promoting interactions and knowledge flows among the different actors in the AIS. These roles need to be delineated in various settings so that the needed capacities could be developed.
15. **Promotion of para-extension services:** Innovative and progressive farmers lead their own extension system among their peer group. Many such initiatives are being implemented by DOE, MOA & FW such as *Adarsha Rythu, Krasnik Bandhu, Gopal Mithra*, Farmer Friend etc. Profile of such farmers need to be studied and their approaches must be analysed to promote para-extension services for the betterment of farming community.
16. **Meta-analysis of research in extension:** Capacity building on research in extension also forms one among the capacity building agenda of XSM division. Hence, the division needs to do research on agricultural extension research that is happening across the country in a meta-analysis mode to capture, collate and synthesize the research results, so that appropriate policy strategies are suggested for strengthening extension research.

Sub-themes of Institutional Innovations in Agricultural Extension for Inclusive and Sustainable Agricultural Development / Public-Private Partnership/ Market-oriented Extension

Theme on Institutional Innovations in Agricultural Extension for Inclusive and Sustainable Agricultural Development / Public-Private Partnership/ Market-oriented Extension addresses the governances and innovation aspects of ICAR-NAARM strategy. The sub-themes identified are as follows:

1. **Promotion of producer organizations (commodity groups, FIGs, FOs, producer companies, etc.):** Producer organizations such as commodity groups, farmer interest groups (FIGs), farmers' organizations (FOs), producer companies, etc. extend broad-based services to their producer members. Keeping in view, the limitations of public extension system, these models are to be studied and strategies are to be recommended for promotion of these models.

2. **Facilitating rural producer-driven market interventions:** Issues in marketing of agricultural produce and forward integration need to be analysed and appropriate recommendations need to be communicated to the NAES.
3. **Addressing value-chain management:** Globalized market economy expects Indian farmers to be competitive in specific niche areas with comparative advantage. This scenario necessitates value addition of primary produce and focus on secondary agriculture. XSM division must address the issues in these arenas and provide pragmatic solutions.
4. **Promoting agribusiness and agri-entrepreneurship:** Individual and group entrepreneurship models are emerging to address the issues in market linkage, value addition, secondary agriculture, export management etc. XSM division must address the issues in these arenas and provide pragmatic solutions.
5. **Climate change and NRM Extension:** Climate change issues pose a major threat to productivity and profitability of primary producers. Similarly, fast depletion of natural resources like land and water and their indiscriminate exploitation also threatens the agricultural operations. XSM division must address these issues with appropriate strategies by analysing the climate resilient and natural resource conservation approaches.
6. **WTO and Agricultural Extension:** Impact of WTO policies and the respective implications must be thoroughly studied and appropriate policy measures must be recommended.

Sub-themes of Information and Communication Technologies (ICTs) and Knowledge Management & Sharing

Theme on Information and Communication Technologies (ICTs) and Knowledge Management & Sharing addresses the governances and innovation aspects of ICAR-NAARM strategy. The sub-themes identified are as follows:

1. **Documentation of experiences and knowledge sharing through publications and policy fora:** The experiences of NAES studied at various locations need to be collated and synthesized and appropriate policy measures are to be communicated through various publications such as policy papers, briefs, discussion papers, research papers etc. and various policy fora.
2. **Mass media (Electronic and print media):** The role of mass media in taking agricultural knowledge to the unreached through participatory modes needs to be studied.
3. **Critical factors of innovation spread:** Certain agricultural innovations spread among the farmers at a much faster pace without extension efforts. The characteristics of such innovations and the spreading mechanism need in-depth analysis for recommending appropriate policy strategies.
4. **Repository of extension outputs of commodity-based research institutes:** The XSM division of NAARM must have a repository of extension outputs and outcomes of various commodity-based research institutes of ICAR to develop effective course modules for frontline extension system and developing customized modules on functional extension aspects suited to specific research institutes.
5. **M-extension:** Modern modes of agricultural extension based on ICTs such as M-extension are emerging as alternatives to traditional extension system. Such approaches need analysis in terms of methodology, effectiveness, efficiency, content validity etc. Such analysis also must lead to policy recommendations that guide accreditation of all these ICT initiatives, so that quality services are reaching the framing community.
6. **Interpretation, validation and sharing of agricultural knowledge:** Many knowledge management initiatives addressing information needs of the stakeholders have a huge volume of valuable information. However, there are no

specific components of extension system to capture, treat and disseminate the information to the needy stakeholders. This issue needs to be addressed through in-depth studies and relevant policy recommendations.

7. **Identifying research priorities and sharing with SAUs as research agenda of M. Sc. and Ph. D programmes:** Research priorities of agricultural extension around the emerging agricultural challenges are evolving. Such priorities are to be identified and communicated to SAUs for conducting demand-driven M. Sc. and Ph. D research programmes.
8. **Capturing success stories of frontline demonstrations:** Frontline demonstrations (FLDs) are one of the successful modes of transfer of agricultural technologies. Success of FLDs in demonstrating the productivity potentials and profitability of improved agricultural technologies need to be studied, documented and communicated widely for further application.
9. **Establishing digital media forum for participatory knowledge management:** Lack of adequate manpower warrants establishment of media forum for dissemination of improved production technologies through farmer-farmer extension. The emergence of role of ICTs in technology dissemination facilitates establishment of digital media forum. This approach needs analysis and up-scaling.
10. **Use of social media for knowledge management:** Social media like Facebook, twitter etc. provide opportunities for dissemination of good practices of agricultural extension and knowledge management. Use of such media for effective knowledge management needs in-depth study.
11. **Management of Indigenous Technical Knowledge (ITKs):** ITKs are the valuable resources for improved production technologies for application. Hence, ITKs need documentation, validation and dissemination.

Sub-themes of Gender Empowerment

Theme on gender mainstreaming addresses all three aspects of ICAR-NAARM strategy such as leadership, governance and innovation. The sub-themes identified are as follows:

1. **Collating gender studies and experiences and sharing:** Engendering agriculture is an important issue in taking forward agriculture as a profession. There are many studies addressing such issues. Such studies need to be collated, documented and shared.
2. **Undertaking gender analysis and developing tools and methodologies:** Developing methodologies for gender analysis in NARS and assessing gender participation in agriculture is of top-most priority, keeping in view the role of women in agriculture.
3. **Facilitating gender-sensitive extension approaches:** The need to incorporate gender concerns in extension has become apparent owing to their differential roles and needs in agriculture. Extension approaches that specifically address gender-specific issues in agriculture need to be developed.
4. **Household food and nutritional security:** As the agriculture sector offers the greatest potential for achieving sustained improvements in household food security and individual nutritional well-being, attention needs to be given to increase the production and consumption of food and ensuring that the poor have adequate access to adequate quantities of safe, good quality food for a nutritionally adequate diet. Therefore, issues on food and nutritional security of rural community need to be addressed.
5. **Urban agriculture and edible greening:** Keeping in view the emerging needs on urban agriculture, backyard agriculture and kitchen gardening at the back drop of nutritional needs of urban population, such studies need to be undertaken.

Stakeholders of "Extension Systems Management" Division

The following are the targeted stakeholders of "Extension Systems Management" division:

Extension Professionals of ICAR institutes and KVKs: The extension professionals (extension scientists/ HoDs of Extension or Social Sciences Divisions) serving in 113 ICAR institutes strive to disseminate the technologies developed by their respective institutes through various modes of technology transfer. Need-based programmes will be organized to address the capacity building needs of these professionals. Similarly, professionals of KVKs (Heads and SMS of KVKs) strive to disseminate the technologies developed by both ICAR institutes and SAUs. Hence, the Division organizes need-based and mandated programmes address the capacity building needs of KVK professionals.

Extension Professionals of SAUs: The faculty with agricultural extension background (Faculty/ Heads of Extension/ Social Sciences Divisions/ Directors of Extension Education) serve for their universities to disseminate the technologies developed by the fellow faculty. They also create manpower in extension though higher education in agricultural extension. The Division also addresses the capacity building needs of these professional through need-based programmes.

Professionals of Private Sector & NGOs: The extension professionals of NGOs and private agri-business industry strive to disseminate need-based technological innovations as per the demands created by the farming community. The Division also executes special modules for such professionals to enhance their soft as well discipline-based competency requirements. In addition, the Division also executes specialized modules to address the capacity building needs of the agripreneurs, FPOs and start-ups, so that these individuals or organizations mobile effectively the technological innovation as per the needs of the farmers.

Way Forward

The "Extension Systems Management" Division of ICAR-NAARM will strive to act as an integrated unit for extension research management and policy advocacy. It will focus on modules regarding creation, dissemination and application of knowledge in agricultural extension. The strategy will be training, education, research and consultancy and policy advocacy. The Division will strive to facilitate 'organizational renewal' of NAES institutions. The Division is mandated towards capacity strengthening of NAES stakeholders. It will straddle the interface between science, education, technology transfer and policy. It will transform NAES into a vibrant innovation system through addressing the needs of human resources and institutional management challenges.

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Lead Paper-9

Model for Convergence of Farmers' Innovation and Entrepreneurial Activities: Evidence from Empirical Learnings

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In the 1940s, biologists began developing high-yield varieties which paired with new fertilizers and pesticides, dramatically transformed the way we are able to eat today as the amount of food harvested per unit area increased manifolds. These science-based technologies triggered changes in agriculture and ultimately pressure on natural resources, including land and water, leading to compromised sustainability of agriculture, to cope with, small-scale producers need to continuously innovate to adapt to the changing environment and changing markets. Production systems will have to become more resilient, and technology for development must go well beyond raising yields to saving water and energy, reducing risk, improving product quality, protecting the environment, and tailoring to gender differences" (World Bank, 2008)., Innovation processes are looked at nowadays from an evolutionary perspective, that a variety of innovations and innovation processes compete in a dynamic selection environment in which the 'best fitting' survives in a given time and space context (Bijker et al., 1987; Rotmans et al., 2001). Such 'fitting' involves not only adaptation to prevailing contextual conditions, but also the active influencing, re design or destruction of pre existing conditions and frameworks, respectively the 'overthrowing' of previously dominant 'socio technical regimes' (Geels and Schot, 2007).

Agrarian distress and farm level stresses are the issue of concern in the present situation. Farmers face a unique set of stressors, because many farmers could not imagine doing anything else for a living, since farming is part of their identity. The farm, the activity of farming and the social environment in which this occurs form a very important part of farming families' lives. In India agriculture is undergoing a structural change leading to a crisis situation. The relative contribution of agriculture to the GDP has been declining without proportionate decline in people dependent on it leading to huge pressure and distress. A positive or negative attitude influences a person's reaction to stressful situations. All change produces stress, even change that is positive. Whether positive or negative, change demands adjustment to the particular situation. Some physical fears that can cause stress are dangerous machinery, exposure to toxic chemicals or to extreme environmental conditions, and contact with diseased livestock. Psychological fears associated with stress include failure, not being able to get the crops in, inability to manage debts, and children giving up the agricultural way of life.

Innovations from R&D system play an important role in optimizing resource utilization, but apart from systematic experimentations, innovations in the form of grassroots-level technologies and methodologies developed by some of the innovative farmers are benefiting widely to farmers. Such innovative technologies and methodologies are largely confined to some locations. As per social learning framework strategy proposed by Noguera et al (2016), pro-environmental values and intentions with time as a determinant factor in the social learning process play role while trying to change values and attitudes through the dissemination of innovations. Reij and Waters-Bayer (2001) suggest participatory approaches to agricultural research that build on local knowledge and innovation can stimulate and diffuse innovation capacity among farmers and external scientists. Farmers' innovation in the context of sustainable agricultural and natural resource management can lead to innovative ways of reducing dependence on external inputs. Innovative techniques often represent adaptation of existing knowledge as their development is mostly through local creativity. Such innovations having additional advantage over conventional innovations to tackle second generations' problems require different set of capacities on the part of farm innovators to scale their innovations in addition to be innovative, learning institutes for which are yet to be come into existence. (Nain et al, 2018).

As such the benefits accrued from such innovative ideas need to be widely shared across the sections and the scientific talents behind such farmers' level innovations need to be encouraged and recognized. Valuable ideas and techniques generated by them largely go unnoticed owing to lack of proper documentation and opportunities for wider dissemination as the geographical proximity is significant and positively affecting knowledge exchange within the *informal advice network,* but not important in the formal AKIS (Kabirigi et al., 2022).In the same wake a framework was conceptualized at Indian Agricultural Research Institute, New Delhi to institutionalize such farmers' innovative ideas and systematic investigation methodology was adopted.

Triggers of Distress

Farmers deal with everyday tasks of money management, decision-making and equipment maintenance. The physical and mental stress of farming can take a toll on a person's health. Uncertainty causes stress. Since the first domestic animal raised and the first seed sown, agricultural production has involved uncertainty. Uncertainty may cause feelings of being out of control, which often cause more stress. Attitudes also cause stress. A positive or negative attitude influences a person's reaction to stressful situations. All change produces stress, even change that is positive. Whether positive or negative, change demands adjustment to the particular situation. Farmers face a unique set of stressors, because many farmers could not imagine doing anything else for a living, since farming is part of their identity. The farm, the activity of farming and the social environment in which this occurs form a very important part of farming families' lives. A threat to any one of these can pose a significant emotional burden. The economic consequences of hard times on families living in rural areas can include; less money spent on recreation and time off, food, clothing, education, a holiday or entertainment for the family, household maintenance, increased risk of breakdowns and accidents with farm equipments, increased reliance on credit and personal debt, migration of family members and in extreme cases the sale of a portion of the farm resulting in the reduced remaining land holding being less financially viable into the future. Some of the hazards of ongoing stress for farming families may include; persistent fatigue, substance abuse (misuse of alcohol), withdrawal and self-imposed isolation from support networks, difficulty in making rational (or any) decisions, symptoms of depression and in the extreme, this may lead to thoughts of suicide.

All this gets compounded by varied climatic change, natural calamities, unbearable burden of debt and increased competition from imports and exploitation by middlemen which leads to farmer stress. It has been observed that suicides are concentrated mostly in low rainfall, poorly irrigated regions and has small fraction of the agrarian population. Poor imprudence in the use of land, water, fertilizers, and other key inputs due to failures of governance, poor management of public extension catering to agriculture and pricing, subsidy policies inimical to the prudent use of resources and effective exploitation of the potential of available technology. Little scope for expanding area being exhausted due to urbanization, industrialization and the scope for further expansion of irrigation getting diminished due to depletion of ground water, the institutional barrier comprising governance, the quality of public systems, and economic policies has become the most serious impediment to farmer stress. Production systems will have to become more resilient, and technology for development must go well beyond raising yields to saving water and energy, reducing risk, improving product quality, protecting the environment, and tailoring to gender differences

The continuum of Farmer Innovation

The significance of farmers' innovation however ranges from being useful only to the individual farmer, to a wider range of farmers. Innovation involves the interaction of individuals and organizations possessing different types of knowledge within a particular social, political, policy, economic, and institutional context (World Bank 2006b).Important dimension of the concept of "farmer innovation" is that it embraces not only technological innovation, but also new ways of managing livelihood in general (networking, communication, institution building, information management, marketing, planning, accessing resources, etc). As a conceptual understanding platform, Prolinnova-Ethiopia (2004) adopted the following schematic presentation (Figure 1) to explain the conceptual framework of farmer innovation.

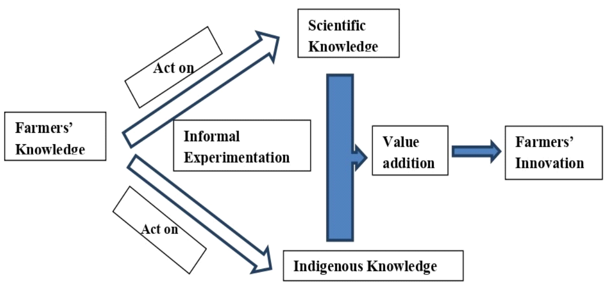

Figure 1:

Why farmers' innovations?

Agricultural development is innovation-driven, and ultimately, innovation makes the difference in farmers' adoption decision. To enable farm produce to be competitive, innovative farming practices within the framework of commercial agricultural production for long-term improvement and sustainability are important. Innovations from R&D system play an important role in optimizing resource utilization but apart from systematic experimentations, innovations in the form of grassroots-level technologies and methodologies developed by some of the innovative farmers are benefiting widely to farmers. Achiever farmers have been earning higher by innovating and exhibiting entrepreneurial behaviour than other farmers who seem to struggle. Such innovative technologies and methodologies are largely confined to some locations. Farmers are creative and generate relevant local innovations. Farmer-led innovation, in which farmers play a central role in the generation of new knowledge, technologies and ways of working, is increasingly recognised as necessary to secure the social, economic and environmental sustainability of farming.

Farmer-led innovations are evolving under specific agro-climatic and socio-economic conditions and such innovations should be widely adopted and sustained. The farmers identified a number of new/indigenous traditional crops and developed varieties with enhanced productivity and better quality through selection. Farmers also developed low cost processing technologies for value addition, increased shelf-life and better marketability for various farm products. In addition, a number of farm implements and tools were designed and manufactured by the farmers to increase operational efficiency and productivity. Women farmers have contributed in diverse germplasm conservation, postharvest management and value addition which helped in enhancing the farm income. Most of the farming practices traditionally adopted by the farmers are those which were evolved after long experiences of the farmers and communities under specific agro-climatic and socio-economic conditions.

Local innovations have been extended in different scales; however, 70 percent of local innovations were extended beyond the village and 30 % were confined only in village. As far as the impact of farmer-led innovation is concerned increased production has been the major outcome of most of the farmers' innovations, followed by increased satisfaction and knowledge. Another important area of impact of farmer led innovations may be farmers' capacity to continue the process of innovation to address other challenges through strengthening individual capacities, such as confidence, knowledge and handling experimentation and innovation. On the basis of case studies it has been inferred that strengthening institutional & individual capacities for scaling up technologies, facilitation of networking amongst extension service providers & farmers in the region, mobilising and allocating resources for scaling up of technological activities and facilitating the sharing of available knowledge on new technologies & innovations are the major determinants of maximizing farm income, whereas, regarding the perceived role of support system in innovating and enhanced farm profitability; market support system, financial institutional support system, informal networking, incentives & policies, technological backstopping and social acceptance & social support system played a major role. Regarding the perceived role of support system in innovating and enhanced farm profitability; market support system, financial institutional support system, informal networking, incentives & policies, technological backstopping and social acceptance & social support system played a major role.

Scaling up of Farmer led innovations

In order to scale-up valuable farmer- led innovations, it has become necessary to identify the potential farmers-led innovations, followed by their validation and refinement. This necessitates "bottom up" approach with farmers' participation in reorienting

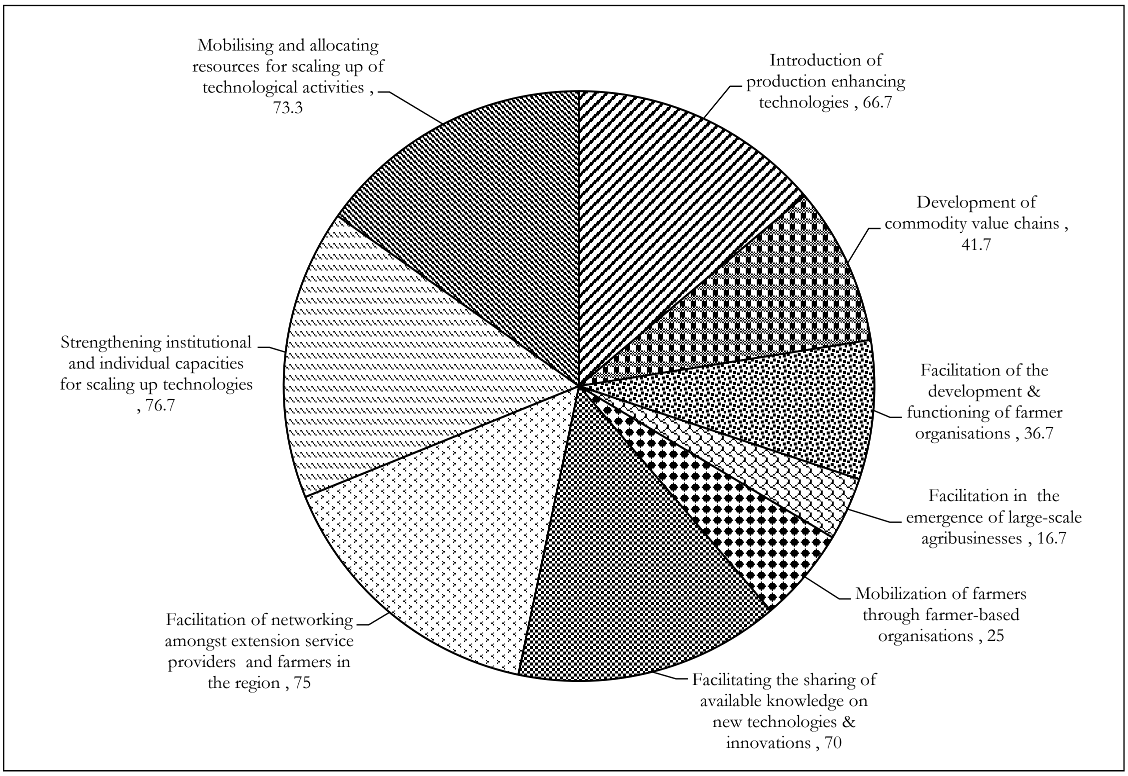

Figure 2: Perceived determinants for maximizing farm income

research and outreach programmes. Innovative technologies identified in one region need to be popularized in similar eco-regions elsewhere, through publication, documentation and dissemination of Success Stories. Involvement of Research Institutions is quite critical to understand and blend the traditional innovations with scientific refinements for their large scale adoption and popularization. In addition to scaling out specific innovations, efforts are needed by all involved- ranging from farmers to international research scientists - to share and scale out the approaches of stimulating and supporting farmer experimentation. Farmer-led research can both generate and harvest social energy, so that people are willing to move beyond individual or household gains and engage in activities that benefit others in the community.

Requirement of different set of Capabilities

Conventional strategies for encouraging innovation in agriculture tend to focus on creating incentives for private sector investment, most commonly by creating strong intellectual property rights regimes, ensuring open access to markets and increasing technology adoption rates among farmers, whereas farmer innovations in formal agricultural research is desirable for; even farmer innovations run the risk of not becoming as geographically widespread as they theoretically could be, may be taken up into the agricultural advisory service after validation by research system and can gear towards real needs by taking men and women farmers' priorities into account and involving them actively in the programmes of the research and development. Despite the huge amount spent on developmental aid, one cannot find many databases, either online or offline, of innovative solutions developed by the disadvantaged people themselves.

Farmers need to be innovative to deal with 'second generation problems' like maintaining soil fertility, animal health, community issues related to resources etc., farmers will need to be innovative in how they apply these 'solutions' to fit their own situations. Institutionalization of any farmers' innovation is a complex process that requires capacity strengthening and change in individuals as well as change in organizations through all layers in addition to convergence of activities between institutions to share the resources and capital. The commercialization depended on many factors like feasibility and significant economic impact of the innovations. The farm innovators require certain distinguishing capacities like foreseeing institutional requirements and linkages, comparative financial impact and success analysis ability in addition to analyse projected demand and

Table 1: Capacities required for scaling up of Farmers' Innovations

S.No.	Subject matter of capacities for Scaling up innovations	Rank
1.	Documentation of the innovation/ intervention	IX
2.	Distinguishing technical, organizational, and/or process elements	VIII
3.	Analysis of need or demand for the service among the larger population	VII
4.	Analysis of the required changes to make the innovation applicable to other parts of the country / other target groups	VI
5.	Comparative analysis of the costs associated with the innovation	II
6.	Evaluation of the innovation's comparative impact and success	III
7.	Refinement and simplification of the innovation	IV
8.	Analysis of the possibilities for achieving economies of scale	V
9.	Analysis of the institutional requirements and linkage for implementing the innovation	I

Table 2: Perceived characteristics of the farmers' innovations for scaling up

S. No.	Parameters	Weighted Mean Score
a.	**Credibility**	**5.95**
1	Based on sound evidence	6.2
2	Can be subjected to independent external evaluation	5.6
3	Capable to work in diverse social and situational contexts	6.4
4	Supported by eminent individuals and institutions	5.0
5	Implementable within existing systems and infrastructure	6.8
6	Small deviation from current practices of perspective adopters	6.2
7	Involvement of less number of people in adoption decision	5.8
8	Low technical sophistication of the components and activities	6.0
9	Clear and easily replicable	5.6
b.	**Complexity Vs Simplicity**	**6.2**
1	Simple with few components	6.3
2	Easily added or adjusted on to existing systems	6.1
c.	**Testability**	**5.6**
1	Able to be tested by users on a limited scale	5.8
2	Little supervision and monitoring	5.3
3	Not particularly value or process intensive	5.7
d.	**Observable results**	**6.43**
1	Very visible and tangible impact to casual observation	6.7
2	Clearly associated with the intervention	6.4
3	Evidence and documentation exists with clear emotional appeal	6.2
e.	**Relevancy**	**6.75**
1	Addresses an objectively significant, persistent problem	6.7
2	Addresses a need which is sharply felt by potential beneficiaries	6.8
3.	**Relative advantage over existing practices**	**6.65**
4	Current solutions for this issue are considered inadequate	6.7
5	Superior effectiveness to other established options	6.6
f.	**Sustainable source of funding**	**5.93**
1	Superior cost-effectiveness to existing or other solutions clearly established	6.2
2	Does not require a large commitment of funds at scale	6.1
3	Scope for its own internal funding (user fees) or endowment	5.5
	Overall	6.33

required changes in socio cultural and infrastructural domain. FLIs having additional advantage over conventional innovations to tackle second generations' problems require different set of capacities on the part of farm innovators to scale their innovations in addition to be innovative, learning institutes for which are yet to be come into existence. World Health Organisation (WHO 2010) also emphasized on planning actions, increasing capacities, making strategic choice and assessing environment among the steps to scale up. Scaling up of innovations required commitment and greater budgetary support towards innovations mainstreaming in all location specific farmer-led innovations and suggested involvement of private sectors for commercialization of replicable innovations through corporate social responsibility fund. Documentation of the innovation, distinguishing the elements and types of innovations, assessing need among the larger population and analysis of the required changes to make the innovation applicable to other target groups were placed at lower end, may be due to their less importance in scaling process.

On the basis of 649 innovations analysis; relevancy, relative advantage, sustainable source of funding, observability of the results and complexity, respectively in overall were ranked as the top determinants of the scalability of farmer led innovations. Although 'credibility' of the innovation was not perceived as major determinant in overall but the sub components like 'implementable within existing systems and infrastructure', small deviation from current practices and cultures of perspective adopters', 'capable to work in diverse social and situational contexts' and 'sound evidence base' were among the high rated sub components of the major determinants. In case of testablility, all three sub components were perceived almost equal determinant of scalability. In case of 'complexity', having few components leading to less confusion and modification of knowledge and skill was perceived important determinant.

Farmer Led Innovations and Entrepreneurial Behaviour

Farm Innovators could have effectively become consultants and entrepreneurs leading to off- farm income generation options but the lack of proper sustenance support, institutional requirements for up scaling and out scaling and related constraints hindered farmer to farmer extension, institutionalization of such innovations and their blending with the modern scientific knowledge for the benefit of farming community at large. To enable farm produce to be competitive, innovative farming practices within the framework of commercial agricultural production for long term improvement and sustainability is important. The innovations led by farmers have neither been institutionalized for their horizontal and vertical expansion nor properly recognized. As a result, many technologies developed by innovative farmers have not reached to other farmers. Although, the initiative in the form of protection of propriety rights of the farmer-led innovations by government and non-government bodies have been taken in recent past but at a limited scale. Achieving impacts at the scale can only happen by leveraging the dynamism of private enterprise. institutional mechanism and human resources base in rural ecosystem was found lacking in social processes of group and enterprise management skills along with marketing and communication skills. The capacity building interventions not only helped in changing entrepreneurial competencies but broadened the horizon of the participants to adopt secondary agriculture and launch their own income generating activities. The backward and forward linkages in the form of advisory services, input supply, marketing of the produce, financial backstopping was at a fairer level and the support and convergence of various stakeholders like banks, NGOs, research institution, state line department brought positive impact in the form of initiation of income generating activities. The price spread analysis of major commercial crops of the project location showed very wicked picture where the producers' share was found even less than one fifth of the consumer rupee in some cases. In order to reduce distressed sale and length of marketing chain the producers were trained and motivated in primary processing and were linked with innovative farmers and already established entrepreneurs for marketing and enhanced profitability. Screening for scalability of farmers' innovations and efforts for their institutionalization implied need for creation of platform for exchange of information and experiences, developing and disseminating theme-based knowledge products and undertake analysis of partner institutions to assess their potential as participants and building capacity of partner institutions. The framework for agri-enterprise development for maximizing farm profitability was found to be the function of entrepreneurial competencies, entrepreneurial climate, and farmers' innovations.

Model for Scaling Farmers' Innovations

With the huge network of Krishi Vigyan Kendras and ATARIs innovations can be tested, verified and institutionalized, social media can be used for farmers to farmer interaction on innovative issues, creation of effective alliance of farmers with a mixture of traditional knowledge, farmers' innovations and scientific knowledge, more institutional arrangements to initiate collective production processes, networking mechanisms of stakeholders and popularizing the identified innovative technologies through documentation, publication, success stories and dissemination in different ecosystems. With the initial experiences several initiatives were taken in the form of experimental interventions like; creation of social media platform through WhatsApp and analysis of content sharing pattern, documentation of innovative farmers' success stories in the publication form, inclusion of few innovative farmers in IARI outreach programme to facilitate transfer of technologies, devoting separate session in Pusa Krishi Vigyan Mela for innovative farmers, linking farmers with public sector seed production corporation and so on. The systematic analysis of the content shared the social media platform showed that most of the content shared was knowledge intensive with a mix of personal farming experiences. WhatsApp being the potential source for socialization and internalization promoted the creation of social wealth in the form of discussion forums of Innovative farmers for learning exchange. The extension mechanism for purposeful farmer to farmer learning exchange has been created which in turn is a step towards innovative farmer led extension delivery mechanism. The experiences of explorations and action interventions showed that human resources base in rural ecosystem was found lacking in social processes of group and enterprise management skills along with marketing and communication skills. The capacity building interventions not only helped in changing entrepreneurial competencies but broadened the horizon of the participants to launch their own income generating activities. The backward and forward linkages in the form of advisory services, input supply, marketing of the produce, financial backstopping was at a fairer level and the support and convergence of various stakeholders like banks, NGOs, research institution, state line department brought positive impact in the form of initiation of income generating activities. As per social learning framework strategy proposed by Noguera et al (2016), pro-environmental values and intentions with time as a determinant factor in the social learning process play role while trying to change values and attitudes through dissemination of innovations.

Some of the actionable points aroused include; Establishing and maintaining a database (including physical library) of available technologies, innovations and all sponsored/ unsponsored reports and publications; Establishing and maintaining a meta-database of agricultural information and means for facilitating it to act as a platform for exchange of information and experiences; Developing and disseminating theme-based knowledge products (posters, radio and TV messages, pamphlets, etc.); Publishing lessons learnt (Print as well as electronic) from development and adoption of innovation activities; Undertake an analysis of partner institutions to assess their potential as participants in maximizing

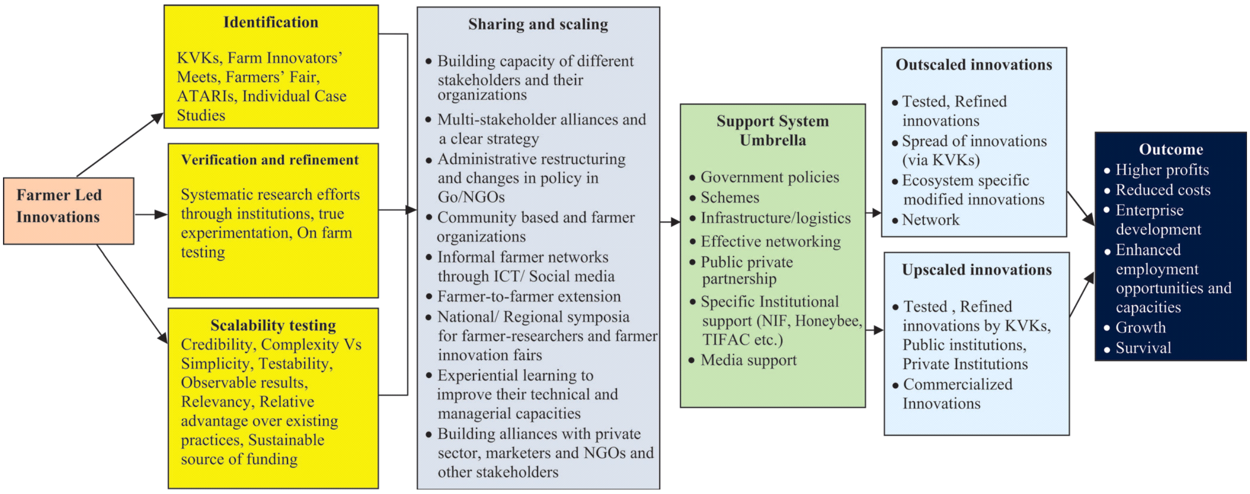

Figure 3: Model for Scaling Farmers' Innovations

farm profits as primary information centers; Building capacity of partner institutions (both human and infrastructure) to enable them become functional primary information centers as well as active partner; Developing of institutional policies and quality assurance protocols; and facilitating a strong network of Innovative Farmers for the purposes of learning exchanges and up scaling and out scaling their innovations.

The farmer led innovations are driven by a range of interlinked factors: economic factors (the inability to afford external inputs or grow enough food to be food secure), environmental factors (the need to adapt to climate fluctuations or restore infertile soils which can not be rested due to small landholdings), social factors (migration, HIV /AIDS, and scarce labour availability), cultural factors (need to use certain plants for ritual and other purposes), and political factors (availability of subsidized fertilizers and seeds as a form of political patronage by a neo- patrimonial state). In the farm sector, determinants of entrepreneurial success turnover and annual income play the major role in enterprise development. The model of agricultural science and technology as a centralized activity, undertaken by experts and diffused to farmers, has been challenged by collaborative research and innovation approaches in which farmers, scientists, and engineers can learn together about the nature of the problems being faced and the potential of different solution pathways. Hence, the model to scale the farmers' innovation (Figure 2) may act as a guiding tool.

A skilled workforce is always necessary to continue fast-paced growth and pull millions out of poverty. There was a need of 129.79 million skilled workforce by 2022 in 24 key sectors like agriculture, food processing, handloom etc. But only 4.69% were undergoing formal skill training (NSSO, 2011-2012). Agriculture sector alone required the 24.8 million in 2022 (National Policy on Skill Development and Entrepreneurship, 2015). In agriculture sector only 18.5% of workforce is skilled, of which 0.5% have formal technical education (IAMR, 2013). The innovations led by farmers have neither been institutionalized for their horizontal and vertical expansion nor properly recognized. As a result, many technologies developed by innovative farmers have not reached to other farmers. FLIs having additional advantage over conventional innovations to tackle second generations' problems require different set of capacities on the part of farm innovators to scale their innovations in addition to be innovative, learning institutes for which are yet to be come into existence. (Nain et al, 2018; Nain et al.,2019). Although, the initiative in the form of protection of propriety rights of the farmer-led innovations by government and non-government bodies have been taken in recent past but at a limited scale.

This initiative was intended to enhance awareness of the innovative capacities of the farmers, to identify farmer-led innovations having potential to be adopted for larger impact and to share the experiences of farmers-led innovations in the field of agriculture and allied sector. It was highlighted that identification of innovative farmers is not an end in itself, but how these farmers can be supported in improving their works and help them ensure sustainable livelihood and how best the spirit of innovativeness among the smallholder farmers can be cultivated. It was stressed that there is great need for developing a closer network of all innovative farmers among themselves and also with the researchers. Innovative ways to increase production, improve organisation, or reduce dependence on external inputs, farmer innovations were found having significant potential to improve the quality of life for farming families in Malawi and reduce their impact on the environment. The farmer led innovations are driven by a range of interlinked factors: economic factors (the inability to afford external inputs or grow enough food to be food secure), environmental factors (the need to adapt to climate fluctuations or restore infertile soils which cannot be rested due to small landholdings), social factors(migration, HIV /AIDS, and scarce labour availability), cultural factors (need to use certain plants for ritual and other purposes), and political factors (availability of subsidized fertilizers and seeds as a form of political patronage by a neo- patrimonial state) (FAO, 2012). In the farm sector, determinants of entrepreneurial success turnover (.019) and annual income plays major role in enterprise development (Kobba et al., 2020). Hence the conceptual model proposed to scale the farmers' innovation (Figure 3) may act as a guiding tool.

CONCLUSION

Farm Innovators could have effectively become consultants and entrepreneurs leading to off- farm income generation options but the lack of proper sustenance support, institutional requirements for up scaling and out scaling and related constraints hindered farmer to farmer extension, institutionalization of such innovations and their blending with the modern scientific knowledge for the benefit of farming community at large. Institutional mechanism and human mobilization for networking and resource optimization, collectivization, technologies and methodologies of secondary agriculture are the keys for maximizing farm income. Human resources base in rural ecosystem in general is lacking in social processes of group and enterprise management skills along with marketing and communication skills. The capacity building interventions not only have the potential for changing entrepreneurial competencies but broadening the horizon of the participants to launch their own income generating activities.

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Lead Paper-10

Extension Beyond Technology Transfer: Challenges and Strategies

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ABSTRACT

India's agricultural extension system is the largest in the world. It caters to the technology and information needs of about 146.5 million farm families. During last more than 60 years, focus of extension agencies on production technologies yielded very good results and hence India become self-reliant in food production. Significantly, the extension system had played its role untiringly in a transfer of production technologies from lab to land, besides the agricultural scientists, farmers, and marketing network. But the farmers at the individual level are not realizing remunerative prices for their produce. A farmer who is a good manager should be able to make as much profit from farming as from any other business. The aim of most of the farmers should be to earn profits. Crops should be grown only to earn the profit, not just some profit but as much profit as possible. Today, around 145 million Indian farmers' main concern is about declining farm income on the one hand and the increasing cost of inputs on the other. Majority of the farmer sale their produce through middlemen just after harvesting and they fetch less price for their produce. Therefore, extension functionaries need to play a major role to build the capacity of the farmers to meet the emerging challenges and make the farmers to realize better prices to their farm produce and intensive extension efforts are required to be done on market-led extension.

Keywords: Beyond, Challenges, Extension, Strategies, Technology, Transfer

Prologue

The focus of extension agencies on production technologies yielded very good results and hence India becomes self-reliant in food production. During the last 60 years, the emphasis was on the production-led extension, as a result of food grain production increase fivefold. The extension system had played its role untiringly in a transfer of production n technologies from lab to land, besides the agricultural scientists, farmers, and marketing network. But the farmers at the individual level are not realizing remunerative prices for their produce. Therefore, extension functionaries need to play a major role to build the capacity of the farmers to meet the emerging challenges and make the farmers to realize better prices to their farm produce. Market-led extension so far is a peripheral issue in the extension scenario. Hence, the extension focus should extend from mere production to market-led extension on an end-to-end basis to double the farmers' income. However, the goal of doubling farmers' income by the year 2022 has been dubbed as impossible and unrealistic by some experts (Gulati and Saini, 2016).

The Indian farmers have to withstand the possible onslaught of international competitors both in domestic as well as overseas market. The market-led extension would be of an effective instrument to protect the interest of the farming community. The market-led extension will assist the farmers in solving the problems faced in marketing their produce. The agricultural extension system has so far concentrated their efforts on production technology, whereas the market-led extension will take care of not only the production but also the marketing of their produce. Market-led Extension in which agriculture & economics coupled with extension is the perfect blend for reaching at the doorsteps of the farming community with the help of technology. Market-led Extension is the market ward orientation of agriculture through extension and agriculture without economy is nothing, thus the market linkage is a must for agriculture for the benefit of farming community.

The high cost of transportation due to more cost of petroleum products is also another major issue for marketing of agricultural commodity. Fragmented supply chain and lack of integrated cold chain, the predominance of APMCs and absence of independent regulator does not encourage private investment. Lack of adequate scientific storage facilities near to production belt results in severe losses of agricultural commodities. There are so many problems in an agricultural market like inadequate access of markets and market information by the farmers, competitiveness has almost lost, quality assurance is an always a question mark before the consumer while purchasing the product whether it is fruits, vegetables or any agricultural commodity. No grading and standardization lead to consumer dissatisfaction. Correct market information is not reaching to the farming community due to lack of market intelligence and almost no price discovery of agricultural commodities. In India, there are 7,566 regulated markets, 21,780 rural primary markets and area served per regulated market varies from 103 sq km in Punjab to 11215 sq km in Meghalaya.

As per the recommendations of the National Commission on Farmers (2004) the availability of markets should be within 5 km radius (approx. 80 sq km) for the benefit of the farming community. In the market-led agricultural extension, aim is to improve the efficiency of the farmers to compete in the market. If we see the domestic market scenario, about 80 % of marketable surplus through private trade - 2 million wholesalers and 5 million retailers. Post-harvest losses about 10 per cent food grains and 25-30 per cent in perishables (as per millennium study), which has now come down to 3.95 - 6% for cereals and 5.85% - 18% for fruit and vegetables as per recent study of ICAR. In recent times, it has been clearly observed that agriculture, an important economic sector having vital socio-economic implications has been lagging behind in growth when compared to other sectors. Given the dependence of almost 60 percent of the population's workforce on this single activity, it was decided by the Government to improve agricultural growth on a war footing. Upon close analysis, it was observed that the lack of efficient private participation and presence of inefficient markets for agricultural products were the hurdles preventing growth in agriculture, apart from input resource constraints like limited irrigation, and improper crop usage.

With the globalization of market, a farmer will have to transform himself from mere 'producer' in the domestic market to 'producer-cum-seller' in a wider market sense in order to best realization of the returns for his investments, risks and efforts (Reddy and Jaya, 2002). A farmer who is a good manager should be able to make as much profit from farming as from any other business. The aim of most of the farmers should be to earn profits. Crops should be grown only to earn the profit, not just some profit but as much profit as possible. Today, around 138 million Indian farmers' main concern is about declining farm income on the one hand and the increasing cost of inputs on the other. A majority of the farmers sale their produce through middlemen just after harvesting and they fetch less price for their produce. The extension system needs to be oriented with knowledge and skills related to the market. Hence, the income of farmers has to be doubled, extension system need to focus on market- led extension.

The following market-led extension strategies are suggested for doubling farmers' income.

Strategic plan in market-led extension

In the changing context of agricultural scenario, extension professional has to play a crucial role for dissemination of most recent market information to the farming community and enabling farmers to get optimum returns out of the enterprise. We have to identify the market demands in terms of produce for the present and the future. Preparation of a strategic plan in market-led extension at district, block, and village level will have to be one of the important functions of state machinery of agricultural extension. A multidisciplinary team of experts drawn from local Agricultural University, KVK, NGOs, State Agricultural departments, input agency will have to be involved in preparation of the strategic plan. SWOT analysis of the market i.e. Strengths (demand, high market ability, good price etc.), Weaknesses (the reverse of the above), Opportunities (export to other places, appropriate time of selling etc.) and Threats (imports and perishability of the products etc.) need to be analyzed about the markets. Accordingly, the farmers need to be made aware of this analysis for planning of their production and marketing.

Advice on product planning

Advising on selection of crops and varieties as per their agro-climatic and socio-economic conditions and marketability of the produce is the important function of market led extension. Extension agencies need to advice to the farmers based on the market demand considering the market intelligence so that farmers grow right crop at right time and they fetch more price for their produce. Also need to advice on alternate marketing if there is glut in the market at the time of harvesting of produce. Farmers need to know the answers to questions like what to produce, when to produce, how much to produce, when to sell, with what price to sell, and in what form to sell. We have to identify the market demands in terms of produce for the present and the future. Hence, the income of farmers has to be doubled, extension system need to advice the farmers on product planning considering the market demand and supply.

Secondary and specialty agriculture

Agriculture strategy should not only be to achieve higher yields by reducing cost of cultivation but also increasing the farmers' income by diversifying farming and generating employment opportunities in agro-industries in the rural areas. Efforts should be strengthened to achieve higher productivity with sustainability of soil and crop. In order to survive the competition both in domestic and international market the focus should be on high quality produce, low cost of production and high productivity. The smallholder farmers have to adopt diversified agriculture in a farming system mode, including both secondary and specialty agriculture such as: protected cultivation, mushroom production, bee keeping, sericulture, growing low volume high value crops like nuts, spices, medicinal plants, nutri-crops, etc, seed production of vegetable hybrids, nursery raising to provide disease free sapling, fish seed production, growing of flowers, vegetable seedlings to promote peri-urban agriculture. Hence, we need to promote crop diversification, secondary and specialty agriculture among smallholder farmers to enhance the income level.

Processing and value addition

Most agriculture produce is not in a form suitable for direct delivery to the consumer when it is first harvested. Rather it needs to be changed in some way before it can be used. Of course, processing is not the only way of adding value to a product. Storing products until such time as they are needed adds utility and therefore adds value. Similarly, transporting commodities to purchasing points convenient to the consumer adds value. In short, any action, which increases the utility of the good or service to prospective buyers, also adds value to that product or service. Small and marginal farmers are exploited by middlemen and traders for marketing of their produce due to lack of post-harvest management and absence of storage facilities. In agriculture sector, processing and value addition has not been conceived as a main strategy to bring more efficiency, productivity and profitability, as a result a majority of the farmers sale their produce through middlemen just after harvesting and they fetch less price for their produce.

Thus, there is need to emphasize on processing, value addition and linking farmers with market. The development and promotion of an efficient value chain is crucial for the speedy development of agriculture sector and for increasing producers' shares in consumers' rupee. If the income of farmers has to be doubled, the farmers have to move up to the value addition to fetch better prices for their produce. Food processing industry is also found to be much more labour intensive as compared to other industries (Rao and Dasgupta, 2009). Promoting food processing in rural areas will also generate employment and help in shift of workforce from agriculture to industry Chand, 2017).

A majority of the small holder farmers sell their produce without grading, packaging as a result they fetch less price for their produce. To improve the profitability of the farmers there is need to develop capacity of the farmers on good marketing practices like processing, grading, packaging, labeling, storage, transportation etc. and facilitating the farmers for direct marketing to the retailers and consumer, which can help to realize the better price for their produce.

Reducing post-harvest losses

Post-harvest huge losses of food grains, fruits and vegetables are a matter of serious concern for India's agriculture sector. The orientation of farmers by the government in almost all the states are towards production and their negligent attitude towards post harvest losses, lack of quality consciousness and absence of food processing units and unavailability of modern storage/cold storage are responsible for huge post harvest losses. In India, food grain production has been steadily increasing due to advancement in production technology, but losses have remained static at 10 per cent. This means that the loss of food grains is also increasing with the increase in food production. It has also been reported that almost every year, India loses about 21 million tonnes of wheat, which is almost equivalent to the total wheat production of a country like Australia and the reason being inadequate storage facilities and poor distribution (Phukan, 2014).

Post harvest losses of horticulture produce vary between 5-30 per cent of total production. According to Ministry of Food Processing Industries (2016) harvest and post-harvest losses of India's major agricultural produce is estimated at Rs 92,651 crore ($13 billion). The government need to focus on establishment of post harvest infrastructures like food processing units, modern storage structure at village and block level, proper transportation and good marketing facilities to reduce huge post harvest losses. Moreover, there is need to aware the farming community to reduce the post harvest losses from farm gate to market. The industry, stored grain managers and other stakeholders in the system need to be taught on scientific and effective methods of protecting stored grains. Protecting the food grains, fruits and vegetable from losses would be helpful in making more food available for consumption, export and doubling the income level of farmers.

Direct Marketing

In India, private trade is 80 percent marketed surplus and direct marketing farmer-consumer is negligible. An effective answer to these issues lies in the establishment of direct linkages between farmers and consumers. Direct marketing of agricultural produce helps in eliminating middlemen and makes the farmers directly responsible for selling his/her produce. In order to promote the development of direct agricultural marketing in the country, the Govt. of India enacted the *Scheme for the Development of Agricultural*

Marketing Infrastructure, Grading and Standardization. As a crucial component of the scheme, all Indian states and union territories are required to amend their specific APMC acts in pursuance of the development of direct agricultural marketing practices.

Many Indian states adopted the concept of direct agricultural marketing. Examples include *Apni Mandi* in Haryana, *Uzhavar Sandhai* in Tamil Nadu, *Shetkari Bazaar* in Maharashtra and *Rythu Bazar* in Andhra Pradesh. Farmers need to be informed about the benefits of direct marketing and how to gain the bargaining during direct marketing. Direct marketing helps in ensuring financial returns for farmers as well as increased consumer satisfaction. It has been realized that the marketing channel for farm products, which are highly perishable (fruits, vegetables and flowers) should be as short as possible. Perishable farm produce should move quickly from farmers to consumers. If farmers directly sell their produce to the consumers it will not only save losses but also increase farmers' share in the consumers' rupee.

Promotion of FPOs, FPCs and CIGs

Collectivization of producers, especially small and marginal farmers, into producer organizations has emerged as one of the most effective pathways to address the many challenges of agriculture but most importantly, improved access to investments, technology, inputs and markets. There is need to build a prosperous and sustainable agriculture sector by promoting and supporting member-owned producer organizations, which enable farmers to enhance productivity through efficient, cost-effective and sustainable resource use and realize higher returns for their produce, through collective action supported by the government, and fruitful collaboration with academia, research agencies, civil society and the private sector.

In India, around 70 per cent farmers are marginal (owning less than one hectare) and they are not efficient to market their small produce individually and they sell their produce through middlemen/ commission agent and they fetch less price. Therefore, Farmers Producer Organizations (FPOs), Farmers Producer Companies (FPCs) and Commodity Interests Groups (CIGs) need to be encouraged as an alternative channel. Promotion of FPOs and building their capabilities with regard to management of their farm enterprise are the crucial roles of extension professional in light of market-led extension.

APMC Reforms

The biggest market reform relates to APMC Act. The Act chiefly imposes restrictions on who can buy produce from farmers, and where farmers can sell their produce as well. Conceived in an age when marketing of agri-products was haphazard, the APMC Acts regulated the establishment of independent market yards in specific geographic areas. The intention of State regulation of agricultural markets was to protect farmers from the exploitation of intermediaries and traders and also to ensure better prices and timely payment for their produce. Exporters, processors and retail chain operators cannot procure directly from the farmers as the produce is required to be channelized through regulated markets and licensed traders. The mismatch between demand and supply lead to farmers getting lower prices for their produce, and resulting in huge wastages to the order of 5 to 7 % for food grains and 25 to 30% for fruits and vegetables.

Direct selling to either traders or private institutional buyers was prohibited, except on special approval from the Government. The states to de-notify perishable commodities like fruits and vegetables from the APMC Act. A new initiative namely e-NAM has been undertaken to encourage states to adopt e-trading platform for agricultural commodities. This is a game changer move as it involves integration of APMC mandis across the country using electronic platform (Chand, 2017). The initiatives need to be taken to implement the new

Model APLM Act 2017 by all states. Also, for the proposed electronic network for agricultural marketing (eNAM), it is necessary that movement of agricultural produce is not restricted by the State Governments. National Agriculture Market needs to be implemented in a phased manner to achieve a fully integrated market of the nation for the benefit of farming community.

Strengthening market information

Market information is essential to the government for creating a policy environment for the smooth conduct of marketing business. Market-oriented production and upgrading farmers knowledge about the market, market analysis and market intelligence are very essential for the benefit of the farmers. As far as possible, marketing decisions should be based on sound market information. Market news refers to the current information about prices, arrivals and changes in market conditions. This information helps the farmers in taking decisions about when and where to sell his produce. The availability of market news in time and with speed is of the utmost value. Sometimes a person who gets the first market news gains a substantial advantage over his fellow traders who receive in late. Market news quickly become obsolete and requires frequent updating. Reuters Market Light AgTech Pvt. Ltd., other govt. and private organizations provides market information to the farmers through SMS. The government also provides day to day information through AGMARKNET Portal and Mobile Apps.

The role of market intelligence is to reduce the level of risk in decision-making. Through market intelligence the seller finds out what the customer needs and wants. Generation of data on the market intelligence would be a huge task by itself. Departments of market already possess much of the data. Hence, establishment of linkages between agriculture line departments and departments of market strengthens the market-led extension. This includes information relating to such facts as the prices that prevails in the past and market arrival over time. An analysis of market intelligence helps us to take decisions about the future. It is an essential function for the formulation of sound prices and trade policy and its successful implementation. The formulation of a sound prices policy requires an analysis of long term trends in the data on prices, arrivals, demand-supply and other information. Acquiring complete market intelligence regularly on various aspects of markets and agricultural commodity is vital for doubling the farmers' income.

Need for Contract Farming

Contract farming is a forward agreement between farmers and wholesalers/retailers for the production and supply of agricultural commodities and the agreement is generally made at predetermined prices. Through the agreement, the buyers can also provide technical and production support to the grower. The farmers, through the agreement, commit themselves to produce a specific commodity at the buyer-desire quality. Since the Government is a major stakeholder in the contract farming (since most of the produce today is procured by the Government, it is equivalent to farmers producing only for the Government, a variation of contract farming), it is essential to reduce the load on the central and state level procurement system.

Contract farming also paves way for private investment which has the potential to boost the entire sector. Contract farming also brings about a market focus in terms of the selection of crops so that farmers could grow that crop and benefit from it immensely. Farmers get a stable, consistent income through contract farming and these acts as an incentive for the farmer to produce quality produce and also add value to it (like removing the husk and selling only the pulse inside). Contract farming also generates employment in the sense that for landless agricultural farmers, contract farming might prove to be a source of sustenance. Contract farming also promotes rural self-reliance by utilizing the local resources to meet the challenges. Linking processors with producers (farmers) through contract farming or market liberalization has vast scope to raise output and farm income (Chand, 2017).

Epilogue

In order to achieve the increased competitiveness of Indian agriculture there is a need for shifting from production-led extension to market-led extension. Market-led extension establishes its position by helping the farmers realize high returns for the produce, minimize the production costs, and improve the product value and marketability. Paradigm shift need to be focus from 'supply driven' to 'demand driven' and produce according to the market needs and farmers have to earn high returns. In India, more than 85 per cent smallholder farmers are more efficient in production, yet they face severe problem mainly on account of marketing of their produce. Hence, we need to focus on smallholder farmers for diversification towards high value crops, secondary and specialty agriculture and linking them to market. Intensive extension efforts are required to be done on market-led extension. The extension system needs to be oriented beyond technology transfer enhancing farmers' knowledge and skills related to the market. The market-led extension would be of an effective instrument to protect the interest of the farming community. Hence, there is urgent need for shifting from production-led extension to market-led extension for the benefit of the farming community.

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Theme 1: 01

Strengthening Agricultural Communication among Farmers through Mobile Platforms for Profitability and Food Security

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The present yoga is transforming through strong social communication among diverse social strata through android mobile phones by establishing the audio-video facility. The mobile phone is a communication tool also known as a cell phone, is a portable, handheld device that uses radio waves to connect to a cellular network, allowing users to make and receive calls, send text messages, and access various applications and audio-video services for quick and easy understanding. Mobile platforms are incredibly important for connecting people globally and facilitating daily tasks, knowledge sharing and entertainment activities. Mobile platforms are very useful in modern agriculture for enhancing different operations through apps and services ultimately improving efficiency, productivity and income of farmers. Mobile platforms also facilitate communication between farmers, suppliers and consumers. These platforms are being utilized in agriculture for farm management, market access, agro-advisory services, supply chain management, financial services, education and training etc. although the all farmers may not afford smart phones or internet connectivity moreover a big number would need training to effectively utilize mobile technology for agriculture. At present, these are revolutionizing agriculture by improving efficiency, enabling access to information and markets and providing innovative solutions for farmers followed by addressing the global food security challenges and sustainable farming practices.

Keywords: Farmers, Agricultural Communication, Mobile Platforms

Theme 1: 02

Transforming Agricultural Extension: Evidence-based Insights on Digital Tools for Smallholder Farmers

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This study evaluates the efficacy of digital extension tools in improving smallholder farming outcomes in Uttar Pradesh, India, drawing on primary data from 120 farmers (2023), government initiatives, and peer-reviewed research. Three interventions were analyzed viz. AI-powered crop advisories (e.g., *Kisan Suvidha* portal, MoA&FW 2021); IoT-based precision tools (soil sensors, drone imagery); and Mobile extension platforms (WhatsApp-based advisories, IVR systems). Key findings reveals that the 28–35% improvement in input-use efficiency (IoT tools, $p < 0.05$), 62% gender gap in digital access among female farmers, <30% of state extension budgets allocated to digital infrastructure (NITI Aayog 2022). The study proposes a scalable four-pillar framework as Vernacular mobile interfaces (Hindi/Bhojpuri localization), Gender-inclusive design (voice-based advisories for low-literacy users), Public-private data partnerships (FPOs + agri-tech startups), and Integration with climate-smart practices (e.g., *Krishi Vigyan Kendra* demo plots). Aligned with India's Digital Agriculture Mission (2021–25) and UN Responsible AI principles (2023), this work offers actionable insights for policymakers to bridge the last-mile delivery gap in tech-enabled extension.

Keywords: Digital extension, AI in agriculture, Smallholder farmers, Gender inclusivity, Climate resilience

Theme 1: 03
Impact of Agriculture based Mobile Applications use by Farmers

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Agricultural mobile apps provide real-time based agricultural information and relevant knowledge to improve farmers' decision-making capacity so that they can increase their agricultural product quality and quantity, better aligning the farm output to market-led production; securing better quality and improved price returns. There are a lot of researches have been conducted related to information communication and technology in agriculture but only a few models are being adopted by the farmers at a satisfactory level. There is a huge gap between the knowledge level in agriculture and its utilization at ground level. For example, most of the farmers have sufficient knowledge of these mobile apps but utilization of these apps is found very low especially in the rural area. The results from the findings reported that majority of respondents (71.67%) fully agree on that mobile apps have made agriculture easier with (2.61 WMS) and assigned first rank. Whereas, respondents showed positive impact in increases awareness level about protected crop cultivation which assigned second rank with 2.57 weighted mean score, followed by maintaining proper nutrient management assigned third rank with 2.55 weighted mean score and increase in crop production due to use of mobile apps assigned fourth rank with 2.47 weighed mean score. Majority of respondents agree on that mobile apps have made agriculture easier due to timely availability of information., mobile apps help in maintaining proper nutrient management followed by apps helpful in providing information regarding schemes and policies, helps in reduction in pest and disease incidence. Mobile apps showed positive impact in increasing awareness level about protected crop cultivation, increase in crop production due to use of mobile apps for information, income from agriculture has increases due to use of mobile apps for information, mobile apps have positive effect in adoption of technologies.

Keywords: Agriculture Mobile Apps, Farmers, Information and Positive Impact

Theme 1: 04
Users' Reactions Towards the Content of Horticultural Crop Section in PAU Kisan App

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The study was conducted in four purposively selected districts of Punjab – two with the largest area under vegetable cultivation and two with the largest area under fruit cultivation. The aim of the study was to assess users' feedback on the PAU Kisan app. A list of app users was acquired from the Directorate of Extension Education at PAU Ludhiana. In each selected district, 50 respondents were chosen, resulting in a total of 200 respondents for the study. A well-structured interview schedule was prepared, and data were collected through personal interviews. The findings revealed that over 50 per cent of the respondents found the app's content to be highly practical, useful, motivational, and regularly updated. The majority of respondents also expressed that the content was concise and written in easily understandable language. Furthermore, majority of the respondents showed medium level of trustworthiness in the content.

Keywords: PAU Kisan app, Users' reaction, Content, Practically useful

Theme 1: 05
Use of Artificial Intelligence in Transforming the Indian Agriculture

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India's agriculture sector, which is a vital component of the India's economy, is undergoing a significant transformation through Artificial Intelligence (AI). Through tackling enduring issues like unpredictable weather, workforce shortages, and plant diseases, AI is helping Indian agriculture transition from traditional farming to precision farming. AI based technologies enables farmers to determine the most suitable crops for each season. Additionally, farmers can anticipate market trends and consumer demands, allowing them to achieve better yield and high returns. The analysis of data collected from sensors, drones, and satellite images provides real-time insights of crop health, soil health and weather patterns and allows farmers to make accurate farm decision-making regarding irrigation, fertilization, and pest control. Thus increased the efficiency and sustainability. AI is used in agriculture via precision farming, pest and disease diagnosis, weather prediction, crop yield prediction, automation and robotics etc. Drone technology is getting more popularity in agriculture for producing real time field map, spraying of fertilizers and pesticides, monitoring the heath and yield of crops. They are used mainly for surveillance, are creating solutions to manpower shortage in agriculture and also enabling judicious application of pesticides and fertilizers. The vast network of Agriculture Universities and Krishi Vigyan Kendras were playing a vital role in creating awareness and increasing access of farmers to existing knowledge on AI in agriculture by providing training, demonstrations, and support to farmers and related stakeholders. They work as centres for the introduction and spread of cutting-edge agricultural technologies, such as drones, to improve farming practices and productivity.

Keywords: Artificial intelligence, Agriculture, Drone, KVKs

Theme 1: 06
Role of Traditional Media in Dissemination of Information: Tool for Extension

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Traditional media can indeed be employed as efficient instruments in the task of inspiring farmers and modifying their behavior. The media is utilized by, for, and in conjunction with the populace. Farmers have a very favorable opinion of traditional media as a source of news and information. Traditional media's communication capabilities have been clearly proven throughout the history of development in numerous cultures. The government should boost the use of traditional communication through the Ministry of Information and Culture by holding frequent seminars and workshops to train individuals in the use of Indigenous media. Additionally, the family should encourage indigenous interaction by bringing awareness among their own family members at home. To reach the most farmers in the current technological world, traditional media must be integrated with ICT tools. One must combine the two media so that extension workers may use them effectively and they should learn from each other, complement each other's advantages and develop together.

Keywords: Traditional, media, extension, ICT, dissemination, information

Theme 1: 07
From Screen to Field: How Punjab's Cotton Farmers Reacted to Digital Learning

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The journey of agricultural extension is entering a new era, where digital tools are transforming how farmers learn and adapt. This study captured the reactions of cotton growers from Fazilka and Mansa districts of Punjab towards a specially developed instructional video on Integrated Pest Management (IPM). Sixty farmers engaged with the video, representing a growing curiosity and readiness to embrace digital learning. The feedback was overwhelmingly positive: 90% of the respondents were fully satisfied with the voiceover quality, appreciating its clarity and connection to their everyday experiences. Similarly, 88.33% were highly satisfied with the completeness of the message, while 85% praised the relevancy of the content to their real-world challenges. The simplicity (65%) and newness of ideas (81.67%) also resonated well, making complex concepts easy to grasp. While the majority welcomed the video, some suggested minor improvements in duration and clarity, reminding us that even digital tools must stay farmer-centric. Despite this, the mean satisfaction scores across most video aspects ranged from 2.55 to 2.90 on a 3-point scale, demonstrating a strong endorsement from the farming community. This study reveals a powerful insight: when technology is combined with empathy and local relevance, it bridges the traditional knowledge gap effectively. The findings underline that farmers are not just passive receivers but eager learners, willing to embrace new knowledge when it is presented thoughtfully. In the vibrant cotton fields of Punjab, digital instructional videos are more than a medium; they are a movement towards smarter, sustainable farming practices. The success of this initiative showcases the immense potential of integrating digital tools into agricultural extension, lighting the path toward a knowledge-rich rural future.

Keywords: Agricultural extension, Cotton growers, Digital tools, Instructional video, Integrated pest management

Theme 1: 08
ICT- Based Agriculture Extension : Bridging the Gap Between Farmers and Technology

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This research paper explores the potential of Information and Communication Technology (ICT) based agriculture extension services to bridge the gap between farmers and technology. The study examines the current state of ICT adoption in agriculture, identifies the challenges and opportunities, and proposes a framework for effective ICT-based extension services. ICT-Based Agriculture Extension Services This research paper explores the potential of Information and Communication Technology (ICT) based agriculture extension services to improve farmers' access to information, enhance their knowledge and skills, and increase their productivity and income. The study examines the current state of ICT adoption in agriculture, identifies the challenges and opportunities, and proposes a framework for effective ICT-based extension services. The findings suggest that ICT-based services can bridge the gap between farmers and technology, promote sustainable agriculture, and empower farmers to make informed decisions. The study highlights the importance of user-friendly interfaces, relevant content, and effective delivery mechanisms in ensuring the success of ICT-based extension services.

Keywords: ICT-based agriculture extension services, Farmers' empowerment, Productivity and income

Theme 1: 09

Transformative Impact of Developed Mobile App on Dairy Farmers' Knowledge about Management of Parasitic Infestation and Antiparasitic Resistance

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Mobile is today's most popular device for information dissemination, owing to the 275 million smartphone subscribers present in India. The development of mobile applications offers hope for improving extension services through recent advancements in this field. The IVRI-Parasite Management Guide mobile app is crucial for dairy farmers, enhancing their decision-making ability to address challenges such as internal and external parasitic infestations in dairy animals. The effectiveness of the developed IVRI-Parasite Management Guide app was tested among a total of 160 Small Dairy Farmers (SDF) and Large Dairy Farmers (LDF) of Rajasthan and Uttar Pradesh, the two high-productivity States of India. A structured interview schedule was used for data collection. The overall knowledge of management of parasitic infestation in dairy animals, the Mean Rank Score (MRS) increased from16.70 to 17.62 and 18.77 to 19.17 for SDF and LDF, respectively. Consequently, the knowledge gap reduces from 44.33% to 41.25% and 37.41% to 36.08% in case of SDF and LDF, respectively. Further, under the dimension of prevention and control of parasiticide resistance emergence, the MRS increased from 3.38 to 3.53 and 4.21 to 4.37 for SDF and LDF, respectively. The knowledge gap reduced from 63.30% to 60.98% for SDF and from 533.30% to 51.33% for LDF. This suggests that the app has successfully narrowed the knowledge gap among its users. Further reduction in the knowledge gap can be accomplished by developing mobile apps that are tailored to specific needs, locations, and languages.

Keywords: Dairy farmers, Knowledge, Mobile App, Parasitic infestation, Control of parasiticide

Theme 1: 10

Digital Agriculture: Revolutionizing Farming with Technology

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Digital agriculture is revolutionizing modern farming by integration of advanced technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), blockchain, UAV technology, smart sensors, drones and data analytics. The use of these advanced technologies in agriculture enables precision farming which helps in optimizing resource use in the fields and enhances productivity, thus helping in mitigating global challenges like climate change, food security and agricultural sustainability. Burning issues like climate change, food security and demand for efficient resource management have increased the need for the digitalization of agriculture. Digital farming techniques use smart sensors, AI and data analytics to optimize agricultural practices which improves efficiency reduces costs and enhancing productivity while also minimizing environmental impact. Mobile and web-based applications empower farmers by providing them advisory services, market information, and weather forecasts helping them make timely decisions. AI models help in disease detection and yield forecasting while IoT based smart sensors monitor soil moisture, temperature, and crop health. Block-chain technology ensures supply chain transparency and food traceability whereas drones help in aerial imaging and precision spraying. Additionally agricultural robotics enhances mechanization, minimizing human labor while increasing efficiency. In agricultural extension services digital agriculture also plays a crucial role by improving information dissemination and farmer participation. In the face of climate change and increasing global food demand adoption of digital agriculture is crucial for sustainability. However the challenges like high costs, digital illiteracy and lack of awareness among small and marginal farmers especially in Asian and African countries hinder its adoption. Capacity building, policy support, financial support and infrastructural development are essential for scaling digital solutions in agriculture. Digital agriculture paves the way for a more resilient, efficient, and sustainable food production system, ensuring food security for future generations.

Keywords: Digital agriculture, Precision farming, Artificial intelligence, Block-chain, Smart farming

Theme 1: 11

ICT in Agricultural Extension: A Bibliometric and Analytical Overview

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The integration of Information and Communication Technology (ICT) in agricultural extension services has transformed the way knowledge is disseminated to farming communities, enhancing access, efficiency and impact. This study provides a comprehensive bibliometric and analytical overview of ICT applications in agricultural extension. The bibliometric component of this study analyses research publications from 2010 to 2025, using data sourced from the Dimensions AI database. Key performance indicators, including annual publication growth, citation metrics, leading countries, institutions, influential authors and keyword co-occurrence, were examined using the Bibliometrix R package and Biblioshiny. The results show a steady increase in research activity, with a notable surge starting in 2020 and peaking in 2023. This trend indicates the growing global interest in applying digital technologies within agriculture and extension services. A diverse range of countries contributed to this expanding body of knowledge. Countries in Asia, North America and Europe were key contributors, with African countries also engaging actively, highlighting ICT's potential to bridge information gaps in diverse farming environments. The analytical component of the study explores practical implementations of ICT in extension systems, with a particular focus on the ICAR-National Research Centre on Pig's (ICAR-NRC on Pig) YouTube channel. Various ICT tools such as mobile applications, SMS-based advisories, web portals, call centers and social media platforms have played a key role in facilitating farmer education and advisory services. Among these, YouTube stands out as a highly impactful ICT tool for reaching farming audiences. By analyzing video content types, audience engagement metrics and demographic data, the study highlights how digital platforms serve as effective tools for disseminating information on pig health management, artificial insemination, daily piggery farm operations and more. Data revealed high engagement among the 25–34 age group, predominantly male viewers and a significant portion of non-subscribed users, indicating the potential to expand outreach through strategic content planning. Notably, videos presented in regional languages achieved higher viewer retention rates and longer watch times.In conclusion, ICT tools have the potential to transform agricultural extension services by making scientific knowledge more accessible to farmers and promoting sustainable rural development.

Keywords: mobile applications, SMS-based advisories, AI database, Disseminating information, Viewer analytics

Theme 1: 12
Artificial Intelligence (AI) in Agriculture: Unlocking Potential through Farmer Producer Organizations (FPOs) for Sustainable Agriculture

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In the era of Artificial Intelligence (AI) technologies, the agricultural sector is undergoing a significant transformation. AI possesses the capacity to revolutionize agriculture by augmenting crop yields, diminishing expenses, and improving sustainability. It can in fact deliver solutions for the societal problems of the agricultural industry and most importantly for the primary challenge of growing food and improving its yield for the ever-increasing food demands caused by increasing world population and starvation. AI may offer more effective and practical means to address the various obstacles in agriculture such as increased labour costs, agricultural inputs and crop loss due to poor yields triggered by disease, erratic rainfall and climate change, soil erosion, low market prices for agricultural products.However, the adoption of AI in agriculture is obstructed by several bottlenecks, particularly for small and marginal farmers who confront numerous challenges such as lack of access and expertise to adopt these technologies, small and fragmented land holdings, limited access to credit and markets etc. FPOs have emerged as a promising solution to tackle these challenges. By joining hands and cumulating demand and supply, FPOs can negotiate better prices, improve market access and provide technological assistance to their members. This paper explores case studies and empirical evidence demonstrating how FPOs can facilitate the deployment of AI-powered tools and services, enabling small farmers to enhance productivity, improve decision-making, and gain better market access. Furthermore, the study discusses the critical role of capacity building, digital literacy, and collaborative partnerships in empowering FPOs to effectively leverage AI for the benefit of their member farmers. The paper concludes by outlining key policy recommendations and future research directions to accelerate the integration of AI-driven solutions within the FPO ecosystem, ultimately fostering a more inclusive and sustainable agricultural transformation.

Keywords: Artificial intelligence, Agricultural, Crop yields, Climate change, Sustainability

Theme 1: 13
Vertical Farming: Integrating IoT, Renewable Energy, and Urban Sustainability

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As urban populations grow and arable land declines, vertical farming is emerging as a sustainable solution to address food security challenges while promoting environmental responsibility. By integrating Internet of Things (IoT), renewable energy and urban sustainability, vertical farming enables efficient, resource-conscious food production in cities. This will explores how these technologies work together to enhance crop yields, optimize resource use, and reduces environmental impacts, making urban farming more viable and sustainable. The IoT revolution in agriculture plays a crucial role in improving the efficiency of vertical farms. Smart sensors monitor key factors such as temperature, humidity, light intensity, and nutrient levels, enabling real-time adjustments through automated systems. AI-driven analytics further optimize plant growth by predicting environmental fluctuations and adjusting conditions accordingly. These data-driven solutions ensure precision farming, reducing

resource wastage while enhancing crop quality and productivity. Incorporating renewable energy sources such as solar panels, wind turbines, and bioenergy solutions further strengthens the sustainability of vertical farms. These energy-efficient systems help reduce reliance on fossil fuels, lower operational costs, and enable off-grid farming solutions in urban areas. Additionally, water-saving techniques such as hydroponics and aeroponics significantly reduce water consumption compared to conventional agriculture, making vertical farming an eco-friendly alternative for cities facing water scarcity. Beyond technological advancements, vertical farming contributes to urban sustainability by transforming underutilized spaces, such as rooftops, abandoned buildings, and shipping containers into productive food hubs. This reduces the need for long-distance food transportation, cutting down carbon emissions and ensuring fresher, locally grown produce. By integrating vertical farms into urban planning, cities can promote food resilience, create job opportunities, and improve air quality through increased green spaces. It will discover successful case studies, technological innovations, and policy frameworks supporting vertical farming. By harnessing IoT, renewable energy, and sustainable urban design, vertical farming presents a transformative solution for the future of urban food production.

Keywords: Vertical farming, IoT in agriculture, Renewable energy, Urban sustainability, Hydroponics and Smart farming

Theme 1: 14

Effectiveness and Perception of Farmers towards Multimedia-based Modules in agriculture: A study in Indo-Gangetic region of India

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Information is one of the most vital resources for agricultural and rural development and it's a crucial input for farming. ICT has shown to be quite helpful to farmers in recent years. It has made it easier for them to obtain tailored information about high-yielding seed applications, cropping patterns, better varieties, insect control, fertilizer application, marketing, and entrepreneurship, among other topics. Studies have shown that multimedia which is the combination of graphics, video, sound, animation, and text can provide better presentations and understanding of information that any of these means alone can. Compared to other types, multimedia-based farm advisories are more cost-effective, cover more areas, are easier to use, and increase farmers' access to information. The present study evaluated the perception and effectiveness in terms of knowledge gain of technological information distributed through multimedia-based farm advisories about content and design, ease of understanding, and fulfilment of information needs, based on primary data collected from 1200 farmers in Uttar Pradesh, Punjab, and Haryana. It was found that information need on seed availability was ranked first followed by weed management and insect pest management. Under Information Seeking behaviorit was found that YouTube was the major source of information (67%), followed by WhatsApp (15%), verbal communication with colleagues (13%), Facebook (4%) and Twitter (1%). It was found that 83% of stakeholders watched multimedia packages weekly. Significant knowledge gain was also reported among the multimedia module users with respect to farming practices. Along with appropriate tactics for improved information acquisition, the study also recognized the limitations on multimedia utilization.

Keywords: Multimedia-based extension, Information and communication technology, Knowledge gain

Theme 1: 15
Role of Social Media in Shaping Perception of Farmers for Seeking Agricultural Information

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Information seeking behaviour has drastically impacted by the way farmers engage and communicate on social media. Agricultural development depends on communication networks and knowledge exchange. Hence, this study evaluates perception of farmers towards use of social media for seeking agricultural information and analyzes its relationship with the socio-personal profile characteristics. This quantitative study comprises sample size of 106 farmers selected from two villages of Udham Singh Nagar district in Uttarakhand using systematic random sampling technique. Findings revealed that majority of farmers (75%) had favorable perception about social media for seeking agricultural information providing a wealth of ideas and knowledge, networking with scientific communities, creating discussion platforms, and developing sustained agricultural communications. Interestingly, farmers stay more connected on social media like WhatsApp groups, YouTube channels and Facebook pages. Also, YouTube was found to be most preferred social media followed by WhatsApp and Facebook while Twitter and Instagram were least preferred. Further, correlation coefficient showed that education, media ownership, social media exposure, information seeking behaviour and innovativeness were critical factors in determining the perception of farmers towards use of social media. A highly significant relationship was found between social media exposure and education of farmers with their perception. Continuous use of social media by farmers revealed several problems like inadequacy and confusing information so they expressed their expectation that agricultural scientists and extension personnel's should actively participate on social media, especially for treatment-related information. Results suggested the development of more farmer oriented platforms on social media focusing on YouTube videos that engages and educates the farming community about effective use of social media for acquiring advanced agricultural information.

Keywords: Perception, Social media, Agriculture information, Information seeking behaviour, Farmers

Theme 1: 16
Availability, Accessibility and Frequency of Usage of Information and Communication Technologies (ICT) by Farmers for Paddy Straw Management

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With the rapid growth in the world population, food production is going to be the biggest challenge for the 21st century. Industrialization and urbanization are taking away the available agricultural land and hence there is immense stress on the food production to cater the enormous growth of population. The farming community are struggling to meet the increased demand for food production due to limited agricultural land. Rice straw is a residual byproduct of rice production at harvest. With the rapid advancements in digital technology, ICTs offer a wide range of tools and solutions that can empower farmers with knowledge, facilitate communication and streamline agricultural practices. From mobile applications providing real-time weather forecasts and market prices to sensor-based monitoring systems for optimizing irrigation and fertilizer usage, ICTs hold vast application in revolutionizing agricultural landscapes. However, despite the evident potential of ICTs, their integration into paddy straw management practices remains limited. Various challenges, including infrastructural constraints, digital literacy gaps and the affordability of technology, hinder widespread adoption among farmers. Furthermore, the effectiveness of ICT solutions is contingent upon tailored approaches that consider the diverse socio-cultural contexts and unique challenges faced by farmers in different regions. The study was conducted with objective to find the usage pattern, impact and identify the constraints uses of ICT on Paddy straw management by the farmers. A total sample of 80 respondents randomly from two blocks of Karnal district were selected purposively on the basis of having maximum paddy cultivated area of Haryana. The data revealed that the availability/ accessibility of mobile and television among the farmers was found 100 per cent followed by mobile camera (83.75%) with rank 1st and 2nd respectively. Whereas ICTs tools internet (82.75%) and WhatsApp (84.00%) got 3rd and 4th ranks, respectively.

Keywords: Paddy straw management, Constraints, Availability, Accessibility of mobile ICT usage

Theme 1: 17

Harnessing AI and social media for Agricultural Extension: Strengthening Research-Extension-Farmer (REF) Collaboration in Northeast India

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Agricultural extension services in Northeast India (NEI) face significant challenges due to diverse agro-climatic conditions, difficult terrain, smallholder farming systems, and limited access to markets. Traditional extension methods often fail to reach remote farming communities, leaving a large section of farmers without access to timely advisory services. With increasing digital penetration in rural areas, AI-driven social media platforms have emerged as a powerful tool to bridge the communication gap between researchers, extension agents, and farmers. Platforms like Facebook, WhatsApp, YouTube, and Twitter facilitate real-time knowledge exchange, dissemination of climate-resilient practices, and market intelligence, which are crucial for enhancing agricultural productivity and sustainability in NEI. This paper explores the transformative potential of AI-integrated social media tools in strengthening Research-Extension-Farmer (R-E-F) collaboration in NEI. Case studies from the region highlight how farmers are leveraging WhatsApp for pest management in Arunachal Pradesh, Facebook for market linkages in Assam, and YouTube for organic farming promotion in Sikkim. Additionally, AI-driven analytics can support climate adaptation strategies, precision farming, and decision-making for farmers. However, infrastructure gaps, digital literacy, and policy support remain critical factors in scaling up these innovations. To fully harness the benefits of digital agricultural extension in Northeast India, there is a need for targeted policy interventions, capacity-building programs, and collaborative efforts between KVKs, research institutions, and agri-tech startups. Integrating AI and social media into extension services can significantly enhance knowledge dissemination, empower farmers, and promote sustainable agricultural practices in the region.

Keywords: Agricultural extension, Social media, AI in agriculture, Digital agriculture, Research-extension-farmer collaboration, Climate-resilient farming, Northeast India, Rural development

Theme 1: 18

Innovative Extension Approaches for Revitalising the Extension System of Jammu and Kashmir UT

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The Holistic Agriculture Development Programme (HADP) project titled "Innovative Extension Approaches for Revitalising Agriculture in Jammu and Kashmir" aims to transform the region's agricultural landscape through a multi-faceted extension strategy. The project focuses on bridging knowledge gaps, improving farmer outreach, and promoting the adoption of modern technologies and practices. A key component is the Strengthening of Krishi Vigyan Kendras (KVKs) to enhance their infrastructure, technical capabilities, and field-level extension services. To support evidence-based policy and practice, the project promotes Research in extension to assess effectiveness, identify best practices, and customize solutions to local agro-climatic conditions. The integration of digital technologies is facilitated through cyber extension initiatives, including the establishment of a state-of-the-art multimedia production studio enabling the creation and dissemination of high-quality audiovisual content. This content will be used to educate farmers on best practices, emerging technologies, and government schemes. Specific slots on Doordarshan are allocated to broadcast agricultural programs, ensuring wide accessibility, especially in remote areas. Similarly, Community Radio station 90.8 FM radio kisan Skuast Jammu is providing valuable services to the local community and farmers. The project also includes robust awareness and popularization programs to engage farmers and stakeholders through Trainings, campaigns, demonstrations, and exhibitions. To build future capacity, student exploration programs are integrated to expose youth to agricultural innovation and inspire careers in agri-extension and research. Collectively, these components work synergistically to strengthen the agricultural knowledge ecosystem in Jammu and Kashmir, fostering a more resilient, informed, and progressive farming community.

Keywords: KVKs, Extension approaches, Strengthening, Digital technologies

Theme 1: 19

Feeding the Future: Smart Farming as a Solution to Global Agricultural Challenges

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Artificial Intelligence (AI), the Internet of Things (IoT) and mobile platforms collectively referred to as smart farming or precision agriculture are causing digital revolution in the agriculture industry. Smart farming addresses global food challenges by enhancing productivity, resource efficiency, crop quality, and sustainability. AI helps in yield prediction and disease detection by enabling data-driven decisions based on inputs from sensors, satellite imagery, and meteorological data. Early indicators of pests or nutrient deficits are detected using AI-based picture recognition, enabling prompt, focused treatment. IoT sensors in soil, crops, and machinery provide real-time monitoring for precise farm management. Precision irrigation, automatic fertilization, and equipment management are made possible by these sensors, which monitor temperature, pH, moisture, and other variables.

IoT networks guarantee smooth data transfer and flexible reactions to environmental circumstances. Farmers may easily access digital tools using mobile platforms. Apps for smart phones provide remote system control, weather forecasts, real-time data, and notifications. Smart farming has demonstrated significant benefits, including 15–25 percent yield increases, upto 30 percent cost savings, and improved water and nutrient efficiency. By lowering greenhouse gas emissions and pesticide consumption, it also supports environmental sustainability. Additionally, it promotes environmental sustainability by reducing the usage of pesticides and greenhouse gas emissions. To solve adoption challenges such high costs, low digital literacy, poor connectivity, and data concerns, governments, agritech businesses, researchers, and cooperatives must collaborate. The adoption of smart farming can be accelerated through investments in training, infrastructure, and supportive legislation.AI provides a roadmap for resilient, sustainable agriculture by highlighting successful examples and upcoming technologies including blockchain, AI robotics, and 5G. A revolutionary route to a future in agriculture that is more productive, sustainable, and climate-resilient is provided by smart farming.

Keywords: Smart farming, Artificial Intelligence (AI), Internet of Things (IoT), Mobile platforms sustainable agriculture

Theme 1: 20

Augmented Reality (AR) and Virtual Reality (VR) in Agricultural Education and Extension Education

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Augmented Reality (AR) and Virtual Reality (VR) are immersive technologies that are transforming the way we teach and learn in agricultural education and extension. AR is an interactive experience that combines the real world with computer-generated 3D content, while VR is a fully computer-generated environment that allows users to interact with a virtual world. This conceptual paper focuses on the various applications of AR and VR in agricultural education and extension education. In educational settings, AR and VR are used through AR books, AR magazines, AR maps and AR Apps to enhance interactive learning. In extension education, these tools are helping farmers gain practical knowledge in an engaging way. Students and farmers can learn various topics such as identification of plants, pests and diseases, pruning techniques, insect anatomy, VR farm equipment operation, helping them to learn through interactive visuals and realistic virtual experiences. The use of AR and VR in extension education brings many benefits, such as improving farmers' understanding of complex topics, increasing their interest through interactive visuals and supporting hands-on learning without risk. These technologies allow farmers to perform tasks virtually multiple times, helping them gain expertise without facing resource limitations. AR and VR make learning more effective, especially for farmers with low literacy levels, by using visual and practical methods of communication. However, barriers such as limited availability of hardware and software, usability challenges and the digital divide limit the scalability of these technologies. To overcome these issues and fully harness the benefits of AR and VR in agricultural education and extension services, it is essential to focus on localized content development, inclusive design and capacity-building initiatives.

Keywords: Augmented Reality (AR), Virtual Reality (VR), Digital Tools, Immersive Learning, Interactive Learning

Theme 1: 21
Digital Literacy and Information – Seeking Behaviour among Livestock Farmers: Evidence from Kamrup District, Assam

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Despite various initiatives for promoting digital literacy among farmers in India there exists a digital divide that prevent them from leveraging technological innovations effectively. The current study was conducted with a focus on their ability to access digital information and challenges faced by them. Fifty farmers, selected through stratified purposive sampling, were considered for the study and were interviewed using a structured Interview Schedule between January and April 2025. It was observed that 58 per cent farmers exhibited a moderate level of digital literacy, while 22 per cent showed high engagement with digital platforms. YouTube and WhatsApp, utilized by 78 per cent and 65 per cent respondents were the most frequently accessed sources of digital information, whereas usage of livestock-specific mobile applications such as e-Gopala and Mera Pashu 360 remained comparatively low, represented by 12–15 per cent. These platforms were primarily used together information on disease management, feeding practices, vaccination schedules, and government schemes. Key constraints faced by the respondents in digital engagement include low digital confidence, language barriers, and poor internet connectivity. Despite these barriers, the increasing engagement with mainstream digital platforms highlights a positive shift toward ICT-enabled livestock extension services. The study recommends the introduction of localized training modules, vernacular content, and affordable digital infrastructure to bridge the digital divide. Improving digital accessibility can enhance decision-making and promote entrepreneurship among livestock farming communities in Assam.

Keywords: Digital literacy, ICT, Mobile apps, Livestock extension services

Theme 1: 22
The Role of Social Media Tools for KVKs in the Dissemination of the latest technology

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Global agriculture has witnessed a paradigm shift in the past few decades and extension mechanisms need to stay ahead and equip the farmers by developing their management and decision-making skills; help rural people develop leadership and organizational skills; participate in cooperative credit societies and other support organizations. But the ground reality is hard-hitting with only one extension worker available for every 2879 farmers in India. In this context, The Government of India through Indian Council for Agricultural Research (ICAR) has established a large network of over 731 Krishi Vigyan Kendras (KVKs) across the country with an aim to conduct technology assessment and refinement, knowledge dissemination and provide critical input support for the farmers with a multidisciplinary approach. The social media are the best tools of electronic communication for Krishi Vigyan Kendra's to disseminate and exchange information, sharing thoughts and opinions, influencing and facilitating decision-making by creating, storing, retrieving and exchanging information in any form (text, pictures, video, etc.). Social media is very helpful for dissemination the latest and scientific

technology and it is very advantageously used in Krishi Vigyan Kendras because viz; Highly cost effective, Simultaneously reaches large numbers of farmers, Location and client specific, problem-oriented, User-generated content and discussion among the community members, Easily accessed from mobile phones, Increases internet presence of extension organizations and their client reach and Brings all stakeholders into a single platform at grass root level. The timely availability of right information and its proper utilisation is indispensable for agriculture. Social media-based initiatives can be taken for propagation of information, transfer of technology, procurement of inputs and selling of outputs in a way so that farmers can be benefitted. Keeping this in view, the Krishi Vigyan Kendra, Delhi took all the farming activities to the farmers through digital technology such as Short film through YouTube Channel (Krishi Vigyan Kendra, Ujwa, Delhi) videos, Provide agro advisory through WhatsApp Groups (15), online training and webinar programme organized on various issues like peri-urbun horticulture, milk day, beekeeping, poshanvatika and food processing etc., TV and Radio programme (DD Kisan, Krashi Jagran), Short agro-advisory through M-Kisan portal, Facebook, Twitter, Telephone discussion, ICAR-KVK Portal, Website (www.kvkdelhi.com) and Kisan Sarathi portal etc. assured that digital technology can also be an important means of increasing productivity and profitability, propagation of information, transfer of technology, procurement of inputs and selling of outputs from farm, resulted betterment of farming community.

Keywords: KVKs, Social media tools, Digital technology, Advisory, Transfer of technology

Theme 1: 23

Access to Digital Agricultural Content: Gender Perspectives from Fatehgarh Sahib

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Digital technologies are emerging as pivotal tools with rapid transformation in India's agricultural landscape. Agriculture remains a cornerstone of India's economy, employing a substantial portion of its population, with women playing a vital but often undervalued role. Despite their significant contributions to crop production, livestock management, and post-harvest activities, women farmers in India face numerous challenges, including limited access to resources, information and technology. The advent of digital technologies presents a unique opportunity to address these challenges and empower women in agriculture. Digital content, encompassing mobile apps, online platforms, SMS services, and multimedia resources, can disseminate crucial information on improved farming practices, market linkages, weather forecast and government schemes, thereby enhancing productivity and livelihoods. When taking into account the fact that over 70 per cent of Punjabis as a whole and 42.5 per cent in rural areas have mobile phone internet access, this study becomes more relevant. Nearly half of the Punjab's population has joined social media as a result of higher penetration of internet. It is interesting to determine how it is utilised in obtaining information about agriculture in the current scenario, especially by rural women. The purpose of the present study is to examine how social media platforms are used for obtaining agriculture related information in Fatehgarh Sahib District of Punjab. The present study is based on primary data collected from rural women from farm families from two blocks of Fatehgarh Sahib District. The present study is designed to gain insight into how women from farm families use social media platforms to gather agriculture related information and determine the obstacles faced by these women in accessing agriculture related information on multiple social media platforms.

Keywords: Social media, Utilization, Constraints, Agriculture, Rural women, Gender mainstreaming

Theme 1: 24
Understanding Communication Behaviour of Extension Personnel for improving Advisory Services

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Advisory services are integral component of agricultural extension system entrusted with transferring of information and agricultural technologies from research labs to farmers. The present study was conducted by selecting 104 extension personnel from five districts of Punjab i.e. Ludhiana, Gurdaspur, Bathinda, Ferozpur and Ropar. The data were collected by personally interviewing ADOs and KVK personnel with the help of structured interview schedule. Communication behaviour of the respondents was studied in terms of information seeking behaviour, information processing behaviour and information dissemination behaviour. Study revealed that attitude towards ICT was favourable for all the stakeholders. Majority of the extension personnel sought information from extension activities like participation in trainings, farmer's fair, and workshops. extension personnel were found to be using their smart phones/ computers for information processing. Memorizing method was used commonly by all the stakeholders to retain information. Extension personnel mostly utilized group contact method with mean score of 2.18, followed by mass contact method with mean score of 2.10 and individual contact method having a mean score of 2.03. The important information dissemination methods being used by them were found to be direct interaction with farmers, trainings, field demonstrations, WhatsApp groups, farmer's fair. Provisioning of ICT devices and capacity building of extension personnel may further help to strengthen the extension advisory services for the farmers.

Keywords: Communication behaviour, Information seeking, Processing, Dissemination, ICT

Theme 1: 25
Role of Extension & Advisory Services in Adoption of Climate Smart Agricultural (CSA)

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The adoption of Climate-Smart Agricultural (CSA) practices is pivotal to enhancing agricultural resilience, increasing productivity, and mitigating the adverse effects of climate change on food systems. Climate smart agriculture is a comprehensive strategy for managing farmlands, crops, livestock, and forests that counteracts the negative impacts of climate change on agricultural productivity. There are three main objectives of climate smart agriculture: (1) Productivity- By enhancing crop and livestock production and farm profitability, climatically smart agriculture works to raise overall agricultural productivity and provide greater food security. (2) Adaptation- Climate smart agriculture aims to fortify agricultural infrastructure against the destructive effects of global warming. This entails taking measures to minimize susceptibility to climate-related threats like floods, droughts, or extreme heat. (3) Mitigation- One of the primary goals of climatically smart agriculture is to reduce the amount of greenhouse gases released into the atmosphere because of farming activities, including methane emissions from livestock, paddy rice cultivation, and synthetic fertilizer use. Different stakeholders in agricultural sector try to boost farm efficiency and productivity with little environmental impact, have contributed to the widespread adoption of climate smart farming. Still, farmers, especially in marginal and small landholders, may find it challenging to make the switch to climate smart agriculture. Because of this, CSA practices need government and other stakeholders backing and promotion. However, the successful implementation of CSA practices hinges significantly on the efficiency and effectiveness of Extension and Advisory Services (EAS). EAS play a critical role in bridging the knowledge gap between research institutions and farmers, providing essential technical support, and facilitating the transfer of climate adaptation strategies. This study explores the functional status of EAS in promoting the adoption of CSA practices, focusing on the mechanisms through which these services support farmers, especially in the context of animal husbandry. It examines the challenges and opportunities in the delivery of advisory services, such as inadequate resources, limited extension coverage, and lack of climate change awareness among extension agents. The paper also assesses the capacity of EAS to integrate climate-smart technologies, address local needs, and foster long-term sustainability. Through qualitative and quantitative data, the study identifies key barriers to CSA adoption and proposes recommendations for strengthening the role of EAS in climate change adaptation. The findings underscore the need for enhanced training, investment in extension services, and the creation of farmer-centered, context-specific advisory systems to accelerate the adoption of CSA practices.

Keywords: Climate-smart agriculture, Extension and advisory services, Adoption, Climate change, Agricultural resilience, Technical support, Knowledge transfer, Sustainability

Theme 1: 26

Behavioural Insights into the Adoption of Smart Farm Solutions by Smallholder Farmers in Telangana, India

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Smallholder farmers are essential to driving agricultural productivity and ensuring food security in India. Agritech and smart farming solutions offer transformative potential to improve their livelihoods by enhancing access to quality inputs, markets, and timely information, while also mitigating risks and offering a range of valuable services. The Government of India's Digital Agriculture Mission aims to serve as a comprehensive umbrella initiative to support digital agriculture efforts by Central and State Governments, as well as academic and research institutions. However, a significant barrier to the adoption of Agritech among small and marginal farmers is the lack of awareness and digital literacy. Addressing this challenge requires a focused emphasis on capacity building and training. This study explores the evolving Agritech landscape in India, analyzes various business delivery models, and identifies key adoption challenges. It further investigates the behavioral intentions of farmers toward Smart Farm Solutions (SFS) using the Decomposed Theory of Planned Behavior framework. Constructs such as attitudes, perceived behavioral control, subjective norms, and external latent variables including media influence, technical training, social influence, extension services, perceived usefulness and ease of operation, personal efficacy, compatibility, resource availability, and background factors were used to assess farmer intentions. Data was collected from farmers in the Rangareddy district of Telangana State, India. Findings indicate a strong willingness among farmers to adopt SFS, driven primarily by social norms, technical training, and the ease of learning the technologies. However, limited access to critical resources such as financial capital, labor, and equipment continues to be a major constraint. The study highlights the need for increased investment in skill development and resource support. These insights provide valuable guidance for policymakers, Agritech companies, and researchers aiming to empower smallholder farmers & build sustainable, inclusive, & profitable agri-food systems.

Keywords: Smart farming solutions, Agritech, Decomposed theory of planned behavior, Capacity building

Theme 1: 27
ICT based interventions and their Impact on Agricultural Extension Services Delivery in Jammu

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Digital technologies play a key role in advancing economic growth, promoting social inclusion, and enhancing human development. ICT can empower extension workers to collect, manage, access, and share a wide variety of information essential for small- scale producers. This includes guidance on best practices, updates on new technologies, current input and output prices, improved storage solutions, enhanced transportation networks, strategies for collective bargaining with buyers, and timely weather forecasts. Agricultural extension services delivery involves sharing knowledge with farmers, providing guidance and education to support their decision-making, helping them define their goals and explore available options, and encouraging positive developments in agriculture. However, conventional public-sector extension programs, which employ various strategies to promote the adoption of new technologies, have generally struggled to achieve significant success. This study explores the effects of a mobile application apps on the delivery of agricultural extension services in Jammu. An impact analysis is conducted using randomized survey data, addressing potential systematic selection bias through the application of double difference methods and reflexive comparisons. A combination of quantitative and qualitative indicators is used to assess both the direct and indirect effects of the mobile application apps on the delivery of extension services, as well as on farmers' knowledge, awareness, and attitudes toward new technologies. ICT-based mobile application apps have not only improved the agricultural service delivery system and increased awareness and knowledge of agricultural technologies and information but have also positively influenced farmers' attitudes toward adopting new technologies and embracing new ways of life in the future.

Keywords: Information communication technology, Agricultural extension services, Mobile application apps, Impact analysis, Jammu

Theme 1: 28
KRISHI VEER: A User-Centric Mobile Solution for Sustainable Agricultural Development

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In the rapidly evolving field of agriculture, mobile applications have emerged as transformative tools enhancing farmers' productivity, fostering innovation among researchers, and strengthening consultancy services through extension agents. Critical factors influencing the adoption and effectiveness of these applications include their centralized accessibility and zero-cost subscription models. One type of such initiative has been taken by agriculture and computer science students of THE NEOTIA UNIVERSITY, KOLKATA giving one stop solution to the famers and named this innovation as "*KRISHI VEER*". The *KRISHI VEER* mobile application, developed in the year February 2025 is the outcome of primary research conducted in the Murshidabad and South 24 Parganas districts of West Bengal. The app was developed using a shared server hosted by Hostinger and scripted in JAVA, the application was launched on the Play Store through the Play Console platform. KRISHI

VEER provides free access to an array of features, including GPS-enabled imaging, an area unit converter, a fertilizer calculator, real-time weather updates, pest and disease diagnostics with solutions, expert consultation in agriculture, and information advanced agricultural practices—all through a seamless login process. Within two months of its launch, the platform has benefited approximately 600 farmers by providing solutions through dedicated YouTube and WhatsApp channels. The application's social media presence, including Facebook and Instagram, further supports agricultural students by giving a platform to practice agriculture-based questions. Additionally, the KRISHI VEER website offers detailed discussions on the causes and solutions of various plant diseases, supported by visual representations. As, this application is in its initial stage of development, therefore, future updates will incorporate user-centric features such as vocational training programs (e.g., mushroom cultivation) and affordable crop-medicine selling, aimed at further addressing the needs of the agricultural community. This research underscores the challenges faced by the agricultural sector and highlights the potential of user-oriented mobile applications in fostering sustainable development in India's agriculture.

Keywords: Agri-tech, Mobile application*, Krishi Veer*, Digital Agriculture and Farmers

Theme 1: 29
Web-Driven Seed Hub Information System: Development and Implementation

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Timely availability of sufficient quantity of quality seed is an important step in enhancing the yield and production of any crop. Realizing importance and to ensure the availability of location specific high yielding varieties and quality seed, the Ministry of Agriculture and Farmers welfare, Government of India established seed hubs in country through Krishi Vigyan Kendra's (KVKs), CAUs/SAUs and ICAR institutes. To enhance productivity of Rapeseed-Mustard in country, ICAR established Rapeseed-Mustard Seed Hubs through ICAR-IIRMR, Bharatpur operated at six centres at different locations, these centres focus on production and distribution of Rapeseed-Mustard seeds of improved and farmer-preferred varieties. Effective information delivery and management are crucial for smooth coordination and functioning in any system. It ensures that all parts of the system are working together effectively, preventing misunderstandings and enabling efficient decision-making. The challenge encountered by the nodal agency in seed hub administrative procedure such as documenting activities, organizing correspondence with all aspects and prepare reports, which is still performed manually using the Ms-Word/ MS-Excel form, thereby increasing the risk of data errors and the time required to generate the desired reports. To address the challenges faced by the nodal agency in managing seed hub administrative procedures manually, the development of a web-based system can significantly enhance efficiency and accuracy. Such a system would help in streamline information management such as documentation, correspondence, and reporting, reducing data errors and administrative overhead. We developed Rapeseed-Mustard Seed Hub Information System, a centralized, web-based platform that efficiently manages and disseminates seed-related information such as availability, variety, source, quality, quantity, seed category, distribution, etc. to stakeholders like farmers, suppliers, agricultural officers, and policymakers. A dynamic, user friendly and responsive web-based system has been developed using Laravel, Bootstrap, MySQL, HTML,etc. Laravel, a PHP framework, handles the backend logic, routing, and database interactions, while Apache acts as the web server. MySQL handles the database management, while Bootstrap provides pre-designed CSS styles for creating a visually appealing and responsive user interface and HTML provides the structural foundation for the web pages.

Keywords: DSS, Web based, MySQL, Seed Hub, Effective information delivery

Theme 1: 30
Land use Change Analysis in a Himalayan Watershed using Remote Sensing and GIS

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The Himalayan regions are active geographically characterized by young fragile ecosystem along with the inherent environmental problems of natural occurrence such as, soil erosion, earthquakes, landslides and flash floods. Moreover, the hydrologic condition of watershed is also changing with time owing to dynamic change in land use condition due to urbanization, agriculture expansion, deforestation, afforestation and implementation of conservation measures. This change of land use has a considerable impact on the runoff characteristics and related hydrological processes and therefore it is quite necessary to map like the change of land use in the watershed in order to formulate the developmental strategy. In the present study, the temporal land use change analysis in Bino watershed which is situated in Almora and Pauri Garhwal districts of Uttarakhand, India during span of ten years (2000-2009) using remote sensing and GIS techniques. The land use/land cover map of Bino watershed for 16 September, 2000 and 23 September, 2009 were prepared using the satellite imageries of LANDSAT 5 TM by unsupervised image classification in ENVI 4.7 software. The major land use/land cover classes found in the watershed include dense forest, open forest, agricultural land, waste land, built-up area and water body. It was found that out of total geographical area of 296.366 km^2 under study, the highest percentage of 36.75% was covered by dense forest followed by open forest (22.64%), agricultural land (21.71%), waste land (14.43%), built-up (4.32%) and water body (0.14%) in the year 2000. While in the year 2009, 29.15% of total area was occupied under open forest which was followed by dense forest (27.17%), agricultural land (25.75%), waste land (10.57%), built-up (7.08%) and water body (0.28%). The annual land use change index (LI) was found to vary from 1.86 (agricultural land) to 9.87 (water body) over the ten years.

Keywords: Land use land cover, Watershed, Remote Sensing, GIS

Theme 1: 31
Integrating GIS and Big Data for Climate Resilience Mapping in the Northeast Himalayan Region of India

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Climate change poses a significant threat to the Northeast and Himalayan regions of India due to their fragile ecosystems, socio-economic vulnerabilities and geographical isolation. This study adopts a data-driven approach to assess climate resilience by developing a Climate Resilience Index (CRI), leveraging spatial secondary datasets integrated through GIS and remote sensing. The CRI encompasses multi-dimensional indicators under four key pillars: exposure, sensitivity, adaptive capacity and transformative capacity. This enables high-resolution spatial analysis at various administrative levels–state, district, block and village. Using big data management and geospatial analysis, 13 Indian states and union territories were classified into five resilience categories: Very Low, Low,

Medium, High and Very High. State-level analysis reveals that Arunachal Pradesh has the lowest resilience score (0.252), while Tripura and Mizoram exhibit the highest resilience scores (above 0.30). Most states in the region fall into the Low to Medium resilience range, underscoring regional disparities and the need for targeted climate adaptation measures. At the district level, Arunachal Pradesh is particularly vulnerable, with 88% of its districts categorized as Very Low in resilience. Conversely, Tripura and Mizoram show stronger resilience, with more than 60% of their districts in the Very High category. Village-level analysis further highlights the vulnerability of Arunachal Pradesh, where 80.88% of villages fall under the Very Low resilience category, followed by Manipur (52.7%), Meghalaya (40%) and Assam (36.3%). In contrast, Tripura (52.86%) and Mizoram (48.03%) have the highest shares of villages in the Very High resilience category. The study illustrates the critical role of digital technologies like GIS and spatial analytics in building comprehensive resilience frameworks, enhancing climate risk assessment and supporting adaptive planning at multiple administrative scales.

Keywords: Vulnerable, Climate resilience index, GIS and remote sensing, Climate risk

Theme 1: 32

Design and Development of Mushroom Expert System Application

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In Meghalaya, mushroom cultivation holds a great potential as agri-business venture. Access to accurate and comprehensive information is essential for mushroom cultivation. However, mushroom cultivators suffer from lack of technical information. The advances in Artificial intelligence, like Expert system offers potential solution to address the information gap by emulating the humans in narrow domain of expertise. The ADDIE model – which stands for Analyze, Design, Develop, Implement, and Evaluate – is a widely preferred instructional design framework for creating effective e-learning platforms. Hence, a study was taken up with the objective to design and develop a need based mushroom expert system mobile application for the farmers of Meghalaya. The data were collected from three districts of Meghalaya viz. West Garo Hills, East Khasi hills and Ri-Bhoi by interviewing 120 numbers of mushroom growers. The front-end analysis revealed that farmers mostly needed information on nutritional and medicinal properties of mushroom, spawn production technology, schemes, diseases of mushroom etc. with information need priority index of 2.5, 2.45, 2.09, 2.16 respectively. An android expert system application with 8 modules was thus designed and developed based on information needs of the mushroom growers. The modules of the application focus on various aspects of oyster and button mushroom cultivation. The application was developed using React Native framework. The disease prediction module was build using YOLOV5 software, which works on the principle of convolutional neural network. The disease detection module detects 6 diseases of mushroom. The application is hosted on amazon web services and it was implemented among the 120 respondents. The application needs further assessment and refinement through participatory efforts of relevant stakeholders. Use of the mushroom expert system can enhance the effectiveness of mushroom related capacity development efforts by various stakeholders.

Keywords: Mushroom, Expert system, Information dissemination

Theme 1: 33
Data-Driven Farming: GIS for Agricultural Optimization

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Geographic Information Systems (GIS) technology has emerged as a transformative tool in the field of agriculture, offering powerful capabilities for spatial analysis and data integration. By collecting, organizing, and analyzing geographically referenced data, GIS enables farmers, researchers, and agricultural planners to make informed decisions grounded in spatial accuracy. This technology allows for the creation of detailed, multi-layered maps that reflect real-time field conditions, soil characteristics, crop patterns, topography, and climate data–thereby facilitating more precise and effective farm management strategies. At the farm level, GIS empowers farmers to implement precision agriculture practices. These include the site-specific application of inputs such as seeds, fertilizers, and irrigation water based on intra-field variability. Instead of treating an entire field uniformly, farmers can target specific areas with the exact resources they need, reducing input waste, minimizing environmental impact, and improving overall productivity. Farmers employ GIS to precisely manage inputs across variable field conditions, while extension services use this technology to deliver tailored, location-specific recommendations to agricultural communities. The visual nature of GIS outputs transforms complex data into accessible formats that improve knowledge transfer between researchers, advisors, and producers. This technology supports various agricultural functions including land suitability assessment, resource allocation, and production planning at scales ranging from individual farms to regional agricultural systems. As accessibility improves through user-friendly applications and mobile solutions, GIS continues to gain traction among diverse agricultural stakeholders, promoting data-driven approaches that enhance productivity while supporting sustainable land management practices.

Keywords: Geographic information systems (GIS), Agricultural extension, Spatial analysis, Precision agriculture

Theme 1: 34
Role and Importance of ICT in Agricultural Extension

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India is predominantly an agrarian economy, where a large portion of the population depends on agriculture and its allied sectors as the primary source of income and livelihood. In this context, the integration of Information and Communication Technology (ICT) in agriculture holds immense potential to transform the delivery and effectiveness of agricultural extension services. ICT can significantly enhance the efficiency, reach, and impact of extension efforts by providing timely, accurate, and relevant information to farmers and other stakeholders in the agricultural value chain. The application of ICT in agricultural extension enables farmers to access real-time data on weather forecasts, market prices, crop management techniques, pest and disease control, and other critical agricultural practices. This facilitates informed decision-making, reduces risks, and ultimately contributes to increased productivity and profitability. Additionally, ICT tools can offer farmers access to financial services such as microcredit, crop insurance, and digital payment systems, which help them invest in farm inputs, manage risk, and ensure financial inclusion. Moreover, ICT fosters stronger connectivity between farmers, extension workers, scientists, and agricultural institutions. Through mobile phones, the internet, and digital platforms,

stakeholders can engage in two-way communication, enabling knowledge exchange, remote diagnostics, and continuous learning. ICT also paves the way for delivering value-added services such as e-commerce platforms for direct marketing of agricultural produce, telemedicine for rural healthcare support, and e-governance services to ensure better access to government schemes and subsidies. Importantly, ICT supports the core objective of agricultural extension, which is the dissemination and transfer of scientific knowledge and innovations to the farming community. ICT-based extension tools-such as mobile apps, community radio, video conferencing, SMS advisories, and digital kiosks-can reach even the remotest areas, bridging the rural-urban digital divide and ensuring inclusive development. The integration of ICT in agricultural extension systems in India has the potential to revolutionize traditional practices by making extension services more dynamic, accessible, and impactful. By empowering farmers with timely information and digital tools, ICT not only enhances agricultural productivity but also contributes to sustainable rural development and food security.

Keywords: Information and Communication Technology (ICT), Agricultural Extension, Krishi Vigyan Kendra (KVK) and Farmer Empowerment

Theme 1: 35

Digital Extension for Transforming Agriculture: A Comprehensive Review of ICTs and Innovations in India

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Digital agriculture extension services empower farmers with tailored information, timely support, and opportunities for active engagement, contributing to improved agricultural practices, enhanced productivity, and sustainable rural development. This comprehensive review explores innovations and challenges in digital agriculture extension services. Various technologies and platforms in digital extension, such as mobile applications, web portals, social media, and Interactive Voice Response (IVR) systems, catering to diverse user preferences and create a comprehensive ecosystem, empowering farmers with end-to-end solutions. Various types of Information and Communication Technologies (ICTs) that can be used for digital extension services in agriculture development like mobile based ICTs, web based ICTs and other digital tools. Advantages of digital extension services are accessibility, scalability, cost effectiveness, real-time information, personalization, real time information, peer learning and collaboration, interactive communication, multilingual support, data driven decision making, continuous learning. The advantages of digital agriculture extension services are far-reaching. They significantly enhance accessibility by providing farmers with up-to-date information at their fingertips, regardless of location. Services are scalable, allowing for the expansion of digital platforms to serve larger groups of farmers without a corresponding increase in costs. Digital tools are often cost-effective, reducing the need for physical infrastructure, travel expenses, and printed materials, making them a more affordable solution compared to traditional methods. These platforms offer real-time information, enabling farmers to make timely decisions based on immediate weather conditions, market prices, or pest outbreaks. Additionally, digital services can provide personalized recommendations, taking into account factors such as a farmer's geographic location, crop type, and specific challenges. Few challenges are limited access to internet connectivity, lack of digital literacy, language barrier, reluctance to adopt digital technologies, limited investment in digital infrastructure. Developing user friendly digital platforms with localized content and language, collaborative training and capacity building programme can help to overcome the challenges.

Keywords: Digital agriculture, Web portals, Social media, ICTs

Theme 1: 36
Perceived Constraints and Suggestions in Utilization of ICT by the KVK Scientists of NE Region of India

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The present study aimed to examine the constraints faced and suggestions offered by scientists working at Krishi Vigyan Kendra (KVKs) for the effective utilization of Information and Communication Technology (ICT) in KVK activities. A total of 110 KVK scientists from the region were randomly selected to participate in the study. The findings revealed several critical barriers that hinder the optimal use of ICT in the functioning of KVKs. The major constraints identified by the respondents included inadequate ICT infrastructure facilities within KVKs, difficulties in time management for learning and adapting to ICT tools, frequent internet disruptions and slow server functioning, lack of access to ICT services in rural villages, insufficient funding allocated for ICT development, poor mobile network coverage, and a general lack of motivation or willingness among learners to engage with ICT resources. These challenges collectively limit the capacity of KVKs to leverage ICT for agricultural extension, knowledge dissemination, and farmer engagement. However, the study also highlighted a set of constructive suggestions provided by the scientists to overcome these issues. Key recommendations included the provision of alternative power sources (such as solar energy) to address electricity shortages, the establishment of ICT facilities at the individual user level within KVKs, the organization of regular training programs to enhance the capacity of scientists and extension workers in using various ICT tools effectively, and the development of village-level information kiosks to ensure last-mile connectivity and access to relevant agricultural information for rural communities. Implementing these suggestions could significantly enhance the role of ICT in strengthening the agricultural knowledge system and improve the outreach and effectiveness of KVK activities.

Keywords: NE region, Constraints, Information and Communication Technology (ICT), KVK

Theme 1: 37
Crop Yield and Disease Prediction by using Data Mining Framework

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India is the world's second most populous country and agriculture employs the vast majority of its people. Farmers continue to plant the same crops without testing new varieties, and they apply fertilizers in haphazard amounts without comprehending the inadequate composition and quantity. As a result, agricultural output suffers while the soil becomes acidic and the player is damaged. So we created a solution to help farmers using machine learning techniques. Based on soil content and climatic conditions, the present technology will choose the optimum crop for a certain piece of land. In addition, the system offers information on the necessary fertilizer content and quantity, as well as the seeds for growth.

Keywords: Machine learning, Crop prediction, Decision tree, Rainfall prediction, Crop recommendation

Theme 1: 38
Role of Technology in Agriculture Advancement

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Indian farmers require a wide range of crop technology solutions to enhance agricultural productivity, optimize the use of resources, and build resilience against climate change and other emerging challenges. Key technological areas include precision farming, improved seed varieties, smart irrigation systems, and better access to both agricultural information and financial services. To explore the specific information needs related to crop technology, a study was conducted using a descriptive research design. Data were collected from a total of 75 randomly selected farmers, with 25 participants drawn from each of the three selected villages. The primary data collection method was a structured interview schedule, which focused on identifying information needs associated with crop production technologies. The study revealed that a significant majority of the respondents (76%) expressed a need for improved storage techniques. Additionally, 50.66% of farmers reported a need for information related to cultivation technologies. Irrigation technology was another area of concern, with 48% of respondents indicating a need for information, followed by 46.66% of farmers who required guidance on fertilizer application and spraying techniques. Despite technological advancements, India's agricultural sector continues to face several challenges, including the need to enhance productivity and nutritional quality of crops, reduce production costs and environmental impact, and adapt to the growing threats posed by climate change. Addressing these challenges requires the strategic adoption and dissemination of appropriate crop technologies to farmers at the grassroots level. Ensuring timely and need-based access to agricultural knowledge can empower farmers to make informed decisions and contribute to sustainable agricultural development.

Keywords: Crop technology, Agricultural information needs, Precision agriculture, Climate-resilient farming

Theme 1: 39
Digital Tools in Agricultural Extension: Enhancing outreach through AI, IoT and mobile platforms

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Public extension systems often struggle to reach every farmer because they lack sufficient funding and personnel to provide in-person support across all regions. This is exacerbated by the fact that farmers are sparsely populated across large areas and oftentimes isolated. Even the most effective public extension services typically reach only about 10% of farmers directly–and this percentage can be even lower when resources are scarce. Information and Communication Technology (ICT) offers farmers timely access to critical data such as weather forecasts, market trends, and crop management practices, thereby enabling them to make more informed agricultural decisions and enhance their productivity. Additionally, ICT facilitates access to financial services, including microfinance and insurance, which support farm investment and risk management. Furthermore, ICT strengthens the connection between farmers, extension agents, and researchers, promoting efficient knowledge and information exchange. It also opens up opportunities for farmers to benefit from value-added services such as e-commerce platforms, telemedicine, and e-governance initiatives. In India, the government has implemented several policies and initiatives like NeGP, e-NAM, aAQUA, Digital Green, e-Arik, e-Sagu, VASAT, Village Resource Centre,

Warana Wired Village Project, DACNET, ICT-e-Choupal, iShakti, IKSL. ICT in agricultural extension should use affordable, user-friendly, and accessible technologies suited to the local context and target users. In conclusion, the integration of ICT and IoT into agricultural extension systems offers a data-driven, scalable solution to the limitations of conventional outreach models. These technologies facilitate real-time monitoring, precision agriculture, and enhanced decision support.

Keywords: Information and Communication Technology (ICT), IoT (Internet of Things), Agricultural productivity

Theme 1: 40
ICT in Agriculture for Effective Teaching-Learning and Training of Stakeholders

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Education is the process of learning and knowing, which is not restricted to our school text-books. It is a holistic process and continues through our life. Even the regular happenings and events around us educate us, in one or the other way. It would not be an exaggeration to say that the existence of human beings is fruitless without education. An educated person has the ability to change the world, as he/she is brimming with confidence and assured of making the right moves. Education of tomorrow should be able to play its role more effectively by making the individuals creative, active and efficient. Success of education cannot be achieved merely by substituting mechanical methods for human beings, but by developing new patterns using both human beings and technological advancements in order to teach more people better and more rapidly. Education can be facilitated and accelerated with the help of this mass media under educational technology. It makes better citizens, ensures a productive future, opens new vistas, spreads awareness, helps in decision-making and bolsters confidence. The term "Media" is derived from Medium, which means carrier or mode. Media denotes an item specifically designed to reach a large audience or viewers. The term was first used with the advent of newspapers and magazines (print media). However, with the time, the term broadened by the inventions of radio, TV, cinemas (audio visual media) and internet (e media). In the world of today, media has become almost as necessary as food and clothing. The media has a strong social and cultural impact upon society. Because of its inherent ability to reach large number of public, it is widely used to convey message to build public opinion and awareness. The media has the power of educating people, the good and the bad. Since it affects the eyes, the ears and the mind simultaneously nothing can overcome the influence of the media. The media in the advanced society should perform a noble mission of enlightening people and discourage sectarian, communal and divisive trends. By using various kinds of Media in the classroom we can enhance students' understanding and promote it where necessary. The use of audio and video with student teachers is crucial also in giving feedback and training, in Reflective Teaching, in analyzing and synthesizing, in tracking students' progress over time, in editing certain options, in testing, in peer coaching, etc. Media also can help with many issues such as: motivation, clarity, recycling, drafting, revising, editing, variety, mixed-ability classes, updating information in the textbook, giving life and color to classroom procedures and methods, thus at the same time helping the students improve accuracy and fluency. There are a lot of issues that can or cannot be solved by media. ICT-based initiatives in agriculture aim to leverage technology to improve farming practices, enhance efficiency, and increase productivity. These initiatives encompass a wide range of applications, including precision agriculture, remote sensing, data analysis, and knowledge dissemination.

Keywords: Education, Media, Technology, ICT in Agriculture, Public Awareness

Theme 1: 41
Data-Driven Farming: GIS for Agricultural Optimization

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In today's agricultural landscape, farmers face significant challenges including resource constraints, climate variability, land degradation, and increasing demand for food production. In this present scenario, there is a need for a technology that offers transformative solutions by providing precise spatial analysis, real-time monitoring capabilities, and data-driven decision support systems and GIS is one such tool for this task. GIS (Geographic Information System) is a technology that captures, stores, analyses, manages, and presents various types of geographical and spatial data. I helps in storing large amounts of data, which can be accessed, and modified to calculate and map different quality indices for land suitability. GIS allows users to visualize, question, analyse, and interpret data to understand relationships, patterns, and trends in the form of maps, reports, and charts. Farmers can employ GIS to precisely manage inputs across variable field conditions, while extension services use this technology to deliver tailored, location-specific recommendations to agricultural communities. The visual nature of GIS outputs transforms complex data into accessible formats that improve knowledge transfer between researchers, extension officers, and producers. This technology supports various agricultural functions including monitoring crop health, managing resources, planning land use, and optimizing agricultural operations based on geographical variables like soil conditions, topography, and climate patterns. The role of GIS continues to expand, particularly in supporting evidence-based decision making for agricultural planning and management, representing a significant advancement in modern farming practices.

Keywords: Geographic Information Systems (GIS), Agriculture, Remote sensing, Data-driven farming

Theme 1: 42
Role of Traditional Media in Dissemination of Information

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Traditional media can indeed be employed as efficient instruments in the task of inspiring farmers and modifying their behavior. The media is utilized by, for, and in conjunction with the populace. Traditional media–such as folk songs, storytelling, street theatre, puppetry, wall paintings, and community radio–have long served as powerful and culturally resonant tools for communication, education, and social transformation. These forms of media can be effectively employed to inspire farmers, influence their attitudes, and encourage the adoption of improved agricultural practices. Unlike modern mass media, traditional media often communicate in the local language and idioms, are embedded in community life, and carry a high degree of trust and familiarity. This makes them especially well-suited for engaging rural populations, including those with limited literacy or access to digital technologies. Farmers have a very favorable opinion of traditional media as a source of news and information. Traditional media's communication capabilities have been clearly proven throughout the history of development in numerous cultures. The government should boost the use of traditional communication through the Ministry of Information and Culture by holding frequent seminars and workshops to train individuals in the use of Indigenous media. Additionally, the family should encourage indigenous interaction by bringing awareness among their own family members at home. To reach the most farmers in the current technological world, traditional media must be integrated with ICT tools.

Keywords: Traditional, Media, Extension, ICT, Dissemination, Information

Theme 1: 43
Agriculture Drones: A Novel Tool in Modern Agriculture

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Agriculture continues to be the imperative sector of the Indian economy, as it is a more or less a compulsion for livelihood of farmers. Addressing new-fangled Indian agriculture problems such as scarcity in farm workers, reduced yield, inconsistent quality as well as market fluctuations, farmers needs novel technologies to meet out these problems. Adoption of digital technology is one which improves way to help farmers in better farming. The digital technology in India is now at the crucial stage. Ministry of Agriculture and Farmers Welfare, Government of India, has promoted agricultural drones through Agricultural Drone Project under Sub Mission on Agricultural Mechanization for the year 2022-23. Krishi Vigyan Kendra's and State Agriculture Universities were taking up large scale demonstrations of this technology on the farmers' fields. In the prevailing situations of scarcity of farm workers, agricultural drones are best alternate to perform operations like spraying of agrochemicals. Dr YSRHU-KVK, Venkataramannagudem is one among the nodal institute implementing Agricultural drone project. So far, more than 500 demonstration organized in erstwhile West Godavari district, covering major agricultural crops (Paddy, Maize, Groundnut & Blackgram) and horticultural crops (Cashew, Banana, Chillies, Citrus and Bhendi). Agricultural Drones saves time and are best in efficient use of resource utilization with substantial water savings. Unit economics of drone spray cost per acre vis-à-vis manual labour cost is also making head away. Drone flying for agricultural operations can also be a good opportunity for rural youth.

Keywords: Agricultural drones. Demonstrations, Time saving and water saving

Theme 1: 44
AI as Academic Ally: Enhancing Research and Teaching Workflows through Intelligent Tools

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Artificial Intelligence (AI) is rapidly becoming an indispensable companion in academia, revolutionizing the way knowledge is created, taught and managed, leading to a new era of productivity, innovation and personalized learning. In this fast-evolving landscape of AI tools, it is essential for academicians and researchers to stay informed about practical use cases and applications, embracing these tools as valuable assistants rather than aliens. This abstract presents a comprehensive overview of selected AI tools and their specific roles across the academic workflow. A curated selection of widely-used AI tools was analysed based on their functionality, relevance and application across different stages of academic workflows and major AI tools use cases were identified. In research processes, platforms like Elicit facilitate evidence-based questioning and automate literature synthesis, while Research Rabbit allows users to visualize and explore interconnected academic papers through dynamic citation networks. Napkin supports the ideation process by organizing fragmented thoughts into interconnected visual notes, helping in conceptual clarity and academic brainstorming. Similarly, Notebook.ai, originally built for creative writing and world-building can be utilized to structure complex academic narratives and research frameworks. Additionally, tools such as ChatGPT, Claude and Quillbot enhance academic writing by assisting with content generation, language refinement and grammar correction.

Keywords: Academic writing, Research, Personalized learning, Literature review, Teaching

Theme 1: 45

Digital Revolution in Agriculture: IoT for Sustainable Farming Practices

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The agricultural sector, a cornerstone of global sustenance, stands at the cusp of a profound transformation driven by the digital revolution. Today's Agriculture 4.0 era involves the use of modern technologies, and has greatly enhanced agricultural operations by creating low-cost sensor and network platforms that optimize production efficiency while minimizing the use of energy and water resources. IoT technologies offer a paradigm shift by enabling data-driven decision-making, optimizing resource utilization, and fostering environmentally responsible cultivation. The use of IoT technologies in agriculture can lead to advanced farm management, reducing waste and increasing crop production with minimal environmental impact, real time monitoring of critical parameters such as soil moisture, nutrient levels, etc. which can empower farmers to make precise interventions. IoT-enabled pest and disease detection systems allow for early and targeted interventions. The use of IoT technology in agriculture offers many opportunities to transform farming practices. Farmers can improve efficiency, productivity, and sustainability through smart irrigation, precision farming, crop and soil monitoring, supply chain management, livestock monitoring, etc. Incessant study, development, and acceptance of IoT-driven solutions are crucial to retain agriculture as a viable alternative among increasing difficulties such as climate change and resource shortages. It can enhance and promote sustainability through reduced environmental impact and the conservation of resources. It demands collaborative efforts between technology developers, policymakers, researchers, and farmers to ensure equitable and sustainable implementation of IoT base technologies in the farming sector.

Keywords: IoT (Internet of Things), Agriculture, Precision farming; Sustainable Agriculture, Farmers, Technologies

Theme 2: 46

Effect of Different Diets on Comparative Biology of Rice Moth, *Corcyra cephalonica* and their Eggs Parasitized by *Trichogramma Chilonis*

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The rice moth, *Corcyra cephalonica* (Stainton) is one of the most important host insects used for mass production of many predators and parasitoid. The present investigation was conducted at the Biological Control Laboratory, Department of Entomology, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, during the year 2022-23. To determine the efficient rearing media for rearing *Corcyra cephalonica*, six treatments of different combinations with grains fortified with yeast, protinex, and groundnut were used for rearing of *C. cephalonica*. Among different diets combination, the diet maize 96% + groundnut 4% obtained maximum fecundity (330 eggs) and oviposition period (4.38 days), minimum total developmental period of male and female (52.95 and 54.65 days). The minimum fecundity (240 eggs), oviposition period (3.75 days) and longest total developmental periods of male (61.70 days) and female (62.50 days) were found. The different food materials also affected the per cent parasitization on the eggs of *C. cephalonica* by egg parasitoid *Trichogramma chilonis*. The maximum per cent parasitization was done when host eggs reared on wheat 48% + rice 48% + groundnut 4% (74%) followed by maize 96% + groundnut 4% (72%). The minimum parasitism was obtained (55%) when reared on rice 96%+ groundnut 4%.

Keywords: Rice moth, Developmental period, Diet

Theme 2: 47

Popularization of Climate Resilient Wheat Varieties through Frontline Demonstrations in Muzaffarpur District of Bihar, India

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Front line demonstrations (FLDs) on wheat were laid down at 465 farmers' fields to demonstrate production potential and economic benefits of improved production technologies comprising bio-fortified varieties namely DBW 187, DBW 252, WB 2 and DBW 296 in Muzaffarpur district of Bihar state during *Rabi* seasons from 2020-21 to 2023-24 in irrigated farming situation. The findings of the study revealed that the improved production technologies recorded an additional yield ranging from 7.1 to 16.0 q/ha with a mean of 11.1 q/ha. The per cent increase in yield under improved production technologies was ranged from 22.5 to 52.9 (DBW 187), 25.6 to 45.2 (DBW 252), 26.6 to 47.7 (WB 2) and 33.8 to 45.5 (DBW 296) in respective years. The average extension gap, technology gap and technology index were 6.7q/ha, 8.3q/ha and 24.4 per cent, respectively in different salt tolerance varieties of wheat. The improved production technologies gave higher benefit cost ratio ranging from 2.0 to 3.0 with a mean of 2.4 as compared to local checks (1.8) being grown by farmers in the region. The results revealed that the maximum number of the respondents had medium level of knowledge and extent of adoption regarding recommended wheat production technology. The study reported lack of suitable bio-fortified HYV as major constraints by beneficiaries followed by low technical knowledge. Thus the productivity of wheat per unit area could be increased by adopting feasible scientific and sustainable management practices with a suitable salt tolerance variety.

Keywords: Adoption, Constraints, Impact, FLD, Bio-fortified

Theme 2: 48

Climate Resilient Agriculture for Small holder Farmers: Micro-level Strategies and steps

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Small and marginal farmers in India face multiple challenges like restricted access to credit, extension services, public irrigation, and electricity which hampers their progress. Indiscriminate fertilizer use raises production costs, and socially disadvantaged groups among them struggle with limited access to information, credit, and markets. Lower education levels restrict knowledge dissemination, forcing them to rely on informal credit sources, leading to chronic debt. Among these, the strongest challenges are the climate fluctuations and associated risk in farm level. Climate risk is the resultant outcome of interplay among variability in weather and climate events, exposure to negative livelihood sustaining factors and vulnerability of a community or household. Smallholder farmers are considered the worst hit by climate change because they typically rely heavily on rain-fed agriculture, have limited resources to adapt to changing weather patterns, and are often located in regions particularly vulnerable to extreme weather events like droughts and floods, making them highly susceptible to crop losses and income disruptions when climate conditions shift drastically; their limited financial capacity further hinders their ability to recover from such impacts. The risk paradigm of IPCC, 2012 postulates that the magnitude of risk may increase if the magnitude of system vulnerability, system exposure and negative climate trend and event increase. Considering the diversity in geographical, social, cultural or agro-economic perspectives in India, this paper presents a methodological aspect for a micro-level (down to farm level) assessment of these risk factors due to climate vulnerability parameters & suggests the micro level strategies to cope with climate change.

Keywords: Climate change, Small holder, Micro level strategy, Vulnerability

Theme 2: 49

Golden Grains, Bluer Costs: A Water Footprint Assessment of Paddy in Punjab

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Punjab, the granary of India, is grappling with a deepening groundwater crisis, largely fuelled by the widespread cultivation of water-intensive paddy. In this context, understanding the crop's water footprint (WFP) is vital for guiding sustainable water management and varietal planning. The present study evaluated the WFP of paddy in five districts of Punjab i.e. Sangrur, Hoshiarpur, Ropar, Fazilka, and Bathinda using the FAO's CROPWAT 8.0 model. District-specific data on crop evapotranspiration (ETc), effective rainfall (Peff) and irrigation requirement (IR) were used to calculate the green, blue and total water footprints (litres/kg of grain) for various paddy varieties sown at different dates. The results highlighted significant spatial and varietal differences. Fazilka recorded the highest total WFP (983 L/kg), followed closely by Bathinda (977 L/kg) and Sangrur (974 L/kg), whereas Hoshiarpur had the lowest (815 L/kg). Among varieties, PR118 in Bathinda showed the maximum WFP (1447.60 L/kg), while PR126 consistently demonstrated lower values across districts (as low as 700.24 L/kg). Early sowing patterns generally led to higher blue water consumption, underlining the importance of aligning planting time with monsoon onset. The study highlighted the need to promote water-efficient varieties and to adopt agro-climatic scheduling to reduce paddy water footprints.

Keywords: Ground water crisis, Water footprint, Paddy varieties

Theme 2: 50

Awareness about Climate Change, Low Carbon Farming and Carbon Credit among the Small Tea Growers of Dibrugarh District in Assam

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Climate change is a major threat in this 21st century which leads to the warming of the planet. Unlike any other agricultural practices, climate change also has a detrimental effect on tea cultivation of Assam. Sustainable agricultural practices such as low carbon farming and carbon credit programmes can help to mitigate the ill effects of climate change impacts. This study investigated the level of awareness of the Small Tea Growers (STGs) of Dibrugarh district in Assam regarding climate change, low carbon farming practices and carbon credit programme. Primary data were collected from 94 STGs from 2 blocks of Dibrugarh district in Assam by using a structured schedule. The awareness levels were measured using Likert scale. The study found that the level of awareness is very high for climate change and associated issues, medium level of awareness about low carbon farming and a very low level of awareness about carbon credit programme which is reflected by obtained maximum possible score of 0.82, 0.50 and 0.27, respectively. The results suggest a clear disparity in awareness levels among the three categories with climate change awareness being relatively higher compared to low carbon farming and carbon credit awareness. There is immense need for awareness programs and policy interventions to promote low carbon farming and carbon credit programme among the STGs of Assam. All the stakeholders and policymakers must come together to create awareness about these important issues by launching awareness campaigns, conducting seminars, workshops, etc. and provide information on the quantification of carbon and financial benefits of participating in carbon credit programs.

Keywords: Awareness, Carbon Credit, Sustainable agriculture, Tea, Assam

Theme 2: 51

Enhanced Farmers Livelihood through Climate Resilient Practices

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The present study carried out by Krishi Vigyan Kendra, Bhilwara in Dolikhera village in Suwana block under sub humid southern and plain Aravalli hills IVA agro climatic zone with their climate vulnerability *i.e.*, drought, heat wave and water stress during 2022-23 to 2023-24.The result indicated that *in-situ* moisture conservation in maize farmers earned a net return of Rs 46840/ ha with B:C ratio of 2.52 over the local cultivar (Rs 33340/ha with 1.48 B:C ratio). Ten foliar sprays of 1% KNO_3 in maize during drought period helped to mitigate the drought effect in maize and gave 25.30% higher grain yield as compared to farmer practices. Improved variety of Black gram PU-01 was demonstrated at 10 farmers field in 8 ha area, which resulted in 29.23% higher yield as compared to local variety. Suitable intercropping systems under real rainfall situations (maize + blackgram 2:2/3:2) are also demonstrated at 10 farmers' fields in 8 ha area which resulted in 34.49% higher yield as compared to local variety.

Keywords: Livelihood, Climate, Resilient, Intervention

Theme 2: 52
Uncertain Urbanism

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Prospective versus reality of green infrastructure in urban spaces is a critical inquiry into the socio-ecological contradictions embedded in contemporary green infrastructure discourse. Anchored in Indian urban contexts, this project challenges the dominant developmentalist and technocratic framings of air and environment, which reduce atmospheric life to data points, AQI scores, and policy targets. It proposes instead an ontological reorientation-towards air as a co-inhabitant, a lived and unequal experience shaped by caste, class, and labor. By interrogating how green infrastructure initiatives often reinforce elite geographies while marginalizing vulnerable communities-through eco-parks, air corridors, and carbon credit schemes-this research argues for a shift from green governance to ontological urban ecology. Drawing from urban sociology, ecological anthropology, and atmospheric justice, it proposes "uncertain urbanism" as a framework that embraces the unpredictability, rituality, and memory embedded in urban airspaces. Rather than treating cities as mechanistic zones of control, this vision treats them as breathing, relational organisms-where green infrastructure must be attuned to both ecological rhythms and social fractures. In this framing, air becomes the first infrastructure, and the right to breathe-freely, safely, and with dignity-becomes central to urban justice. The project culminates in a call to reconceive urban planning as a poetics of relation, where sustainability emerges not through control, but through humility, relationality, and ontological plurality.

Theme 2: 53
Weathering the Risk: Investigating Farmer Withdrawals from PMFBY and Underlying Agricultural Challenges

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The Pradhan Mantri Fasal Bima Yojana (PMFBY) was launched to provide financial protection to Indian farmers against crop losses due to natural calamities, pests, and diseases. However, despite its intended benefits, several farmers have discontinued their participation in the scheme. This study investigates the underlying reasons for the withdrawal of PMFBY by beneficiary farmers in Samba district of Jammu and Kashmir. Data was collected from 225 farmers, including 150 PMFBY beneficiaries and 75 non-beneficiaries, binary logistic regression was used to analyze the data. The findings reveal that dissatisfaction with claim procedures, high premium rates, tedious processes and lack of transparency are the key drivers of discontinuance. Logistic regression analysis indicated that education level ($p=0.02$) and irrigated land holding ($p=0.009$) significantly influenced farmers' decisions to opt out. Farmers also suggested individual-level assessment (84.00%), greater awareness (75.00%) and improved claim settlement mechanisms (59.00%) to enhance the scheme's effectiveness. The study highlights the need for policy reform and targeted interventions to restore farmer confidence and ensure the sustainability of crop insurance in India.

Keywords: Crop insurance, Binary logistic regression, Policy reform

Theme 2: 54

Potentiality of Nanofertilizer based Integrated Nutrient Management on Yield, Quality and Economics of Chow-chow [*Sechium edule* (Jacq.) Sw.] in Chumukedima District of Nagaland

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A field experiment was conducted in Nagaland University, School of Agricultural Science, during 2022-2024 to study the potentiality of nanofertilizer based integrated nutrient management on yield, quality and economics of chow-chow [*Sechium edule* (Jacq.) Sw.] in Chumukedima district of Nagaland. A total of 22 treatments were evaluated and replicated thrice. The data were collected from five randomly selected plants of each treatment and subjected to statistical analysis. Results revealed that the application of different levels of nutrients either alone or in combination significantly increased the quality and economics of treatments as compared to the control. The results revealed that the highest yield was recorded in treatment T_{20} [PM @ 5 t ha^{-1} + ½ of RDF (N through nano urea) + MC] with 681.40 q ha^{-1} whereas the treatment amended with VC @ 2.5 t ha^{-1} + ½ of RDF (N through nano urea) + MC (T_{16}) resulted in better quality with higher values of TSS (4.66 ºB), crude protein (0.64%), total chlorophyll (0.289%), vitamin C (5.00 mg g^{-1}), total carbohydrate (3.75%), crude fibre (0.209%), calcium (12.93%), total phenolic content (1.73 mg g^{-1}) and shelf life (30.57 days). However, this data was statistically on par with T_{20} [PM @ 5 t ha^{-1} + ½ of RDF (N through nano urea) + MC] while in terms of the economics analysis of various treatments, the highest net return and C:B ratio was recorded in T_{20} [with PM @ 5 t ha^{-1} + ½ of RDF (N through nano urea) + MC] with Rs. 4,77,528.45 and 2.34 respectively. Thus, nanofertilizers shows great potential as a key component of integrated nutrient management (INM) and can be recommended to the farmers of Nagaland.

Keywords: Nanofertilizer, Chow-chow, Nutrient management, Nagaland

Theme 2: 55

Scientific Technologies for Sustainable Sugarcane Production

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The ICAR-ISRI, Lucknow has been working with the vision of developing an efficient, globally competitive & vibrant sugarcane agriculture and mission of enhancing sugarcane productivity, profitability and sustainability to meet future sugar and energy requirement. The Institute has developed several cost-reducing, environmental friendly and high yielding technologies. In this study, scientific technologies developed by IISR, Lucknow for sustainable sugarcane production has been discussed. Several high sugar varieties of sugarcane viz., CoLk 94184, CoLk 09204, CoLk 9709, CoLk 11203, CoLk 11206, CoLk 12207, CoLk 12209, CoLk 14201, CoLk 15466, CoLk 16202, CoLk 16202, CoLk 15206, CoLk 16466 & CoLk 16470 have been released for commercial cultivation. Several machines including Deep furrow sugarcane cutter planter, Trench planter, Sugarcane planter-cum-raised bed Multi-crop seeder, Sugarcane-cum-potato planter, Multipurpose inter-culturing equipment, Disc type Ratoon management device (RMD) etc., have been developed for mechanizing sugarcane cultivation.

Innovative planting materials like cane node and bud chip technologies have been developed for reducing the cost of cultivation. Similarly, furrow-irrigated raised bed (FIRB) system has been developed for sugarcane and wheat intercropping system. Improved planting methods like ring-pit planting and paired row system of planting including trench planting have also been found very effective for enhancing the cane yield. Surface drip and fertigation techniques developed by the Institute are helping in economizing the expenses of irrigation and fertilizers. Few biofertilizers have also been recommended for boosting the crop yield. The Institute has identified several bio-control agents like Epiricania melanoleuca, Dipha aphidivora and Trichogramma chilonis for biological control of major insects. IISR has developed a Combo insect trap (combination of light and pheromone) for mass trapping of white grub beetles and monitoring of moths of sugarcane borers. The blue bull repellent has been found very effective in repelling the blue bulls from the fields during night hours. Exogenous application of ethrel and gibberellin acid have been found instrumental in enhancing the yield of plant and ratoon crops. By adopting the above-mentioned scientific technology, farmers can sustain sugarcane production with its enhanced productivity and their net income by reducing the cost of cultivation.

Keywords: Sugarcane, Ring-pit planting, Net income

Theme 2: 56

Comparative Economic Analysis of FLD and Non-FLD Mustard Growers in Irrigated Condition of Muzaffarpur Distract of Bihar, India

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The present study was carried out in Muzaffarpur district of Bihar state as the district has a larger area and production of mustard cultivation. Muzaffarpur district falls under western transitional zone of Bihar. The district has 21950 ha of land under mustard cultivation. A multistage random sampling technique was adopted for selection of blocks, villages and sample farmers. In the first stage, Bandra block within Muzaffarpur district having highest area under mustard was selected. In the second stage, 5 villages with high concentration of area under mustard were selected at random namely, *Tepri, Patsara, Sakri, Kewtsa* and *Harpur*. From each village, 160 FLD farmers and 160 non-FLD farmers' were selected, thus making a total sample of 80 farmers each for FLD and non-FLD mustard cultivation. For evaluating the set objectives of the study, primary data were collected from the sample farmers by survey methods with the help of well-designed interview schedule by personally contacting the sample farmers. The results of the study indicated that FLD farmers were relatively younger than non- FLD farmers, who readily accepted the FLD mustard technology. FLD mustard growers found to be more productive yielding on an average 18.86 q/ha when compared to non-FLD mustard growers 11.09 q/ha, respectively. It was found to be superior in terms of gross income and net income over non-FLD farmers. The benefit cost ratio amply demonstrated the profitability of FLD farmers with 1.3:3.09. The partial budgeting analysis has suggested that farmers could benefit to the tune of Rs. 66500/ha by adopting FLD mustard technology. Further, the study indicated that there has been rapid expansion of area under of FLD mustard registering an impressive growth of 78.99 per cent during the last decade (2005-2006 to 2021-22).

Keywords: Adoption, Comparison, FLD, Technology and Mustard

Theme 2: 57

Carbon Farming for Climate-Resilient Rice Systems in India: Pathways to Low-Emission Agriculture

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Rice-based cropping systems are a cornerstone of food security in Asia, particularly in India, where rice cultivation supports over 100 million farmers. However, conventional rice farming is a major contributor to greenhouse gas (GHG) emissions, especially methane. As climate change intensifies, the agricultural sector faces mounting pressures including erratic weather patterns, declining soil fertility and shifting crop zones, highlighting the urgent need for sustainable alternatives that enhance resilience while reducing emissions. Carbon farming presents an innovative approach to transforming rice-based systems into climate-resilient landscapes through practices that enhance soil carbon sequestration and reduce GHG outputs. This paper explores carbon farming as an integrated climate-resilient strategy within rice-based systems, focusing on interventions such as alternate wetting and drying (AWD), biochar application, organic amendments, residue management, and rice-legume rotations. Drawing on empirical evidence, policy analysis, and case studies from India and other developing economies, the study examines how these practices improve soil health, lower emissions, and sustain productivity. The paper also discusses enabling mechanisms such as government programs, carbon credit markets, and community-based approaches that facilitates adoption. Despite these emerging opportunities, challenges persists in terms of awareness, scalability, and policy coherence. The study concludes by proposing a framework for scaling carbon farming in developing economies, emphasizing inclusive, science-based, and farmer-centric approaches that align agricultural development with climate action. This research offers valuable insights for policymakers, researchers, and practitioners working at the intersection of agriculture and climate change.

Keywords: Climate change, Carbon farming framework

Theme 2: 58

Economics of Diversification: A Study on Integrated Farming in Rainfed Areas

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Integrated Farming Systems (IFS) represent a holistic approach to agriculture that aims to optimize resource use and enhance farm productivity by integrating various agricultural enterprises such as crops, livestock, poultry, fishery, mushroom, and agroforestry. The present study was conducted to identify and evaluate the existing IFS in the Samba district of Jammu and Kashmir, focusing on their composition, economic viability, diversification, sustainability, and efficiency. The data were collected from 50 IFS farmers from Nud and Purmandal blocks of Samba district by personal interview schedule method. Seven distinct IFS models were observed among 50 farmers, FS -I (Crop + Dairy), FS -II (Crop + Poultry), FS -III (Crop + Dairy + Goatry), FS – IV (Crop + Dairy + Mushroom), FS – V (Crop + Dairy + Goatry + Poultry), FS – VI (Crop +Dairy +Goatry + Mushroom), and FS – VII (Crop +Dairy +Goatry + Poultry + Mushroom). Out of the seven FS models, FS- I was the most prevalent system and was adopted by 50% of the respondents. The highest diversification (crop: 0.57 and livestock: 0.52) was found in FS-VII, whereas least diversity was showed by FS-I. Economic analysis demonstrated

that FS-VII generated the highest gross and net returns per annum (Rs. 6,64,657.3/year and Rs. 3,49,780.3/year respectively) along with a Benefit-Cost (B:C) ratio of 2.11:1. However, FS-VI achieved the highest B:C ratio of 2.34:1, indicating efficient resource use. In terms of System Economic Efficiency (SEE), FS-VII again led to additional generation of Rs. 191/day, while FS-II showed the lowest efficiency (Rs. 100/day). The Sustainability Value Index (SVI) of FS-VI was 0.49 which indicates it as the most sustainable and have strong potential for long-term viability. Overall, the analysis highlights that FS-VI and FS-VII tend to offer higher sustainability and profitability. Thus, on the basis of results, it is suggested that promotion of multi-component farming systems could stabilize farm income, resource efficiency and ecological resilience in the area, provided adequate support and capacity building activities are extended to farmers.

Keywords: Integrated farming system, Livestock, Sustainability value index, System economic efficiency

Theme 2: 59

Role of Climate Smart Agricultural Practices in Adoption of Zero Tillage Technology in Rice-Wheat Cropping Systems in Muzaffarpur District of Bihar, India

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Zero tillage (ZT) is defined as planting crops in previously unprepared soil by opening narrow slots or trenches of the smallest width and depth needed for proper coverage of the seed. At least 33.5 per cent of the soil surface remains covered with crop residue. Zero tillage is, in a way, a complete farm management system that should include many agricultural practices, including planting, plant residue management, weed and pest control, harvesting, and crop rotations. The work on ZT in Muzaffarpur district started as early as in the 2012, but it was not successful due to technical difficulties, such as lack of adequate planting equipment and difficulty in chemically controlling the weeds. It restarted in 2020 with introduction of inverted ZT openers by the Climate Resilient Agriculture Project (CRAP) of Govt. of Bihar. In 2020-21 a prototype was developed at Dr. Rajendra Prasad Central Agricultural University, Pusa. After many refinements and adaptation of ZT machine in 2020, about 50 ZT drill machines were supplied to farmers and KVK, Turki. This was done to better understand the problems in machine operations. The combined efforts of CRAP project, Rice-Wheat Consortium for Indo-Gangetic Plains and KVK, Turki resulted in wide spread adoption of ZT after the turn of the century. It is estimated that approximately 540 hectare area is under ZT and reduced tillage in Muzaffarpur district (RWC 2020), covering district of all blocks and the impact of ZT was 54.6%, adoption of ZT in rice-wheat cropping system 59.4%, respectively. The results confirm the trend of slowing down of productivity growth of rice and wheat in Muzaffarpur for adoption of ZT in rice wheat cropping system. The rate of varietal improvement and notification has increased for both the crops, but there is varietal concentration in both the crops. The zero tillage in wheat and crop variety improvement is the major technological interventions in the systems, which have generated the returns to the order of 89.5% in 2021. The estimated IRR is 41.4% and the ratio of net benefits to the cost is 2.9 in zero tillage rice-wheat cropping system.

Keywords: Adoption, Zero tillage, Cropping system, Impact.

Theme 2: 60
Climate Resilience through Agri-Diversification with Arid Legumes

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Cowpea, horsegram and mothbean are the drought tolerant arid legume crops which are important and the cheapest source of plant based proteins, vitamins and minerals for majority of vegetarian population of India. Under the present crisis of climate change, these arid legumes can play an important role in improving agricultural sustainability and providing healthy and sustainable food system. Having ability to fix atmospheric nitrogen in the soil with the help of *Rhizobium* present in root nodules of these crops, arid legumes are also instrumental in climatic change mitigation by reducing dependence on synthetic fertilizers. Inclusion of arid legumes in intercropping and cropping systems, mitigates the risk of soil erosion and depletion as well as higher soil carbon sequestration potential than mono-cropping. Requiring less water, these arid legumes are suitable for rain-fed farming. These crops are helpful in better utilization of land as the most of these crops are grown on marginal land. Arid legumes also being an important crops are grown on marginal land. Arid legumes also play an important role in disrupting pest and disease cycle. During extreme drought situation, mothbean is the only crop which may be cultivated for grain and fodder with minimum water, tillage and other agronomic inputs. Thus, these crops of dry habitats are characterized with low cost of production, important source of livelihood, security of financially ridden arid farmers. These crops have easy adaptability to specific set of environments. Arid legume crops are known for taming drought, sustaining productivity of soil and crop, stabilizing farming systems and ensuring nutritional and livelihood security. Arid legumes enriched with the above mentioned virtues make these crops locally and regionally important to foremost dryland crops of great economic significance.

Keywords: Legumes, Adaptability, Dryland

Theme 2: 61
Climate Resilient Farming Practices: Adapting to Climate Change with Innovative Solutions

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Plant tissue culture is a critical biotechnological tool for large-scale production of healthy, disease-free planting materials. This review emphasizes its importance in horticulture, forestry, and agriculture by analyzing its concepts, techniques, limitations, and developments. Whereas plant tissue culture has many advantages, it suffers from limitations in the form of contamination, prohibitive costs, and somaclonal variation. In order to enhance efficiency and dependability, recent developments consist of the implementation of Plant Preservative Mixture (PPM), biocides, and optimized sterilization procedures. This review discusses the current advances in culture media optimization, contaminant management, and genetic stability, all of which are key to maximizing tissue culture success rates. In the age of climate change, plant tissue culture is gaining more significance in the development

of climate-resilient crops and genetic conservation. By allowing for quick multiplication of superior cultivars, preservation of rare species, and cultivation of genetically altered plants, this method resolves the disadvantages of conventional propagation. Meristem culture, especially, allows for virus-free plant production, resulting in greater yields and better quality crops. Key achievements are successful recovery of healthy planting material, inoculation of cultures, and optimization of shoot initiation. Measures to manage contamination include examining sterilization procedures, testing disinfectants, and enhancing aseptic methods. Challenges have been overcome by refining protocols and adjusting exposure time. Minimizing reliance on conventional propagation methods means that farmers will be able to rely on good and affordable seedlings, resulting in sustainable agricultural development and economic stability. This provides improved productivity, quality fruit, and increased market returns. Plant tissue culture is also important in conserving biodiversity by allowing the mass propagation of endangered and rare plant species in vitro. With continued development in agriculture, this technique is still a sustainable and viable means of enhancing crop productivity, environmental conservation, and food security.

Keywords: Micropropagation, Plant tissue culture, PGRs', Food security and Agriculture sustainability

Theme 2: 62

Understanding Farmers' Perception towards Precision Agriculture in Sugarcane Production in Punjab (India) and Eswatini: A Qualitative Approach

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The present study examines the adoption of precision agriculture technologies in sugarcane production in Punjab, India, and Eswatini, focusing on farmers' perceptions of these innovations and their potential to optimize agricultural practices. Through qualitative methodologies, including design thinking, Q-methodology, and case studies, the research provides a nuanced understanding of the behavioural and contextual factors influencing technology uptake. Precision agriculture technologies such as GPS-guided machinery, GIS mapping, remote sensing, and IoT systems have emerged as pivotal tools in transforming sugarcane production. In Punjab, sugarcane farmers have implemented techniques like subsurface drip irrigation and fertigation to enhance resource efficiency and crop yields. Precision agriculture technologies have enabled more targeted application of water and nutrients, improved productivity while promoting environmental sustainability. Similarly, Eswatini's sugarcane sector has integrated remote sensing, precision irrigation, and AI-based yield prediction to adapt to erratic weather patterns and optimize land use. These tools have shown potential to increase yields and reduce input costs, contributing to the sustainability and resilience of sugarcane production. While the adoption of these technologies has showcased promising results, their successful implementation requires a deeper understanding of farmers' perceptions. This study emphasizes that farmers' attitudes toward precision agriculture are influenced by factors such as compatibility with traditional practices, perceived benefits, and ease of use. Tailored farmer-centric interventions are essential to bridge the gap between awareness and adoption, ensuring these technologies reach their full potential. By contextualizing precision agriculture within regional challenges and socio-economic dynamics, this research offers actionable recommendations for promoting inclusive access to these innovations. It aims to foster sustainable agricultural practices that enhance productivity and resource efficiency, while addressing environmental and economic concerns. The findings contribute valuable insights to global efforts in advancing precision agriculture technologies and achieving resilient food systems.

Keywords: Precision agriculture, Sugarcane production, Adoption barriers, Farmers' perception, GIS mapping

Theme 2: 63
Smart Framing Practices to Mitigate the Effect of Climate Change

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Climate change has become a buzzword since the beginning of the 21st century. The developing country like India is more vulnerable where about two-thirds population directly or indirectly depends on agriculture and allied activities for their livelihoods and economy. Abnormal rainfall pattern, rising average temperature, and increase in the incidence of extreme weather events such as floods, heatwaves, droughts, cyclones, and forest fires are the major signs of climate change. Climate is considered to be the core of agriculture and present situation of changing climatic conditions are exerting large number of adverse effects on agriculture and its variability remain to be a major threat in practicing sustainable agricultural practices among farming community. Climate change is the most important global ecological challenge facing humankind, affecting food production, healthy habitats, freshwater availability, and human well-being etc. which has raised the importance of climate smart farming practices to enhance the resilience of agriculture. So, there is a dire need to smart farming practices including judicious use of water and plant nutrients, soil conservation and remedial measures to enhance soil fertility, pest and insect management, adoption of organic and natural farming practices, crop diversification recognising the emission intensity of crops, wider use of climate resistant and high yielding seeds, particularly by small holder farming community, adoption of sustainable animal breeding practices, arresting conversion of forest land and encroachment of mangroves, reducing crop residue burning; and reducing food wastes at different stages of the food supply chain etc.

Keywords: Effect, Management, Resource, Sustainable and Weather

Theme 2: 64
Assessing Gender-Specific Training Needs for Climate-Smart Agriculture in the Upland Shan Region of Myanmar: A Comparison between Climate-Smart and Non-Climate-Smart Villages

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Mainstreaming gender in climate smart Agriculture requires targeting program to ensure equitable benefits and enhance the effectiveness of agricultural production in addressing climate change. The present study aimed to identify and quantify the training needs of male and female farmers in the Upland Shan Region of Myanmar, focusing on Climate-Smart Villages (CSV) and Non-Climate-Smart Villages (Non-CSV). A structured quantitative approach was used to develop and validate a reliable Training Need Index (TNI) for climate-smart agriculture (CSA), considering five key dimensions: climate-resilient crop cultivation, water management, pest and disease control, resilient livestock practices, and climate-smart technology adoption. Expert validation was carried out with 94 professionals from Myanmar and India, using a five-point Likert scale to assess the relevance of 10 statements per theme. The final TNI included 25 validated items, with Cronbach's alpha ranging from 0.75 to 0.83, ensuring internal consistency. Stratified random sampling was applied across CSV and Non-CSV areas, selecting 200 respondents equally divided by gender. Results showed that most male (56%) and female (70%) respondents had medium training needs, while high training needs were more recorded in Non-CSV respondents

compared to CSV respondents. Regression analysis indicated that local ecological knowledge was the strongest predictor of training needs for male farmers (β= 0.449, p = 0.001), while education level was the primary determinant for female farmers (β = 0.655, p = 0.001). These predictors explained 68.1% of the variance for male farmers and 66.7% for female farmers, respectively.

Keywords: Training need index, Climate smart agriculture

Theme 2: 65

Direct Seeded Rice and Smart Farming Synergy: A Roadmap to Climate-Resilient Food Security

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A paradigm shift in rice production methods is required due to the rising demand for rice, climate change, and the depletion of natural resources. The labour and water requirements of traditional puddled transplanted rice (PTR) provide sustainability issues. A viable substitute that offers notable benefits in terms of labour efficiency, cost effectiveness, and water conservation is Direct Seeded Rice (DSR). In order to improve sustainable production and maximize resource use, this research investigates the integration of smart farming technology with DSR. Precision farming solutions like drone-assisted field monitoring, automated irrigation systems, IoT-based soil moisture monitors, and remote sensing are all included in smart farming. These technologies enable data-driven decision-making when integrated with DSR systems, guaranteeing optimal input application, timely planting, and efficient weed and pest control. Beside lowering the carbon and water impact, the combination of DSR and smart farming increases yield consistency across a range of climates. This study offers case studies and field-level deployments that show how DSR may revolutionize traditional processes when paired with digital agriculture solutions. Without sacrificing production, the results show up to 40% water savings, lower methane emissions, and a 15%–20% decrease in cultivation expenses. Predictive analytics and site-specific nutrient management have also shown promise in reducing environmental effects and raising farmer profitability. A roadmap for scaling smart DSR techniques across various agro-ecological zones and policy recommendations are included in the paper's conclusion. Adopting such integrated systems can be crucial to guaranteeing long-term food security and achieving climate-resilient agriculture.

Keywords: Direct seeded rice, Precision agriculture, Water conservation, Sustainable rice production

Theme 2: 66

Achieving Dairy Aspiration in Climate Realities: Women-Centric Climate Adaptation Plan for Rural Haryana using Fuzzy Cognitive Approach

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Climate variability and extremes are increasingly impacting dairy farming systems in Haryana, India-particularly affecting women dairy farmers, who form the backbone of rural dairy production. Therefore, the study was designed to develop a participatory adaptation planning framework for women dairy farmers across climate-vulnerable districts of Haryana. Participatory Integrated Climate Services for Agriculture (PICSA) and Fuzzy Cognitive Mapping (FCM) approach-based scenario analysis was used to identify the impacts & adaptation

towards four climate hazards viz. heat stress, drought, cold stress and flood on dairy animals as perceived by the women dairy farmers. Fifteen, thirteen, seven, eleven climatic adaptation options were identified through PICSA to cope up with heat stress, drought, cold stress, flood respectively. More than 90 percent of the loss in milk production can be retrieved by implementing the climate adaptation plan to cope with heat stress-related hazards, as perceived by the women dairy farmers. Whereas 44.19 percent of reproductive performance of dairy animals can be improved by implementing the climate adaptation plan to cope with heat stress-related hazards. Effect on fodder production could be retrieved by 77.49 percent by implementing a climate adaptation plan to cope with drought related hazards. Only 15.20 percent of the loss in milk production can be retrieved by implementing the climate adaptation plan to cope with cold stress-related hazards, as perceived by the women dairy farmers. About 48.75 percent and 46.99 percent of loss of livestock and economic loss, respectively can be retrieved by implementing the climate adaptation plan to cope with flood related hazards, as perceived by the women dairy farmers. Hence, upscaling of these proven adaptation plan may increase climate resiliency of the women dairy farmers of rural Haryana.

Keywords: Climate resilience, Women farmers, Fuzzy cognitive mapping, PICSA

Theme 2: 67

Techniques for Quality Nursery Rising of Vegetable Crops for Weaker Section Farmers of Koderma District of Jharkhand

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The farming in Chhota Nagpur plateau of Jharkhand suffers from scattered traced land, erratic climate, rainfed conditions. Majority of (75%) male migrate from Chhota Nagpur plateau region to metro city in search of employment. Therefore, the Chhota Nagpur plateau farming is largely dependent on women. Women are also involved in other responsibilities, as a house wife, mother, farming and social activities, with all these commitments, women workers are very hard pressed which affect their health. Therefore, there is an urgent need for women friendly technologies which could save their time and energy. Majority of farmers follow traditional practices of farming which are not very remunerative. The climate of this area is suitable for the production of off-season vegetables. Some enterprising farmers have started growing vegetable crops on a commercial scale. However, low germination and survivability of vegetable nurseries in open field due to low temperature during December to January and excessive rain during mid-June to August and wild animal are still major problem. To overcome these problems, a trail was conducted to enhance the germination and survivability of vegetable nurseries using poly tunnel. Plots of 1x 6 m size were prepared by making 6 inch raised bed in open field and 2 beds of same size were prepared in a polytunnel for trail in five different villages. Two beds of open field were covered with poly tunnels and the other two were kept opened. In each bed, seeds of chilli, tomato, broccoli, cauliflower, cabbage and brinjal were sown (each crop in 1 X 1 m size). All the recommended practices of nursery growing were followed. The findings showed early and greater germination percentage in nurseries grown in poly tunnel as compared to open fields. The incidences of disease were also less in poly tunnels than in open fields. In poly tunnels, nurseries were ready for transplanting 08-10 days prior to the open field. Based on the result, it can be inferred that use of poly tunnel can provide greater germination, survivability, early and healthy nurseries of vegetable crops.

Keywords: Off-season vegetables, Polytunnel, Nursery

Theme 2: 68

Adapting Tomato Cultivation to Climate Variability: A Study on Sowing Windows, Genotypic Response, and Disease Intensity

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An investigation was conducted in the northern Tripura region to study the conjugal influences of different sowing windows and varieties of tomato as autumn-winter crop to identify the most suitable range of transplanting season in association with varietal specificity on the light of general correlation study and diversity analysis through PCA and clustering behaviour. Over all experimental outcome, pinpointed to the fact that cultivation of tomatoes in the autumn-winter season could be commenced in these areas between second to last week of October with choice of varieties as Arka Abhed, Arka Rakshak and Arka Samrat. With these combinations least significant positive association between yield loss percentage and incidence of TYCLV has been obtained with a value of 0.686 and an insignificant relationship between the yield loss percentage and the outbreak of early as well as late blight had been visualized as 0.416 and 0.414, respectively and consequently it boosted up the yield and quality in a significant manner. Under any kind of deviation, however, this time duration could be extended up to the first week of November with the inclusion of other varieties such as Kashi Aman and Arka Apeksha.

Keywords: Clustering, Blight, Sowing windows, Tomato

Theme 2: 69

Effect of Biosynthesized ZnO Nanoparticles on Drought Tolerance Mechanism in Wheat (*Triticum aestivum* L.)

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Nanoparticles have potential for site-specific delivery of nucleotides, proteins and chemicals including fertilizers for improving crop performance in terms of better growth and productivity. In this study, zinc oxide nanoparticles synthesised from leaves of *Saraca asoca* plant using a green synthesis methodology and characterized with X-ray Diffraction (XRD), Scanning electron microscopy (SEM) and UV visible spectroscopy have been used. Wheat genotypes Raj- 4037 (drought tolerant) and Raj-4238 (drought sensitive) were grown in pots and raised under recommended package and practices. The plants were sprayed with ZnO nanoparticles 0, 100, 200 and 300 ppm at flowering and grain filling stages. The drought conditions were created by withholding irrigation for a period of 8 days at flowering and grain filling stages. The non-stressed plants were irrigated as and when required. Various physiological and biochemical parameters were recorded at flowering and grain filling stages whereas yield and yield contributing parameters were recorded at maturity. Results showed that there was significant decrease in carotenoid, total chlorophyll content, membrane stability index, and relative water content and significant increase in proline, total soluble sugar, MDA and antioxidant enzymes (SOD and Catalase) in both the genotypes under drought. ZnO nanoparticle treatment significantly increased the relative water content,

membrane stability index, total chlorophyll content, carotenoids, proline content, total soluble sugar, MDA and antioxidant enzymes (SOD and Catalase) in both the genotypes with variable magnitude. Among ZnO nanoparticles, 200 ppm was found the most effective concentration for increasing the physio-biochemical parameters and yield of both genotypes under both control and water-stress conditions. On the basis of present investigation, it is suggested that Raj-4037 performed better under water stress condition and application of 200 ppm ZnO nanoparticles can be used to ameliorate the adverse effect of water stress in wheat by adjusting physio-biochemical parameters, yield and yield attributing characteristics.

Keywords: Nanoparticles, Wheat, Genotypes, Carotenoids

Theme 2: 70

Evaluation of Knowledge Levels among Fish Farmers on Climate Change Adaptation Strategies for Sustainable Aquaculture

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Knowledge plays a pivotal role in shaping individual behaviour, especially in fields like fish farming, where understanding climate change is critical. This study assesses fish farmers' knowledge of climate change and its implications for aquaculture through a structured knowledge test. Conducted in the North 24 Parganas and South 24 Parganas districts of West Bengal, data were collected through a structured interview schedule. Based on statistical division using mean and standard deviation, respondents were categorised into three knowledge levels: low, medium and high. The findings revealed that 22.67 per cent of respondents fell into the low knowledge category, indicating limited awareness of climate change impacts on fish farming. Their limited knowledge makes them particularly vulnerable to climate-induced challenges such as rising temperatures, erratic rainfall and disease outbreaks and hinders their ability to adopt adaptive strategies. A majority of the respondents (59.67%) demonstrated a medium level of knowledge. While these farmers showed moderate understanding of climate-related issues, their awareness was often acquired through informal means like peer interactions or partial participation in training programmes. Only 17.66% of respondents were classified under the high knowledge category. These farmers displayed advanced understanding of climate change impacts and were more likely to adopt sustainable practices, such as water quality management, selection of climate-resilient species and farming diversification. Their expertise often stemmed from experience, formal training, and proactive engagement with educational resources. The study highlights the need for tailored knowledge dissemination strategies. Encouraging peer-led learning and continuous education can foster resilience and promote climate-smart aquaculture practices across communities.

Keywords: Climate change, Knowledge level, Aquaculture

Theme 2: 71

Effect of Weed Management under Different Tillage Practices on Growth of Chickpea (*Cicer arietinum* L.)

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A field experiment entitled "Weed management in chickpea (*Cicer arietinum* L.) under different tillage practices in trans-gangetic plain region" was conducted for two consecutive *Rabi* seasons of 2022-23 and 2023-24. The experiment consisted of twenty eight treatment combinations comprising of four different tillage practices (zero, minimum, conventional and deep tillage) and seven different weed control measures (weed free, weedy check, pendimethalin 750 g/ha PPI, pendimethalin 750 g/ha PE, pendimethalin + imazethapyr 800 g/ha PE, diclosulam 25 g/ha PE and flumioxazin 75 g/ha PE). The experiment was laid out in split plot design with three replications. Chickpea variety GNG-1581 was sown at 30 cm row spacing using 60 kg/ha seed rate. The results of experiment showed that deep tillage significantly increased the growth attributes *viz.,* plant height, number of branches/plant, dry matter accumulation, crop growth rate at 0-30, 30-60 and 60-90 DAS, relative growth rate at 30-60, 90 DAS- harvest, number and dry weight of root nodules at 50 DAS, chlorophyll content of chickpea. The highest net returns (Rs. 120806/ha) with B:C ratio of 3.42 were also obtained in deep tillage over zero and minimum tillage. However, it was at par with conventional tillage. Results further showed that weed free significantly increased the growth attributes *viz.,* plant population at 20 DAS and at harvest, plant height, number of branches/plant, dry matter accumulation at 30, 60, 90 DAS and at harvest, CGR at all stages, RGR at 90 DAS-harvest, number of root nodules/plant and dry weight of root nodules/plant at 50 DAS, chlorophyll content at 50 DAS. However, it was statistically at par with pendimethalin + imazethapyr 800 g/ha PE. But at 30-60 DAS significantly higher RGR was recorded under weed free over all other weed control measures whereas diclosulam 25 g/ha PE registered maximum RGR between 60-90 DAS. B:C Ratio (4.04) and net return (Rs. 130879/ha) was also higher in pendimethalin + imazethapyr 800 g/ha PE.

Keywords: Weed management, Chickpea, Tillage practice, Net returns

Theme 2: 72

Association Between Perception and Adaptation to Climate Change with Socio Economic Characteristics of Fennel Growers in Nagaur District of Rajasthan

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The investigation was imperative to study for assessing the association between perception and adaptation to climate change with independent variables of fennel growers in in arid and semi-arid region. Climate change is one of the biggest challenges faced by the world today. The present study was carried out during the year 2019 and total randomly selected samples for the study were 160 out of them 80 small farmers and 80 large farmers. The data was analysed through Multiple linear regression and Paired t Test. The study concluded that there was significant association between the perception about climate change of large farmers with annual income education, age, mass media exposure, and occupation at 01 per cent level of significance. In case of small farmers, mass

media exposure, annual income, and education were found to be positive and significant association with perception at 01 per cent level of significance, whereas, occupation and age were significantly associated with perception about climate change of the small farmers at 05 per cent level of significance. Further the result indicated that extension agency contact, annual income, occupation and education were the important contributing factors for the adaptation measures to climate change as extension agency contact, annual income, occupation, and education were positively and significantly associated with adaptation at 01 per cent level of significance.

Keywords: Association, Independent variables perception, Adaptation, Climate change

Theme 2: 73

Shifting Cultivation and Sustainable Livelihood amidst Climate Change: Can Frontline Extension Act as a Buffer?

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Shifting cultivation, locally known as jhum, has been a dominant agricultural practice in Northeast India since time immemorial. However, the increasingly shortened jhum cycles have had detrimental effects on both forests and the environment. Over 80% of jhumias (practitioners of jhum cultivation) recognize the negative environmental impact, citing a significant decline in forest cover over the years, and nearly 45% report complete forest loss due to indiscriminate jhum practices. Despite limited research on the livelihood sustainability of these marginalized communities, this study explores both the sustainability of jhum-based livelihoods and the social vulnerability of jhumias to climate change through an indicator-based approach. A comparison of jhumias' perceptions of climate change with meteorological data suggests that their observations are largely credible, despite some inconsistencies related to precipitation. Approximately 76% of jhumias have modified their agricultural calendars in response to climate change, especially in sowing, weed control, crop protection, and harvesting decisions—more so than in pre-sowing activities such as land selection and forest clearing. Sustainability assessments reveal that, with the exception of Mizoram, jhum-based livelihoods are largely unsustainable across other Northeastern states. In Manipur, 39.22% of jhumia households fall into the lowest category of livelihood sustainability, while in Assam, this figure rises to 86.67%. Social and financial capital emerged as critical components for improving livelihood sustainability. Vulnerability analysis indicates that jhumia households from the states of Tripura and Mizoram are the most socially vulnerable. Overall, 68.33% of jhumia households are classified as moderately to highly vulnerable. FES interventions have the potential to reduce this vulnerability by enhancing adaptive capacity and decreasing dependence on jhum cultivation. Key determinants of engagement with FES include education, resourcefulness, geographic accessibility, progressive attitudes, and access to alternative information sources. The adoption of technologies such as rainwater harvesting (RWH) and integrated farming systems (IFS) has increased average cropping intensity from 100% to 168%. Furthermore, introducing vermicomposting through IFS enables the recycling of approximately 3.17 tonnes of biomass to produce around 1.24 tonnes of mature compost annually. Incorporating livestock into the model has resulted in a 56.59% increase in net household income. Based on these findings, we recommend that FES programs prioritize easy-to-adopt, low-cost, and low-skill alternative income-generating activities. Emphasis should be placed on integrated farming with animal components, promoting high-yielding and stress-tolerant crop varieties, and increasing seed replacement rates to reduce social vulnerability and improve livelihood sustainability.

Keywords: Shifting cultivation, Climate change, Social vulnerability, Integrated farming systems, Livelihood sustainability

Theme 2: 74

Challenges and Strategies for Effective Implementation of Weather-Based Agro-Advisory Services in Telangana and Andhra Pradesh States of India

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Weather-based agro-advisory services are pivotal for empowering farmers with timely, location-specific weather information to enhance decision-making in agriculture. This study investigates the challenges and proposes strategies for the effective implementation of WBAAS in Telangana and Andhra Pradesh, focusing on cotton-growing regions. Data were collected through surveys from 240 farmers (120 Telangana and 120 Andhra Pradesh) and interviews with 30 agricultural extension workers and weather service providers across six districts in the two states. Statistical analysis revealed that 68% of beneficiary farmers reported increased awareness of weather patterns, while 59% indicated improved yields. However, constraints such as limited access to advisories (affecting 40% of respondents), lack of literacy to interpret technical information (58%), and delayed dissemination (48%) hinder the optimal utilization of WBAAS. Key findings show that 68% of non-beneficiaries were unaware of the existence of AAS, highlighting the need for enhanced outreach. Only 30% of the farmers had access to digital platforms like mobile apps, while others relied on traditional methods such as television and radio, which often failed to provide localized or crop-specific advisories. Technological barriers, including poor mobile connectivity in rural areas, were reported by 38% of respondents. Additionally, there was limited feedback integration, with 72% of farmers expressing a need for customized and actionable advisories. To address these challenges, the study proposes strategies such as expanding the use of mobile-based applications and community radio, improving the content and relevance of advisories, and training programs to enhance digital literacy among farmers. Partnerships between meteorological agencies, agricultural extension departments, and local farmer organizations are recommended to improve dissemination efficiency. Establishing farmer-centric feedback mechanisms and investing in rural communication infrastructure were also identified as critical interventions. With targeted efforts, these services can bridge the gap between climate-smart agricultural innovations and practical farming needs, fostering sustainable development in the region.

Keywords: Weather-based agro-advisory services, Constraints, Strategies, Cotton farmers, Rural communication, Sustainable agriculture

Theme 2: 75

Impact of Training and Information Sources on IPM Awareness among Farmers: A Study in Punjab

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Agriculture is a pivotal element of Punjab's economic landscape, influencing the state's cultural, social, and economic spheres. Indiscriminate and excessive applications of synthetic pesticides have not only damaged environment and agriculture but have also caused their entry into the food chain. Evidences of pesticide threats to human health and economic effects have been documented in several studies. Integrated Pest Management (IPM) emerges as a vital strategy in this context, focusing on long-term pest prevention and management through a combination of biological control, habitat manipulation, cultural practice modification, and the use of resistant plant varieties. IPM represents an ecosystem-based approach, aiming to minimize the reliance on chemical pesticides and promoting sustainable agricultural practices. This study investigates the influence of training exposure and mass media engagement on the awareness and adoption of Integrated Pest Management (IPM) strategies among litchi growers in Punjab's Pathankot and Gurdaspur districts. Data was collected from 100 respondents using multistage purposive random sampling and structured interviews. The findings reveal that only 35% of farmers had undergone formal IPM training, while mass media exposure was predominantly at a medium level among 56% of respondents. A strong positive correlation (r = 0.62) was observed between training exposure and IPM knowledge, and a moderate correlation (r = 0.49) was found with mass media exposure. Trained farmers and those with high mass media engagement demonstrated significantly higher awareness and adoption rates of IPM components compared to their counterparts. Farmers with better exposure were more familiar with biological control methods, economic threshold levels, and alternative pest management strategies. However, constraints such as limited access to training, insufficient localized demonstrations, and lack of targeted media content were identified as barriers to effective IPM adoption. The study underscores the importance of expanding structured training initiatives and enhancing mass media outreach to bridge knowledge gaps and encourage sustainable pest management practices among litchi growers. Strengthening these support systems can significantly boost IPM adoption rates, promoting environmentally sustainable and economically viable litchi production.

Keywords: Adoption, Integrated Pest Management (IPM), Awareness, Respondents

Theme 2: 76

Assessing Determinants of Climate-Smart Agriculture Adoption: A Binary Logistic Regression Approach

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Climate change, characterized by escalating global temperatures, erratic weather patterns, and the increasing incidence of extreme events, presents a formidable challenge to agriculture by compromising crop yields, food security, and rural livelihoods. In response, Climate-Smart Agriculture (CSA) has emerged as an integrative framework aimed at sustainably enhancing agricultural productivity, encouraging resilience to climate-related risks, and mitigating greenhouse gas emissions. CSA promotes the adoption of innovative practices such as improved crop varieties, water management strategies, and agroforestry to assist farmers in adapting to the evolving climate landscape. This study examines the key factors influencing farmers' likelihood of adopting climate-smart agriculture (CSA) practices by applying binary logistic regression to data collected from a survey of 100 farmers in Climate Smart Villages and 100 farmers in non-Climate Smart Villages across eight villages in the Samastipur and Darbhanga districts of Bihar. Binary logistic regression was applied to evaluate factors influencing the likelihood of farmers being climate-smart, revealing differing results for the two groups. For CSV farmers, positive contributors included annual income, owned land, leased-in land, economic motivation, scientism, innovativeness, and frequency of training, while family size had a negative effect. For non-CSV farmers, age, economic motivation, and climate-related information positively influenced the climate-smart score, while fatalism had a negative effect. By quantifying these influences, the study provides insights into critical enablers for CSA uptake, highlighting opportunities for policymakers to better target interventions that support sustainable and climate-resilient farming systems.

Keywords: Climate change, Climate smart agriculture, Logistic regression

Theme 2: 77

Field Evaluation of Synthetic Insecticide and Biopesticides Against Wheat Aphid Complex in Wheat

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Aphid attained the status of regular insect pest with significant impact on crop yield of wheat. The efficacy of six insecticides against wheat aphid was evaluated under field conditions with randomized completed block design in three replications during 2021/22 and 2022/23 at NWRP, Bhairahawa, Nepal. The insecticides Spinosad 45% Spinosyn 0.25 ml lit^{-1}, Imidacloprid 70% EC @ 2 ml lit^{-1}, Fipronil 0.6% GR @ 50 g a.i. ha^{-1}, Neem oil 0.3% @ 10 ml lit^{-1}, Neem leaf extract @ 15 kg 30 lit^{-1} and Neem seed kernel @ 75g lit^{-1}, plain water @ 400 lit ha^{-1} as check and control (without any spray) were applied when the aphid count crossed the economic threshold level. Aphids collected from the field were identified in Entomology laboratory, NWRP; and found *Sitobion avenae*, *Rhopalosiphum padi* and *Schizaphis graminum*. The aphid and natural enemy counts were done in 10 plants and averaged as per plant. The aphid density two days after treatment was reduced drastically, water was found to control aphid effectively. The aphid density of five, seven and ten days post treatment was reduced drastically. Imidacloprid had higher pest reduction with the higher grain yield of 4.2 mt ha^{-1} followed by Spinosad with the grain yield of 4.1 mt ha^{-1} while the least yield with the grain yield of 3 mt ha^{-1} was observed in control plot with high density of aphids which was followed by Neem leaf extract treated plot with the yield of 3.7 mt ha^{-1}. The population densities of the coccinellids and syrphids in the control plots and water applied plots were abundant, while less abundant in other treatments. The efficacy of natural enemies was affected by the application of pesticides with repellent or toxic effect, aphid activity and the environmental condition. Abiotic factors such as plant nutrients, temperature, relative humidity was also responsible for abundance and interaction of aphids and natural enemies and impact on wheat yield.

Keywords: Wheat, Aphids, Pesticides, Aphid density, Natural enemies

Theme 2: 78

Rice Rhizosphere Bacterial Community under Different Nitrogen Application and Soil Moisture Regimes

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Plant-microbe interactions at rhizosphere interface plays significant roles on plants nutrition and such interactions may be under tremendous influence by applied doses of inorganic nitrogenous fertilizers and availability of soil moisture. This study assessed whether applied low and high doses of inorganic N fertilizer under aerobic and submerged conditions alter the core microbiota community in the rhizosphere of scented rice. A control experiment was conducted under aerobic and submerged condition with four different treatments *viz.*, Control (no application), Biofertilizer (CAU Bioenhancer), Low N (25 kg ha^{-1}) and High N (125 kg ha^{-1}) with five replications. Rhizospheric soil were collected and their bacterial community composition was analysed based on

sequencing of the V3-V4 region of the 16S rRNA gene. Values of soil pH, organic carbon and availability of N, P and K, and readily soluble Al were significantly varied between treatment combinations. Growth and yield attributes such as plant height, number of effective tillers and grain and straw yield of rice were also greatly influenced by different soil moisture regimes. The diversity parameters of bacterial community among the treatments varied significantly. A total of 1059 OTUs were identified commonly under aerobic and submerged condition by 16S rRNA sequencing profiling, using a 97% of similarity against the database. 221 OTUs and 400 OTUs were obtained from aerobic and submerged conditions, respectively. Different treatments under submerged condition showed higher indices of richness and diversity estimators (Sobs, Chao, ACE, Shannon, Simpson, and Fisher). The dominant phylum detected were Planctomycetes, Bacteroidetes, Proteobacteria, Actinobacteria, Acidobacteria, Chloroflexi Fibrobacteres, Verrucomicrobia, Firmicutes, Gemmatimonadetes. The top 10 genus in the rhizosphere soil were *Planctomyces, Gemmata, T78, Nocardioides, Rhodoplanes, Candidatus, Solibacter, A17, Pirellula, Nostocoida and Clostridium* and the top 10 species in the rice rhizosphere soil were *Ruminofilibacter xylanolyticum, Gaiella occulta, Phaselicystis flava, Nostocoida limicola III, Clostridium ruminantium, Petrimonas sulfuriphila, Oryzihumus leptocrescens, Trachelomonas volvocinopsis, Roseomonas lacus*. Findings clearly demonstrated the differential influence of high N fertilizer dose under aerobic and submerged conditions on the composition of the core microbiota of scented rice rhizopsphere.

Keywords: 16S rRNA, Core microbiota, Moisture regimes, Rhizosphere, Rice

Theme 2: 79
Assessment of Onion Varieties

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Onion (*Allium cepa* L.) is one of the most widely used spices in Tripura, which is used in making almost every dishes. However, the onion is not cultivated widely by the farmers. The area under onion cultivation in Tripura is 160 ha with a production of 1050 MT. Tripura produces comparatively less onions, which are mostly grown during the Rabi season. The main causes of Tripura's low onion production include farmers' ignorance of production technology, weather fluctuations, difficulties producing seedlings during the Kharif season, and the unavailability of high-potential varieties. Tripura's farmers are not entirely aware of the production technology for onion cultivation. This lack of knowledge and awareness hinders the widespread adoption of onion cultivation practices, limiting production potential. Due to the limited local production, Tripura relies heavily on supplies from other states, particularly during the off-season (July to February). which often leads to price volatility. Thus, discourage local farmers from investing in onion cultivation, as they may face price risks. Therefore, to encourage the local farmers to grow high yielding onion variety and also to give awareness on production technology for wider adoption, The KVK Sepahijala had taken up OFT in three villages of Sepahijala District during 2023-2024 and 2024-2025 to assess the onion varieties, Bhima shakti, Sukhsagar and local variety LS-144.The three onion varieties were sown during October and transplanted in the main field after 40days.The POP provided by ICAR Lembucherra were followed. Yield parameter and PDI, Disease incidence, B:C ratio was recorded and compared with local variety LS144. The variety Bhima Shakti has recorded a higher yield of 83q/ha with B:C ratio of 3.4:1 as compared to yield (80/ha) of Sukhsagar and B:C (3.3:1). Higher Net return of Rs177000 was recorded in Bhima Shakti and net return of Rs 168000 was obtained in Sukhsagar. Farmers variety recorded with 48q/ha yield with B:C of 2:1. Among the two varieties assessed, Bhima Shakti showed favorable outcomes in terms of yield,B:C,PDI and Disease incidence.

Keywords: Onion, Bhima Shakti, Sukhsagar

Theme 2: 80

Building Agricultural Resilience: Climate-Resilient Interventions in Rain-fed Areas of Jammu Region

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Climate variability poses a significant threat to agricultural sustainability, especially in rain-fed regions where exposure to climatic shocks is high and adaptive capacity is limited. The Union Territory of Jammu and Kashmir has experienced clear climate change impacts in recent years, such as receding glaciers, shorter winters, reduced snow cover and rising summer temperatures. Projected temperature increases by 2030 raise further concerns regarding food security and agricultural productivity. In response, the Ministry of Environment and Forests, Government of India, launched the project "Climate Resilient Sustainable Agriculture in Rain-fed Farming Areas of Jammu and Kashmir" in 2016 under the National Adaptation Fund on Climate Change (NAFCC). The Bhalwal block in the Jammu division was selected based on its high climatic vulnerability and low adaptive capacity. A baseline survey and vulnerability assessment conducted in 2016–17 identified 25 highly vulnerable villages, with index values ranging from 0.64 to 0.79. From a list of 1,250 beneficiary farm families, a representative sample of 300 farmers was selected using Slovin's formula and random sampling. A vulnerability index was constructed to assess conditions before and after project interventions. The findings revealed a significant reduction in vulnerability from 2016–17 to 2023–24. Villages such as Doomi (32.63%), Bajwan (28.89%) and Baganitalab (28.43%) showed the highest improvement. By 2023–24, no village remained in the "highly vulnerable" category and there was a notable increase in moderately and less vulnerable villages. These findings highlight the effectiveness of targeted interventions under the NAFCC-funded project in enhancing adaptive capacity and resilience in rain-fed areas of Jammu district. It is recommended that such climate-resilient agricultural models be upscaled and replicated in other vulnerable rain-fed regions to further strengthen rural livelihoods and climate adaptation.

Keywords: Climate variability, Rain-fed agriculture, Adaptive capacity, Vulnerability index and Resilience

Theme 2: 81

Impact of Economic and Grain Yield Parameter of Cluster Front Line Demonstration on Mustard Crop in Gurugram District of Haryana, India

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The ICAR project on cluster front line demonstration was implemented by Krishi Vigyan Kendra, Gurugram with objective to boost the productivity and production of oilseed crop. The main objective of study to assess the economics and yield parameters impact of CFLD in term of grain yield and economic gain in oilseed crop of Mustard in Gurugram district of Haryana during 2018-19 to 2022-23. The data was collected on important growth stages of the crop from demonstration plot as well as farmers practice plot. A total 100 demonstrations was conducted in 45 ha. area under Mustard in Gurugram district during the study. The results showed that the average grain yield in demonstration plot was 14.10 percent higher as compared to farmers practice and the net gain was recorded in mustard was 16.99 percent more in demonstration plot as compared to farmers practice. The B:C ratio was recorded higher in recommended practice with 4.51 as compare to farmers practice 3.88.

Keywords: Economics analysis, CFLD, Yield parameters, Benefit Cost ratio

Theme 2: 82

NDRI Climate Services: An Extension Model for Promoting Climate Smart Dairy Farming in Haryana

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The Indian dairy sector, particularly among smallholder farmers, is highly vulnerable to climate change impacts. To address this, the ICAR-National Dairy Research Institute (NDRI), Karnal developed a Temperature Humidity Index (THI)-based climate service delivery model i.e. "NDRI Climate Services". This model provides weekly district-specific climate advisories to support farmers' operational decisions during thermal stress periods. The study aimed to evaluate the model's impact on operational decisions, economic outcomes, and its acceptability among the smallholder dairy farmers. A total of 360 smallholder dairy farmers from 24 villages in central Haryana were selected using a multistage sampling method. The Difference-in-Difference (DiD) research design was employed, and customized THI-based advisories were disseminated for two years through mobile apps, SMS, and WhatsApp. Villages were divided into experimental and control groups to minimize spillover effects. The study assessed the influence of these services on thermal stress management, feeding, housing practices, and milk production. Results indicated significant improvements in animal feeding practices, such as increased use of oilcake, concentrates, and mineral mixtures. Housing management also improved with better ventilation and cooling strategies. Notably, milk yield increased by 0.38 to 0.50 liters per animal per day during summer across different dissemination modes. Additionally, a high proportion (80–92.22%) of farmers expressed willingness to pay for the service, with an average annual price ranging from Rs. 94.33 to Rs. 137.22. Key determinants of willingness to pay included herd size and exposure to extreme weather events, while factors like age and existing access to climate information negatively influenced it. In conclusion, the NDRI model effectively promotes smart dairy farming in smallholder dairy production systems of Haryana.

Keywords: Climate service, Impact, Dairy farming, Haryana, Resilience

Theme 2: 83

From Impact to Action: Mitigation and Intervention Strategies for a Changing Climate

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Climate change and variability represent some of the most significant global challenges faced by humanity in the 21st century. Their effects are far-reaching, influencing the natural ecosystems, public health, food and water security, and the long-term sustainability of human life. The urgency of the climate crisis demands a shifting focus from merely assessing impacts to implementing actionable and evidence-based strategies. The critical nexus between climate-related impacts, mitigation strategies, and adaptive interventions, presenting a comprehensive approach to tackling the multifaceted nature of changing climate. The discussion includes an overview of current and anticipated consequences of climate variability, such as intensified extreme weather events, rising sea levels, environmental degradation. So, a global and regional analysis is used to highlight the uneven distribution

of these effects. Mitigation efforts which include expanding the use of renewable energy, promoting low-carbon farming practices, enhancing afforestation and reforestation, carbon pricing mechanisms, and innovations in carbon capture and storage technologies. These strategies are assessed not only in terms of their potential to reduce carbon emissions, but also for their social, economic, and environmental co-benefits. It also explores a variety of adaptive solutions aimed at increasing resilience and minimizing vulnerability. These include climate-resilient agricultural practices and ecosystem-based approaches, improved water management, residue management, and advanced early warning systems. Emphasis is placed on inclusive, community-led, and nature-based adaptations that can be scaled across diverse regions. Furthermore, it underlines the importance of cohesive governance, cross sector collaborations, and participatory stakeholder engagement to ensure climate strategies are inclusive, culturally relevant, and rooted in scientific evidence. Strengthening climate education and knowledge-sharing networks is highlighted as essential for empowering local actors and informing policy decisions. Ultimately, the study calls for a paradigm shift—from recognizing climate threats to mobilizing coordinated action. By translating knowledge into policy and practice, we can cultivate a climate-resilient world grounded in justice, sustainability, and shared responsibility.

Keywords: Climate variability, Sustainability, Mitigation strategies, Low carbon farming practices, Climate resilient agriculture

Theme 2: 84

Social Forestry: An innovative Community-Driven Approach practiced by Garo tribe in Conservation of Forest Aid for Rural Livelihood Sustainability

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The West Garo Hills district covers a large area of forest and having both plain and hilly terrain. The study was conducted in four villages of West Garo Hills district of Meghalaya and the total area of reserved plantation under four villages is around 23.5 hectares. *Garo* tribe follows the silvicultural system in this forest land. Tree and bamboo are considered main two components under the system. The local landless and small farmers living in and around the forest area and encroacher were selected as participants and the land is under the jurisdiction of headman or *Nokma* of the village. All intermediate returns from dead tree branches after pruning, thinning, and uprooting are being enjoyed by the stakeholder. Under the social forestry, villagers select the place where forest was already established naturally. For its management of that area, villagers formed a committee namely called Village Forest Management Committee (VFMC) and they make role and regulation for its utility and maintenance. If any one of it found not following the role made the committee, then he/she had to pay fine fixed by the committee. A security guard was also appointed for its take care. Beneficiaries are given right to enjoy the dead tree branches and uprooting only after the approval of the committee. If the committee think that the reserve or forest have abundant of tree and bamboo species and which more sufficient of the village then the committee decide to harvest or sale. After selling, 5% percent of that amount was given to the security guard and rest amount was deposited to the fund of VFMC. The plantation is established on participatory basis are being harvested at the end and the sale proceeds are deposited on the basis of agreement approved by the committee. During forest shortage, the committee stopped from harvesting for a period of 4-5 years until the reserved forest regains its maxima. Forest department sometimes imparts training for its proper maintenance to the villagers.

Keywords: Participatory, Community, Approach, Forest, Garo tribe, Meghalaya

Theme 2: 85
Pradhan Mantri Fasal Bima Yojana: Major Features and Risk Coverage Benefits

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Pradhan Mantri Fasal Bima Yojana was launched for ensuring comprehensive risk cover for crops of farmers against all non-preventable natural risks from pre-sowing to post-harvest stage from *Kharif* 2016. The Scheme has completed 16 crop seasons and is being implemented across States/UTs. The major objectives of PMFBY are providing financial support to farmers suffering crop loss/damage arising out of unforeseen events, stabilizing the income of farmers to ensure their continuance in farming, encouraging farmers to adopt innovative and modern agricultural practices. Food crops like cereals, millets and pulses), oilseed crops and annual commercial / annual horticultural crops are covered under this scheme. The scheme covers various types of risk including basic cover (risk of yield loss to standing crops from sowing to harvesting on an area-based approach basis, against non-preventable risks like drought, dry spells, flood, inundation, wide-spread pest and disease attack, landslides, natural fire due to lightening, storm, hailstorm, and cyclone; prevented sowing/planting/germination risk; mid-season adversity due to adverse seasonal conditions during the crop season viz. floods, prolonged dry spells and severe drought etc.; post-harvest losses only up to a maximum period of two weeks from harvesting, for selected crops risk against localized calamities along with add-on coverage for crop loss due to attack by wild animals. All farmers cultivating notified crops in a notified area during the season are eligible, including sharecroppers and tenant farmers. Farmers pay a maximum premium of 2% for *kharif* crops and 1,5% for *rabi* crops. The Govt subsidize the remaining premium amount. Some key features of the scheme includes the technology integration using mobile technology, satellite data and drones to assess crop damage, add on coverage for interested opted States for additional coverage for specific crops against wild animal attacks and well drafted grievance process. Over Rs. 155977 crore in claims have been paid to farmers since the scheme's inception in 2016. For every Rs. 100 paid as premium by farmers, they have received approx. Rs. 500 as claims. Over 23.22 crore farmer applicants have received claims under PMFBY in the past 8 years. Farmers have paid nearly Rs. 31,139 crore as their share of premium during this period.

Keywords: Financial support, Risk coverage, Crop loss

Theme 2: 86
Village Climate Risk Management Committee: An Institutional Innovation for Climate Resilient Agriculture

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Climate change poses a significant challenge to global agriculture, threatening food security and rural livelihoods. In 2011, the National Innovations on Climate Resilient Agriculture (NICRA) program was started by the Indian Council of Agricultural Research (ICAR) with the goal of strengthening Indian agriculture's resilience through capacity building, technology demonstration, and strategic research. The NICRA-TDC component has been implemented by ICAR-ATARI Zone-VI in nine districts across three states: Assam, Arunachal Pradesh, and

Sikkim. A key grassroots institutional innovation under the technology demonstration component of NICRA, "Village Climate Risk Management Committee (VCRMC)" has been constituted. The VCRMC is a village-level institution constituted in each NICRA village from amongst the participating farmers with about 10 members, including a president and secretary to address climate-related vulnerabilities and manage the implementation of climate-resilient technologies. The VCRMC is formed through participatory discussions with villagers to ensure equal representation from different strata of the village. The VCRMC functioned as the main institutional framework for need-based planning and implementation of climate resilience initiatives. In order to identify and prioritize climate-related issues and the best interventions, VCRMCs held frequent meetings with the farmers and finalized site-specific technology packages that are tailored to the local agro-climatic conditions. These packages may include flood or drought-tolerant crop varieties, water harvesting structures, and better livestock management. In order to provide fair access to tools like power tillers, threshers, and other equipment-which are essential for prompt and effective farm operations amid climate extremes, the committee also oversees special hiring centers for farm implements. The Village Climate Risk Management Committees played a transformative role in building sustainable climate-resilient agriculture through community-driven efforts which may be extrapolated to elsewhere.

Keywords: Climate change, Village climate risk management committee

Theme 2: 87

A Comparative Study on Effect of Agro-meteorological Parameter on Hilly and Valley Agriculture of Manipur

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This study assesses and compares crop production growth patterns, variability, and instability across hilly and valley regions in Manipur, India. The research focuses on analyzing diverse crops: rice, dry chillies, potato, turmeric, rapeseed and mustard, other kharif pulses, maize, and sugarcane across districts (Senapati, Churchanpur, Thoubal, and Bishnupur) to understand their agricultural dynamics. The findings unveil significant variability and instability in crop productivity, where Senapati demonstrates high variability and moderate to increased instability, presenting potential challenges despite favourable growth rates and Bishnupur display average variability and instability across different crops. Compound Annual Growth Rates (CAGR) vary among these districts, with Churchanpur showcasing mixed trends, Thoubal indicating mixed to negative rates, and Senapati and Bishnupur reflecting overall favourable growth rates. P-values highlight varied significant trends, emphasizing the intricate agricultural landscape. The insights underscore the necessity for tailored interventions to enhance productivity, stability, and consistent growth in these regions, especially in addressing specific crop-related challenges across different districts and terrains in Manipur, India. This study briefly outlines the comprehensive study evaluating growth trends, variability, and instability in crop production across varied districts and terrains in Manipur, India, offering valuable insights for tailored agricultural interventions.

Keyword: Comprehensive study, (CAGR), Potential challenges

Theme 2: 88

Impact of Satisfaction of NICRA Intervention on Productive and Reproductive Performance of Dairy Animals

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Climate change has been imposing several challenges for India, affecting major livelihood sources of the country including agriculture and allied sectors. ICAR launched Climate Resilient Agriculture initiative (NICRA) in 2011 with an aim to reduce the climate change risks to agriculture and to make the farmers climate resilient. The current study was conducted in Karnal district of Haryana, with 60 farmers from NICRA beneficiary Villages and 60 from non-beneficiary villages, constituting a total of 120 together. Satisfaction of farmers from the selected services from NICRA was analysed and compared among the beneficiary and non-beneficiary farmers using Mann-Whitney U test. Also, the services provided were correlated with the actual performance indicators of dairy animals. Results revealed that information on timely basis and crop management related information were the highly satisfied services to the beneficiary farmers, and 'timely information' and veterinary related aspects like 'vaccination', 'parasite control' and 'information about disease outbreak' had an upper edge to the beneficiary farmers than non- beneficiary. The correlation results indicated that NICRA services positively affect both production and reproduction indicators of dairy animals. Hence, extending the services of NICRA can be suggested to expand the effective climate-resilient actions to more villages and farmers so that more farmers can effectively reduce the adversities caused by climate change.

Keywords: Climate change, Dairy production, NICRA, Satisfaction

Theme 2: 89

Mapping Rural Household Vulnerability in Manipur: Insights from District to Block-Level Analysis

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This study evaluates climate change vulnerability across Manipur's valley and hill regions at both district and block levels by constructing a vulnerability index. The index classifies areas into five categories: very low, low, medium, high, and very high vulnerability. In the hill region, districts such as Noney, Kamjong, Pherzawl, and Tamenglong are identified as highly vulnerable, while Senapati, Jiribam, and Tengnoupal exhibit the lowest vulnerability. Within the valley, Bishnupur, Imphal East, and Thoubal are classified as highly vulnerable, whereas Imphal West is the least vulnerable district. The primary drivers of vulnerability differ between regions: in the hills, health and nutrition (38.38%), livelihood and handicraft (18.97%), agriculture and allied sectors (15.50%), and infrastructure and sanitation (11.74%) are most influential. In the valley, health and nutrition (45.58%) is the dominant factor, followed by agriculture and allied sectors (13.05%), livelihood and handicraft (11.23%), and water management and irrigation (11.10%). These findings highlight the spatial variability in vulnerability and underscore the need for region-specific adaptation strategies.

Keywords: Vulnerability index, Rural household, Manipur, Adaptation

Theme 2: 90
Crop Technology Intervention Promoting Profitability and Sustainability in North India

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Indian Agricultural Research Institute has been the pioneer in developing improved Agricultural technologies and thrusting them into the farming system leading to increased productivity and profitability through a plethora of programs of transfer of technology. The Institute has implemented adopted village project and partnership program under public-public and public-private partnership mode for assessing and disseminating improved technologies among the farming community across the country. Notable among the technologies, is improved Basmati crop variety PB 1509. IARI has been instrumental in genetic improvement leading to release of semi-dwarf high yielding Basmati rice variety PB 1509 with reduced duration from 160 days to 120 days and enhancement of productivity from 2.5 tons/ha to 6-8tons/ha. The varieties are in great demand among the farmers in the Basmati growing states of India. The variety has contributed to the export of around 5242048.39 MT of Basmati Rice to the world for the worth of Rs. 48389.18 Crores (5837.12 US$ Mill.) during the year 2023-24. Assessment trials has been conducted on improved Basmati PB 1509 in the farmers' fields in the adopted villages of Delhi NCR and other basmati growing region notified in the country under National Extension Program and IARI-VOs partnership program during 2015-2023. Paddy variety PB 1509 was assessed at multiple locations and the study shows that the variety has performed excellently in all the locations. The highest average yield of 60.0 q/ha was accrued at NDRI Karnal Haryana which was followed by GSVS Mathura (53.0 q/ha), Herbal Agro Aligarh (53.0 q/ha), FARMER Ghaziabad UP (50.0 q/ha), NHRD KVK Ujwa Delhi (50.0 q/ha) and NCR khajurka Palwal (50.0 q/ha). The study revealed that the highest increase in yield of the variety over the local variety was 30.59% recorded at Herbal Agro Aligarh which was followed by SKUAST Jammu (23.77%), CPU Hamirpur HP (23.09%) and NCR Rajpur Aligarh (22.86%). The highest net income of Rs.103211.17 per ha was accrued at FARMER, Ghaziabad, UP which was followed by NCR Maholi Palwal (Rs 87712.00 per ha) and HESCO Dehradun (Rs85634.00 per ha). The highest net increment in the income for the tested variety over the local check was obtained at FARMER, Ghaziabad, UP (Rs. 28337.84) which was followed by NCR Rajpur Aligarh (Rs. 21611.00 per ha) and HESCO Dehradun (Rs. 20430.00 per ha). The variety has one of the largest shares in the Basmati rice grown in Northern India. It is having very good productivity and fetches good market price. Besides, it fits very well with the cropping pattern adopted in the region. It is suitable for promoting intensive cropping intensity in the region as it has lesser maturity time. It saves 3-4 irrigations and due to early maturity gives ample time to the farmers for wheat field preparation leading to reduction in residue burning.

Keywords: IARI-VO programme, Basmati varieties, Assessment

Theme 2: 91
Performance of Soybean Varieties under Organic Management System

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Soybean is an important oilseed and legume crop, known to be the most cultivated oilseed crop in India, contributing to approximately 33% of total oilseed production. There is a critical requirement for selecting varieties that are suitable for the region's climate to boost soybean production under stressful environment of hill ecosystems of Meghalaya. As a rainfed crop, soybean is particularly vulnerable to the effects of climate change. In this view, an on-farm testing was conducted with three varieties of soybean *viz.*, V_1 - Umiam Soybean 1; V_2 – VLS 89 & V_3 – JS 335 (check) in eight farmers' fields in East Garo Hills district of Meghalaya in three consecutive years 2022, 2023 & 2024. Results reveal that average yield of the crop (23.61 q/ha), plant height (103 cm), number of pods per plant (67), days to harvest (114), net return (Rs. 73822/ha) & benefit-cost ratio (3.12:1) were recorded significantly higher in V_1 as compared to other varieties. Thus, Umiam Soybean 1 (V_1) was found superior variety under rainfed conditions in the East Garo Hills District of Meghalaya.

Keywords: Soybean, Oilseed crop, Yield, Benefit-cost ratio

Theme 2: 92
Economic Viability of Rice (*Oryza sativa* L.) Varieties to Different Levels of Nitrogen under Wetland Rice Cultivation of Mizoram

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On the subject of the economic sustainability of rice (*Oryza sativa* L.) types to various levels of nitrogen under wetland rice agriculture, a field experiment was carried out in Mamit District in 2023 and 2024. With 'CO-52' at 80 kg N/ha, plant height and dry matter output were at their maximum. Panicles/m^2, full grains/panicle, production of grain and straw (4.50 tons/ha), as well as the uptake of nitrogen by grain and straw, were all noticeably greater with "CO-52." Rising nitrogen levels increased the number of panicles/m^2, the number of filled grains per panicle, the yield of grains and straw, and the amount of nitrogen taken up by grains and straw only up to 80 kg N/ha. The maximum grain production and economics were observed with "CO-52" at 80 kg N/ha, and it was discovered to be the ideal combination for wetland rice agriculture. Varieties and nitrogen levels interacted considerably. However, it is necessary to measure the amount of nitrogen needed for wetland rice, taking into account the cultivars, environment, and management practices. There is a severe paucity of trustworthy knowledge on the crucial agro-techniques for effective wetland rice farming in this area. The goal of the current study was to locate the most productive enhanced cultivars for wetland conditions and to calculate the ideal nitrogen dose.

Keywords: Field Experiment, Nitrogen, Rice yield

Theme 2: 93

Evaluation of Finger Millet Varieties for Higher Production, Productivity and Profitability in Arunachal Pradesh

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Millets are a vital part of the agricultural landscape and traditional diet in Arunachal Pradesh. Finger Millet is the most widely cultivated, along with Foxtail Millet, Kodo Millet, and Barnyard Millet. These millets are used in various food preparations, including traditional beverage like *Apong*, as well as steamed dishes. Area and production of Finger Millet in Arunachal Pradesh is 21872 ha and 20531 tonnes respectively, along with productivity 938.7 kg/ha. Most of the Finger Millet cultivated area is dominating by the traditional variety with low productivity and long duration of the crop. The average productivity of Finger Millet is about 1524 kg/ha at national level, however in Arunachal Pradesh it is about 938.7 kg/ha and in West Siang district it is about 856 kg/ha, which is below the average productivity of the State. Therefore, Krishi Vigyan Kendra, West Siang conducted trials on fingermillet to assess most suitable variety for district to increase the production, productivity and also enhancement of the farmer's income. On farm trial was conducted on Finger Millet during 2023-24 to compare the production potential of four varieties VL Mandua 376, VL Mandua 380, VL Mandua 378 and VL Mandua 379 with local check at farmer's field and KVK farm as well. The result revealed that the VL Mandua 378 was recorded highest yield (17.6 q/ha) followed by VL Mandua 379(16.2 q/ha), VL Mandua 380(16.2 q/ha), VL Mandua 376(15.4 q/ha) and minimum in local check (8.7 q/ha). Maximum Net Return and Benefit Cost ratio (B:C) were also computed and recorded as Rs.52780.00/ha, 2.50 for VL Mandua 378 followed by VL Mandua 379 or VL Mandua 376 (Rs.45780.00/ha, 2.30), VL Mandua 376 (Rs.41780.00/ha, 2.18) and minimum with Local variety (Rs.8280.00/ha, 1.23) respectively. Maximum production efficiency was also recorded as 15.71kg/ha/day, 14.46kg/ha/day, 14.16 kg/ha/day, 6.13 kg/ha/day and economic efficiency 471.25 Rs/ha/day, 408.75 Rs/ha/day,383.31 Rs/ha/day, 58.31Rs/ha/day with VL Mandua 376, VL Mandua 380, VL Mandua 378 and VL Mandua 379 with local check. Hence with the results of above OFT by KVK West Siang and considering the duration of improved variety as 25-30 days earlier than traditional variety it may be concluded that improved variety of Finger Millet varieties from VPKAS Almora are thriving well in the climatic conditions of West Siang region of Arunachal Pradesh, and providing higher productivity and profitability to the farmers.

Keywords: Millet varieties, On-farm trial, Productivity

Theme 2: 94

Livelihood Vulnerability of Climate Change to the Organic Farmers of Sikkim

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The novel study was conducted at the organic state Sikkim on climate Change to identify the notch of livelihood vulnerability of climate change to the farmers. The study covered all the four districts namely East Sikkim, West Sikkim, North Sikkim and South Sikkim through complete enumeration. A total of thirty-two villages were selected for the study. From each village, fifteen organic farmers were selected randomly. A total of four hundred and eighty (480) organic farmers were selected. The study could find that the respondents were at the age category of 33-44 years and majority of them were male (73.1%). Around 50.9% of the respondents had

nuclear family of 2 to 4 members, land holding of more than 2 ha of operational land with farming experience of 10-25 years (43.1%). Majority of respondents (69.4%) have an annual income of Rs. 20,000/- Rs. 45,000/- with education level of upto class X (30.4%). Majority of respondents received extension services like field visit (82.5%), awareness programme (55.4%), training (63.1%) and meetings (67.3%) occasionally. They seek agricultural information and knowledge related to natural resource management (59%) from experienced farmers and friends, on plant protection from state department (23.1%), and on crop improvement from KVK (49.8%). Cent per cent of the respondents heard of frequent occurring of drought and flood due to climate change damaging huge property & assets and soil in field became infertile; also expressed of low yield and productivity of farm (98%), insect pest attack in the farm (90%), unavailability of proper drainage facility (88%), irregular monsoon rain (84%), and facing of dry spell every year, *etc.* Majority respondents (90%) expressed of getting information and alerts on climate change adaptation and mitigation from friends & neighbours. The study developed the Livelihood Vulnerability Index (LVI) integrating seven components which include Socio-Demographic, Livelihood, Health, Social Network, Food, Water and Climate Variations & Natural disasters with twenty-five sub-components. The LVI shows that North and South districts had LVI score of -0.79 and -0.92 respectively which means least livelihood vulnerability of climate change, whereas the East and West Sikkim district had LVI score of 0.92 and 0.70 respectively which indicates higher livelihood vulnerability to climate change. There is a need of climate adaptation and mitigation measures to be intervene robustly in the East and West Sikkim districts. Up-scaling and out-scaling of Climate smart Agricultural technologies need to be rigorously performed in the state.

Keywords: Climate change, Livelihood vulnerability, Organic farmers, Climate smart agricultural technologies, Up-scaling, Out-scaling

Theme 2: 95
Estimation of Genetic Diversity Using D^2 and PCA in Brinjal

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The investigation was carried out to study the genetic diversity of brinjal (*Solanum melongena* L.) during autumn winter season of 2021-2022 by using D^2 and Principal Component Analysis. The experiment was laid in Completely Randomized-Block Design, consisted of 38 genotypes, including one check (NDB-2) and with three replications. Based on D^2, the genotypes were grouped into seven different non-overlapping clusters. Cluster I had highest number of genotypes (23) followed by cluster II (10) and cluster III, IV, V, VI and VII (1). The maximum inter-cluster distance was observed between cluster III and VII. Maximum percent contribution in genetic divergence was showed by fruit circumference, TSS, number of primary branches per plant and minimum contribution by fruit yield per plant. Based on the PCA with 13 traits, it formed 6 principal components (PCs) with more than 1 Eigen value apart from PC6 (0.80). These components indicated maximum variation among the variables with a diversity percentage of 79.30 per cent. The first PC showed 23.43 per cent variation, while the second, third, fourth, fifth and sixth PCs showed the variation of 16.89 per cent, 14.11 per cent, 10.37 per cent, 8.31 per cent and 6.17, respectively. Therefore, the traits coming under the 6 PCs manifest a high degree of genetic variation and they add up the genetic diversity between the genotypes which could be exploited in crop improvement programmes. Thus, there is a great potential for effective crop modification for improved yield and yield-attributing traits in present brinjal germplasm.

Keywords: Brinjal, Genetic diversity, Principal component analysis

Theme 2: 96

Evaluating Climate-Resilient Rice Varieties for Improved Productivity in Eastern Arunachal Pradesh

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A two-location field experiment was conducted across farmers' fields in the Namsai district of Arunachal Pradesh to evaluate the productivity and economic performance of climate-resilient rice varieties. The experiment was laid out in a Randomized Block Design (RBD) and 10 replications. The sites with uniform soil properties, texture, topography, and similar histories of fertilizer application. The treatments included four rice varieties: T_1 – *Swarna Sub-1*, T_2 – *Gitesh*, T_3 – *Luit*, and T_4 – the farmers' local variety (*Khampti Lahi*) and two locations: *Wagon 1* and *Mengkeng Khampti*. Standard agronomic practices were uniformly applied across all treatments. Growth parameters (plant height, number of tillers/m², and effective tillers/m²), yield attributes, and grain yield were recorded. Economic parameters, including cost of cultivation, gross return, net return, and benefit-cost ratio (B:C) were also calculated. Results indicated that the *Swarna Sub-1* variety exhibited significantly superior growth characteristics, yield attributes, and grain yield (47.84 and 46.28 q/ha) compared to the local variety (*Khampti Lahi*) (32.25 and 30.25 q/ha) in Wagon 1 and Mengkeng Khmapti locations, respectively. The *Gitesh* and *Luit* varieties also showed significantly higher grain yields (40.36 and 40.24 q/ha, and 33.8 and 35.91 q/ha, respectively) than the local variety, though slightly lower than *Swarna Sub-1*. Economic analysis revealed that *Swarna Sub-1* achieved the highest gross return (106081 and 102297/ha), net return (70,421 and 71128 q/ha), and B: C ratio (2.97 and 3.29), followed by *Gitesh* and *Luit*, in both Wagon 1 and Mengkeng Khmapti, respectively. Our experimental findings suggest that *Swarna Sub-1*, *Gitesh*, and *Luit* are promising climate-resilient rice varieties capable of enhancing productivity and farmers' income in the Namsai district of Arunachal Pradesh.

Keywords: Climate-resilient, Swarna Sub-1, Khampti Lahi and Rice productivity

Theme 2: 97

Enhancing Climate Resilience Agriculture by Using the Natural Genetic Diversity

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The current agricultural system frequently sacrifices biodiversity in order to increase productivity. The reason for this is that plants contain a wide range of genetic activities and regulatory systems. Differences from natural selection frequently lead to the domestication of crops by artificial selection. For instance, farmers advocate for seeds that do not shatter, which is clearly not a desirable quality for plants in the wild that they need to reproduce their progeny. The main goal of the breeding plans is to create agricultural types with high yields. Therefore, domestication has increased output but decreased genetic variety, sometimes by eradicating beneficial alleles like those that can withstand stress. Many modern crop cultivars lack the genetic diversity found in wild cultivars due to the process of domestication and ongoing artificial selection. Crops were bred for production rather than

other qualities like stress tolerance, which could be recovered with the help of farmers and other farming techniques. Therefore, wild crop cultivars could essentially withstand and live under a wide range of weather fluctuations and unsuitable settings as compared to modern crop kinds. Therefore, it is important to investigate the stress-tolerant traits of the wild cultivars of various crop plants, as they can be considered a primary source of genetic variety. A collection of stress-tolerant alleles can also be obtained from the DNA of varied plants, such as extremophiles, which are suited to the harshest environmental conditions, in addition to the genetic resources from wild cultivars. Therefore, additional comparative research between current crops and model plants and crop progenitors, natural accessions, and extremeophiles are required to gain a more practical understanding of the stress-tolerant traits inherent in naturally occurring stress-resistant plants.

Keywords: Domestication, Artificial selection, Stress tolerant, Extremophiles

Theme 2: 98

Assessing Climate-Induced Weather Changes and Agricultural Productivity in Manipur

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This study analyzes temperature and precipitation trends in Manipur over a 34-year period using non-parametric statistical methods. Results show that minimum temperatures typically occur in January, February, November, and December, ranging from 4.9°C to 22.6°C, while maximum temperatures during June to August range between 19°C and 29°C. Although slight increases were noted in other months, they were statistically insignificant. Trend analysis reveals a significant rise in mean, minimum, and maximum temperatures, especially during the monsoon months. This warming trend is likely due to increased solar radiation, reduced cloud cover, and changes in atmospheric moisture. These shifts have critical implications for agriculture, water resources, biodiversity, health, and livestock, emphasizing the urgency for adaptive responses. Seasonal analysis indicates erratic variations in minimum temperatures from June to December, along with gradual increases in mean and maximum temperatures during the monsoon season. These changes, particularly in minimum temperatures, are significant and suggest potential disruptions to local environmental and agricultural systems. Temperature trends during cropping seasons highlight increasing vulnerability of Kharif and Rabi crops to warming conditions, while Zaid crops appear less suited to the region's changing climate. The precipitation analysis demonstrates high seasonal and interannual variability, alongside a notable decline in monsoon rainfall over the decades. Between 1985 and 1994, rainfall peaked at about 47.94% of the total but has since declined. Monthly data show that January, February, November, and December consistently receive less than 50 mm of rainfall, offering useful information for managing flood and drought risks. These findings confirm a clear trend of climate variability and change. Policymakers are encouraged to implement adaptation strategies focusing on sustainable agriculture, water management, biodiversity conservation, and greenhouse gas mitigation. Future research should integrate climatic and socioeconomic data to develop a comprehensive, resilient regional response.

Keywords: Weather change, Precipitation analysis, Temperature, Agriculture system

Theme 2: 99

Double Cropping Practices for Enhancing Agricultural Productivity in Sribhumi District of Assam

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Crop productivity in Assam faces significant challenges due to seasonal weather variations and traditional farming practices that often restrict farmers to opt for a single crop per year. A study was designed to assess the efficacy of rice-based double cropping systems as a sustainable strategy in the Sribhumi district of Assam, India. The study included two systems viz. (i) Rice followed by Rajmah and (ii) Rice followed by Toria across a 20-hectare (ha) participatory demonstration area. Following flood-induced damage to the medium-duration rice (135-140 days) variety Numali, the short-duration (105-110 days) variety Disang was introduced as a contingency, measure with recommended management practices. The program was conducted with 16 farmers across 15 ha of rice–rajmah (rice varieties Numali/Disang with rajmah varieties Kota Rajmah and Tripura Selection) and 5 ha of rice–toria (Toria variety TS-38). Results showed that the rice–rajmah system achieved a Rice Equivalent Yield (REY) of 123.05 q/ha and a Production Efficiency (PE) of 51.27 kg/ha/day, significantly outperforming the rice–toria system (REY: 62.16 q/ha, PE: 25.90 kg/ha/day). Economic analysis revealed gross returns of Rs. 2,83,004/ha for rice–rajmah and Rs. 1,42,959/ha for rice–toria, compared to Rs. 1,00,004/ha from rice monocropping, representing a 367%- and 55%- increase in income respectively. Both double cropping systems achieved 200% cropping intensity, demonstrating enhanced land use efficiency, economic resilience, and crop diversification. The successful use of short-duration varieties as a flood contingency highlights a scalable and climate-resilient strategy for similar agro-ecologies across South Asia.

Keywords: Double cropping, Rice Equivalent Yield, Production Efficiency, Cropping Intensity, Contingency planning

Theme 2: 100

ArcHydro-Based Watershed Delineation and Hydrological Assessment of Manipur Valley

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The ArcHydro extension in ArcGIS provides a systematic method for watershed delineation by integrating digital elevation models (DEMs) and hydrological principles. The process begins with preparing a hydrologically correct DEM, filling sinks or depressions that hinder water flow. Flow direction is computed to determine the path of water movement, followed by flow accumulation to identify areas of concentrated flow. Stream networks are defined using threshold values applied to flow accumulation data. Accurate watershed delineation is highly dependent on the resolution and quality of the DEM, with higher resolution data yielding more reliable

results. In the context of Manipur's valley regions, rainfall data from 2000 to 2017 reveals considerable variability, ranging from a low of 927 mm in 2006 to a high of 2439 mm in 2017. Such extremes suggest periodic droughts and flooding, impacting agriculture and water resource availability. Notable low-rainfall years, including 2008, 2009, and 2014, likely resulted in reduced moisture availability and agricultural stress. Conversely, high rainfall years like 2000, 2003, 2010, and 2016 supported better water availability. These fluctuations point to an erratic rainfall pattern influenced by monsoonal variation and broader climatic shifts. Estimated runoff data from 2008 to 2017 further illustrates the hydrological response of the watershed, with values ranging from 922.5 MCM in 2008 to over 2600 MCM in years like 2010 and 2015. The alternating trend of high and moderate runoff volumes reflects both rainfall variability and potential land use changes. Understanding these spatial and temporal hydrological dynamics is essential for effective water resource planning, flood control, and agricultural sustainability in the valley regions of Manipur. The integration of ArcHydro tools with local hydrometeorological data enables informed decision-making for climate resilience and watershed management.

Keywords: ArcHydro-based Watershed Delineation, Hydrological Assessment, Climate Resilience

Theme 2: 101

Vertical cum Staking Farming Techniques: Play A Key Role as Protected Cultivation Technology for Summer Vegetables Crops in Plain Condition of India

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India is second largest vegetable producer in the world but still production and productivity is very low. This is primarily due to erratic climatic conditions. Consequently, even required 300g per capita per day vegetable is not available. High yielding hybrid varieties of vegetables and protected cultivation technologies have shown great potential in different climatic conditions. However, such findings are very scanty in plain conditions of India. Therefore, present experiment was conducted on with increase in urbanization, industrialization and nuclear families the land holdings are decreasing day by day. But one can produce above 50% more marketable quality and 30% yield of produce by using vertical space technique, vegetables which have spreading growth habits like; cucumber, bottle gourd, bitter gourd, ridge gourd, Sponge gourd, pointed gourd, Rounded gourd, Beans and tomato can be grown by using vertical space cultivation technique. In traditional system the number of plants or seeds per unit area is reduced 30-40% as these vegetables need more space to spread on ground due to which it is difficult to carry out all the cultural practices? The crop get severely affected during rainy season when the whole crop is immersed in water and the crop is highly infected by diseases and the mortality rate is very high, therefore, the vertical space cultivation is the best technique to overcome these problems. Vertical space cultivation technique helps the farmers are harvest quality produce for longer durations per unit area by protecting the crop from all biotic and abiotic stresses. This technique is compulsory or mandatory under greenhouse vegetables. The farmers of urban, peri-urban and villages can utilize this technique to get higher returns per unit area from cucurbits, Beans and tomato crops.

Keywords: Vertical cum staking farming, Protected cultivation technology, Vegetables

Theme 2: 102

Integrated Nutrient Management Practices with Nano fertilizers for Enhancing Potato Yield

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A field experiment was conducted at the Krishi Vigyan Kendra, Dhaura, Unnao, U.P, India, farm to evaluate the impact of integrated nutrient management (INM) practices on potato (*Solanum tuberosum* L.) yield. The primary objective of this study was to assess the effectiveness of INM practices, including the use of nano fertilizers, bio-stimulants, and soil amendments, on potato yield. The experiment was conducted with six treatments that included: T1: 100% NPK,T2: 100% N, 50% P_2O_5, 100% K_2O, T3: 100% N, 50% P_2O_5, 100% K_2O with seed treatment and one spray of nano DAP at 30 DAS,T4: 50% N, 50% P, 100% K with seed treatment one sprays of nano DAP at 30 DAS, two spray of nano urea at 30 & 60 DAS and one spray of Sagrika at 30 DAS, T5: 50% N, 50% P, 100% K with seed treatment and one spray of nano DAP at 30 DAS, two spray of nano urea at 30 & 60 DAS and one spray of Sagrika at 30 DAS and one spray of Nutrax at 30 DAS, T6: 50% N, 50% P, 100% K with seed treatment and one spray of nano DAP at 30 DAS, one spray of nano urea at 50 DAS, one spray of Sagrika at 30 DAS, one spray of Nutrax at 30 DAS with Sagrika soil application. The results showed significant variations in potato yield across the treatments. The highest yield was recorded in T5 (278 q/ha), followed by T6 (265 q/ha), T3 (230 q/ha), T4 (226 q/ha), T2 (188 q/ha), and T1 (186 q/ha). The use of nano fertilizers, bio-stimulants, and soil amendments can enhance nutrient uptake, improve soil health, and promote plant growth. This study demonstrates the potential of INM practices in improving potato yield. The integration of nano fertilizers, bio-stimulants, and soil amendments offers a promising approach to boost crop yields while minimizing environmental degradation. By reducing reliance on chemical fertilizers, this strategy can also alleviate the financial burden on farmers associated with high production costs, thereby promoting sustainable agriculture and economic viability.

Keywords: Potato, INM, Nano fertilizers, Sustainable agriculture

Theme 2: 103

Ecoflo Treadle Pump: A Sustainable Solution for Off-Grid Agricultural Irrigation

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The Ecoflo Treadle Pump is a novel irrigation technology which addresses the problem of limited access to electricity, particularly for rural farmers those depend on agrarian activities for their livelihoods. This foot-operated pump, introduced in Bangladesh in 1985, is made of tough plastic instead of metal so that it is rust-free, lightweight and can be carried to areas of need. It lifts water from up to 15 feet and can discharge up to Rs 45 feet at a speed of 5000 litres per hour over a distance of 1 km, making it ideal for medium sized farms. Unlike electric/fuel pumps, Ecoflo treadle pump is a non-mechanical operated pumps and hence no electricity

is required during the operation and thus is cost effective and also failure rates are less and maintenance cost also very low. Its affordability and efficacy allow smallholder farmers to have water throughout the year, resulting in increased crop yield and quality of life. Furthermore, the pump can also be used as an all-purpose workhorse when power supply is uncertain. The Ecoflo Treadle Pump has been shown to be cost-effective with annual running costs 36% cheaper and annual depreciation costs reduced by 47% on 0.50 ha demonstration land, translating into substantial savings for farmers. The pump's modular design enables easy moving, and makes the sprinkler/drip irrigation easily fitted. This revolutionary pump is not only cheap; it is also green, running without electricity or fossil fuel. With its minimal maintenance and user-friendliness, it is an appealing technology for smallholder farmers to address the limited access to water and erratic power supply. The broader implications of the Treadle Pump are not limited to national or international impacts, but also on rural community sustainability resiliency that are realized through improved food security and economic benefit that the pump accrues.

Keywords: Ecoflo treadle pump, Sustainable solution, Off-grid agricultural irrigation

Theme 2: 104

Model for Scientific Crop Residue Management and Environmental Stewardship

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The model presents a pioneering, community-centric approach aimed at eliminating the practice of stubble burning through a blend of technological intervention and behavioral transformation. Diverging from conventional outreach strategies, this model emphasizes first-time technology adopters, long-term engagement, and multi-dimensional interventions-technological, social, emotional, and religious. The model centers around the promotion of eco-friendly machinery such as the Happy Seeder, which not only prevents residue burning but also improves wheat productivity, conserves irrigation water, and enhances soil health. With over 79,645 farmers trained across 503 sessions and 87,000+ participants in 873 "Harvest Field Days," the model ensured widespread adoption and advocacy. It promoted spiritual stewardship by involving religious leaders and institutions such as SGPC and celebrating *Baisakhi* as "No Crop Residue Burning Day". Uniquely, the model empowered school and college students as change agents to influence family decisions, engaging over 37,500 students from 258 institutions. This inclusive strategy acknowledged supplementary grassroots efforts-highlighting real-life stories such as youth-driven initiatives and the citation of exemplary cases during the Prime Minister's *Mann Ki Baat*. The model's success is reflected in the development of over 300 "Residue Burning Free Villages" and strong farmer buy-in, with a 93% continued adoption rate of CRM technologies. Sustainability is ensured through the establishment of Innovation Hub Villages, entrepreneurial Custom Hiring Centres, and institutional convergence across public, private, and civil society stakeholders. This model has influenced policy-level decisions and is embedded in the IEC component of the Government of India's Central Sector Scheme on CRM. It serves as a scalable blueprint for sustainable and socially rooted agricultural transformation.

Keywords: Crop residue management, Behavioral change, Innovation hub

Theme 2: 105

Inclusion of Indian Mustard in Rice-Wheat System to Achieve Self-sufficiency in Oilseed Production

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Continuous monocropping, inappropriate cropping patterns, burning of crop residues, imbalanced fertilization, and limited use of farm manure have led to the depletion of soil organic carbon (SOC), causing soil health deterioration and exacerbating food insecurity, particularly in the context of climate change. Crop diversification is a critical strategy to improve soil health, enhance resilience to climate impacts, and promote rural livelihood security. This study hypothesizes that diversification, particularly through the introduction of high-yielding varieties of mustard, can result in improved food security, income generation, and overall well-being. To test this, Krishi Vigyan Kendra, Mahrajganj, conducted Front Line Demonstrations of a high-yielding Indian mustard (*Brassica juncea*) variety RH-761 as part of the crop improvement of the National Innovations on Climate Resilient Agriculture (NICRA) project during *Rabi* seasons of 2023-24 and 2024-25. The trials were implemented in three NICRA villages of Mahrajganj with 60 farmers (20 per village), each cultivating 1 acre of mustard. Results showed a significant yield increase of 25.19% and 27.46% over traditional practices for the respective years, along with substantial economic gains. Gross returns increased by 31.18% and 33.43%. These findings suggest that the adoption of high-yielding mustard varieties offers a viable alternative to wheat, contributing to national self-sufficiency in oilseed production while promoting sustainable agricultural practices.

Keywords: Climate change, Diversification, Livelihood, Monocropping, Oilseeds

Theme 2: 106

Impact of Varietal Innovation for the *Brassica juncea* on Risk Management: An Empirical Study

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India holds a prominent position globally in the production and import of oilseeds and edible oils, with its vegetable oil economy ranking fourth after the USA, China, and Brazil. Despite this, yield gaps ranging from 36% to 57% persist across major oilseed crops. In the case of rapeseed-mustard, 305 varieties have been developed in India, with 247 notified officially. The ICAR-Directorate of Rapeseed-Mustard Research has released 11 varieties suited to varied agroecological zones since 1993. This study aims to assess the economic impact of adopting the high-yielding Indian Mustard variety Giriraj (DRMR IJ 31), which is noted for wide adaptability, high adoption, and a long technological lifespan. Using the MODEXC model, the economic surplus to producers and consumers from Giriraj adoption was estimated, incorporating both yield gains and risk reduction benefits. Data were collected from 2,843 Frontline Demonstrations (FLDs) on Giriraj conducted under AICRP between 2015–16 and 2021–22. Complementary primary data were gathered through field

surveys, stakeholder consultations, and Focus Group Discussions (FGDs), involving over 500 stakeholders. Results indicate a yield advantage of 10–30% under varied agro-climatic conditions, with better resilience to stresses—demonstrated by a 2–3% lower yield coefficient of variation (CV) than traditional varieties. The current adoption rate of Giriraj is around 4%, projected to rise to 5% by 2030 under business-as-usual (BAU) scenarios. The adoption of Climate Resilient Mustard (CRM) varieties like Giriraj has generated an estimated economic surplus of USD 500,000 and contributed to lifting nearly 800,000 individuals out of poverty. In conclusion, bridging yield gaps through improved seed dissemination and irrigation expansion is critical. Given the low share (2.2%) of total research investment in oilseeds, enhanced funding and policy support are vital to scale up CRM technologies for India's smallholder-dominated mustard sector**.**

Keywords: Adoption level, Economic Surplus Model (ESM), Risk Reduction Benefits (RRBs)

Theme 2: 107

Inclusion of Summer Green Gram in Rice –Wheat Cropping System in Faridabad District of Haryana, India

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Rice–wheat cropping is the major agricultural production system In India among different cropping systems. The production of green gram in district Faridabad is very less as compared to state and national average. For large scale popularization of improved technologies, front line demonstrations are an important tool in agriculture. After harvest of wheat farmers used to have fallow fields so summer green gram could be a great option for the farmers in rice- wheat system during summer season. The improved technologies having higher production potential under the paddy-wheat-summer green gram cropping system can be popularized through cluster front line demonstrations. This study was conducted to evaluate the difference between practices followed by the local farmers in summer green gram crop and demonstrated improved technologies and to give an option to farmers who used to have fallow lands after harvest of wheat till next crop of paddy. A two years study from 2021 to 2022 during summer seasons was carried out in various villages of Faridabad district of Haryana by conducting cluster front line demonstrations at farmers' fields. With the participation of farmers, a total of 100 demonstrations were laid out in three years in 40-hectare area with the objective of improving yield productivity and to demonstrate the impact of improved technologies of pulses production potential to the farmers. Latest variety of moong seed MH 421 was treated with fungicide Thiram and bio fertilizers like *rhizobium* and Phosphorus Solubilizing Bacteria, weed management by means of chemical i.e. pendimethalin, balanced fertilizers application and integrated pest management were the improved technologies used. Three years study results showed that there was a positive impact of CFLDs on the yield of summer green gram and other aspects. Yield was recorded higher under demonstrated trials as compared to farmer's local practices. Average summer green gram yield for the years 2021 to 2022 was recorded higher (651 kg/ha) under improved technologies than under farmers practice (500 kg/ha). Higher gross return (44920), net return (24858) and benefit cost ratio (2.23) was found under improved technologies over farmer's practices. Present study has improved the economic aspects of farming community under cluster front line demonstrations over farmers' practices.

Keywords: Economics, Yield, Extension gap, Technology index, Technology gap, Summer green gram

Theme 2: 108
Characterization of Climate Change-Induced Climatic Scenarios in Coastal Odisha: A Vulnerable Zone on the East Coast of India

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India's diverse geographical landscape contributes to its unique climatic profile, including two monsoon seasons, two cyclone periods, a hot weather season marked by severe thunderstorms, dust storms, and heat waves, and a cold weather season characterized by snowstorms in the Himalayan region, cold waves, and fog. Consequently, different states experience varied climatic extremes. Coastal regions, in particular, have become increasingly vulnerable to extreme weather events, with Odisha being among the most hazard-prone states in India. These climatic changes pose significant risks to agriculture, threatening the livelihoods of rural communities. To address these challenges, climate-informed planning and evidence-based management are essential. Agricultural development and extension initiatives must begin with an in-depth climatic characterization of the region. This study examined 22 coastal blocks from six districts of Odisha using Indian Meteorological Department (IMD) daily gridded data from 1980–2021 and records of extreme weather events over the past 40 years. Summary statistics and trend analyses were conducted to evaluate climatic indicators such as the frequency of heat and cold waves, severe and moderate meteorological droughts, and rainfall variability. Principal Component Analysis (PCA) was employed to derive a composite hazard index from the climatic indicators. Based on this index and using the Cumulative Square Root Frequency method, the blocks were classified into different hazard levels. The results identified three blocks in Puri district (Krushnaprasad, Puri Sadar, and Gop) as having very high hazard indices, whereas blocks such as Kujanga (Jagatsinghpur), Rajnagar (Kendrapara), and Rangeilunda and Chikiti (Ganjam) had notably lower indices. These findings underscore the variability of climate risks even within similar agro-ecological zones. Regional climate characterization provides critical insights for understanding farmers' climate change awareness and supports the formulation of targeted preparedness and extension strategies. This approach can serve as a strategic framework for enhancing resilience through localized extension services.

Keywords: Climate change, Climate characterization, Hazard index, Odisha

Theme 3: 109
Showcasing Rice Residue Management Technologies: A Strategic Platform-Based Approach

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The rice-wheat cropping system is the most dominant in India, particularly in the northwestern plains. After harvesting paddy, the common practice of burning crop residues to quickly prepare the field for wheat sowing leads to severe environmental pollution and degradation of soil health through the loss of organic matter and essential nutrients. Conservation agriculture offers sustainable alternatives to this practice, emphasizing minimal soil disturbance and residue retention. Various mechanized sowing technologies, such as Happy seeder, Super seeder, Smart seeder, Surface seeder, Zero till drill, and others, have been developed to sow wheat directly into paddy residues without burning. However, perceived operational complexity among farmers has hindered widespread adoption of these methods. To demonstrate the field performance of different wheat sowing techniques under residue-retained conditions, a demonstration was conducted at the farm of PAU-Krishi Vigyan Kendra, Sri Muktsar Sahib, during *Rabi* 2023-24. A strategic/learning platform was established at the KVK farm, where seven sowing methods, *viz*. Surface seeder, Smart seeder, Happy seeder, Super seeder, straw incorporation with MB Plough, Zero till drill, and conventional method were demonstrated using wheat variety PBW 766 under recommended agronomic practices. Among all the methods, Super seeder recorded the highest number of effective tillers/m^2 (437.5), followed closely by MB Plough incorporation (435.0) and Smart seeder (422.5). The maximum number of grains per ear (72.3) and grain weight per ear (3.8 grams) were also observed in Super seeder plots. However, it also showed the highest lodging percentage (60%). The Zero till drill showed the least lodging (5%) but produced the lowest grain yield (55.0 q/ha), similar to the Happy seeder. Super seeder achieved the highest grain yield (58.75 q/ha), followed by Smart seeder and MB Plough (both 57.5 q/ha).

Keywords: Crop residue management, Happy seeder, Smart Seeder, Strategic platform, Super seeder

Theme 3: 110
Assessing Farmer Groups' Knowledge on Nutrition-Focused Agriculture

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Nutrition-sensitive agriculture is crucial for improving rural health and food security, but farmers' awareness of its principles remains limited. A knowledge assessment tool was developed to evaluate the understanding of nutrition-focused agriculture among members of Farmer Interest Groups (FIG) of Farming System for Nutrition, with the objective of enhancing practices and health outcomes. The tool prioritised critical understanding over memorization to distinguish informed participants from those with limited knowledge. Following rigorous item difficulty index and item discrimination index, a finalized set of questions was selected. Reliability assessments demonstrated a satisfactory level of consistency. The study focused on purposefully selected farming system for nutrition groups from three villages. Findings revealed that a majority of participants demonstrated limited knowledge, while a smaller segment displayed proficiency, underscoring gaps that necessitate customized educational interventions for farming communities.

Keywords: Knowledge test, Farmer Interest Group (FIG), Farming System for Nutrition (FSN)

Theme 3: 111

Designing of the Participatory Approach-based Decision Support System (PDSS) for Horticulture Crops of Meghalaya

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Decision support system (DSS), since it was first designed in the 1970s, has taken various forms from simple DSS to PDSS to IDSS (Integrated Decision Support System). Some of these types could not take off because of a lack of farmers' participation in their design, which excluded problems faced by farmers in the cultivation of different crops. This failure of different DSS to solve the farmers' problem led involvement of the farmers in the designing of the DSS and this took the form of the PBDSS (Participatory Bottom-up approach based Decision Support System). While designing PBDSS, participation of the farmers was ensured by providing an interview schedule to them Project is taken in the state there are different aspects of ITK based DSS. Meghalaya state was selected purposely because its climate is suitable for both vegetables and fruits, then District Ri-Bhoi was selected purposively because the Institute is located in this district more over institute is working in these villages already. Five villages *viz*: Mynan, Nonglakhia, Nongkya, Nongthymmai, Kyrden were selected purposely from Meghalaya which are growing both fruit and vegetables. Profile information of these villages in respect of fruits and vegetables cultivation was collected through secondary data. Then, 20 farmers were selected from each village. A decision support system based on the bottom-up and participatory approach is a better one as compared to others. It provides problem-based area area-specific solutions. Thus, this type of PBDSS is more practical and has more adaptability among the farmers. Collection of primary data ensures participation of the farmers in the designing of the DSS, thus making it Participatory, area-specific, problem problem-oriented.

Keywords: Decision support system, Participatory, Horticulture crops, Bottom-up approach

Theme 3: 112

Detecting and Handling Data Errors: Improving Data Quality in Social Science

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Ensuring data quality is a critical aspect of research, as inaccuracies in data collection, entry, and analysis can significantly compromise research validity and lead to erroneous conclusions. This review explores prevalent data errors, including sampling errors, measurement inconsistencies, nonresponse bias, data entry mistakes, and missing values, all of which can impact the reliability of empirical findings. A systematic review of error detection and mitigation techniques is presented, incorporating statistical, computational, and methodological approaches to enhance data integrity. Key strategies such as imputation techniques, deletion methods, and triangulation approaches are examined to address inaccuracies and ensure robust data handling. The review also highlights the implications of outliers, duplicate entries, and misclassification errors, which can distort analytical results and misinform policy decisions. Ensuring rigorous data validation and robust error-handling mechanisms is essential in social science research, particularly in fields such as agricultural extension, where data reliability directly impacts policy recommendations and advisory services. By implementing systematic quality control frameworks, researchers can enhance the accuracy, reproducibility, and credibility of their findings, ultimately strengthening evidence-based policymaking and knowledge dissemination.

Keywords: Data quality, Error detection, Social science research, Agricultural extension, Data validation

Theme 3: 113

Knowledge Level of Farmers on Rice IPM Practices

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Rice (*Oryza sativa*) is one of the most important staple crops globally, serving as the primary food source for over half of the world's population. The present study was conducted in Punjab state to assess the knowledge level of farmers about the recommended rice IPM practices A total of 200 farmers were randomly selected from five districts *i.e.* Ropar, Ludhiana, Gurdaspur, Shri Muktsar sahib and Ferozpur representing different agro-climatic zones of Punjab. Two blocks from each districts were selected and from each selected block two villages were selected randomly thus constituting 20 villages. Findings of the study revealed that most of the respondents were in the age group of 39-54, educated up to senior secondary level and belongs to joint family with operational land holding of 2-4 hectare. Majority of the farmers had medium level of mass media exposure and extension contacts. Farmers possessed medium level of knowledge about various cultural practices like recommended date of transplanting rice, recommended varieties of rice, crop rotation, summer deep ploughing. Most of the farmers had medium level of overall knowledge regarding the mechanical and chemical practices of IPM however they lacked knowledge on ETL of insect-pest. The overall knowledge about the biological practices was found low. Majority of the farmers had knowledge about the major insect pests of rice crop.

Keywords: Knowledge level, Integrated pest management (IPM), Rice, Pest

Theme 3: 114

Analysis of Seed Source Networks and farmers' preferences for Rice in Punjab, India

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Access to high-quality seeds is crucial for farmers to secure food and nutritional security, alleviate poverty, as seeds are fundamental to food security. Farmers often manage diverse seed portfolios to optimize yields and mitigate production risks. This study explored the current seed source network for rice crops in Punjab and investigated the reasons behind farmers' seed preferences. Conducted in five agroclimatic zones of Punjab, India, the research utilized a multi-stage sampling design and personally interviewed 200 farmers. Findings revealed that most farmers sourced rice and basmati seeds from private seed dealers, followed by farmer-saved seeds. Farmers preferred formal sources like private seed dealers for their availability, and institutions like PAU/KVK and agricultural departments for their seed quality. Informal sources, such as farmer-saved seeds and seeds from neighbours/relatives, were preferred for their affordability and accessibility. The limited distribution of seeds through public departments indicates potential gaps in formal seed delivery systems, potentially restricting access to certified seeds and improved varieties. There is a need to integrate formal seed systems to meet the demand for rice seeds and to train informal seed sources to maintain seed quality within the farming community.

Keywords: Formal seed source, Informal seed source, Seed source network, Farmers' preferences

Theme 3: 115
Translational Agriculture Research: Out-of-Box Extension System

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Agricultural research has made significant advancements, yet the challenge remains in ensuring that scientific innovations reach and benefit farmers effectively. A significant gap exists between scientific research and their adoption at the farm level. Translational Agricultural Research (TAR) is an emerging approach that aims to ensure research outputs are effectively implemented through innovative and dynamic extension systems. This paper explores the "Out of Box" Extension System, which reimagines traditional extension models by integrating multi-stakeholder participation, digital tools, and farmer-led innovations. Agricultural innovation has evolved from traditional practices to technology-driven solutions. The shift from Green Revolution technologies to precision farming, artificial intelligence (AI), and climate-smart agriculture has changed the way agricultural research is conducted and disseminated. Farmer-led innovation, agri-startups, and digital platforms are now reshaping agricultural extension. An innovation system comprises multiple actors, including research institutions, policymakers, extension agencies, private sector players, NGOs, and farmers. The effectiveness of agricultural research depends on coordinated efforts among these stakeholders. This paper highlights approaches to mobilizing all actors, including public-private partnerships, participatory research, and multi-channel knowledge dissemination. Knowledge translators act as intermediaries between researchers and farmers, ensuring that scientific innovations are simplified, localized, and made accessible. These include agricultural extension officers, agri-entrepreneurs, digital platforms, and progressive farmers who facilitate the last-mile delivery of research-driven solutions. A revamped, translational research-driven extension system is crucial for ensuring that agricultural innovations reach smallholder farmers efficiently. This paper advocates for a multi-actor, technology-enabled, and demand-driven extension system that enhances farmer participation, digital outreach, and sustainability in Indian agriculture.

Keywords: Artificial Intelligence (AI), Climate-smart agriculture, Farmer-led innovations, Precision farming, Translational Agricultural Research (TAR)

Theme 3: 116
Revitalising Mustard Farming Through 'Sarson School on AIR': An Innovative Technology Delivery Model

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Radio remains a vital tool for rural outreach, with its unparalleled reach and credibility. Recognizing this, ICAR-IIRMR designed and developed the "Sarson School on AIR" technology delivery model, a pioneering radio-based extension approach that has revolutionized mustard farming in Rajasthan and Uttar Pradesh through bridging the knowledge gap among mustard farmers. This model leverages the widespread reach of radio to disseminate improved mustard technologies, enhancing farmers' knowledge, adoption, and productivity. The program aims to provide real-time information on improved mustard technologies, promoting sustainable agricultural practices and enhancing farmers' livelihoods. This innovative model involves content creation, radio broadcasting and feedback mechanism. Scientists from ICAR-IIRMR develop 24 technology delivery modules

covering mustard production and protection technologies. These modules are designed to provide comprehensive information on best practices, new technologies, and seasonal advisories. The modules are broadcast weekly through selected AIR stations in Rajasthan and Uttar Pradesh during the crop season. This ensures that farmers receive timely and relevant information to inform their decision-making. A feedback mechanism is built into the model, allowing stakeholders to provide suggestions and feedback on the content and delivery of the program. This feedback is incorporated to refine the model and ensure its relevance and effectiveness. This model has had a significant impact on mustard farming in Rajasthan and Uttar Pradesh. The program has reached over 50 lakh farmers, enhancing their knowledge and adoption of improved mustard technologies. The program has contributed significantly to enhance mustard production and productivity in Rajasthan and Uttar Pradesh. Farmers have reported increased yields, improved crop quality, and reduced crop losses. The program has promoted soil conservation and management practices, leading to improved soil fertility and reduced soil erosion. The program has proven to be cost-effective, providing real-time information to a large audience at an affordable cost.

Keywords: Radio-based extension, Mustard farming, Technology dissemination, Farmer empowerment, Participatory communication

Theme 3: 117

Behavioural Nudges for Better Soil Management: Reinforcement as a Tool in Extension Advisory

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Sustainable soil management is critical for long-term agricultural productivity, yet the adoption of scientific recommendations by farmers remains limited due to gaps in information dissemination and behavioural inertia. This study investigates the effect of soil test-based advisory and reinforcement on farmers' soil management decisions. The research was conducted using an experimental research design among farmers in Punjab. The study was conducted in the Ludhiana district in all seven tehsils. Further, one village from each tehsil was randomly selected and eight respondents were randomly selected from each village, thus making a sample size of 56. Data were periodically collected at baseline, midline and endline surveys using interview schedule. Soil samples were collected and analysed to generate field-specific nutrient management recommendations. These advisories were shared with farmers through participatory methods, including personalized reports, personal field visits, and group meetings. Furthermore, behavioural nudges were used to reinforce these messages, including follow-up strategies such as reminder visits, phone calls, and WhatsApp messages. The findings indicate that farmers, after receiving both advisory and reinforcement, were significantly more likely to adopt recommended practices such as balanced fertilizer use, incorporation of organic matter, and reduction in indiscriminate fertilizer application without any significant yield reduction in rice and wheat crops. The reinforcement approach through behavioural nudges was pivotal in strengthening farmers' understanding, enhancing trust in scientific information, and encouraging peer learning. This study highlights the effectiveness of integrated extension models that combine technical advice with behavioural nudges in the form of reinforcement, creating continuous engagement and enabling behaviour change. The results offer valuable insights for designing scalable and farmer-centered strategies for sustainable soil health management.

Keywords: Advisory, Reinforcement, Behavioural Nudge, Soil Management Practices

Theme 3: 118

Farmer Producer Company (FPC) Mediated Technology Delivery Model in Vegetable Sector for an Efficient Extension System

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Many promising agricultural technologies are available which can enhance farmers' income. However, how these technologies can be delivered to the right farmers' group, followed by an effective marketing strategy, is a researchable issue. An efficient technology delivery system is required and hence studies are being carried out in the Varanasi region for developing an effective technology delivery model (TDM) through FPC. Complying with the objectives of the project, a new FPC, Sumrat Bhumi Producer Company Limited, has been formed on 16th September 2021 at Ghorawal, Sonbhadra after overcoming all hurdles of FPC formation. A brainstorming session was conducted among the BODs of the FPCs to identify the working priorities and 87.5% told that FPC should work on product-specific agriculture. According to 78.66% of the BODs, FPC should focus on maximum diversity of one single product and 73.8% was in consensus that agriculture input business should be the priority for FPC for quick earnings. Needs were assessed for the members of FPCs and the top most need was managing low or marginal profit from agriculture with R^2 value 0.430 and weighted average 4.98. To encounter this, interventions were carried out through mushroom production, beekeeping, protected cultivation and vegetable cultivation in open conditions. Trainings were organised and knowledge, skill and attitude were measured before and after training. In case of mushroom training knowledge increased from 38.65% to 92.45%, skill increased from 29.33% to 86.75% and attitude changed from 54.55% to 75.55%. Likewise, changes in knowledge, skill and attitude were recorded for beekeeping and protected cultivation training. Demonstrations of improved vegetable varieties from ICAR-IIVR conducted at farmer's field and results were compared with the existing cultivar. Finally, logical models on technology delivery were proposed for effective dissemination and sustainability.

Keywords: FPC, Technology delivery, Extension system, Vegetable cultivation

Theme 3: 119

Exploring the Factors Shaping Artificial Insemination Technology Adoption in Pig Farming: Evidence from Assam

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Artificial Insemination (AI) is an innovative reproductive technology with the potential to enhance productivity and genetic quality in pig farming, particularly among smallholder systems in Northeast India. Despite its advantages, AI adoption in the region, especially in Assam, remains limited. Given the importance of pig farming for rural livelihoods and food security in this area, understanding the factors influencing AI adoption is critical. This study investigates the determinants affecting the uptake of AI among smallholder pig farmers in Assam, employing a mixed-methods research design. Data were gathered from 180 randomly selected farmers

across various districts through structured interviews, focus group discussions, and field observations. Using an Average Treatment Effect (ATE) estimation framework, the study assessed both actual and potential adoption levels. Results showed that while 39% of farmers currently use AI, a potential adoption rate of 61% suggests a 22% gap primarily attributed to limited awareness and access to the technology. Further analysis through an ATE-based probit model identified several key factors influencing adoption. These included the farmer's age, experience in pig farming, the maximum number of pigs reared annually in recent years, the number of breeding sows owned, proximity to AI service centers, access to extension services and participation in training or demonstration programs. Moreover, higher educational attainment, better access to advisory services and stronger market connections were positively associated with AI adoption. Compared to conventional models, the ATE-based analysis provided deeper insights into the likelihood of technology uptake. The findings underscore the need for targeted interventions, such as strengthening extension services, improving the availability and affordability of AI, and implementing localized awareness campaigns. These efforts could significantly bridge the adoption gap and support sustainable pig farming practices in the region.

Keywords: Artificial insemination, Adoption, Pig farming, Food security

Theme 3: 120

Development of Knowledge Test to Assess Agricultural Literacy Level Among School Students

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Agricultural literacy enables individuals, particularly in rural communities, to understand and apply core agricultural concepts and policies, which are essential for improving economic, social, health, and environmental well-being. The present study was conducted in Ludhiana district of Punjab. A multistage random sampling design was employed, selecting two blocks from the district and further, one rural school was selected from each identified block. The study sample included students from classes 10th and 12th. For assessing the agricultural literacy level of the respondents, a knowledge test was developed based on the Food and Fibre System Literacy (FFSL) framework, covering five thematic areas: (i) understanding food and fibre systems, (ii) history, geography, and culture, (iii) science, technology, and environment, (iv) business and economics and (v) food, nutrition, and health. The test consisted of cognitive test items. The initial pool of 162 items was developed. These items were administered to the judges to check their initial relevancy to the context and to scrutinise the nature of items being prepared. After the scrutiny, the items were revised. The items of the developed test were subjected to item analysis, calculation of difficulty index, discrimination index, and point biserial correlation coefficient, ensuring the validity and reliability of the instrument. The final test consisted of items with a difficulty index ranging between 0.4 and 0.6, a discrimination index above 0.30 and a point biserial correlation coefficient above 0.26. The reliability of the test, calculated using the Kuder-Richardson formula (KR-20), was 0.91, while the intrinsic validity was found to be 0.95. The final instrument included 50 standardized cognitive items. The developed research instrument exhibited strong psychometric properties, ensuring its effectiveness in assessing participants' agricultural literacy level and also the developed test has wider applications in assessing the agricultural literacy level in the context of the Indian agricultural food system.

Keywords: Knowledge assessment tool, Agricultural literacy, Item analysis, Reliability, Validity

Theme 3: 121

Exploring the Boundless: A Comprehensive Review of Factors Affecting Scientists' Creativity

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The exploration of creativity within various domains such as education, work, art, and science has gained significant attention, revealing its fundamental role in human development. Despite the recognition that creativity is a basic human trait, ongoing debates persist regarding how to measure, apply and develop creativity. Research indicates that creativity is not solely reliant on stable personal characteristics; rather, it emerges from a complex interplay of individual, cognitive, affective, behavioural, and contextual factors. This comprehensive review aims to delve into various factors that shape scientists' creativity, emphasizing the need to understand and foster this essential component for innovation and progress in scientific endeavours. A conceptual framework for the functionality of creativity as a determinant of research output is also proposed through the study. Accordingly, the paper summarises the factors affecting creativity of scientists categorizing them into two *viz.*, Individual factors and Environmental factors. Individual factors encompass the personality of the individual and domain-relevant knowledge and skills, while environmental factors include organizational support, peer group support, and pressures. Accordingly, various strategies have been proposed to enhance the creativity of scientists. Through this paper, one can delve into understanding the complex interplay of factors that impact scientists' creativity which can ultimately contribute to the advancement of scientific innovation and discovery. These insights are valuable for researchers and professionals in the scientific community, as they shed light on the various elements that can either foster or hinder creativity in a scientific context. Ultimately, by recognizing and understanding these factors, the scientific community can work towards creating an environment that nurtures creativity, leading to enhanced innovation and scientific advancement.

Keywords: Scientific creativity, Individual factors, Environmental factors, Innovation in research, Organizational support

Theme 3: 122

Engaging Youth in Agriculture: Innovations and Strategies for a Sustainable Future

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Agriculture remains the backbone of many economies, especially in developing countries, it faces a critical challenge like, declining youth involvement. Young people today frequently migrate to cities and non-agricultural industries because they believe that agriculture is outmoded, labour-intensive, and financially unsatisfying. To guarantee food security, jobs, and sustainable rural development, this trend must be reversed. Agriculture needs to be repositioned as a cutting-edge, profitable industry to appeal to the younger generation. Traditional agricultural methods are being transformed into intelligent, effective systems through the integration of contemporary technology, including artificial intelligence (AI), the Internet of Things (IoT), drones, mobile platforms, and precision farming instruments. Through data analytics, remote farm management, and tech-based solutions,

these technologies give young people the chance to get involved in agriculture. One important tactic is to encourage agripreneurship in addition to technology advancements. Agriculture becomes a platform for creativity, self-employment, and income production when young people are encouraged to launch agri-based businesses in sectors including organic farming, food processing, agritourism, and e-commerce. Youth engagement can be further strengthened by government assistance through incubation centers, subsidies, training programs, and access to credit and land. By updating agricultural education, providing practical training, and showcasing the achievements of young farmers and agri-entrepreneurs, educational institutions also play a critical role. By empowering youth through innovative and supportive frameworks, the agricultural sector can be transformed into a dynamic and attractive field with long-term impact. The next generation can be inspired and attitudes can be changed by raising awareness of the breadth and promise of agriculture.

Keywords: Youth in agriculture, Agri-entrepreneurship, Smart farming technologies, Sustainable development, Agricultural education

Theme 3: 123
Assessment of Farmer Producer Organisation in West Garo Hills of Meghalaya

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The study was conducted at the West Garo Hills district of Meghalaya. A total of four FPOs, namely Mikasal Farmer Producer Company Ltd., Tikrikilla Agrofed Producer Company Ltd., Demdema Agrofed Producer Company Ltd. and Bitegram Agrifed Producer Company Ltd. were selected purposively. The study covered 25 members of Farmers from each FPO, comprising a total sample of 100 FPO members. The study targeted to assess the socio-economic changes of the FPO member farmers in the district. Primary data were collected through face-to-face interviews of the respondents with pre- pre-structured interview schedule. The study found that, majority of the respondent farmers (65%) were female and majority of them had an educational level of below class X (48%) followed by high school (21%), higher secondary (7%), graduation (5%) and illiterate (19%). The majority of the respondents have medium family size (58%) with four to six family members. Further, the study revealed that majority (38%) of the respondents were marginal farmers with landholdings below 1 Ha. The source of agricultural information for the farmers were personal localite, which includes fellow farmers and neighbours, and personal cosmopolite, which includes FPO personnels, etc. The study uncovered that after joining FPO, the respondent farmers have increased in social participation (up to 75%). The perceived benefits of farmers after joining FPOs, farmers were found no increase in facilities for market access (83%), gets assistance and access to inputs and technology through FPO (52%), lack of financial benefits (68%), acknowledged social benefits (84%) including enhanced social cohesion, a sense of belonging, and improved social status through FPO membership. The findings aim to provide evidence-based insights that will leveraged the development of target policy interventions and institutional support mechanisms for strengthening and long-term sustainability of FPOS in Meghalaya as well as other regions.

Keywords: FPO, Garo hills, Social participation, Perceived benefits, Sustainability

Theme 3: 124
Mass Multiplication of *Beauveria bassiana* on Different Media

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Beauveria bassiana is a widely utilized entomopathogenic fungus in biological control programs. The present study aimed to evaluate the efficacy of various solid grain and synthetic media for the mass multiplication of *B. bassiana*, focusing on spore production and radial growth. The experiment was conducted in the Biological Control Laboratory, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, using a Completely Randomised Design with three replications. Six solid grain substrates: green gram, chickpea, wheat, rice, maize, and sorghum were assessed, with data recorded at 7, 14, 21, and 28 days after inoculation. Among these, chickpea exhibited the highest spore yield (88.33×10^5 spores/ml) at 28 days, followed by sorghum (55.67×10^5 spores/ml) and green gram (40.67×10^5 spores/ml). Maize and rice showed comparatively lower sporulation throughout the study period. In parallel, four synthetic agar media-PDA (Potato Dextrose Agar), BDA (Banana peel extract Dextrose Agar), P_1DA (Papaya peel extract Dextrose Agar), and SDA (Sabouraud Dextrose Agar) were tested for radial growth and sporulation. PDA recorded the highest radial growth (36.00 mm) and spore production (86.33×10^5 spores/ml) at 28 DAE followed by P_1DA and SDA. Although SDA showed good performance, P_1DA demonstrated similar sporulation and radial growth at a significantly lower cost, making it a cost-effective alternative for large-scale production. In contrast, BDA showed the least sporulation and radial growth among the synthetic media. These findings provide valuable insights for optimizing mass production techniques for *B. bassiana*, thereby enhancing its practical utility in integrated pest management (IPM) programs as an efficient and economical mycoinsecticide.

Keyword: *Beauveria bassiana,* Inoculation, Radial growth, Sporulation.

Theme 3: 125
Farmers' Willingness to Pay for Agricultural Extension Services: A Case Study of Cost Cost-Sharing Approach in Meghalaya

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Agricultural extension in India finds itself in the midst of significant changes and uncertainty, particularly because of variability in the funding pattern of extension expenditure and inadequate manpower in the agricultural extension system. Complete privatization and commercialization of extension services in India will spell doom for the agricultural industry because majority of our farmers have weak capital base to be able to pay fully for extension services. It is on this basis that a participatory, i.e. cost sharing approach is being advocated in order to bring more accountability on the part of the farmers and the extension agents. Cost sharing extension approach assumes that cost sharing with local people will promote a programme that is more likely to meet local situations and where extension agents are more accountable to local interests. Success of the approach is often measured by the farmers willingness of to pay (WTP) for the services. Against this backdrop, the study has been undertaken in Meghalaya with the objectives to understand the farmers' willingness to pay for extension service on cost

sharing basis pertaining to agriculture and allied sectors and to identify the determinants for Farmers' WTP for Agricultural Extension Services (AES). The study revealed that majority of farmers (87%) were favorably disposed to cost-sharing. Subsidy on inputs was recognized as the most desired service in the supposed cost sharing extension approach. Using the contingent valuation method, it was found that 63.33% of farmers are WTP maximum 80.00% subsidy for the AES particularly inputs, a few with the condition of ensuring economic viability or will discontinue otherwise. Binary probit regression revealed that independent variables *viz.* education (p= 0.012**), farm size (p= 0.004**) and clientele satisfaction (p<0.001**) with the existing AES are the important determinants possibly affecting farmers' WTP for extension services. The findings from the study imply that advocating cost sharing or fee-based services may prolong the provision of agricultural advisory services and enhance pluralism in extension service if the farmers are provided inputs on time, clientele satisfaction with the existing AES and ensuring accessibility to the various AES as and when needed.

Keywords: Cost sharing, Willingness to pay, Agricultural extension services, Perception

Theme 3: 126

Strengthening Agricultural Innovation and Extension System for Delivering Various Agro-advisory Services

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National Agricultural Research and Education Systems (NARES), Agricultural Knowledge and Information Systems (AKIS) and Agricultural Innovation Systems (AIS) are interlinked as 'NARES emphasizes on the innovation of knowledge, AKIS on the innovation and diffusion of knowledge, and AIS on the innovation, diffusion, and application of knowledge. AIS represents a dynamic network where diverse stakeholders, *viz.*, farmers, researchers, policymakers, etc., interact. This interaction highlights the importance of both supply (the availability of new technologies) and demand (the willingness to adopt them) in driving agricultural innovation. In response to agriculture's increasing complexity, shaped by market demands, resource constraints, and sustainability goals, strong extension services are essential. Consequently, AIS is now evolving into the Agricultural Innovation and Extension System (AIES). A robust framework for AIES emphasizes collaboration among research institutions, policymakers, private enterprises, and community-based actors. It seeks to establish a dynamic ecosystem where service providers precisely determine "who will offer whom, with what services, and at what standard" to meet the needs of agro-advisory service seekers. This creates a dynamic ecosystem that fosters the generation and dissemination of practical solutions to real-world agricultural challenges. Efficient convergence of components through public-private partnerships, under the supervision of the government, is imperative to minimize duplication of tasks. In this backdrop, the present study has been undertaken in the state of Odisha to assess the various aspects of AIES. Preliminary findings suggest that state line departments predominantly fulfil technology transfer needs, while Krishi Vigyan Kendras (KVKs) cater to capacity building. Agricultural Technology Management Agency (ATMA) addresses holistic farming system requirements, including gender mainstreaming and value addition, and SHGs promoted and linked to the banks by Non Government Organizations (NGOs) ensure access to farm credit. Farmer Producer Organizations (FPOs) play a pivotal role in marketing farm produce, significantly enhancing farmers' income. The successful implementation of the convergence model requires a prudent monitoring and evaluation process. Using smart technology and fostering collaboration among AIES stakeholders will promote India's farming community.

Keywords: Agricultural innovation system, Extension services, Agro-advisory, AIES, Knowledge dissemination

Theme 3: 127
Status of Mechanized Rice Residue Management in Rice-Wheat Cropping System of Sri Muktsar Sahib District

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The Rice–Wheat cropping system prevalent in northwestern India, particularly Punjab, faces significant challenges due to a narrow window period between rice harvesting and wheat sowing. These factors often compel farmers to resort to open burning of paddy straw, contributing to severe air pollution and degradation of soil health. It is estimated that nearly 75–80% of paddy fields are harvested using Combine Harvester, leaving loose rice straw residues in the field. In Punjab, Haryana, and Uttar Pradesh alone, around 23 million tonnes of rice residue are burned annually, resulting in nutrient loss, depletion of organic carbon, and significant economic and ecological costs. To address this, both in-situ and ex-situ Crop Residue Management (CRM) technologies have been developed and promoted. In-situ methods, such as straw retention and soil incorporation, are considered the most sustainable. Technologies like the Happy Seeder, Super Seeder, Smart Seeder, Surface Seeder, Paddy Straw Cutter-cum-Spreader, Rotavator, and Mould Board Plough have been introduced by Punjab Agricultural University to facilitate sustainable residue management. This study was conducted to assess the adoption patterns of CRM technologies in the Sri Muktsar Sahib district of Punjab. A survey of 120 randomly selected farmers revealed that full residue burning was practiced by only 0.83% of respondents on 0.36% of the study area. Partial management was observed in 30.16% of the area, while 69.5% was fully managed with CRM machinery. Zero till drills and Super Seeders were the most commonly adopted tools. The findings underscore the importance of technical training, hands-on exposure, and affordable access to CRM machinery to increase adoption. Promoting these technologies through strategic demonstration platforms can play a crucial role in transitioning toward sustainable and environmentally responsible residue management practices.

Keywords: Surface seeder, Super seeder, Happy seeder, Mould board plough, Rice residue management

Theme 3: 128
Empowering Agricultural Extension Professionals for Enhanced Post-harvest Management and Food Security

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Post-harvest systems are vital for achieving food security, poverty alleviation, and sustainable agriculture. Despite significant advancements in post-harvest management research, many innovations remain underutilized, as research outputs often stay confined to universities and institutes. This creates a significant gap in transferring agro-processing and post-harvest technologies to farmers and stakeholders. The agricultural advisory system's focus on production-related technical aspects further limits the dissemination of knowledge about post-harvest technologies. Bridging this gap requires strengthening communication between researchers and extension service providers to ensure that post-harvest technologies reach the intended beneficiaries. Farmers must be made aware of available technologies and their practical applications to address their specific needs effectively. Agricultural

extension workers and advisory service providers, with their close engagement with farmers and rural communities, are uniquely positioned to reduce post-harvest losses and enhance food and nutrition security. To address this, capacity-building initiatives are crucial. Training and field demonstrations on post-harvest technologies were organized for Subject Matter Specialists (SMS) from 82 Krishi Vigyan Kendras (KVKs) across India. These programs equipped SMS with the knowledge and skills to effectively transfer post-harvest technologies to farmers, promoting the reduction of losses and increasing the processing of agricultural commodities. By empowering these extension personnel, the gap between laboratory innovations and field applications can be narrowed, ensuring sustainable agricultural development and improved livelihoods for farming communities.

Keywords: Post-harvest technologies, Technology transfer, Capacity building, Agricultural extension

Theme 3: 129

Enhancing productivity and profitability of *Gobhi Sarson* through frontline demonstrations in Sri Muktsar Sahib district of Punjab

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Rapeseed-mustard (*Brassica* spp.) stands as the second most important oilseed group in India after groundnut, comprising crops which includes *toria, gobhi sarson, taramira*, raya, and African sarson. In Punjab, during the 2022-23 season, these crops were cultivated over an area of about 45 thousand hectares, producing approximately 73 thousand tonnes, with an average yield of 16.23 quintals per hectare. *Gobhi Sarson* (*Brassica napus* L.), a member of the Brassicaceae family, exhibits superior tolerance to low temperatures and frost compared to Indian mustard (*B. juncea*) and shows resistance to white rust. The introduction of canola-quality *gobhi sarson* with low erucic acid (<2%) and glucosinolate levels (<30 μmol/g has expanded its suitability for both human consumption and as a protein-rich animal feed. Punjab Agricultural University has played a pivotal role in developing canola quality *gobhi sarson* varieties/hybrids. Notably, it has introduced canola *gobhi sarson* variety GSC-7, which is recommended for cultivation in Punjab. However, many farmers in Sri Muktsar Sahib district continue to cultivate traditional, non-canola varieties with suboptimal agronomic practices, leading to lower yields and poor oil quality. Under such situations, frontline demonstrations serve as a vital tool for transferring technology to farmers, and it is imperative to showcase high-yielding, nutritionally superior varieties to enhance crop productivity. The present study aimed to assess the performance of canola-quality Gobhi Sarson variety GSC-7 with recommended practices through frontline demonstrations in Sri Muktsar Sahib district. Krishi Vigyan Kendra, Sri Muktsar Sahib implemented frontline demonstrations (FLDs) during the *rabi* season of 2023-24. The demonstrations featured GSC-7 along with recommended practices such as proper seed rate, spacing, nutrient management, and targeted pest control. Results showed an 8.42% increase in seed yield under improved practices. Demonstration plots achieved a net return of Rs. 50,780 per hectare, compared to Rs. 43,880 under farmer practices, yielding an additional income of Rs. 6,900 per hectare. The technology gap and extension gap were 3.0 and 1.3 q/ha, respectively, with a technology index of 13.5%, indicating good adaptability. To boost *gobhi sarson* productivity in the region, it is essential to strengthen technology dissemination through collaborative efforts.

Keywords: Canola, Frontline demonstration, *Gobhi sarson*, Oilseed

Theme 3: 130

Evaluating Capacity Building of KVK Personnel through a Partial Kirkpatrick Model Approach

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Effective capacity building of Krishi Vigyan Kendra (KVK) personnel is essential for advancing agricultural extension and fostering rural innovation. This study evaluates a structured training program for Subject Matter Specialists (SMSs) using a partial adaptation of the Kirkpatrick Model, focusing on Reaction and Learning levels. The program was designed to enhance institutional knowledge, functional competencies, and extension strategies among newly recruited and early-career SMSs from Punjab, Himachal Pradesh, Uttarakhand, and Jammu & Kashmir. Reaction-level data were collected using a structured 25-items Likert-scale questionnaire covering training environment, institutional components, delivery methods, and perceived learning outcomes. Learning-level evaluation was conducted through a 23-question knowledge test administered before and after the training. Descriptive statistics and paired sample t-tests were used for analysis. Results revealed high satisfaction across all domains, with the highest ratings for training relevance, Question and Answer (Q&A) sessions, and knowledge enhancement. Areas such as accommodation and the theory-practice balance showed scope for improvement. The mean difference in knowledge scores before and after the training was statistically significant, indicating substantial cognitive gain. The findings confirm the training's immediate effectiveness in both participant satisfaction and learning outcomes. Recommendations include enhancing practical exposure, refining accommodation facilities, and incorporating a more balanced mix of theoretical and experiential content. This study demonstrates the utility of the partial Kirkpatrick Model for evaluating short-term training programs in public extension systems and highlights its role in informing evidence-based improvements in capacity-building initiatives.

Keywords: Kirkpatrick model, Training evaluation, KVK, Agricultural extension

Theme 3: 131

Impact of Organizational Culture on Employees' Job Satisfaction in Indian Universities

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The way an organization operates, its culture, has a big effect on how employees think, feel, and act. This also influences how happy they are at work. This study explored the main type of work culture and its impact on their job satisfaction at two different universities, *viz.* Punjab Agricultural University (PAU) and Guru Nanak Dev University (GNDU). To do this, faculty and staff were randomly selected for the survey. The questions were based on Cameron and Quinn's model of organizational culture for measuring prevalent culture at selected universities and Job satisfaction was measured by using Herzberg's Two-Factor Theory, which looks at what motivates employees and what basic needs must be met for them to be satisfied at their work place. The answers were measured on a five-point scale. The results showed that PAU mostly had a "Hierarchy" culture, which means it focused a lot on rules, systems, and procedures, followed by clan (team-focused), market (competitive), and adhocracy (creative and flexible) cultures. On the other hand, GNDU mainly had a "Clan" culture, which feels more like a team or family, followed by market, hierarchy, and adhocracy cultures at PAU.

About 56 per cent of the employees were somewhat satisfied with their jobs, around 38 per cent were very satisfied, and only about 6.67% were not very satisfied. At GNDU, about 51 per cent were somewhat satisfied and 49 per cent were highly satisfied. The results of the study clearly show that the kind of work environment an organization creates plays a big role in how satisfied employees feel with their jobs. When the organizational culture is positive, supportive, and familiar, where people feel valued, respected, and comfortable, it tends to increase job satisfaction. Employees are more likely to enjoy their work, stay motivated, and perform better. On the other hand, when the culture is negative, unfamiliar, or overly demanding where there's too much pressure, little support, or rigid rules it can make employees feel stressed, disconnected, and less satisfied with their jobs. Based on these findings, the study recommends that organizations, especially universities, should take steps to create a healthier and more engaging work environment. One way to do this is by regularly offering faculty members the chance to attend professional seminars, workshops, and conferences. These events not only help employees grow in their careers but also make them feel valued and invested in. Another important step is to encourage faculty to think creatively and independently. When people are given the freedom to express new ideas and explore different ways of doing things, it boosts their sense of purpose and engagement.

Keywords: Organizational culture, Job satisfaction, Clan culture, University culture

Theme 3: 132

Exploring Farmers' Wellbeing in Dryland India: A Framework-Based Assessment

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Farmers' wellbeing is a dynamic process that reflects how individuals perceive the progression of their lives. Specifically, it pertains to the overall welfare of farmers, shaped by both qualitative and quantitative factors. As wellbeing can vary from person to person based on socio-economic background and cognitive outlook, a one-size-fits-all approach may not be effective. In this context, the present study developed a Multidimensional Wellbeing Assessment Framework tailored to agrarian systems and applied it to assess farmers' wellbeing in dryland regions. An exploratory research design was employed, with data collected from Nagarkurnool district in Telangana and Chincholi taluk in Karnataka. Findings revealed that 54% of the farmers had low wellbeing, 38% were in the medium range, and only 9% experienced high wellbeing. Low wellbeing was more prevalent among small and marginal farmers, with only 11% of medium landholding farmers falling into this category. Wellbeing levels also differed across farming systems: 66% of crop-only farmers reported low wellbeing, compared to just 25% of those involved in integrated systems combining crops, horticulture, and livestock. The highest levels of wellbeing were observed among farmers practicing crop + horticulture + livestock, followed by those involved in crop + livestock, crop + horticulture, and crop-only systems. Gender differences were also evident, as 57% of women-headed households reported low wellbeing, in contrast to 40% of male-headed households. The investigation further revealed that significant difference on the subcategory of wellbeing i.e. material, security and freedom was present among the farmers based on landholding and farming system at one percent level of significance. Studying wellbeing plays a crucial role in advancing rural development, as it offers a clearer understanding of rural livelihoods, highlights existing challenges and progress, improves the assessment of wellbeing indicators, and equips rural stakeholders with the knowledge of their roles and potential influence in driving positive development outcomes.

Keywords: Wellbeing, Dryland agriculture, Multidimensional framework, Farming systems, Rural development

Theme 3: 133

Development and Evaluation of a Scale for Measuring Attitude of Farmers Toward Green Manuring

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Attitude is an organized predisposition to think, feel, perceive and behave towards a cognitive object. This research aimed to develop a measurement tool that can determine the attitude of farmers towards the use of green manuring in agriculture. The method of summated rating was followed in the development of a scale to measure the attitude of farmers towards green manuring. Attitude in this study was operationalised as the predisposition of the farmers towards green manuring. A total of 26 statements concerning experts' opinions were selected. Response for the selected statements was obtained from 100 adopter farmers of green manuring in Punjab state. The finally developed scale consisted 17 statements. Presence of single construct in the scale developed, obtained by using exploratory factor analysis, confirmed its unidimensionality. The reliability and validity of the scale indicates its precision and consistency of the results. In the process of forming the scale items used with reference to the experts' views, a draft scale consisting of 22 items has been created by removing 4 items from the first scale consisting of 26 items. During the unidimensionality process of scale, five items having high loading on more than one factor were eliminated from the final scale. It has been thought that they did not contribute enough in measuring the attitude demanded to be measured, and have been removed from the scale. In this research, a total of 17 items, including 11 negative items and 6 positive items, included in final scale. The high value of reliability and validity of the scale indicated the precision and consistency of the results. Single construct in the scale developed, obtained by using exploratory factor analysis confirmed its unidimensionality. The scale developed in the present study will be of great utility to researchers, agricultural planners, educators and administrators in general in formulating the relevant policies and programmes so that maximum number of farmers could be benefitted while sustaining environment.

Keywords: Attitude; Likert's summated rating, Green Manuring, Scale, Factor analysis

Theme 3: 134

The Last Song I Sang: Buddhist Tribal-Ecosystem Collapse or Emergent Development-Monopoly of Social versus Monopoly of Knowledge

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This research explores the entangled lifeworld of the Buddhist Bhutia tribal community, particularly the Tolchha subgroup of Uttarakhand's Niti valley within the context of ecological collapse, displacement and state-led development in the Indian Himalayas. Situated in the shadows of the Himalayas, Bhutia tribal Buddhist cosmology has long embodied a sacred relationality between the land, ritual and the divine. However, geopolitical shifts, notably the 1962 Indo-China border closure and Delhi-Dehradun expressway construction above Rajaji National Park, neo-liberal conservative policies have not only displaced these communities geographically but also epistemologically. Political transformation of Buddhist Tribal-forest societies under the weight of green governance, late development and epistemic violence, asks questions: What becomes of civilization when its Gods are

replaced by metrics, its forests by protocols, its rituals by projects? This study critiques the ethnicization and commodification of the environment under state politics and ecotourism, and instead foregrounds Bhutia chants, meditative practices, and liturgical enactments as counter-cartographies-ritual forms that reclaim sacred geographies and assert vernacular sovereignty. Employing an interdisciplinary methodology that draws from anthropology, religious studies, cultural geography and stochastic mathematics, the research traces how ritual repetition, ecological attunements and sacred soundscapes form an alternative grammar of survival and transformation. The theoretical frame invokes the ergodic hypothesis and Poisson process modelling, not to quantify the sacred into but to analogically map the unpredictability and patterned recurrence within Bhutia meditative and ecological experience. At its core, this inquiry centres the monastery (particularly Mindrolling, Dehradun) as a threshold where fragmented pasts are reassembled into livable presents. Through an ethnographic, social ecology lens and knowledge structure system, the project situates the Bhutia experience within broader discourses of borderland identity, ritual sovereignty and the cosmological resistance to linear models of development. Ultimately, this research proposes a radically relational theory of transformation, where chants, silence and ritual acts do not resist modernity as rupture but inhabit it as continuity. In the echo between breaths, pine wind, and chants, the last song of the Bhutia is not an elegy but an act of world-making-where the sacred survives not beyond the ruins but within them.

Keywords: Bhutia tribe, Ecological cosmology, Ritual sovereignty, Eco-tourism, Knowledge systems

Theme 3: 135

Darjeeling Mandarin Plant Health Clinic: An Innovative Extension Approach for reviving the mandarin cultivation in the Himalayan region of West Bengal

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Darjeeling Mandarin is the major cash crop of Darjeeling & Sikkim Himalaya and act as a lifeline of hill agriculture. But its cultivation is declining at an alarming rate due to different biotic and abiotic stresses. Many initiatives were taken in past to address the issue, but so far with limited success only. Hence, an innovative lab to land technology delivery model namely 'Darjeeling Mandarin Health Clinic' was thought of involving the Indian Agricultural Research Institute (IARI), State Department and farming communities in a convergence mode. The "Darjeeling Mandarin Plant Health Clinic" was established at Mungpoo and Sittong of Darjeeling district, West Bengal, for diffusing the recommended mandarin growing technologies in the adopted villages. Initially, the elite clone of mandarin was identified through physical and biochemical analysis at IARI lab. Thereafter, the identified superior clone was used for developing healthy planting materials both at IARI and in selected villages. The farmers from the villages were trained in pest and disease identification of mandarin and their management, production of healthy planting grafted and budded planting materials and their maintenance. A total of 8000 grafted planting materials were distributed through health clinic and farmers are producing these planting materials at a large scale for revival of Darjeeling mandarin cultivation in neighbouring villages. So far, 50 acre area has been revived with healthy grafted planting materials under this approach. The trained para-extension agents of plant health clinic provided diagnostic and advisory services at the village level in local dialect (Nepali) based on plant sample.

Keywords: Extension model, Decline in mandarin cultivation, Plant health clinic

Theme 3: 136

Participatory Assessment of the Perceived Effectiveness of IARI's Extension Models for Information Dissemination in Uttar Pradesh

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Effective information dissemination is a cornerstone of participatory agricultural development. Extension models that foster community involvement and enable knowledge exchange play a critical role in ensuring the sustainability and scalability of innovations. This study aimed to assess the perceived effectiveness of three participatory extension approaches developed by the Indian Agricultural Research Institute (IARI), namely the IARI Model Village (IMV), IARI-National Extension Programme (NEP), and IARI-Voluntary Organizations (VOs) approach, in terms of their ability to share agricultural knowledge and catalyse adoption. The study was conducted in Uttar Pradesh during 2022, involving 120 farmers and 30 stakeholders selected through a stratified multiple-stage sampling technique. Results indicated that the IARI-VOs approach (X=18.4) was perceived as the most effective in facilitating information dissemination and technology transfer, followed by the IMV and NEP models. Among various indicators, 'farm expenditure' scored highest, suggesting tangible outcomes from knowledge uptake, whereas 'family savings' ranked lowest. A positive and significant relationship was found between perceived effectiveness and farmers' landholding and scientific orientation, highlighting the importance of resource availability and progressive mindsets in participatory extension. Multiple regression analysis revealed that landholding and economic motivation enhanced the perceived effectiveness of the IARI-NEP model, while scientific orientation was a key determinant for the IMV approach. The findings underscore the importance of participatory extension strategies that align with local socio-economic contexts and encourage farmer engagement for effective knowledge sharing. This study supports the continued development and refinement of inclusive extension models to ensure futuristic agriculture is both knowledge-intensive and community-driven.

Keywords*:* Economic motivation, IARI extension approaches, Perceived effectiveness, Scientific orientation, Stratified multiple-stage sampling

Theme 3: 137

Varietal Diversity of Rice Crop in Sub-Tropical Jammu Region of Jammu and Kashmir

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In the Jammu region, rice (*Oryza sativa*) is the main cereal crop cultivated on an area of 0.15 million hectare (mha) in *kharif* season under irrigated condition. A study was conducted in Jammu, Samba and Kathua districts of Jammu region to find out the varietal diversity of rice. A sample of 240 rice growers was selected by multistage sampling technique. Majority of farmers in the sub-tropics had cultivated basmati (70%) followed by semi-fine varieties (13%), coarse varieties (9%) and hybrids (8%) in the study area. Extent of adoption of basmati rice was 100, 92 and 84 per cent in the Samba, Jammu and Kathua districts. Extent of adoption with

respect to area was basmati (72%) followed by semi-fine varieties (14%), coarse varieties (7%) and hybrids (7%). Basmati varieties cultivated were Basamti-370 and Pusa-1121. Semi-fine, coarse varieties and hybrids of rice were also cultivated by the rice growers in the study area. The semi- fine variety *Sharbati* was cultivated by 12.5 per cent of the farmers in Kathua and Samba districts each, whereas in Jammu district 21.25 per cent of the farmers cultivated *Sharbati* rice. The coarse varieties *Jaya* and *PR-113* were cultivated by 5 per cent and 33.8 per cent of the farmers respectively in Kathua district. None of the farmer in Samba and Jammu districts cultivated these coarse varieties. In hybrids, Dhanya 748 was cultivated by 11.25 per cent of the farmers of Kathua district and only 1.25 per cent of the farmers of Samba district cultivated this hybrid. Other hybrids like Dhanya 834 was cultivated by 2.5 per cent each was cultivated by Jammu and Samba districts. The other rice hybrid VNR 2355 was cultivated by 7.5 per cent of the rice growers in Jammu district. None of the farmers of Kathua district cultivated hybrid rice Dhanya 834 and VNR 2355.The mean varietal diversity of rice crop in the study area was 0.131±0.009 calculated by using Thiel's entropy index. The mean varietal diversity index of Jammu, Samba and Kathua was 0.103, 0.127 and 0.161, respectively. The difference in mean varietal diversity index of rice between Jammu and Kathua was 0.056 which was found to be statistically significant (p=0.011). The varietal diversity in rice crop is on the lower side, especially in Jammu district. This could be due to because of the farmers predominantly cultivating Pusa-1121 and Basmati-370.

Keywords: Varietal diversity, Sub-tropics of Jammu, Rice crop

Theme 3: 138

Effectiveness of Livestock Extension Service Delivery: Women Farmer's Perception

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The present study was undertaken to evaluate the effectiveness of livestock extension service delivery for women farmers under the State Department of Animal Husbandry (SDAH) in the Central Plain Zone of Uttar Pradesh. This zone comprises 14 districts, out of which four districts–Sitapur, Lucknow, Hardoi, and Unnao–were selected randomly. One block from each district and two villages per block were chosen using a random sampling technique. From each village, 25 women farmers rearing milch animals were selected, resulting in a total sample size of 200 respondents. Data were collected through personal interviews to assess the perceived effectiveness of livestock extension services. The study used a modified version of effectiveness indicators originally developed by Mishra (1994), covering nine dimensions: awareness of service providers, frequency of visits, field meetings, regularity of meetings, field days, demonstrations, supervisory visits, research-extension linkage, and training for women farmers. The findings revealed that 79% of women farmers were aware of SDAH personnel, such as Veterinary Officers and Livestock Extension Officers. However, only 40% reported village visits by personnel, and just 50% noted joint meetings of male and female farmers. Demonstrations were largely absent, as reported by 70.5% of respondents. Only 23.5% of women had attended training for lady livestock workers. The overall effectiveness score was 43.83, categorized as poor. Inadequate outreach, administrative burden on SDAH personnel, and lack of women-specific extension programs were major constraints identified.

Keywords: Women farmers, Livestock extension, SDAH, Uttar Pradesh

Theme 3: 139
Innovative Approach: Solar Farm Demonstration Unit

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Agri-voltaic system of 110 kw was established at Krishi Vigyan Kendra (NHRDF), New Delhi during 2020-21 with the financial support of Delhi Transco limited (DTL), Govt. of NCT of Delhi and NABARD, New Delhi. The cultivated area of Agri-voltaic system is 1500 m^2, length of panel is 65 m, width of each panel is 3 m and inter space between two panel is 7.5 m and height of each panel from ground level is 3.5 m. The objectives is to establish Solar Farm Demonstration Unit (SFDU) to increase income of farmers by installation of solar plants in their agriculture land, which would enhance power production and profitable cropping modules. Modern agriculture s as mechanization for farm operations, irrigation, processing and value addition of farm produces etc. are the consuming energy, which is about 7 to 8% in the country. AV offers a solution to the increasing demand for food and energy and combines crops with solar photovoltaics on the same land. This system is best suitable for increasing the income Rs.50439/acre/season to farmers where solar irradiation is available in plenty and connected to local grid through group metering system, the results show the economic value of the solar demonstration farm. This system was also utilized for vegetable crop production. The following cropping pattern were adopted in *kharif* season with combination of onion + tomato+ brinjal + cucurbits crops + leafy vegetables, in *rabi* season onion +cauliflower+ cabbage + root vegetables + leafy vegetables and in summer okra (seed production) + cucurbits crops + leafy vegetables. These crops were grown on beds irrigation by drip system below the Pannel and inter space. These cropping patterns performed well in every season and gave good remunerative return. In summer, *kharif* and *rabi* season yield reduction was 19.01 %, 18.9% and 14.2%, respectively due to shading effect on crops under solar panels. The average electricity is generated around 11000 to 16000 units/month from 1500 square meters area. The maximum in March is followed by November and June months. This preliminary modeling study showed that for vegetables yields in India may be enhanced while the income of the farms deploying the proposed agri-voltaic systems could increase by over 10 times annually as compared to conventional farming.

Keywords: Agrivoltaics systems, Crops, Renewable solar energy, Income

Theme 3: 140
Social Networks and Farmers' Access to Seed Information: A Study of Paddy Farmers in Chota Nagpur Plateau

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Access to timely and reliable seed information is critical for enhancing agricultural productivity and sustainability, particularly among smallholder farmers in diverse agro-ecological regions. This study aimed to examine the role of social networks in facilitating access to Rice seed information among Paddy farmers in the Chota Nagpur Plateau, focusing on four blocks viz. Mandu, Kuru, Churchu, and Kisko. Using social network analysis, the research identifies the key actors, their centrality within the network, and the structure of information flow

across both formal and informal channels. The findings reveal distinct patterns in the organization and connectivity of networks across blocks. In Mandu, the State Agricultural University (SAU) emerged as a critical node with the highest degree and betweenness centrality, acting as a major source and intermediary of seed information. In contrast, the network in Kuru was dominated by the Farmer Producer Organization (FPO), reflecting its central role in bridging farmers with input dealers and extension officers. Churchu's network was led by a local NGO, emphasizing its function as both an information provider and a broker. Meanwhile, input dealers held dominant positions in Kisko, indicating their dual role as suppliers and knowledge sources. The study also categorizes ties as formal, informal, and peer-based, highlighting the prevalence of formal ties in Mandu (49.24%) and a higher share of informal ties in Churchu and Kisko. Kuru stood out with the highest proportion of peer-to-peer ties (37.6%), indicating a stronger reliance on local, trust-based information exchange. Overall, horizontal information exchange was more prominent in Mandu, Churchu, and Kisko, whereas Kuru exhibited a more vertical, centralized structure. These findings underscore the importance of leveraging both institutional actors and community-based networks to enhance the dissemination of agricultural knowledge. Tailoring interventions to strengthen network linkages, especially for marginalized farmers can significantly improve the reach and impact of seed information in diverse agro-ecological settings of the plateau.

Keywords: Social networks, Seed information, Social network analysis, Paddy farmers, Chota Nagpur Plateau

Theme 3: 141

Knowledge Level of Litchi Cultivation Practices in Sub-mountainous Region of Punjab

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The study entitled "Knowledge level of litchi cultivation practices in Sub-mountainous Region of Punjab" was undertaken with the objectives to study socio-economic characteristics and the knowledge level of respondents about litchi cultivation practices. The study was conducted in the three districts, i.e. Pathankot, Hoshiarpur, and Gurdaspur, which were purposively selected due to having highest area under litchi cultivation resulting in a total sample size of 220 farmers for the study. It was observed that most respondents were middle-aged (43–58 years), educated at the senior secondary or graduate level, and lived in joint family systems. With moderate landholdings and over a decade of experience, they formed a well-established farming community. The majority earned Rs. 1–1.7 lakh per acre from litchi, with income influenced by cultivation methods and market access. Digital platforms like WhatsApp and YouTube served as key information sources, though dependence on contractors and agents remained high, and institutional support was underutilized. Respondents exhibited strong practical knowledge in essential agronomic practices such as soil selection, plant spacing, and irrigation. However, significant gaps were observed in technical areas, particularly soil pH understanding and nutrient management for young trees. Knowledge improved with tree age, suggesting that experience enhances technical understanding. Despite this, nearly half of the respondents had low overall knowledge, and only a small fraction were highly knowledgeable. Correlation analysis revealed education ($r = 0.51$) and youth involvement as major positive influences, while age negatively correlated with knowledge ($r = -0.27$). These findings underscore the urgent need for targeted training, effective extension services, and digital outreach to address knowledge gaps and enhance the efficiency of litchi cultivation.

Keywords: Socio-economic, Litchi cultivation practices, Respondents, knowledge level

Theme 3: 142

A Study on Farmers' Knowledge and Access to Basic Facilities in an Adopted Village

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Agriculture and livestock remain the backbone of rural India's economy, with a large portion of the rural population depending on them for their livelihood. To design effective rural interventions, understanding farmers' knowledge and access to basic facilities is vital. This study was conducted in Dariyapur Naubatpur, an adopted village in Patna district by Bihar Animal Sciences University (BASU), Patna. A benchmark survey, door-to-door interviews, and focused group discussions were conducted with 238 randomly selected farmers. Key gaps identified included: animal welfare and awareness camps (71.43%), visits by veterinary/AH officials (69.33%), training programs at the village level (68.49%), emergency veterinary care (63.45%), and market linkages for livestock and milk products (62.61%). Other deficits were insufficient input dealer facilities (62.18%), poor marketing channels (58.82%), poor AI services (47.48%), vaccination/deworming (44.96%), special rations (37.39%), PDS (33.19%), and mid-day meals (28.15%). In terms of knowledge, farmers showed limited knowledge on: record keeping (57.14%), green fodder availability round the year (54.62%), calf care (52.10%), selection of good dairy animals (51.68%), dairy breeds (50.84%), mineral feeding (46.22%), and schemes and subsidies (34.87%). Knowledge was very low on silage making (33.19%), credit/insurance facility (32.35%), repeat breeding (31.09%), sex-sorted semen (27.31%), and integrated farming system (23.53%). The study highlights critical gaps in knowledge and basic services. Targeted interventions like training, awareness camps, veterinary outreach, farmer-scientist interactions, advisory services, and input support can significantly enhance productivity and improve livelihoods in the village.

Keywords: Access to basic facilities, Adopted village, Farmers' knowledge

Theme 3: 143

Outscaling of Agricultural Technologies through Integrative Development Model and Collaborative Partnership Model

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The Indian Agricultural Research Institute (IARI) continuously release a basket of agricultural technologies. The technologies are disseminated through traditional methods of on campus, off campus training, creating awareness through exhibitions, Pusa Krishi Vigyan Mela, exposure visits, farmers-scientist interaction, field day, Pusa Samachar, etc. In order to out scale the technologies to all the corners of the country, the Centre for Agricultural Technology Assessment and Transfer (CATAT) unit of IARI has adopted 2 models *viz.*, (1) Integrated Development Model, (2) Partnership Extension model, in collaboration with ICAR Institutes, Agricultural Universities and Voluntary Organisations. Integrated model is the selection of three model villages in NCR region and assessing the suitability of the technologies in the farmers' field in collaboration with the production unit members who represent different divisions of IARI. The partnership extension programme model is executed with 26 institutes of ICAR institutes/ State Agricultural Universities/ Voluntary Organisations in which IARI technologies of both

kharif and rabi crops are assessed in different locations. Through this model, the technologies technologies have been scaled up across diverse and distant locations. The assessment of the technologies is varied and IARI has been adopting this model since many years and from the assessment it has been proven that IARI Partnership extension programme is one of the best models for the dissemination of agricultural technologies. In order to create a feedback mechanism and to disseminate the latest technologies to the partnership institute, two workshops are being conducted by the CATAT unit of IARI every year in kharif and rabi seasons. To highlight one season i.e., in Rabi 2024-25 a total number of 2778 assessment trials were done covering states of Gujarat, UP, Haryana, HP, Maharashtra, Rajasthan, J&K, A&N, Odisha, Kerala, WB, Uttarakhand and MP. Through this model, several notable outcomes emerged from the introduction of improved crop varieties in non-conventional regions, highlighting the potential of adaptive varietal selection beyond the traditional zones. Notably, spinach variety Pusa Bharati received well in Karnataka; Spinach variety Pusa All green success in Andaman, Bhindi Pusa-5 in Kerala, paddy variety Pusa 44 in Jharkhand, moong variety Pusa Vishal in Hazaribagh district of Jharkhand etc. Hence, many farmers across the country are benefiting and IARI technologies are reaching not only in the national capital region and also in the far-flung regions of the country.

Keywords: Assessment of technologies, Technology dissemination, Non-conventional regions, Voluntary Organisations

Theme 3: 144

Empowering Farmers Through Collectives: Success Stories and Prospects of Farmer Producer Organizations in Indian Agriculture

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Farmer Producer Organizations (FPOs) are increasingly recognized as a vital instrument for empowering smallholder farmers in India. By organizing producers into formal collectives, FPOs enhance the bargaining power of farmers, facilitate access to markets, reduce input costs, and improve overall profitability. This paper explores the effectiveness of FPOs in transforming rural livelihoods by analyzing prominent success cases and identifying key enablers of their growth. India's agrarian economy, characterized by small and fragmented landholdings, often limits individual farmers' capacity to compete in a market-driven system. FPOs address this issue by enabling collective action in procurement, production, processing, and marketing. Government initiatives like the formation of 10,000 FPOs under the Central Sector Scheme have further accelerated their adoption. Case studies such as Sahyadri Farms in Maharashtra and Velanmai Farmers Producer Company in Tamil Nadu demonstrate how strategic leadership, market integration, and access to value addition can turn farmer collectives into successful agribusiness ventures. Despite their achievements, many FPOs face challenges related to access to working capital, skilled management, market intelligence, and scalability. The lack of awareness, inadequate training, and limited digital adoption also restrict their full potential. This study draws on field data, organizational reports, and stakeholder interviews to understand the factors behind successful FPOs and offers recommendations for strengthening weaker ones. The findings suggest that enabling policies, professional handholding support, strong governance, and digital platforms can significantly improve FPO viability. By building resilient farmer institutions, FPOs can play a transformative role in enhancing rural incomes, reducing agrarian distress, and creating sustainable value chains.

Keywords: Farmer producer organizations, Value chains, Smallholder agriculture, Agri-entrepreneurship

Theme 3: 145
Cluster Frontline Demonstration (Oilseed Model Village) on Soybean: A Success Story

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Soybean is an important oilseed crop in Nagaland. The area and production of soybean were 13765 ha and 17344, respectively, with the productivity of 12.60 q/ha. The choice of variety and plant population are essential to achieve synchronous maturity and higher productivity of soybean. The farmers, with their adoption of poor agronomic practices, are responsible for low productivity. The farmers generally cultivate long duration local varieties of about six months, low yielding, susceptible to insect pests and diseases, which drastically results in low productivity of soybean. Cluster Frontline Demonstrations on Oilseeds Model village were conducted in Toshiho and Yeveto villages under Niuland district in an area of 20 hectares and 50 beneficiaries during the Kharif 2024-25 season. The soybean variety which was used for the Cluster Frontline Demonstration was KDS 753, which is also known as Phule Kimiya. It is semi-determinate, early-maturing cultivar developed by Mahatma Phule Krishi Vidyapeeth, Rahuri, in 2020. The crop performed quite well and the results were promising. The average yield in case of the improved variety (KDS-753) was found to be 20.92 qt/ha, whereas the local variety yielded 15.86 qt/ha. There was a 31.90% increase over the local variety and the cost benefit ratio was worked out as 3.04:1 for the demonstrated variety and 2.59:1 in case of farmers' variety. The success of the CFLD significantly enhanced farmers' income and fostered broader adoption of the demonstrated technologies. This initiative emerged as an effective extension approach for improving oilseed productivity and advancing the goal of self-sufficiency in edible oil production."

Keywords: Cluster frontline demonstration, Soybean, Variety-KDS-753

Theme 3: 146
Transforming Rural Agriculture: The Integrated Development of Village Approach for Sustainable Farming Practices

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The Integrated Development of Village approach has been strategically adopted to enhance the agricultural and allied sectors in selected rural areas, to establish development standards that can serve as replicable models for other villages. This approach is focusing on the integration of advanced technologies to foster the development of agriculturally sound villages. As part of this initiative, the institute selected three villages from diverse agro-climatic zones within the National Capital Region (NCR), based on findings from a preliminary survey or pilot study. The study identified these villages as socio-economically underdeveloped and characterized by a low level of adoption of modern agricultural practices. Consequently, these villages were designated as lighthouse villages, with the intention of transforming them into exemplary models for sustainable agricultural practices and technological integration. The development in these villages aims to not only improve agricultural productivity but also promote socio-economic growth by introducing innovative farming techniques and technologies that

can be replicated in other similar rural areas. For this the technological basket in Rabi and Kharif season is shared with the farmers. In the present study, the results of Rabi 2022-23 with an innovative approach are analyzed. The comparison of wheat and mustard varieties from the Rabi 2022-23 season reveals notable differences in terms of yield, cost of cultivation, gross return, net return, and benefit-cost ratios between demo and local plots. Among the wheat varieties, HD-2967 demonstrated a yield of 50.25 q/ha, yielding a net return of Rs. 84,050 with a benefit-cost ratio of 1.63. HD-3086 performed similarly with a yield of 50.57 q/ha, offering a net return of Rs. 84,754 and a ratio of 1.64. HD-3226 showed the highest yield increase of 15.86%, reaching 52.14 q/ha, resulting in a net return of Rs. 87,108 and a benefit-cost ratio of 1.65. HD-3237 and HD-3271 had slight yield reductions (52.50 q/ha and 46.5 q/ha respectively) but still offered competitive returns, with HD-3237 achieving the highest net return of Rs. 89,000 and a ratio of 1.73. HD-3059 saw a yield of 46.0 q/ha, resulting in a net return of Rs. 75,600 and a benefit-cost ratio of 1.49. In terms of mustard varieties, Pusa Vijay yielded the highest return, with a net return of Rs. 95,225 and a benefit-cost ratio of 2.93, outpacing other varieties. Pusa M-30, Pusa M-27, and Pusa M-28 also demonstrated favorable outcomes, with net returns ranging from Rs. 88,625 to Rs. 94,225 and benefit-cost ratios between 2.6 and 2.73, indicating efficient returns compared to the local checks. The data clearly illustrates the superiority of demo plots in all varieties across both wheat and mustard, emphasizing the benefits of advanced agricultural practices for improved productivity and profitability.

Keywords: Integrated Village Development, Agricultural Innovation, Technological Integration, Socio-Economic Growth and Rural Development

Theme 3: 147
Socio-economic Constraints Faced by Fish Farmers in Hisar District

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The fisheries sector has been recognized as a powerful income and employment generator as it stimulates growth of a number of subsidiary industries and is a source of low-cost animal protein to the people, particularly to the economically weaker sections of the society and thereby, it is an advantageous position to ensure national food security. The study was conducted in rural areas of Hisar district of Haryana state and 25 fish farmers were the sample. Age distribution among farmers reveals a relatively balanced representation, with 55.00 per cent of respondents falling within the age group up to 35 years, and 45.00 per cent in the age range of 36-50 years. It's evident that there's a consensus regarding certain aspects, such as the suitability of loamy soil for fish culture, with 70.00 per cent of respondents affirming its efficacy. Additionally, 90.00 per cent of respondents recognize the detrimental effects of overfishing on ecosystems and fishermen's livelihoods, indicating a widespread awareness of the need for sustainable fishing practices. 25.00 per cent of farmers exhibited a low level of knowledge, while 45.00 per cent demonstrated a medium level and 30.00 per cent showed a high level of knowledge. 30.00 per cent of farmers exhibited a low level of adoption, while 50.00 per cent demonstrated a medium level and 20.00 per cent showed a high level of adoption. regarding technological constraints, respondents unanimously ranked the complexity of information highest with WMS: 3.00, followed closely by concerns about the high cost of technology (WMS: 2.55). Other significant concerns include technology not suited to the existing environment, lack of location-specific technologies, and issues with storage techniques, disease, pest management, hatching techniques, and fry/fingerling supply.

Keywords: Knowledge, Socio-economic, Fish, Adoption, Constraints

Theme 3: 148

Incidence of Perceived Social Isolation Among the Agricultural Students of CAU, Imphal in Meghalaya

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Social isolation is a multidimensional concept encompassing both objective and subjective elements. The absence of quality social relations is often referred to as subjective or perceived social isolation, or, more commonly, as loneliness. Perceived social isolation is emerging as a significant mental health challenge following stress. In India, this trend is increasing among young people and students. There is a lack of studies on perceived social isolation focusing on agricultural students. Hence, this study was conducted to investigate the incidence of perceived social isolation among agricultural students at Central Agricultural University, Imphal in Meghalaya with the following objectives: i) To assess the prevalence of perceived social isolation among the agricultural students of CAU, Imphal in Meghalaya, and ii) To determine the factors affecting perceived social isolation. A cross-sectional mixed method-based study was conducted among 205 agricultural students via Google Form survey. Perceived social isolation was measured adopting the six-item de Jong Gierveld loneliness scale. Associations of loneliness with different aspects were analysed using the descriptive statistics, Mann-Whitney U test, Kruskal-Wallis H test and regression analysis. The study revealed that 58% of the students felt moderately lonely, while 18.50% felt severely lonely. Urban background and being theist were associated with higher emotional loneliness, whereas proficiency in Hindi but not in English was associated with higher social loneliness. In conclusion, the findings of this study indicate that perceived social isolation is prevalent among agricultural students at the university.

Keywords: Agricultural students, Determinants, Perceived social isolation

Theme 3: 149

Exploring Farmers' Attitude towards the adoption of CAU-Bioenhancer in Meghalaya

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The study was carried out in the Ri-Bhoi district of Meghalaya, with the objective to assess farmers' attitude towards adoption of CAU-Bioenhancer. A total of 90 respondents comprising 60 adopters of CAU-Bioenhancer and 30 non-adopters of CAU-Bioenhancer were selected for the study. Primary data was collected through face-to-face interviews using pre-structured interview schedule, ensuring comprehensive and reliable information from the respondents. The study found that majority of the respondent farmers (71%) were female and majority of them had an educational level of below secondary level (46%) followed by high school (24%), higher secondary (6%), graduation (2%) and illiterate (18%). Majority of the farmers had a medium family size (60%) with six to eight family members. Further, the study revealed that majority of the respondents (39%) were marginal farmers with landholding below 2 ha. The findings revealed a significant difference in the attitude towards the adoption of CAU-Bioenhancer between the adopters and non-adopters of CAU-Bioenhancer. Among the CAU-Bioenhancer adopters, 80% expressed a favourable attitude, expressing confidence in its

effectiveness, willingness to continue its usage and show readiness to recommend to fellow farmers. The respondents also had knowledge on CAU-Bioenhancer and its contribution to soil health, sustainability, and reduced dependency on synthetic inputs. Among the non-adopters of CAU-Bioenhancer, very less number (33.3%) showed a favourable attitude, while majority (66.7%) showed of neutral to unfavourable attitudes towards its adoption. The majority of non-adopters were sceptical of the bioenhancer's impact on yield and soil health, limited knowledge (13.3%), lack of exposure to demonstration programs (6.7%), etc. The findings give a positive and progressive attitude among adopters of CAU-Bioenhancer as compared to non-adopters, underlining the need for targeted training (suggested for 100% outreach), demonstrations and awareness campaigns to bridge the attitudinal gap and encourage wider adoption of CAU-Bioenhancer to bring sustainable agriculture in Meghalaya as well as other regions.

Keywords: CAU-bioenhancer, Adopters, Attitude, Awareness, Sustainable agriculture

Theme 3: 150

Digitizing Indigenous Technical Knowledge (ITK): A Sustainable Approach to Knowledge Management in Agriculture

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Indigenous Technical Knowledge (ITKs), embedded deeply within the traditional agricultural practices of India, represent a rich repository of context-specific, need-based, and time-tested solutions developed and transmitted orally from generation to generation. These knowledge systems-shaped by centuries of observation, experimentation, and adaptation-are intrinsically local, sustainable, and eco-friendly. However, with the advent of intensive agriculture, modern input-dependent technologies, and increased mechanization, these desi techniques and grassroots innovations have been gradually sidelined or forgotten. The knowledge once preserved by elderly farmers is now on the verge of extinction, as it is neither formally documented nor digitally archived. Preserving ITKs is imperative for ensuring the sustainability and resilience of farming systems, especially in regions like Bihar, where agriculture remains the primary livelihood source for a majority of the population. Bihar is known for its diverse agro-climatic zones and culturally rich farming traditions. Yet, much of the traditional knowledge-such as organic pest repellents, indigenous seed storage methods, water conservation practices, and weather forecasting based on local indicators-remains undocumented and vulnerable to permanent loss. In the digital era, preserving ITKs through digital means has emerged as a viable and impactful tool for knowledge management. Creating digital repositories, android-based applications, e-learning modules, short documentaries, and audio-visual recordings can help capture, validate, and disseminate these traditional practices in engaging formats. Such initiatives not only make knowledge accessible to younger generations but also bridge the gap between modern science and traditional wisdom. Moreover, digitally archived ITKs can support agro-ecological transition, climate-resilient farming, and low-input agriculture—key pillars of sustainable development. Efforts must be made to involve local communities, extension personnel, and academic institutions in identifying, documenting, and verifying ITKs, particularly those relevant to Bihar's diverse farming communities. Incorporating these practices into educational curricula and extension systems can enhance their acceptability and usage. Thus, the preservation and digital dissemination of ITKs is not merely a cultural obligation but a strategic move towards sustainable agriculture and empowered rural communities.

Keywords: Indigenous Technical Knowledge (ITK), Sustainable farming, Digital preservation, Knowledge management, Bihar Agriculture and Traditional Practices

Theme 3: 151
Brokpas: The Backbone of Yak Husbandry

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Yak is a multipurpose animal and plays crucial socio-economic and cultural roles in the communities that rears this bovine species. It is reared in the transhumance system and involves annual migration in search of cooler climate and pasture for the herd. The tradition of yak rearing has been kept alive by the yak herders known as 'Brokpas' in Arunachal Pradesh. Therefore, this study was carried out to gain vital insights into the socio-personal and socio-economic characteristics of the herders. The study was carried out in West Kameng and Tawang. One hundred twenty respondents were sampled, sixty in each district. The study revealed that median age of the herders is 49.7 years. The median yak rearing experience is 35 years. About 77.5 per cent were reported to be illiterate. Nuclear family type was the leading trend, as reported in 95 per cent. Affiliation to organisations was reported to be very low with 95 per cent having no affiliation. The rearing system followed was keeping yaks and yak hybrids together, which was reported by 58.33 per cent of the respondents. The mean of the yaks and yak hybrids owned was observed to be 33.05 and 21.71 respectively. In terms of labour involved,85 per cent reported that they were solely involved in looking after the yaks. While 56.67 per cent of the respondents reported to involved the help of family members during the migration. The median annual income was found to be Rs. 100000/- while the annual income from yak was reported to be Rs. 15000/-. The median annual grazing tax was observed as Rs. 5000/-. Interestingly, all respondents agreed that yak rearing was profitable and expressed willingness to continue in the future.

Keywords: Brokpas, Yak husbandry, Socio-economic characteristics, Transhumance, Arunachal Pradesh

Theme 3: 152
Study on Understanding of Millets for the Indigenous Communities of Eastern Himalayan Region, India

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Millets, indigenous cereals to the various tribal farmers of Northeast India, face low production due to limited awareness of their nutritional and health benefits. The investigation on understanding of millets by the Indigenous Communities of the Eastern Himalayan Region using primary and secondary data reveals that the crops have been indigenous to many tribes of region. Amongst the states, Arunachal Pradesh is cultivating maximum area under millets, followed by Nagaland and Manipur. The awareness and knowledge level of the respondents are also found to be significant from the states of Nagaland, Manipur and Arunachal Pradesh with maximum distribution from the category of youths. The study also divulged that more than half of the respondents were farmers and they had medium knowledge of millets. Majority of the respondents (55.6%) preferred millet-based value-added products and 82.2% of the respondents divulged about the health benefits of the millet products. Independent factors such as age, health consciousness, level of education and occupation plays an

important role in ascertaining the acceptance and attitudes towards millets by the respondents. Policy recommendations such as development of millet centric-forum for overall monitoring & evaluation and performance appraisal of all stakeholders involved in millets promotion programs, inclusion of millets production program in Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), formation of FIGs, FPOs for production and marketing of millets, organization of clusters for production enhancement and empowerment of youths & women under millet promotion programs, supply of quality seeds, good agricultural practices, contract farming for enhancing millets production system, regularization in buy-back policy of millets and investment in research-extension including mass awareness & popularization and development of farmers' friendly tools & implements for pre-and–post harvesting processes, linking with RKVY & APEDA can reach the sustainable millet mission in the north eastern region of India.

Keywords: *Jhum,* FIGs, FPOs, MOVCDNER, RKVY and APEDA

Theme 3: 153

Livelihood Securities of Tribal Farmers in Farmer FIRST Villages of Namkum, Ranchi, Jharkhand

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The study was conducted in Farmer FIRST Programme (FFP) villages with objectives to assess the suitability of selected technologies and to enhance livelihood security of farmers. Suitability of selected technologies was assessed under six modules. Under crop based module, drought tolerant variety of paddy- Swarn Shreya was adopted by 250 households. Under horticulture based module, wilt resistant grafted tomato, grafted brinjal, fruit plants, etc. were adopted by 195 households. Under Rice fallow management in NRM module, rabi (wheat, lentil, gram, etc) and spring crops (bottle gourd, cucumber, etc.) were grown by 30 households in more than 12 ha of land after harvesting of paddy. Under livestock based module, feeding mineral mixture to the animals, vaccination and deworming of animals were adopted by 230 households. Average milk yield in cow was increased from 1.9 litre per day to 2.4 litre per day due to feeding mineral mixture. The Black Bengal buck was introduced to improve the progeny of the goat. TxD boar was introduced for improving pig progeny. Under enterprise based module, during 2022-23, 83 farmers took up mushroom cultivation and the additional net income generated was only Rs.4.46 lakh. During 2022-23, due to adoption of various technologies in the project villages, additional net profit of Rs. 35.34 lakhs and additional number of 3758 man days were generated. Diversification in farm enterprises took place over the years. Two hundred beneficiary farmers were randomly selected for assessing livelihood security. Livelihood Security Index (LSI) developed by Devi (2007) was modified and used for the study. The data were collected from beneficiary farmers and analyzed using mean, standard deviation, livelihood security index, paired t-test and correlation coefficient. Livelihood options of farmers had increased during 2016-17 to 2022-23. Significant positive changes at 5 per cent level of significance occurred in livelihood security of farmers.

Keywords: Livelihood security, Tribal farmers, Farmer FIRST, Diversification

Theme 3: 154

Effectiveness of Aquaculture Worker training programs in improving the livelihood of fish farmers in West Godavari district of Andhra Pradesh

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Aquaculture plays a crucial role in the livelihoods of rural communities in West Godavari district of Andhra Pradesh. The study aimed to assess the effectiveness of an aquaculture worker training program on knowledge gain among participants regarding improved aquaculture practices at Krishi Vigyan Kendra, Dr YSR Horticultural University in Venkataramannagudem. It was observed that the majority of participants enrolled in the training course to learn best management practices in aquaculture. During the year 2019-2020, two aquaculture worker training programs were conducted under the Agricultural Skill Council of India, with 25 trainees participating in each training. Data were collected from a total of 50 trainees. A survey schedule was created using a three-point scale: strongly agree, agree, and disagree. We collected data from all 50 trainees on various aspects of the training program. The overall training effectiveness score was 88.75 percent, which included factors such as training output, teaching quality, physical facilities, and course content/subject matter of the training. Based on the pre- and post-training score knowledge improved by 40 percent in awareness of banned antibiotics used in aquaculture, 36 percent in water quality parameters for fish and shrimp culture, and 32 per cent in the identification and management of fish and shrimp diseases. The data revealed that immediately after completing the training, the majority of trainees (52.38%) exhibited a high level of knowledge regarding improved aquaculture practices, while 38.10% demonstrated a medium level of knowledge. These results clearly indicate that the aquaculture worker training programs were effective in enhancing the knowledge gained by the trainees.

Keywords: Aquaculture training, Knowledge gain, Fish farmers, Livelihood improvement, West Godavari, Participatory extension approach

Theme 3: 155

Factors Influencing the Discontinuance of Millet Production by Farmers of East Khasi Hills District

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Krishi Vigyan Kendra, East Khasi Hills, Meghalaya

In the East Khasi Hills District of Meghalaya, a diverse range of Millets, viz. finger millet, foxtail millet, pearl millet, job's tears, and other minor millets have been traditionally grown. These millets cover an area of 262 ha, producing 322 tonnes in 2020 (State level crop statistics report, DoE&S, Meghalaya 2020). In line with the International Year of the Millets in 2023, various developmental establishments had undertaken several activities to create awareness on the importance of the crop and motivate the farmers to grow millets, especially in the areas that had traditionally grown this crop. The study was undertaken in 2023-2024 to identify the factors influencing farmers to discontinue growing millets during the earlier years before the recent initiation of the celebration and to provide inputs on what needs to be done to sustain the cultivation practices of traditional

crops. For this study, 60 farmers who previously cultivated millets but had discontinued were selected from the East Khasi Hills district. The samples were selected using purposive sampling, and data were collected using a structured schedule. The factors identified by the farmers for their discontinuance of growing millets earlier were the availability of alternate crops (65%), followed by the lack of demand in the market (51%), and the non-availability of improved, higher-yielding varieties (36%). The farmers reported that even though millets required less water and no additional input, the longer duration of the crop cycle meant that they could not grow other crops, which led them to discontinue. The farmers reported that with the growing demand and renewed interest, and incentives provided by the developmental agencies seen in the various millets during the last few years, they were more inclined towards growing the millets again. Further analysis indicated that age, education, and farming experience had a significant influence on the discontinuance of cultivation of the millets. Therefore, it is concluded from the study that to sustain the growth of traditionally grown crops in the area, it is essential to create a demand for the same with better marketing and processing facilities, along with the introduction of higher-yielding varieties.

Keywords: Millets, Discontinuance, Traditional crops, Market demand, East Khasi Hills

Theme 3: 156
Impact of KVKs' Activities on Oilseeds and Pulses in Uttarakhand

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Uttarakhand is a northern State and situated on the southern slope of the mighty Himalayas. The climate and vegetation of different cities of this state vary with the altitude of its location. Pulses and oilseeds are emerging as the backbone of hill agriculture in Uttarakhand, as farmers adapt to the mounting challenges posed by climate change. Uttarakhand's agriculture includes a variety of oilseeds and pulses, with soybean being a principal oilseed and horsegram being a leading pulse crop. Other common oilseeds include mustard, groundnut, and sunflower. Pulses grown include lentil, black gram, and various others like kidney beans and pigeon pea. Several factors influence the adoption of oilseed and pulse production, including land fragmentation, low productivity, climate variability, and lack of storage and distribution infrastructure. Other key factors include unremunerated prices, shortage of quality seeds, and limited access to technology and knowledge. Additionally, biotic and abiotic constraints, socio-economic factors, and physiological mechanisms can affect pulse production. The availability of high-yielding, pest-resistant varieties is crucial for increasing pulse and oil seeds production. Addressing these factors is crucial for increasing oilseed and pulse production in Uttarakhand and achieving greater self-sufficiency in these crops. Krishi Vigyan Kendras (KVKs) in Uttarakhand have demonstrated a positive impact on oilseed and pulse production by introducing high-yielding varieties, improving nutrient management, and addressing weed issues. Through front-line demonstrations and on-farm trials, KVKs have shown that improved technologies can significantly boost productivity and profitability for farmers. KVKs have introduced improved varieties of oilseeds like soybean (PS-1241), mustard (Advanta-432), toria (PT-303), and groundnut (Kaushal), resulting in higher yields and better returns for farmers. In pulses, KVKs have demonstrated high-yielding varieties of lentil (Pant Lentil-4), blackgram (Pant Urd-35, Pant Urd-30, Pant Urd-31), and pigeon pea (UPAS-120, Puas 992), leading to yield increases of up to 28%. In Uttarakhand, the area under pulses increased from 51,478 ha in 2005-06 to 64,314 ha in 2022-23, a 25% increase.

Keywords: Technological interventions, Capacity building, Socio-economic impact, Sustainable development

Theme 3: 157

Assessment of Yield and Economic Performance of Kharif Onion (*Allium cepa* L.) Varieties in Bundelkhand Region of U. P.

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A on-farm testing (OFT) was conducted on the 17 farmers' fields of the Hamirpur district of Uttar Pradesh with the objective to find out the most suitable varieties of *kharif* onion for two successive years i.e. 2018-19 and 2019-20. The present study revealed that onion variety Bhima Super performed better in growth, yield, yield attributing parameters and economic returns as compared to Agrifound Dark Red and N-53 varieties. Maximum plant height (53.50 cm), number of leaves per plant (12.57), leaf length (46 cm), fresh weight of bulb (118.18 g), cured weight of bulb (106 g), bolting percentage (1.35%) and bulb yield (254.84 q/ha) were found in Bhima Super followed by Agri found dark red and N-53 and minimum neck thickness of bulb was observed in N-53 (1.18 cm) and minimum days to harvesting were found (120.33) in Agri found dark red followed by Bhima Super and N-53. The Bhima Super variety an additional net return of Rs. 58800 and Rs. 112350 over Agri found dark red and N-53. Highest B:C ratio was obtained with Bhima Super (6.1) as compared to Agrifound Dark Red (5.51) and N-53 (5.11). The consumer preference was more in case of Bhima Super variety for its high shelf-life and fetches higher price in the market. Bhima Super variety registered 35.87% increased yield over N-53 variety.

Keywords: Kharif onion, Bhima super, Yield, Economic returns, Bundelkhand region

Theme 3: 158

Knowledge level of Farmers Towards Improved Pineapple Production Practices in Uttar Dinajpur District of West Bengal

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Pineapple (*Ananas comosus*) is one of the most important tropical fruit in the world. The cultivation of pineapple originated in Brazil and gradually spread to other tropical regions of the world. In 1548 the Portuguese introduced its cultivation in India. Currently, 85 countries around the world produce about 29.361 million tons of pineapple. India currently ranks as the 6th largest producer of pineapples globally and West Bengal is the highest producer in India. Uttar Dinajpur District is one of the major contributor in pineapple production of West Bengal. Pineapple is a good resource for bromelain (An enzyme that may aid in digestion and reduce inflammation) along with some other nutrition and vitamins. It was experienced that all the farmers do not adopt the recommended pineapple production practices at the same time and at the same rate due to lack of proper knowledge. The study was done to determine the extent of knowledge of the recommended Pineapple production practices by the respondents. A purposive sampling technique was employed, and a total of 120 respondents were selected from seven villages within the Chopra block of Uttar Dinajpur District. Data was collected using a pre-tested knowledge and schedule was developed based on that. Data was analysed using appropriate statistical tools and

techniques. In terms of knowledge, about pineapple production technology, 55.83 per cent of the respondents had a medium level of knowledge, followed by 16.67 per cent with low level of knowledge and 27.50 per cent with high level of knowledge. The study also established positive and significant relationships between the independent variables, such as age, educational qualification, annual income, extension contact, mass media exposure, scientific orientation, risk orientation, with the knowledge of farmers regarding improved pineapple production practices. Overall, the study provides valuable insights into the knowledge of farmers in the study area and highlights the importance of various factors in influencing their level of knowledge of improved pineapple production practices.

Keywords: Pineapple, Chopra block, Knowledge, Production practices, Respondents

Theme 3: 159

Adoption of Unified Payment Interface (UPI) in Agri-Retail Market: A Hybrid Approach of PLS-Structural Equation Model (PLS-SEM) – Artificial Neural Network (ANN)

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This study investigates the adoption of the Unified Payment Interface (UPI) within the agri-retail sector in the Konkan region of Maharashtra, India, amidst a rapidly evolving digital landscape influenced by technological advancements, changing consumer behaviours, and government-led initiatives such as the “Digital India” campaign. The UPI, developed by the National Payments Corporation of India (NPCI), has experienced significant adoption following pivotal events such as the 2016 demonetization and COVID-19 pandemic, both of which have catalysed a national shift toward cashless transactions. Utilising the Technology Acceptance Model (TAM) as the analytical framework, this research explores the determinants of UPI adoption among 150 purposively selected agri-retailers from the Ratnagiri and Sindhudurg districts. The demographic analysis indicated that most respondents were middle-aged, possessed moderate educational qualifications, and belonged to the medium-income category, factors contributing to a generally moderate level of UPI adoption. Among the digital payment platforms, Google Pay and PhonePe are the most frequently used. The key determinants influencing the adoption process include perceived usefulness, perceived ease of use, and perceived risk, as postulated by the TAM. Facilitators of UPI adoption include growing customer demand for digital payments, widespread smartphone penetration, and the availability of financial incentives. Conversely, major barriers include concerns about data security, limited digital literacy, and inadequate network infrastructure. Furthermore, this study examines the awareness and utilization of digital marketing platforms in the agri-retail context. While awareness, particularly of platforms such as WhatsApp, is relatively high, actual adoption remains limited, indicating a significant gap between knowledge and practice. This disparity underscores the necessity of targeted digital literacy programs and infrastructural support to enhance the effective deployment of digital marketing tools in the agri-retail sector. These findings offer critical insights for policymakers, financial institutions, and technology developers seeking to expand the adoption of digital payment systems and promote broader technological integration within rural and semi-urban agricultural markets.

Keywords: Unified Payment Interface (UPI), Agri-Retail Market, Technology Acceptance Model (TAM), Digital Payment Adoption, Digital Literacy and Infrastructure

Theme 3: 160

Bridging Research and Field: Participatory Demonstration of Improved Potato Varieties in Leh, Ladakh

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This study presents the outcomes of a Front-Line Demonstration (FLD) programme aimed at empowering tribal farmers from seven remote villages in Leh district, Ladakh, by introducing improved potato varieties developed by the ICAR-Central Potato Research Institute, Shimla in partnership with Krishi Vigyan Kendra (KVK), Leh, Ladakh. A participatory research framework was deployed to ensure collaborative engagement between scientists and local communities through on-site varietal demonstrations and knowledge exchange. The improved variety *Kufri Himalini* outperformed local cultivars, yielding 34–36 t/ha—nearly double the output of traditional varieties (18 t/ha) and was lauded for its shape and tuber quality. *Kufri Karan* (28–30 t/ha), *Kufri Chandramukhi* (28–30 t/ha) and *Kufri Jyoti* (28–30 t/ha) also demonstrated significant yield advantages, underscoring the varietal adaptability under Ladakh's unique agro-climatic conditions. Notably, the enhanced yield and favourable consumer's preferences of *Kufri Himalini* translated to nearly double the farmer's income compared to the local variety. The favourable results of the programme have been reported to the District Agriculture Department, with plans under consideration to develop Likir village as a dedicated potato seed hub.

Keywords: Participatory research, Frontline demonstration, Improved varieties, Potato cultivation, Farmer empowerment, Ladakh

Theme 3: 161

Socio Economic and Demographic analysis of Vishunpur Village of Gorakhpur District

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This study undertakes a comprehensive socio-economic and demographic analysis of Vishunpur village in Gorakhpur district, Uttar Pradesh, through the application of Participatory Rural Appraisal (PRA) techniques. Organized by Krishi Vigyan Kendra (KVK), Belipar, the study captures a multi-dimensional profile of the village, encompassing landholding patterns, cropping systems, literacy levels, livestock assets, technological penetration, and infrastructural status. The PRA approach enabled active community involvement in identifying key developmental gaps and potential interventions. The findings indicate that despite a strong literacy rate and increasing access to farm mechanization and ICT tools, significant challenges persist in terms of land fragmentation, irrigation facilities, and support for marginalized groups such as Scheduled Castes. The study contributes actionable baseline data to aid policy makers, planners, and development agencies in crafting targeted and inclusive rural development strategies.

Keywords: Participatory rural appraisal, Socio-economic analysis, Productivity, Rural development, Livelihood, Infrastructure, ICT, Demographic study

Theme 3: 162

Assessment of Extension Methods for Awareness, Utilization and Knowledge Creation about Soil Health Card

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Krishi Vigyan Kendra, Sitamarhi, Bihar

Soil is a fundamental resource for farming, providing essential nutrients required for plant growth. Maintaining soil health is crucial for sustainable agriculture, as it enhances fertilizer efficiency, reduces nutrient loss, and improves yield. However, many farmers rely heavily on chemical fertilizers without assessing their soil's fertility status, leading to long-term soil degradation. Soil testing is a widely accepted, science-based approach to evaluate the soil's nutrient profile and its capacity to support plant growth. Despite the proven benefits of soil testing, its adoption among farmers remains limited. In an effort to address the problem, an action research study was carried out to access the impact of extension methods in several treatment groups of farmers, including those having only SHC (T_1), SHC with literature (T_2), SHC with customized social media advisory services (T_3), and those having SHC along with both literature and customized advisory services (T_4). The study was carried out in Northern Bihar in 2023–2024 with a sample size of 60. The knowledge level of farmers group (T2) and (T3) are (mean score 7.60) and (mean score 8.40) respectively than that of farmers group (T4) who received SHC along with both literature and customized social media advisory (mean score 10.20) (T_4). When it comes to implementing the SHC guideline, farmers who use SHC alone without extension tools had the lowest score (T_1) of 0.47, while those who use SHC in conjunction with literature and advisory services (T_4) have the greatest score (3.73). The results of the Difference in Difference (DID) methodologies show that farmers with extension literature (T_2) has been an improvement in awareness of SHC's ability to save additional expenses by providing necessary nutrients (33.33%) than those without literature (T_1). In comparison to T_1 and T_4, it has been revealed that farmers have been more aware in terms of expenditure saving in judicious nutrients use (53.33%), getting idea on crop wise recommendation of nutrients and fertilizer (46.67%) and effective while use on regular basic (40%) than those farmers who have only SHC (T_1). Hence, it can be inferred that a mix of extension tools is more effective than a single method alone at raising awareness, knowledge, and implementation of SHC recommendations.

Keywords: Extension methods, Knowledge, Awareness, DID method, Soil Health Card

Theme 3: 163

What Determined Farmers of Meghalaya to Practice Integrated Framing System? Application of Protection Motivation Theory

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Given the socio-climatic and economic challenges in Meghalaya's agriculture-based economy, farmers are adapting by practicing integrated farming systems on their small and scattered land holdings. Practicing integrated farming systems offers farmers diversified income streams, enhances food security, promotes the efficient utilization of resources, and contributes to the overall resilience of the farming system. The purpose of this study was to explore the motivations behind Meghalayan farmers' adoption of integrated farming systems amidst socio-climatic and economic challenges. This study employed survey design. The study was conducted in two districts of Meghalaya including Ri-Bhoi, East Khasi Hills districts. A total of 348 respondent farmers were surveyed employing snowball sampling methods during August to December 2024. This study applied Protection Motivation Theory (PMT) to identify the factors influencing farmer's intension to practice Integrated Framing system. The collected data was analyzed by applying Partial Least Square Structural Equation Modelling (PLS-SEM) technique. The result revealed that there is significant and direct effects of the five constructs of perceived severity, perceived vulnerability, response cost, response efficacy, and self-efficacy on the intention to practice integrated farming system among farmers in Meghalaya. The finding of the study has theoretical, practical and policy implications. This research offers insights that can guide decision-making processes and assist encouraging behavioural changes in agricultural practices. It helps identify crucial points and necessary strategies for the successful adoption of integrated farming systems among farmers here in Meghalaya.

Keywords: Integrated farming system, Protection motivation theory, Farmer behaviour, PLS-SEM

Theme 4: 164
Scope of Rapeseed-Mustard Cultivation in Assam: A SWOT Analysis

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Rapeseed-mustard cultivation holds significant importance in Assam's agricultural landscape, serving as a vital source of edible oil and contributing to the state's agrarian economy. Rapeseed-mustard farming is deeply rooted in Assam's agricultural practices, providing a foundation for expansion. Active government initiatives and collaborations with research institutions bolster the sector's development. Availability of rice fallow lands offers opportunities to increase cultivation areas without displacing other crops. The weaknesses are low productivity, limited awareness and infrastructure gaps. The opportunities are technological adoption, market demand and value addition. The threats are climate variability, market competition and resource constraints. Assam's rapeseed-mustard sector stands at a pivotal juncture, with substantial efforts underway to enhance production and achieve self-sufficiency in mustard oil. While challenges persist, strategic interventions focusing on technological adoption, farmer education, and infrastructure development can unlock the sector's full potential, contributing to the state's economic growth and food security.

Keywords: Agriculture, Rapeseed, Mustard, SWOT Analysis

Theme 4: 165
Sustainable Income Generation through Integrated Farming System of Farmers in Bhilwara District of Rajasthan

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Today's environment, increasing demand for meat in rural and urban areas can help small and part-time farmers earn good profits by trading with the goat and poultry farming. Integrated farming system is a sustainable agricultural system that integrates livestock, crop production, goatry, poultry and other systems that benefit each other. It is based on the concept that 'there is no waste' and 'waste is only a misplaced resource' which means waste from one component becomes an input for another part of the system. Integrated farming system approach is considered to be the most powerful tool for enhancing profitability of farming systems especially for small and marginal farmers to make them bountiful. Due to less investment and maintenance costs for shed, it can be done in coordination with agriculture crops. The present study was carried out in Mandalgarh block of Bhilwara district in Rajasthan to find out a sustainable and economically viable mixed farming model by integrating different components like crop, goat and poultry on 1.5 acre land holding. A farming system model having 10 goats + 20 poultry birds along with crop cultivation was found to be the best suitable with a net income of Rs 60260/- year as compared to crop cultivation alone i.e. Rs 21980/ year with a benefit cost ratio of 1: 2.80 and employment generation of 280 days. Integrated farming system help adequate amount of feed was also available for animals. Based on the study it is inferred that integrated farming system with 10 goats along with other components like poultry is the most significant and beneficial system which can sustainable the income of farmers to improve their nutritional and livelihood security.

Keywords: Sustainable, Integrated farming, income, employment, land holding

Theme 4: 166

Innovative Way of Fish Farming Using Chicken Waste and Vermi Meal: A Way Forward for Sustainable Livelihoods through Waste to Wealth

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The present investigation was carried out to evaluate the growth performance of *Clarias magur* in response to different nonconventional diets. Juvenile magur weighing average 8.49 ± 1.98 g and 15.83 ± 4.83 g (Raha and Pasighat) were reared in tanks maintaining water level at 50 ± 5 cm with six inches of soil bed. The fish were stocked @ 4 no./m^2 and fed with four iso-nitrogenous (35% crude protein) experimental diets D-1 (Vermi meal), D-2 (Chicken viscera meal), D-3 (Vermi meal+ Chicken viscera meal) and D-4 (Fish meal) @ 5 to 10 % of body weight in two split doses daily in the morning and evening. The diet D-4 was considered as reference diet. The experimental diets were prepared by using ingredients such as Fish meal, Vermi meal, Chicken viscera meal, Rice polish, Wheat flour & Vitamin and mineral mixture at different combination. The result reflected that the growth performance observed after six months of rearing the fish fed with Fish meal based diet was the best (204.93 g Raha; 194.54 g Pasighat), followed by 100% replacement of Fish Meal with Chicken viscera Meal (200.81 g Raha; 192.61 g Pasighat); Fish meal with mixture of Vermi meal and Chicken viscera meal (190.32 g Raha; 179.69 g Pasighat); and Fish meal with Vermi meal (181.30 g Raha; 174.58 g Pasighat). The present findings reflected that 100 % replacement of Fish meal can be done with Chicken viscera and mixture of Vermi meal and Chicken viscera meal without affecting the growth performance of the fish and flesh quality as differences in growth performance are almost negligible.

Keywords: Fish farming, Chicken waste, Vermi meal, Livelihoods, Waste to wealth

Theme 4: 167

Eco-Friendly Floor Cleansers-A Way for Controlling Water Pollution

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Cleaning is an important activity to maintain a healthy and safe home environment. In earlier times soaps, soda, salt, ash etc. were used to perform cleaning activities. These products were very cheap and eco-friendly. But with the modernization and globalization, these natural items have been replaced by synthetic detergents and chemicals. Some of the chemicals used in preparation of utensils, laundry and floor cleansers many health and environmental problems. So there is a need to prepare and promote green home cleansers for minimizing health and environmental problems. Keeping this in mind, two floor cleansers were prepared in the laboratory using mostly home available ingredients, their efficiency was compared with three most popular commercial utensils cleansers in terms of their cleaning efficiency and cost-effectiveness. The result of the study revealed that the laboratory prepared cleansers were found to be more efficient in removing stains from floor as compared to selected commercial cleansers. The result of microbial examination of washed plates, cups, pressure cooker and saucepan revealed that laboratory prepared cleansers were powerful disinfectant also. The result of field trials indicated high level of satisfaction among respondents regarding the performance of laboratory prepared acidic floor cleanser. Therefore these cleanser need to be prepared and promoted for wide spread use.

Keywords: Antimicrobial, Cleansers, Cost-effectiveness, Green ingredients, Microbial

Theme 4: 168

Vermicompost Technology - An Environment Friendly Sustainable Waste Management Solution for the Cold Arid Desert Ladakh

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Vermicompost is a fine granular, dark brown/black (gold) organic product prepared by earthworms by using animal dung and organic wastes which is useful for soil health. It is a cost-effective and environmental friendly technique that uses worms to break down organic waste into nutrient-rich compost. It has four times more plant nutrients than conventional cattle dung compost due to biological properties, rich in population of soil micro-organisms compared with those in conventional composts. Besides, vermicompost has adequate amount of micro and macronutrients depending on source of earthworm's feedstock. Earthworms promotes soil fragmentation and increase aeration of soil by volume 8-30 per cent. This study was carried out in cold arid desert Ladakh to disseminate the vermicompost technology among the farmers of Ladakh where temperature variation is +32ºC to -35ºC and decomposition of manure takes 2 years, in the name of soil fertility organic carbon varies from (0.12 to 1.005%) and organic matter varies (0.2 to 1.73%) which are the biggest challenges in this region. Under such circumstances vermicompost technology is an appropriate environmental friendly solution as resource efficiency sustainable waste management technology, which not only solve the issue of decomposition but at the same time enhance soil fertility and doubling the income of farmers & youth of Ladakh.

Keywords: Vermicompost, Waste management, Resources efficiency, Soil fertility

Theme 4: 169

Effect of Organic Loading Rate (OLR)/Dilution Rate on Biogas Production from Pig Feces at Field Level

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Voluminous Pig faeces generated in swine production chain, when not utilized in a scientific way, leads to plethora of environmental problems. Several alternatives are available to tackle it like physiochemical treatment, aerobic processes (nitrification/denitrification), composting and anaerobic digestion (AD). Out of these, AD is considered as most efficient method for utilization of pig faeces for biogas production, but the efficiency of production is very low at field level. Therefore, the present study was conducted to study the effect of different OLR on enhanced biogas production from pig faeces. Four biodigesters with different OLRs/dilutions, i.e., 9.29 (1:8, T_0), 12.36 (1:6, T_1), 18.50 (1:4, T_2), and 37.17 (1:2, T_3) gVS/L, were set up at the swine production farm (SPF). Different parameters for enhancing the efficiency of biogas production, *i.e.*, quantity, quality, hydraulic retention time (HRT), calorific value, were studied. The current investigation revealed that**,** highest efficiency was achieved in T_3 biodigester having maximum ($P<0.01$) biogas production (0.05 m^3/kg fresh feces) as well as steepest Volatile Solid reduction (21%) as compared to other OLR/dilution. There was no significant difference in the biogas composition in terms of CH_4 (%), CO_2 (%), O_2 (%) and NH_3 (ppm) among different groups. From the results, it was concluded that an OLR of 1.86g.VS/L.d or dilution of 1:2 (TS nearly 7.4 %) may be used to produce 1m^3 of biogas from 20 kg of pig faeces (TS nearly 22%) for enhanced biogas production.

Keywords: Anaerobic digestion, Biogas, Organic Loading Rate, Pig faeces

Theme 4: 170

Soil Organic Carbon and Available Nutrient Content as Influenced by Erosion Control Measures in Lower Shivaliks of Jammu

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Research was conducted to study the impact of various erosion control measures on soil organic carbon and other nutrient content in lower *shivaliks* of Jammu. The experiment was laid out on a catchment exhibited sandy loam texture and 3-6% slope gradient. The various erosion control measures employed include cover crop, agrostological measures, terrace farming, contour plowing, perimeter runoff control and overgrazing prevention. From the study it was concluded that the organic carbon content was highest in cover crop (8.14 g kg^{-1}) followed by agrostological measures, contour plowing, terrace farming, perimeter runoff control and lowest in overgrazing prevention (2.11 g kg^{-1}). In case of available nutrient content, a similar trend was observed in case of nitrogen, phosphorous and potassium. In cover crop, the content of available nitrogen, phosphorus and potassium was recorded (426.22 kg ha^{-1}, 28.52 kg ha^{-1}, and 292.04 kg ha^{-1}, respectively. Hence, from the above study it was concluded that these erosion control measures, because have the ability to reduce runoff and sediment yield are effective in maintaining soil organic carbon content and nutrient status of soil. Besides this they also add organic matter to soil thus enhances organic carbon content and available nutrient in soil.

Keywords: Erosion control measures, Runoff, Sediment Yield, Organic carbon

Theme 4: 171

Socio Economic Impact for Sustainability of Agriculture Through Adoption of Super Seeder

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Super seeder is a proposal and sustainable solution to crop residue management by integrating the leftover residue into the soil in spite of burning it, which improves soil health and protects environment pollution. The study was conducted in rural areas of Karnal district of Haryana state among 80 adopter farmers of Super seeder agricultural technology. The objectives of the research were to know the socio-economic impact and adoption level of Super Seeder for sustainability of Agriculture. Results revealed that 22.50 percent of the respondents reported low level of adoption. Meanwhile, 45% of the respondents had a medium adoption level, while around one-third of the respondents exhibited a high adoption level. Age, education, subsidiary occupation, annual income, mass media exposure, and socio-economic status were significantly associated with adoption level of the farmers. Majority (82.50%) of the respondents agreed that there was an increase in investment in their children's education, ranking it as the top benefit. Approximately three-fourth of the respondents marked an increase in social participation. Moreover, 72.50 percent of the respondents reported an increase in household assets. Respondents were agreed that there was an improvement in their social status (rank IV). Furthermore, 65 per cent of the respondents reported an increase in expenditure on social ceremonies such as marriages and funerals. Exactly half of the respondents acknowledged an increase in agricultural land leasing.

Keywords: Agricultural technology, Socio-economic impact, Adoption, Super seeder, Sustainability

Theme 4: 172
Enhancing Farm Productivity and Livelihoods through Integrated Interventions under the Farmer FIRST Programme

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During 2024–25, the Farmer FIRST Programme (FFP) at ICAR-IARI, New Delhi, focused on participatory technology application, sustainable agripreneurship, and capacity-building initiatives across selected villages of Palwal district, Haryana. Natural Resource Management interventions, covering 14.8 ha, demonstrated a 5.7% yield increase in paddy (PB 1847), an enhanced cost-benefit ratio (2.44) through IPM in paddy (PB 1692), and up to 9.31% yield gain in mungbean (Pusa 1641). In crop-based demonstrations across 65.2 ha, wheat cultivar HD 3226 recorded the highest yield of 53.25 q/ha with net returns of Rs. 98,928.75/ha, 8.01% higher than the local check. Paddy varieties PB 1692, PB 1718, and PB 1509 yielded over 40 q/ha, with PB 1885 providing the maximum net return (Rs. 1.15 lakh/ha). Mungbean varieties (Pusa Vishal & Pusa 1641) delivered average yields of 10.75 and 10.10 q/ha, achieving benefit-cost ratios up to 2.94. Enterprise-based interventions included cucumber cultivation in insect-proof net houses (Benefit-Cost ratio 3.19), mushroom production yielding 1035 kg annually, and natural farming in vegetables showing an 84.62% higher income compared to traditional systems. Farmer participatory seed production in wheat and paddy led to a 13–20% net income rise. Capacity-building activities included kisan gosthis, field days, and animal health camps, engaging over 300 farmers. Extension visits, publications, media coverage of success stories on natural farming, and institutional linkages with the Department of Animal Husbandry further amplified the project's impact. The interventions significantly enhanced productivity, profitability, resilience among smallholder farmers and fostering sustainable rural livelihoods.

Keywords: Participatory technology application, Integrated farming system, Natural farming, Agripreneurship, Capacity building

Theme 4: 173
Integration of Farming Enterprises in Resource Mobilization among Tribal Farmers of Tuensang District in Nagaland

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Tuensang district lies in the eastern part of Nagaland State is a tribal dominated community with Agriculture practices as their main occupation. The Major activities take place under Jhum conditions as hilly terrain of the district hinders settle cultivation. Crops such as Maize, Kholar (Rajmash), Jhum paddy, millet, potato and vegetable cultivation dominate the yearly activities, however off farm activities like poultry, piggery, goatery, fishery, rabbitry and apiary also play a role in sustenance. The present study highlights the integration of different farming enterprises involved in resource Mobilization that enhances self sustenance and economic growth. It reveals that more than 60 per cent of tribal farmers were involved in farming practices that involved the integrated between 7-9 different enterprises.

Keywords: Tribals, Resource, Sustenance, Jhum, Enterprise

Theme 4: 174

Impact of Veterinary Interventions on Pig Farmers' Income and Asset Ownership: A Case Study from the Tribal Sub-Plan in Assam

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This study assessed the welfare impact of piggery-based technological interventions under the Indian Government's Tribal Sub-Plan (TSP) in tribal-dominated districts of Assam. Over 2022–24, these interventions, implemented by the ICAR-National Research Centre on Pig, Guwahati significantly improved animal productivity and shifted traditional, low-input pig farming to more commercialized systems. The study, based on cross-sectional data from 320 Scheduled Tribe (ST) farmers across Karbi Anglong, Dima Hasao, Goalpara, and Kokrajhar districts, found marked enhancements in food, habitat, occupational, educational and social security post-TSP implementation. Key activities included awareness programs, input distribution, farmer-scientist interactions, field demonstrations, and extensive training on scientific pig farming. To evaluate the impact, the study employed inverse propensity-weighting regression adjustment (IPWRA), with inverse propensity weighting (IPW) and coarsened exact matching (CEM) used for robustness. Simultaneous equation modelling was applied to trace impact pathways. Results showed that TSP beneficiaries had significantly higher farm and domestic asset holdings and farm income. Farm income rose by 23–27%, while asset holdings improved by 14–16%. Adoption of interventions was more likely among households with greater livestock ownership, farming experience, off-farm income and better access to training and extension services. As pig farming is a major livelihood source for ST households, promoting advanced piggery technologies such as improved germplasm, artificial insemination, affordable feeds, disease management and value addition is vital. Focusing on experienced farmers with larger livestock holdings and using participatory methods like Farmer Field Schools and local demonstrations can further support technology adoption and uplift tribal livelihoods.

Keywords: Tribal sub plan, Pig farmers, Impact, Interventions, Income

Theme 4: 175

Promising Practices in Sustainable Agriculture in India

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Environmentally friendly farming techniques include organic farming, crop rotation, and reduced tillage aim to reduce the negative impact of agriculture on the environment and integrates practices that sustain the health of ecosystems, landscapes, and communities. These methods reduce environmental impact, foster soil health, conserve water and reduce chemical use, among other practices. Organic farming has emerged as an essential ecological and sustainable process that fundamentally excludes the use of synthetic fertilizers and pesticides. It fosters the natural behavior of plants by maintaining soil health, improving biodiversity, and reducing non-renewable energy use. Natural farming in the Indian context is a local low-input climate resilient farming system that advocates the complete elimination of synthetic chemical agro-inputs. Natural farming allows for a wide range of agro-ecological practices - composting, mulching, green manuring, crop rotation, intercropping, tree intercropping, livestock integration takes a holistic approach to farming systems. Vermicomposting is considered a climate-resilient practice as it manages soil and crops in a sustainable manner with limited quantity of chemicals and improves soil health and crop productivity. It also minimizes fertilizer use and related emissions. Crop rotation

improves soil health, optimize nutrients, and combat pest and weed pressure. Rainwater harvesting is a process of collecting, conveying and storing the rainfall in an area for beneficial purposes. Keeping in the view the paper has following objectives. 1) To study the need and demand for highlighting sustainable agriculture's potential in India. 2) To study what sustainable agricultural practices are prevailing across India? Paper addresses the impact of sustainable agricultural practices on farm income, environment and social outcomes and then what are the gaps in current knowledge about these practices. This study aims to explore and promote the large-scale adoption of sustainable agriculture practices across India, tailored to the country's diverse agro-climatic conditions and socio-economic realities.

Keywords: Sustainable Agriculture, Environment, Natural farming, Climate resilience

Theme 4: 176

Integrated Livelihood and Nutritional Security through Sustainable Interventions in Tribal Communities of West Godavari District of Andhra Pradesh

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Tribal communities, often located in remote and marginalized regions, face multidimensional challenges related to livelihood security, nutritional deficiencies, and limited access to modern agricultural practices. This study evaluates the impact of targeted extension interventions aimed at enhancing the livelihood and nutritional status of tribal households through the implementation of low-cost, sustainable activities. The initiatives included the promotion of millet processing and value addition, backyard poultry, Integrated nutrient management for cattle health, introduction of kitchen gardening, promotion of composite fish culture, goat rearing, introduction of improved pulse production technologies and establishment of community nutri gardens conducted in tribal villages of Buttaigudem and Polavaram Mandals, West Godavari district. These interventions were introduced as a part of Tribal Sub Plan projects of ICAR-ATARI-X, Hyderabad as an integrated development model supported by local extension systems. The millet processing and value addition has contributed regular income to the tribal women apart from healthy food, the backyard poultry units contributed to nutritional security and supplemental income generation, especially empowering women in the household. Mineral mixtures improved cattle health, resulting in increased milk yield and overall livestock productivity. Kitchen garden kits and nutri gardens establishment played a significant role in enhancing household-level dietary diversity, providing year-round access to vegetables and nutrient-rich greens. Composite fish culture, introduced in community water bodies and farm ponds, added a protein-rich dietary component while generating additional income. The cumulative effect of these interventions demonstrated a marked improvement in livelihood resilience, dietary diversity scores, and awareness about scientific farming practices among tribal beneficiaries. The promising result in the study shows the positive approach and increased in income levels, nutritional enhancement, improvement in production and productivity, enhances the socio-economic impact, and sustainability of the communities. This study underscores the effectiveness of integrated, low-cost technologies in addressing livelihood and nutritional insecurity in tribal settings. It further highlights the importance of culturally sensitive, community-driven extension approaches to achieve sustainable rural development.

Keywords: Livelihood, Nutritional security, Sustainable interventions, Tribe

Theme 4: 177

Secondary Agriculture: Paving the Way for Sustainable and Resource-Efficient Entrepreneurship

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Agriculture and allied sectors which serve as the primary source of livelihood, is also a largest sector for waste generation. Every year, at least 1,300 million metric tonnes of agricultural waste are generated, and the number is anticipated to increase as the world's population grows. Despite significant post-independence agricultural growth, challenges like income disparity, minimal processing and post-harvest loss persist. Secondary agriculture serves as a multifaceted approach, by fostering a conducive environment for resource-efficient entrepreneurship. It is paving the way for policymakers and stakeholders to harness the potential of rural communities and bolster economic growth. This study was conducted in Dhubri district of Assam on 2024 using the mixed method research (exploratory sequential) design to explore how entrepreneurial behaviour differs in complex mechanisms of secondary agricultural enterprises with a sample of 100 respondents. The entrepreneurial behaviour of farmers following different agricultural enterprise was found to have significant positive correlation with education, average annual income, enterprise investment, mass media use, level of aspiration, economic motivation, deferred gratification and value orientation and negatively correlated with age. The results of multiple regression analysis unravelled that among the 23 attributes, five variables *viz*., economic motivation, deferred gratification, household status, value orientation and market orientation has explained 63.6 per cent of the entrepreneurial behaviour with an adjusted R square of 0.616. Thus, the study aids in establishing the fact that there is a significant difference between the factors (attributes) influencing entrepreneurial behaviour. Therefore, for appropriate and effective policy advocacy for boosting farmer's income and optimum resources utilization, the focus should be directed strategically more on these attributes of the secondary agriculture-based entrepreneurs.

Keywords: Entrepreneurship, Post-harvest loss, Secondary agriculture, Sustainable

Theme 4: 178

Farming System of Small and Marginal Farmers under Irrigated Condition in Muzaffarpur District of Bihar, India

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The study was conducted in Kurhani and Bandra blocks of Muzaffarpur district in Bihar state. Samples of 240 small and marginal farmers were selected from six villages by using proportionate random sampling technique. A farming system index was worked out as a ratio of number of complementary units of farming system practiced by an individual farmer to the total number of components of farming system being practices in irrigated areas. The findings of three different type of farming systems (agriculture, animal husbandry and agro-forestry) with four main components were adopted by the small and marginal farmers in irrigation situation. The main components were crops, animal husbandry, horticulture and agro-forestry. Eighty-five per cent of respondents practiced four main components, while about 18.9% of respondents practiced three components in their farming systems. Results indicate the crops grown and the crop combinations followed in the study area.

More than one third of the respondents 39.67% followed maize + potato + field pea + chillies types crop combination and another one third of the respondents 56.87% followed mustard + chickpea + onion+ greengram. Maize and chickpea were the important food crops and potato, chillies and onion were the cash crop widely grown by the respondents. Most of the respondents raised food crops mainly for consumption and for fodder. Animal husbandry included the rearing of livestock component such as cattle, goat, and buffalo rearing. Almost all the farmers 95.6% possessed dairy animals. Most of the respondents reared the breed of cattle Sahiwal and Black Bengal breed of goat. Horticulture included cultivation of fruit trees and vegetables. Litchi, lemon, anola, pomegranate and banana were the fruit trees grown by the respondents. Growing trees on the bunds and common places along with crop and animal husbandry was being practices. Mohagani, sagwan, neem, babul and nutan were the tree grown by the farmers. The trees were planted across the irrigation channel, bunds, borders, wastelands and fallows. The benefits acquired from the trees were fruits and vegetables for home consumptions, oil, fodder, manure, agricultural implements, income, fuel and live fencings.

Keywords: Farming system, Irrigated, Horticulture, Animal husbandry, Agro-forestry

Theme 4: 179

Sustainable Farming Through an Integrated Waste Management Approach: A Case Study of Agricultural Transformation

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Sustainable rural development in Punjab relies on innovative practices that integrate agriculture with other related sectors, ensuring both economic viability and environmental sustainability. In Panjab, farmers have embraced a holistic approach to waste management and resource efficiency by utilizing animal dung and urine in eco-friendly ways, contributing to both agricultural productivity and economic growth. Ram Singh, a farmer in Pathankot, Punjab, 52 years old, has successfully integrated biogas production, vermicomposting, and the fermentation of animal urine into his farming system. By utilizing animal dung waste for biogas generation and producing high-quality vermicompost, Ram Singh has enhanced resource efficiency, minimized waste, and adopted environment-friendly technologies that contribute to both his farm's productivity and the surrounding community's sustainability. He uses animal dung to produce biogas, providing a renewable energy source that reduces reliance on conventional fuels. The by-product slurry from the biogas process is used as fertilizer in fields after drying. He also prepares vermicompost from animal dung, which he sells to neighbouring farmers at a rate of Rs 8/kg. This not only helps improve soil fertility but also provides an additional income stream for Ram Singh, contributing to his financial resilience. Furthermore, Ram Singh ferments animal urine and applies it to his fields as a natural insecticide and fungicide, reducing the use of chemical pesticides and promoting more sustainable farming practices. This natural alternative not only lowers production costs but also helps protect the environment by reducing chemical runoff into nearby water bodies. Through the integration of biogas production, vermicomposting, and fermented urine as a pesticide, Ram Singh exemplifies a holistic approach to farming that combines resource efficiency, waste management, and environmentally friendly technologies. His success serves as a model for sustainable livelihoods and circular economy, demonstrating how small-scale farmers can enhance productivity, improve their incomes, and contribute to the broader goal of sustainable rural development in Punjab.

Keywords: Biogas production, Circular economy, Environment-friendly technologies

Theme 4: 180

Suggestions for Strengthening Integrated Farming Systems in Punjab: A Path to Sustainable Agriculture

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Integrated Farming Systems (IFS) have emerged as a sustainable approach to enhancing agricultural productivity, resource efficiency, and farmer income. However, their effective implementation requires continuous refinement based on farmer-driven insights. This study was purposively conducted in the three adopted villages *viz.,* Mardanpur, Kamalpur and Gadapur of Block Ghanaur, Patiala district, Punjab. This study evaluates suggestions from 300 Integrated Farming System adopters under the All India Coordinated Research Project to prioritize actionable measures for improving IFS practices. The findings revealed that the development of location-specific IFS models through research activities is the top priority, with 60 per cent of respondents expressing high agreement and a total score of 755. This is followed by the need for appropriate governmental policies with score 716 and ensuring proper marketing channels and fair product pricing with score 671. Sufficient farmer training, improved storage facilities, and a developed cooperative system also emerged as significant needs. Lower-ranked suggestions include coordinated extension services and the demonstration of IFS models. Across all enterprises reveal a strong need for price stabilization (93.33%), crop insurance (89%), with emphasis on promotion of high-value crops and storage in crop production. Horticulture highlighted cold storage (100%), training and agro-processing. Dairy improvements focused on milk cooperatives (97%), veterinary services (85%), and feed subsidies. Goatry stressed disease control (86%), marketing and breeding programs. Poultry recommendations prioritized infrastructure and disease control (100%), feed and medicine subsidies and organized marketing. Fisheries emphasized training (100%), processing units (93.33%), and supportive policies. Mushroom farming needs cold storage and loans, while beekeeping requires cooperative marketing and promotions. Vermicomposting called for market visibility, awareness and training. The study underscores the critical role of tailored research, supportive policies, market accessibility, and farmer-centric training programs in enhancing the adoption and success of IFS. These findings provide a roadmap for policymakers, researchers, and practitioners to optimize IFS frameworks for sustainable agricultural development.

Keywords: Integrated farming systems, Agricultural policies, Sustainable farming

Theme 4: 181

Livelihood and Nutritional Security of Tribal Farmers: Some Successful Interventions of KVK Pratapgarh

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Sustainable agriculture development is essential for boosting socio-economic status in rural areas. Agriculture, livestock and allied sector development is the major support system to rural economy, which provides livelihood, nutritional and income security to the farmers. At present the science and technology is developing very fast in terms of quality and quantity. KVKs through advisory services and progress forges to reinforce the farmers capacity to innovate. Present day status shows that role of extension has changed from production intensive to income facilitator, because now a days farming is beyond subsistence, it is more like a business. Agriculture extension is no longer just about improving yields and providing food but also to make money. For this KVK, Pratapgarh of Rajasthan is making necessary field level interventions. Looking to the need of farmers, low-cost technologies have been demonstrated at KVK farm. Some technologies are being adopted by the farmers namely Azolla, Low cost shade net house, Honey bee rearing, Nutritional gardening and Organic farming. Azolla unit is protein rich fern which helps in increasing milk productivity (15-20%) of cattle as well as good egg production of poultry and fast weight gain of broilers. Low-cost shade net house is prepared by using bamboos by which a farmer can earn extra income of Rs. one lakh within a year by selling seedlings of different vegetables and fruit crops. Honey bee rearing helps tribal farmers to earn additional income through selling honey. It also increases production of field crops through pollination. Nutritional gardening and organic farming help all farm families to eat fresh organic vegetables and keep themselves healthy. Hence in addition to farmers practice, extra and low-cost technologies can help farmers for livelihood and nutritional security.

Keywords: KVKs, Technologies, Azolla, Low cost shade net house, Honey bee rearing

Theme 4: 182

An Ergonomic Assessment of Improved Agricultural Tools for Reducing Drudgery in Farm Women

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Rural women play a major role in shaping the country's economy through their active participation in agriculture. In Meghalaya, more than 60% of the agricultural operations like transplanting, weeding, harvesting, storage of food grains are handled exclusively by women. These farm women however, work continuously in difficult postures which results in pain and discomfort in different parts of their body which ultimately lead to drudgery. Although various drudgery reducing tools and equipment are available but maximum among them are designed according to requirement of men. Therefore, the study aims to identify which of the farming activities causes highest drudgery to the farm women and to suggest a location-specific women friendly tool or equipment for the activity. For this study, 60 farm women from West Jaintia Hills district of Meghalaya were selected. A majority, 81.67% of the farm women responded that manual post-harvesting was the most drudgery farming activity, followed by 63.33% on pest & disease management and 58.33 on land preparation farming activity. Based on these results and location specific farming activity, the chaft cutter and turmeric grinder was introduced to farm women to reduce post-harvest drudgery, the power sprayer for managing pest and disease and brush cutter for land preparation. On comparing the traditional methods of performing the farming activities with the improved machines, the working heart rate, the energy expenditure, the total cardiac cost of work and the overall discomfort rate of the farm women was much lesser in the in case of the latter. Moreover, the farm women highlighted that using the improved equipment, there was reduction in musculo-skeletal pain like pain in upper back, shoulders, hands and fingers. Therefore, by using these drudgery reducing tools, their physiological stress can be reduced to a great extent. It is thus essential that the tools and implements for farm women are developed to suit their body posture.

Keywords: Agricultural tools, Drudgery, Farm women

Theme 4: 183

Effect of Feeding Fermented Rice in Growth and Reproductive Performance of Crossbreed Hampshire Pig

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This study was conducted to see the effects of feeding fermented rice residue on the growth performance of pigs. Fermented rice residue, a cost-effective and nutrient-rich feed alternative, was evaluated for its impact on pig growth rates, feed efficiency, and overall health. A total of 24 number of Crossbreed Hampshire piglets weighing on an average 14 to 14.5 kg (3 months old) were divided equally into three groups of 8 number each where, T1 gr receiving a conventional diet and the other two groups supplemented with fermented rice, in T2 gr 40% maize, 30% Rice bran with 30% fermented Rice residue and in T3 gr consisting of 20% maize, 30% Rice bran with 50% fermented Rice residue respectively. Over a period of 6 month period this study was conducted. Piglets were reared in different feeding regime and conducted trial on growth parameters such as monthly body weight gain, early sexual maturity and body weight were recorded with the help of weighing balance. Final body weight at 9 month was found to be 77±0.48,79±0.35 and 80±0.465 in T1, T2 and T3 group respectively and early sexual maturity was found in T3 gr at the age of 8 months as against of 8.5 months in other 2 groups. There was no significant difference in body weight gain. Results indicated that pigs fed fermented rice increase in body weight gain compared to the control group, along with improved FCR. There was no significant difference in body weight gain but it reduces cost of feed and thereby minimise cost of feed up to 40%. Additionally, pigs on the fermented rice diet exhibited enhanced better growth rate. The pigs consuming fermented rice was notably higher, leading to improved economic viability for producers. These findings suggest that incorporating fermented rice into pig diets up to 50% can optimize growth performance and more sustainable pig farming practices. Further research need to be explored on the long-term effects and potential benefits of fermented rice on pig health and meat quality.

Keywords: Fermented rice, Piglet, Growth rate, Feed efficiency

Theme 4: 184

From Learning to Empowerment of Tribal farmers through Backyard Poultry Farming

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Two training programs were organized under the Tribal Sub-Plan project for 40 tribal farmers (including 38 women) from Naugawa Thago, Khatima, U.S. Nagar, Uttarakhand, focusing on scientific backyard poultry farming. Prior to the intervention, only five tribal farmers were engaged in poultry farming. The objective of the program was to equip these below-poverty-line farmers with essential knowledge and skills to improve their livelihoods and promote sustainable farming practices. The five-day training covered key topics such as breed selection, poultry nutrition, disease management, housing, and bio security measures, all critical for improving the productivity and sustainability of poultry farming. Each participating farmer was provided with 25 improved

poultry birds of the breeds CARI Nirbheek and CARI Shyama, along with necessary poultry feeds. To assess the effect of the training programme, farmers' knowledge level was measured using pre- and post-test scores. The results demonstrated a significant improvement in their understanding, with a t-value of 3.9287 and a p-value of 0.0294, indicating that the training was effective. The intervention not only provided the farmers with a new source of livelihood but also contributed to enhanced nutritional security. This initiative, thus, played a crucial role in empowering the tribal farmers and improving their economic and food security.

Keywords: Backyard poultry, Training, Knowledge level, Nutritional security

Theme 4: 185

Effect of Lemongrass, Aloe vera and Combination of Lemon Grass and Aloe vera Supplementation on some Blood Parameters and Histomorphometry of Small Intestine in Broilers under Heat Stress Condition

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The study was conducted to see the effect of lemongrass, aloe vera and combination of lemongrass and aloe vera as dietary supplement on growth performance of Cobb strain broilers under normal and heat stress condition during their growth phase. The birds were reared under standard management practices. Chicks were randomly distributed in different groups of controls and treatments (C1, C2, T1, T2 and T3) with 3 replicates of each containing 20 chicks. Birds under control, C1 and C2 groups were reared on normal basal diet without lemongrass and aloe vera at normal environmental temperature and under heat stress (up to 48^{0}C), respectively. Birds of treatment -1 (T1), treatment-2 (T2) and treatment-3 (T3) groups were reared under heat stress condition (up to 48^{o}C) and provided with lemongrass @ 15mg/kg and aloe vera @ 1.5mg/kg in powder form and combination of lemongrass and aloe vera @ 15mg/kg and 1.5 mg/kg, respectively for the period of 42 days. Blood samples were collected on 3, 28 and 42 days of interval. One drop of whole blood was used for estimation of blood glucose using Contour plus monitor glucometer. Serum samples were separated from collected blood to study the biochemical parameters and antioxidant enzyme activities. Birds were sacrificed and tissue samples of small intestines were collected for the histomorphometrical study. Significantly higher ($P<0.05$) creatinine level were recorded in C2 (heat stressed) group as compared to other experimental groups (C1, T1, T2 and T3) on day 28 and 42 of experiment. Activities of GPx, SOD and catalase were recorded significantly higher ($P<0.05$) in C2 (heat stress) group on 42 day as compared to other experimental groups of broiler chicken. Among the treatment groups, lower activities of antioxidant parameters were recorded in T3 as compared to other supplemented (T1 and T2) groups. Significantly higher ($P<0.05$) values of histomorphometric parameters of small intestine were recorded in C1, T1, T2 and T3 groups as compared with the heat stressed (C2) group on 28 and 42 days of experiment. Inclusion of lemongrass and aloe vera in feed have significant ($P<0.05$) positive effect on blood parameters and histomorphometric parameters of small intestine in Cobb strain broiler chicks during heat stress condition. Dietary supplementation of both lemongrass and aloe vera @15mg/kg and 1.5 mg/kg can be recommended in broilers for overall better performance.

Keywords: Cobb strain broilers, Lemon grass, Aloe vera, Heat stress

Theme 4: 186
Integrated Farming for Environmental Sustainability: Resource Efficiency and Waste Reduction approaching Integrated Farming System

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This study undertakes a comprehensive evaluation of the economic viability and resource utilization efficiency of Integrated Farming Systems (IFS) in comparison to traditional farming practices in Ri-Bhoi district, Meghalaya. By analyzing the cost and returns of IFS, the research reveals that farmers adopting IFS achieve higher income levels and more efficient resource use than their traditional counterparts. The integration of multiple farm enterprises, such as crops, livestock, and fisheries, enables IFS farmers to diversify their income streams and optimize resource allocation. However, the study also identifies that certain components of IFS are underutilized due to constraints in input availability, highlighting the need for targeted policy interventions. To enhance the profitability and sustainability of IFS, the study recommends measures to ensure timely access to essential inputs, improve market linkages, and provide support services to IFS farmers. By addressing these challenges, IFS can be further leveraged to promote agricultural development, improve rural livelihoods, and contribute to food security in the region. The findings of this study offer valuable insights for policymakers, farmers, and stakeholders seeking to promote sustainable agricultural practices in Meghalaya and similar regions. This study compares the economic outcomes of Integrated Farming Systems (IFS) and traditional farming practices. Results showed that IFS incurs higher labour costs but yields higher returns, particularly from fish production and cabbage cultivation. The benefit-cost ratio is highest for fish, followed by cabbage and piggery. While IFS demonstrates more efficient resource use than traditional farming, both systems exhibit underutilization of resources. The findings suggest that IFS can be a profitable and sustainable approach to agriculture, with potential for optimizing resource allocation and improving productivity.

Keywords: IFS, Traditional farming, Sustainability, Resource use efficiency

Theme 4: 187
An Evaluative Study on Factors Influencing Adoption of Sugarcane Cultivation in Punjab

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The study analyses the socio-economic factors that influences the adoption of sugarcane cultivation in the Punjab state. The study was conducted in all agro-climatic zones of Punjab. Multistage sampling technique was employed to select the farmers for the study. Three categories of respondents were selected – Adopters, Non-Adopters and discontinuer (who discontinue sugarcane cultivation) for the study. The sample size of the study was 360 respondents made of 180 adopters, 90 non-adopters and 90 discontinuer of sugarcane cultivation. Primary data were collected using semi-structured interview schedule while secondary data which relate to the objective of the study were collected from Department of Agriculture and Farmers Welfare and Sugarcane mills. Findings show that out of thirteen independent variables, six were found to be significantly affecting the adoption of sugarcane cultivation. All the socio-economic characteristics showed a positive relation with the adoption of the sugarcane crop, whereas only risk-bearing capacity showed a negative relation. Mass media

exposure, extension contacts, and knowledge level regarding sugarcane cultivation had a significant and positive relation with the adoption of the sugarcane crop. Factors such as age, operational land holding, education, innovativeness, and social participation, show positive but non-significant relation with the adoption of sugarcane crop. Risk-bearing capacity showed a negative regression value which was 0.59. The results showed that respondent's contacts with extension agencies and exposure to mass media, was encouraging the rate of adoption of sugarcane cultivation. Therefore, the following recommendations were made: there is a need to increase the extension activities through different platforms on cultivation and recommendation of sugarcane crop. Also, it is crucial for government to form and implement more policies that enhance the adoption of cane cultivation.

Keywords: Adoption, Sugarcane, Socio-economic, Risk-bearing, Mass media

Theme 4: 188

Seed to Success: Improving Livelihoods through Rice Seed Production: A Success Story of Mrs. DS Toreiphun

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This is the story of Mrs. DS Toreiphun, a determined 47-year-old farmer from the hill village of Laiching Maipou in Chandel District, Manipur. Like many others in her community, she relied on age-old farming traditions-saving seeds from previous harvests and planting them season after season. But over time, her yields began to suffer. With just one hectare of land and rice being her family's main source of food and income, the declining productivity posed a serious challenge. She was harvesting only around 43–45 q/ha., barely enough to sustain her household. Things began to change in 2024, when she joined the Participatory Seed Production (PSP) Programme under AICRP on Seed (crops) led by ICAR-KVK Chandel. Through this initiative, Mrs. Toreiphun received hands-on training in scientific seed production—learning everything from selecting the right variety (in her case, RC Maniphou 16), preparing the field, managing pests, maintaining isolation distances, to post-harvest handling and storage. Guided by KVK experts throughout the season, she carefully applied these techniques on her land. The results were nothing short of remarkable. Her yield jumped to 58.35 q/ ha. Her net income rose to Rs. 1, 57,010/- and the benefit-cost ratio stood at an impressive 3.0:1. But the impact of her success went far beyond her own field. Other farmers in her village took notice. Her story sparked curiosity and inspired many to consider switching to certified seed production themselves. Thanks to a buyback arrangement supported by ICAR RC for NEH Region, Mrs. Toreiphun was also assured of a market for her seeds-offering both stability and a sustainable path forward. Today, her farm is more than just a source of livelihood-it's a local learning site. She has become a role model, especially for women, showing what's possible with the right knowledge and a bit of courage to try something new. Her journey is a powerful example of how science, when made accessible and relevant, can transform lives in even the most remote corners of the country. Her story is a reminder that real change often starts with just one person willing to take a step forward. And when that step is supported by the right training, inputs, and market access, it can grow into something much larger-bringing hope, opportunity, and resilience to entire communities.

Keywords: Livelihood, Rice, Seed production, Success

Theme 4: 189

Strengthening Rural Infrastructure and Conservation of Natural Resources through MGNREGA: A study in Chhattisgarh

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Chhattisgarh has consistently ranked among the top states in India for providing employment under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). A total of 18.51 lakh workers are registered in Chhattisgarh state under MGNREGA. The state Government redefines MGNREGA and providing 50 days extra employment to the beneficiaries from state funds, hence offering a total of 150 days secured employment through MGNREGA. The present study was conducted in Balodabazar and Bhatapara blocks of Baloda Bazar district in Chhattisgarh state. Major objective of the study was on people's perception on strengthening of rural infrastructure and conservation of natural resources through MGNREGA scheme. A sample of 120 beneficiaries of MGNREGA scheme was drawn for the study following multi stage and systematic random sampling methods with the help of MGNREGA job cards. Data were collected from 120 respondents from four villages (02 from each block) with the help of a semi-structured interview schedule. The study findings clearly indicates that more than three fourth of the respondents (75.83%) had medium level of perception towards conservation of natural resources and functioning procedure of MGNREGA. Those who had low and high perception about MGNREGA were merely 16.66 per cent and 7.5 per cent, respectively. The respondents highly appreciated the scheme for its expediency in improving and rejuvenating natural water bodies and other infrastructure in rural areas and ensuring timely livelihood for rural people. Further, the study also focuses on near to perfect and a very thoughtful functioning and implementing procedure of the scheme like timely payments to the beneficiaries, transparency in work and wages, adequacy of wages, gender equality, jobs in village vicinity and other facilities like first aid, children's play zone facilities are bringing significant change in people's life.

Keywords: Rural infrastructure, Natural resources, Infrastructure, MGNREGA

Theme 4: 190

Assessing the Economic Benefits of Extension Services for Scheduled Caste Pig Farmers in Assam

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This study evaluates the welfare outcomes of piggery-based technological interventions carried out under the Scheduled Caste Sub-Plan (SCSP) in Assam between 2023 and 2024. Drawing on cross-sectional data from 240 Scheduled Caste pig farmers across multiple districts, the research highlights substantial improvements in animal productivity, livelihood stability and overall welfare. The ICAR-National Research Centre on Pig, Guwahati, led a range of initiatives for SC pig farmers, including awareness campaigns, input distribution, farmer-scientist interactions, live demonstrations and year-round training sessions to promote scientific pig farming practices. To assess the impact, the study employed inverse propensity-weighted regression adjustment (IPWRA), supported by robustness checks using inverse propensity weighting (IPW) and coarsened exact matching (CEM). The adoption impact pathway was analysed using simultaneous equation modelling. Findings indicate that SCSP beneficiary farmers saw a 14–16% steep increase in farm income and an 8–10% rise in asset ownership compared to non-adopters. Larger livestock holdings and greater off-farm income were positively linked to higher rates of technology adoption. Key drivers of adoption included farming experience, livestock assets, off-farm employment and access to extension services. To strengthen adoption, the study suggests prioritizing experienced households with significant livestock resources and advancing Scheduled Caste empowerment through participatory approaches like Farmer Field Schools (FFS) and technology demonstrations. Additionally, scaling up technologies such as improved pig germplasm, artificial insemination, scientific management, cost-effective feed, disease control measures and value-addition in pork products is vital for enhancing livelihoods and fostering sustainable development among the marginalized communities in Assam.

Keywords: Schedule caste sub plan, Pig farmers, Impact, Interventions, Income

Theme 4: 191

Interrelationship and Cause-Effect Analysis of Different Indicators Based on Rice Farming on Economic, Social and Ecological Sustainability

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Path analysis indicates how the variables relate to one another and develop logical theories about the processes influencing a particular outcome. It decomposes the associations between different variables into causal (direct and indirect) and non-causal (spurious) components. Causal relationship between variables may consist of direct and indirect effects. Direct causal effects are effects that go directly from one variable to another. Indirect effects occur when the relationship between two variables is mediated by one or more variables. The composite sustainability index was significantly correlated with twelve out of nineteen variables, when equal weights were given and seven out of nineteen variables, when absolute weights were assigned. There was a strong and positive significant correlation between rice productivity, labour availability, per capita income, supply of food grains through PDS, livestock density, female literacy, telecommunication density, and employment in organized sector and number of co-operative societies with the overall sustainability. Besides this, the livestock density had positive and significant correlation with the overall sustainability. Though it negatively affects the ecological sustainability, it helps in improving the overall sustainability through regular flow of income to the farmers. Strong and negative significant correlation (-0.45) between overall sustainability and fertilizer consumption, when absolute weights were assigned and it shows that even if it is significant, the fertilizer consumption in the study area (hill districts) in not in optimum level. The per capita output of food grains is low in valley districts due to high population density but the other sustainability indicators have done well in the valley districts. This is the root for negative correlation coefficient of the factor. The village electrification had negative and significant correlation with overall sustainability, which signifies the lack of reliable electricity supply in the hill districts of Manipur.

Keywords: Cause-effect analysis, Indicators, Rice farming, Sustainability

Theme 4: 192

Empowering Rural Women: Adoption of Drudgery-Reducing Tools in Vegetable Cultivation in Haryana

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This study, conducted in 2023–24 across Panipat and Sonipat districts of Haryana, assessed the nature of work and contribution of women in cultivation of vegetable and explored the socio-economic factors influencing the adoption of drudgery-reducing agricultural tools. A purposive sample of 60 beneficiaries was selected, and data were gathered through structured interviews. Key variables included respondents profile, education, socio-economic status and mass media exposure. Statistical tools such as percentages, means, and correlation coefficients were used for analysis. Findings revealed that most respondents were under 30 years of age, with a significant portion from backward or scheduled castes. Educational levels were generally low, and income was modest. Active involvement in vegetable cultivation was observed, particularly in harvesting (56%), seed sowing (47%), and land preparation (44%). The most cultivated vegetables included potato, onion, garlic, cucumber, cauliflower, radish, peas, ladyfinger, and tomato. Knowledge assessment revealed the highest awareness for improved serrated sickle and vegetable trolley (Rank I), followed by gloves and mittens (Rank II), vegetable plucker (Rank III) and so on. The study emphasizes the critical role of rural women in agriculture and highlights the need for targeted training and dissemination of appropriate tools to reduce their labour burden and enhance productivity.

Keywords: Women labour, Drudgery, Vegetable cultivation, Agriculture tools

Theme 4: 193

Minimizing Drudgery: Assessment and Intervention Strategies for Farm Women in Crop Production

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Rural women in India play a critical role in managing households, farms, and livestock, engaging in a wide range of agricultural and allied activities. Their contributions, though varied across regions, are fundamental to rural economies. Daily tasks often require unnatural postures like bending and stretching, leading to cardiovascular strain and musculoskeletal problems. Agricultural work remains highly laborious and energy-intensive due to limited access to improved technologies, causing significant physical and psychological stress. Poor working conditions, repetitive movements, and reliance on muscular strength further increase drudgery. Improving women's health and working conditions is essential, as they are key to national development, cultural preservation, and resource management. The study was conducted in two phases to assess the human physical drudgery experienced by farm women. Phase I employed an exploratory research design, involving 150 randomly selected farm women–50 each from wheat, paddy, and vegetable cultivation–to collect baseline data on the Human Physical Drudgery Index (HPDI). In Phase II, experimental data were collected to analyze the most drudgery-prone agricultural activities associated with wheat (Rabi), paddy (Kharif), and vegetable cultivation. A total of 45 healthy female participants (15 for each crop type), aged 25–45 years, non-pregnant, non-lactating, and without a history of cardiovascular or chronic illness, were selected through random sampling. Each task was evaluated over three replications of ten-minute work cycles, without rest, to assess physiological and postural stress. Key

ergonomic parameters measured included Heart Rate, Blood Pressure, Energy Expenditure Rate (EER), Total Cardiac Cost of Work (TCCW), Physiological Cost of Work (PCW), and perceived psychological stress. These indicators helped quantify the physical burden associated with traditional agricultural tasks in the paddy–wheat–vegetable cropping system. The study found that the physical workload for harvesting, threshing, and load carrying in the wheat production system was moderate, based on heart rate and energy expenditure. Previous research indicates that paddy/wheat harvesting in hot climates imposes significant cardio-respiratory strain. To reduce the risk of accidents and fatigue, it is recommended that workload for men should not exceed 35% and for women, 28% of their aerobic capacity during 8-hour shifts. In the study, the threshing operation in paddy cultivation was identified as the most drudgery-prone activity. The mean heart rate increased from 79.33 beats/min (resting rate) to 130.66 beats/min (with an Energy Expenditure Rate (EER) of 12.05 kJ/min), reflecting a heavy threshold physical workload. Similarly, during the load-carrying task following threshing, the resting heart rate of 82.66 beats/min rose to 124.33 beats/min, with an associated EER of 11.05 kJ/min and a Total Cardiac Cost of Work (TCCW) of 441.05 beats, further indicating a heavy workload. According to the threshold physical workload levels, all major activities in paddy cultivation–transplanting, threshing, and load carrying–were classified as heavy, while harvesting was categorized as moderate based on heart rate and energy expenditure rate.

Keywords: Farm women, Drudgery, Crop production, Energy expenditure rate, Ergonomics

Theme 4: 194

Assessment of Productivity and Profitability of Improved Maize Varieties in West Garo Hills, Meghalaya

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Maize is an important staple crop in Meghalaya, especially in the hilly tracts of the Garo Hills, where it serves as both a food source and a means of livelihood for smallholder farmers. However, productivity in this region has traditionally been low due to reliance on local varieties and sub-optimal agronomic practices. This study was conducted to evaluate the productivity and profitability of improved maize varieties under the specific agro-climatic conditions of the Garo Hills, with the goal of identifying suitable varieties for wider adoption by local farmers. This study was undertaken to evaluate the performance and profitability of two improved maize varieties, Megha Maize-1 and Megha Maize-2, in comparison to the local farmer's practice. The results demonstrated clear advantages for the improved varieties, particularly Megha Maize-1, which recorded the highest yield of 3.15 t/ha, outperforming Megha Maize-2 (2.40 t/ha) and the farmer's practice (2.03 t/ha). Megha Maize-1 also achieved superior economic returns, with a gross return of Rs. 99,086/ha and a net return of Rs. 59,286/ha, yielding a B:C ratio of 2.48. In comparison, Megha Maize-2 and the farmer's practice recorded lower net returns of Rs. 49,260/ha and Rs. 28,900/ha, and B:C ratio of 2.25 and 1.74, respectively. Farmer feedback highlighted Megha Maize-1 as the most promising variety, recommending its wider dissemination through Frontline Demonstrations (FLDs) to enhance farm productivity and income. The study concluded that Megha Maize-1 holds significant potential for improving maize production and profitability in the challenging hilly terrains of Garo Hills, thereby contributing to regional food security and farmer welfare.

Keywords: Productivity, Profitability, Megha Maize 1, Megha Maize 2

Theme 4: 195
Resource Conservation Practices in Rice-Wheat Cropping System: An Ecological and Sustainable Approach

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Rice-wheat is the major cropping system in India as well as in the world. The rice-wheat cropping system is very productive, but has exhausted natural resources with decline in ground water level, soil carbon stocks, soil plant available nutrients and resulting in buildup of pest and diseases. Moreover, intensive cultivation practices in rice-wheat coupled with indiscriminate use of inputs led to decline in total factor productivity, increased energy crisis and decline in agricultural profitability. Along with the decline in sustainability, disturbances in natural resources and ecological balance are also in question. Conservation of natural resources is a step towards successful crop production. Therefore, it is imperative to adopt resource conservation technologies for reversing natural resources. Resource conservation technologies include technologies in terms of new varieties, efficient equipment with little or minimum pre-planting tillage, soil and water management practices that are cost-effective and environmentally friendly. Resource conservation technologies improve input use efficiency at a lower cost and preserve the ecological integrity of crop production systems. The stability of the traditional rice-wheat system in the long run has been questionable. The need to meet the high growth in food demand will put enormous pressure on the managed production system. To reduce the ill effects of the traditional rice-wheat cropping system; efforts have been made to develop several resource conservation technologies. The shift from transplanted rice to direct sowing in rice production system is a testimony to resource conservation technologies. Zero tillage/minimum tillage/pre-plantation reduction, well irrigated raised bed system (FIRBS), surface seeding, drip irrigation, crop residue management are some more examples of resource conservation techniques. Given the globalization of agriculture, the cost of production and the energy requirement are of great importance. Reducing these parameters without compromising on yield and soil quality is the need of the day to ensure sustainability of the eco-system.

Keywords: Rice-wheat system, Resource conservation, Sustainability

Theme 4: 196
Creating Wealth from Waste Pineapple Leaves

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Pineapple leaves are a significant byproduct of pineapple cultivation and improper disposal can lead to environmental pollution and waste management issues. Usually, the by-products of pineapple (leaves) were thrown after collecting the fruits. Although, the pineapple leaves are biodegradable, they can cause a great problem if disposed improperly. If utilized with proper extraction method, this waste can be used as a raw material for producing high quality fiber. Waste management of pineapple leaves is an important aspect of sustainable agriculture and environmental conservation. In the PLF extract process, microorganisms play an important role in separating the gummy substance that surrounds the pineapple leaves, resulting into decomposition of the fiber and easy separation of the fiber from the raw material/waste. PLF is used to produce a wide range

of weaving fabric items including dresses, and accessories. The average leaf length of the pineapple (var. Queen) is 69.42 cm and 73.35 cm for Kew variety leaf breath was recorded maximum with Kew (5.27 cm) and (5.21 cm) for queen variety. The average weight of a pineapple leave is 35 g (kew) and 25 g (queen) No of leaves/kg: Kew (29 nos.) and Queen (40 nos.), One of the innovative solutions for disposal is extraction of pineapple leaf fiber. The Pineapple Leaf Fiber (PLF) is a natural and sustainable textile material that is obtained from the leaves of the pineapple plant. Manual method through retting by using NINFET Sathi Retting Accelerator @ 0.5% and scrapping can be used for the extraction of the PLF Fiber yield /kg: 15 gm (Kew) and 11gm (queen) after drying. Some of the reports of pineapple fiber are finess (tex) is 2.5, colour (%) 58.4 and bundle strength (g/tex) is 18.0. By adopting sustainable and environmental friendly approaches one can reduce waste and promote rural development.

Keywords: Diversification, Innovation, Pineapple Leaf fiber

Theme 4: 197

Dynamics of Sustainable Livelihood Index in Marngar Village, Meghalaya: Impact of FFP Interventions

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This study quantitatively evaluates changes in the Sustainable Livelihood Index (SLI) of the Marngar village cluster, Meghalaya, over a five-year period following the implementation of the Farmers' FIRST Programme (FFP). The Marngar cluster in Ri-Bhoi district, Meghalaya, is characterized by a predominantly agricultural economy, limited infrastructure, and significant socio-economic challenges. The analysis integrates baseline and post-intervention data across five capital components: natural, physical, financial, human, and social. At baseline, financial capital was the most influential (weight: 0.4092), followed by physical (0.3384), social (0.1199), natural (0.0709), and human capital (0.0615). Mean SLI at baseline was 0.1224, with individual values ranging from 0.06 to 0.46, and the population distributed as 49 in hardly sustainable, 34 in sustainable, and 17 in most sustainable classes. Post-intervention assessment revealed a mean SLI increase to 0.1742, with the highest value reaching 0.80, indicating substantial livelihood improvements for some households. The weighting of Sustainable Livelihood Index shifted, with increased importance of natural (0.1094) and physical (0.4706) capitals, reflecting the impact of environmental and infrastructural enhancements. Financial capital's weight decreased slightly to 0.4445, suggesting a more balanced contribution from all capitals. Current mean component values were: natural (0.3826), physical (0.0655), financial (0.1269), human (0.3910), and social (0.1705). The distribution of SLI classes shifted to 50 hardly sustainable, 41 sustainable, and 9 most sustainable, indicating both improvement and heterogeneity in outcomes. A paired t-test confirmed a statistically significant increase in SLI post-intervention, supporting the effectiveness of FFP activities in enhancing livelihood sustainability. These findings highlight the critical roles of targeted infrastructural and environmental interventions, while also indicating persistent variability in livelihood outcomes across the population. Further research is recommended to identify specific drivers of improvement and address remaining disparities.

Keywords: Sustainable livelihood index, Capital, Assessment

Theme 4: 198

Popularizing Potato Crop for Crop Diversification and Sustainability of Tribal Farmers of Meghalaya

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Potato is the second most important crop in Meghalaya after paddy, and it is the most significant cash crop of the state. The main potato growing season of Meghalaya is summer that covers 12577 ha area (65% of total potato growing land) with total production of 143122 metric tons (76% of total potato production). Potato production in the state is primarily confined to the Central Shillong Plateau, *i.e.* east khasi hills, west khasi & southwest khasi hills which covers about 94% of total potato areas and produce about 96% of total potato production in the state. Keeping in mind, the prevalent opportunities for growing potato cultivation in the state, ICAR, KVK, Ri-Bhoi in collaboration with CPRI(RS), Upper Shillong aimed to introduce and demonstrate potato variety Kufri Himalini in Ri-Bhoi district of Meghalaya. Training and demonstration were taken up during rabi season of 2022-23 in 5 villages covering 10.0 ha area. Kufri Himalini is a medium maturing potato variety which has a high level of resistance to late blight in foliage and moderate resistance in the tubers. Technology package was followed from sowing to harvesting of crop. The results during harvest revealed that the variety yielded 12-18 tubers per plant with an average weight of 450-550 g per plant, which is comparatively higher when compared with traditional farming practices. The average tuber yield of 164.6 q/ha was recorded with organic cultivation practices. The enhancement of net return fetched Rs. 62,620/- with a profitability ratio of 2.35. Additionally cropping intensity of the district has also increased to 115 percent. The technology gap, extension gap as well as technology index was found to be satisfactory with the introduction of improved potato variety. The horizontal spread was very fast in few pockets but non availability of quality seeds in remote areas hindrance further spread though it might help to raise income, food and nutritional security significantly for the tribal farmers of Ri-Bhoi district.

Keywords: Potato, Crop diversification, Himalini, Cropping intensity, Horizontal spread.

Theme 4: 199

Impact of Organic Amendments on French Bean Growth, Yield, and Soil Health in Phek District, Nagaland

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French bean (*Phaseolus vulgaris* L.) is an important vegetable known for its nutritional value and economic significance. However, its growth and productivity are often limited by nutrient availability and soil quality. The acidic soils, limited fertility, and inadequate nutrient management practices prevalent in Phek district, Nagaland, resulting in poor crop yields, reduced soil fertility, and decreased agricultural productivity. A field experiment

was conducted during the kharif season in Thipuzu village of Phek district, Nagaland, to evaluate the impact of organic sources on the growth, yield, and soil parameters of French bean. The experiment consisted of three replications and five treatments: T1 (control), T2 (biofertilizer), T3 (vermicompost), T4 (farmyard manure or FYM), and T5 (biofertilizer + vermicompost + FYM). The results indicated that treatments receiving biofertilizer, vermicompost, and FYM significantly (at 5% level) enhanced growth and yield parameters, as well as improved soil fertility compared to the control. Soil analysis revealed a significant increase in pH, organic carbon content, and available N, P, and K in treatment T5, with values recorded at 5.68 (pH), 266.53 kg ha^{-1} (N), 20.87 kg ha^{-1} (P), and 174.53 kg ha^{-1} (K), outperforming all other treatments. These findings demonstrate the potential of the biofertilizer + vermicompost + FYM combination to sustainably enhance French bean yield.

Keywords: Organic amendment, French bean, Yield, Soil properties

Theme 4: 200
Economic Feasibility of Kiwifruit Cultivation in Lower Subansiri District of Arunachal Pradesh

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Kiwifruit cultivation is a promising avenue for horticultural development in the mid-hill regions of Arunachal Pradesh. An attempt has been made to study the economic and financial feasibility of Kiwifruit cultivation in Lower Subansiri District of Arunachal Pradesh. This study was conducted in the Lower Subansiri district employing a comprehensive approach through purposive sampling, a diverse array of 60 respondents, comprising farmers were engaged across selected villages, namely Tajang, Hija, Hong and Hari and two blocks- Ziro I and Hong-Hari within the district. Utilizing established analytical frameworks, including cost concepts and Benefit Cost Ratio (BCR). From the study it was revealed that the total costs for establishing a kiwifruit orchard per hectare are Rs. 2,72,512.77 for small, Rs. 2,82,199.412 for medium, and Rs. 2,89,991.34 for large orchards, with an overall average of Rs. 2,81,567.8421. The total maintenance cost per hectare is Rs. 31,728.69 for small, Rs. 34,009.76 for medium, and Rs. 35,046.64 for large orchards, with an overall average of Rs. 33,595.03. The gross return from Kiwifruit orchard of small, Medium and large was Rs. 5,06,700/ha, Rs. 5,01,750/ha and Rs. 4,93,200/ha respectively. Despite these cost escalations, returns above expenditure remain promising, with a combined benefit-cost ratio of 1.59, demonstrating the economic viability of kiwifruit cultivation, particularly for small-scale farmers. Moreover, the cost of establishing a kiwifruit orchard is high, thus the government may be advised to give direction to the financial institution to offer loans to the cultivators with fair interest rate. Majority of the orchardists do not get the better remuneration due to low prices of produce and price fluctuations as they are selling their produce immediately after harvest. The reasons for distress sale may be lack of cold storage and low shelf life of kiwifruit. Therefore, to tackle the problem cold storages should be established. Efforts are essential to unlocking the full economic potential of kiwifruit cultivation for fostering sustainable agricultural development and livelihood improvement within the hilly regions of Arunachal Pradesh.

Keywords: Kiwifruit cultivation, Cost concept, Economic potential

Theme 4: 201

Evaluation of Herbal Feed Supplements for Sustainable Poultry Production Under Backyard System

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In India, backyard poultry production is a growing sector providing a significant source of animal protein and livelihood security to the rural population. Although, the production of healthy and high-performing poultry is essential for the sustainability and profitability of this enterprise, there has been an increasing interest in recent years for exploring natural and sustainable alternatives to the costly poultry feed along with feed additives. Keeping this in mind, the Krishi Vigyan Kendras of Zone-IV planned On Farm Trials at farmer's field to evaluate the growth performance of backyard chicken fed with different herbal feed supplements like Tulsi (*Ocimum sanctum* 1% w/w), Moringa (*Moringa oleifera* 3% w/w) and Turmeric (*Curcuma longa* 1% w/w) as compared to commercial feed under field condition. A total of 60-day-old chicks were procured and acclimatized for seven days prior to the start of the trial. The birds were randomly divided into four groups (n=15 per group), each housed in a separately with access to natural foraging, shade, and clean drinking water. Herbs were air-dried, ground into powder, and mixed into the feed daily before feeding. Birds were fed twice a day with a locally formulated feed made from grains, kitchen scraps, and available greens. It was observed in present trial that the technology options *i.e.*, TO1 (Control), TO2 (Tulsi), TO3 (Moringa) and TO4 (Turmeric) were found superior than Farmer's Practice in terms of egg production and egg quality traits. Moringa (3%) supplementation showed the best results in body weight gain, feed conversion ratio, egg production, and immunity. Likely due to its high protein, antioxidant, and vitamin content. Tulsi (1%) contributed notably to immune enhancement and respiratory disease resistance due to its antimicrobial and adaptogenic properties. The net profit per bird along with benefit cost ratio was also highest in Moringa supplemented group. Turmeric (1%) showed a balanced improvement, especially in yolk pigmentation, disease resistance, and immunity. All herbal groups had a significantly lowers the mortality rate compared to the farmer's practice. No adverse effects were observed in any group due to herbal supplementation.

Keywords: Sustainability, Backyard poultry, Herbal feed

Theme 4: 202

Improved Hand Tools and Equipment for Reducing Labour Drudgery in Sugarcane Cultivation

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Sugarcane is an important industrial crop of India, cultivated over 5 million hectares area. Sugarcane cultivation requires various operations like land preparation, planting (sett cutting, furrow making, placement of seed setts in furrows, fertilizer and chemicals application, soil covering over setts), irrigation, weeding/interculturing, earthing up, plant protection, harvesting including detrashing and detopping and ratoon management. Most of the cultural operations are labour intensive. Therefore, there is an urgent need to switch over to mechanize the crop cultivation to enhance overall production and profitability. Use of suitable implements can play a significant role

in enhancing production and yield of sugarcane on sustainable basis. Sugarcane cultivation is being mechanized with the objectives of timeliness of operation, reduced cost of farm operations, reduced human drudgery and enhancing yield of other critical inputs like labour, chemical fertilizers and agricultural chemicals. ICAR-Indian Sugarcane Research Institute, Lucknow has developed several hand tools for reducing labour drudgery. Manual sugarcane bud chipper has been developed to remove buds from the sugarcane stalk for raising seedlings for transplanting. IISR manual harvesting knife is used to cut the cane stalks closed to ground surface during harvesting. IISR manual cane detrasher has been developed to remove dry trash from standing as well as harvested cane. With this tool, thirteen persons can cover one ha field per day. IISR manual sugarcane detrasher cum detopper strips dry leaves and cut the green top. IISR manual cane node/bud-chip/sett cutting machine performs three operations separately viz., cutting cane node, bud chip scooping and seed sett cutting for being used as planting material. Manual multi crop planter has been developed for sowing intercrop in sugarcane, with the field capacity of 0.07 ha/h and 0.10 ha/h in wheat and mustard, respectively. A manual light weight weed cleaner has been developed for weed control. A solar powered manual sprayer has been developed for spraying herbicide/ fungicide. These improved manual tools enhances the capacity and efficiency of the operation with less time, cost and drudgery as compared to conventional practices and needs popularization for wide adoption among farmers.

Keywords: Improved hand tools, Labour, Drudgery, Sugarcane cultivation

Theme 4: 203

Adoption of Natural Farming Practices: An Analysis of Challenges and Opportunities in Tonk District

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Natural farming, as described by Palekar (2010), is a farming practice that is pain-free, care-free, loan-free, and driven by passion. It promotes chemical-free, sustainable agriculture while aiming to reduce cultivation costs, improve food quality, enhance soil fertility, and ensure food and nutritional security. The present study was conducted in Tonk district of Rajasthan, where 120 trained farmers were selected through simple random sampling from three blocks. Villages were chosen based on preliminary surveys that indicated a significant interest in ecological farming. The study focused on the level of adoption, constraints faced, and factors influencing the adoption of natural farming practices. The results showed that 68 percent of farmers were in the medium adoption category. Among various components, the adoption of *Jeevamrita* and *Beejamrita* was found to be higher. The overall Adoption Quotient was 64.24 percent. To study the factors affecting adoption, a Multinomial Regression Model was applied. Extension contact ($P < 0.05$), landholding size ($P < 0.10$), and experience in natural farming ($P < 0.10$) were found to be significant factors influencing adoption. Constraints faced by the farmers were analyzed using the Garrett Ranking technique. Marketing constraints emerged as the major problem, with high price fluctuation ranked first, followed by lack of transport facilities and high transportation costs. Financial constraints, particularly low yield compared to conventional farming, were also significant. Technical and input constraints such as lack of skill for seed treatment and lack of quality seed supply were reported but were comparatively less critical, as the farmers surveyed had received prior training.

Keywords: Agroecological practices, Garrett ranking technique, Natural farming, Sustainable agriculture, Zero budget natural farming

Theme 4: 204

Mushroom Cultivation: An Enterprise for Recycling Waste to Generating Employment for Hill Farmers

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Mushrooms have been the coveted food item for all with no cholesterol and carbs content being heartful and healthful with beneficial vitamins and minerals. Mushroom cultivation process utilizes the agro-wastes to convert to protein rich food, a process of converting waste to wealth for the resource poor hill farmers. The congenial climate conditions of Meghalaya provide ample scope for cultivation of different mushroom species at different elevations of the state, round the year. The climate at high altitudes is congenial for cultivation of button and shiitake mushrooms, while at the mid and foot hills different species of oyster mushrooms are cultivated throughout the year. Button mushroom is cultivated with paddy straw and in the long method has a B:C ratio of 1.6-2.0 which varies with seasonal and off seasonal cultivation. Oyster mushroom cultivation has been growing as a household activity in the recent past which has impact on its availability in the market round the year. A kilogram of oyster mushroom usually priced at Rs. 250 in the local market earns the grower B:C ratio of more than 2. Growing health-conscious consumers have aggravated the gap in demand and supply of quality mushroom spawn. Available resources in the state provide easy production and ready market for mushroom spawn. Spawn production as an enterprise can attract the youth for a lucrative employment opportunity with low investments. An initial investment of Rs. 40000-50000/- with minimum existing facilities can earn a turnover of 2-2.7 B:C ratio. Mushroom processing and value addition can be a game changer for the tourism prime state. Mushroom spawn production, fresh mushroom cultivation, processing and value addition is a boon for the landless small and marginal farmers, farm women/housewives and the youths. Mushroom production can be a cottage/small scale industry for the farmwomen and members of the SHGs. It can also be an organized industry creating a mushroom hub in the state.

Keywords: Mushroom, Enterprise recycling waste, Employment, Hill farmers

Theme 4: 205

Research and Developmental Efforts made at ICAR-ISRI, Lucknow for Sugarcane Mechanization for Reducing Labour Drudgery

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Since its establishment, ICAR-IISR or presently ICAR-ISRI, Lucknow initially took- up R&D work on animal drawn equipment. Then, work on tractor-drawn semi-automatic/automatic equipment was started. Seedbed can be prepared with tractor operated culti-harrow which perform operations of cultivating, harrowing and planking in a single pass. For seed treatment through heat therapy, Moist-hot air treatment unit was developed for protecting the crop from seed-borne diseases. For planting operations, prototype of tractor drawn PTO operated 2-row sugarcane cutter planter with four discs was developed, followed by development of a ridger type cutter planter and paired row sugarcane cutter planter. Ring-pit digger was developed for mechanizing the ring-pit planting. IISR deep furrow sugarcane cutter planter was developed for sugarcane planting in deep

furrows, followed by development of IISR trench planter for mechanizing trench planting. For planting of companion crops, IISR tractor operated deep furrow sugarcane planter-cum-multicrop raised bed seeder, sugarcane-cum-potato planter and trench planter-cum-seeder were developed. For weed management, two models of IISR tractor operated sugarcane manager have been developed. Recently, IISR tractor operated multipurpose interculturing equipment has been developed for inter row interhulturing and intra-row herbicide spraying attachment. A tractor operated side mounted whole cane harvester for cutting of single rows of cane and tractor front mounted sugarcane windrower harvester for harvesting two rows of cane was developed. A new prototype of tractor front mounted sugarcane harvester was developed for cutting and windrowing of two rows of cane. This harvester provided partial solution of sugarcane harvesting and rest of the operations such as detrashing and detopping could be performed manually. Power operated sugarcane detrasher was developed for removal of green top as well as dry trash from the harvested sugarcane stalk. IISR deep furrower has been developed for earthing up. A ratoon management device was designed and developed for stubble shaving, off-barring and deep tilling treatment of manure and bio-fertilizer, application of chemical, etc., interculturing and ridge making, followed by development of ratoon manager. For performing ratoon initiation operations, disc type ratoon management device was developed. Thus, ISRI has developed number of innovative and very efficient machinery with less time, cost and drudgery for mechanization of sugarcane cultivation and signed MoAs with several manufacturers for large scale manufacturing and popularization.

Keywords: Sugarcane, Mechanization, Labour, Drudgery

Theme 4: 206

Evaluation of Hybrid Rice Genotypes for their Suitability for Production in Terai Region of Nepal

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Eighty hybrid rice genotypes obtained from different multinational companies and National Rice Research Program, Hardinath's hybrid rice breeding program including three hybrid checks and two inbreed checks were evaluated in alpha lattice design with two replications at five different locations of Terai region of Nepal during 2021 with the objective of registering the high yielder and disease and insect pest resistant F_1 rice genotypes to increase the food and nutritional security in Nepal. Observations recorded were days to 50% heading, days to 85% maturity, plant height (cm), panicle length (cm), number of tillers per hill, number of filled grains and unfilled grains per panicle, grain yield, thousand kernel weight (g), phenotypic acceptability test, disease scoring and insect pest scoring at nursery as well as at the trial during hybrid rice monitoring. Based on grain yield of genotypes, the yield advantages over the popular checks as well as best inbreed checks were determined. Among the tested rice genotypes, *viz.,* KLN-2112, KRHN-358, WR-115, S-9002, WR-116, TMRH-5750, HAPL-2244 (Gold), HH1-10, NPH-X5, PAN-2112 Gold, MR-8222, MRP-5556, S-7002, TMRH-5786, HYBRID PADDY-644, S-4003, NPH-X5-1, SRI-2244 Gold, GS Aroma King, WR-117, US-380 and US-362 had yield advantage more than 5% over Hardinath Hybrid 1 variety of rice and disease and insect scores ≥ 3 for the economically important diseases and insects and phenotypic acceptability test value >3. Hence the genotypes are found suitable for the registration provided the stability & disease & insect reactions remains same in previous succeeding year.

Keywords: Hybrid, Inbreed, Yield advantage, Phenotypic Acceptability

Theme 4: 207

Perceived Effect of IARI Wheat Varieties on Livelihood of Farmers in North Western Plain Zone and Central Zone of India

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This research sought to understand how IARI wheat cultivars enhance farmers' livelihood within India's Central Zone and North-Western Plain Zone. Conducted in 2023, the research used a multi-stage sampling method to choose 160 farmers, including 120 adopters and 40 non-adopters of IARI wheat variety. The livelihood was assessed through two key dimensions: livelihood security and livelihood assets. In order to quantify the scale values of various components of livelihood asset and livelihood securities, the normalized ranking method was implemented. Additionally, the perceived effect of IARI wheat variety on farmer's livelihood was measured using Livelihood Security Index and the Livelihood Asset Index. Results outlined that adopters of IARI wheat variety in the North Western Plain Zone, recorded mean Livelihood Security Index and Livelihood Asset Index scores of 0.81 and 0.97, respectively. The adopters in the Central Zone demonstrated slightly higher scores, with a mean Livelihood Security Index of 0.83 and a mean Livelihood Asset Index of 1.02. In contrast, non-adopters of IARI wheat variety in the North Western Plain Zone showed significantly lower scores, mean Livelihood Security Index of 0.65 and Livelihood Asset Index of 0.86. Similarly, non-adopters in the Central Zone reported mean Livelihood Security Index and Livelihood Asset Index scores of 0.65 and 0.93, respectively. Higher score of Livelihood Security Index and Livelihood Asset Index within adopters of IARI wheat varieties affirm their promising contribution to livelihood enhancement in the study area. These insights are of great value for researchers and policymakers, those who are aiming to understand the impact of crop varieties on rural livelihoods and agricultural sustainability.

Keywords: North western plain zone, Central zone, Livelihood security index, Livelihood asset index, IARI wheat varieties

Theme 4: 208

Comparative Assessment of Different IFS Models for Small and Marginal Farmers in Noney District Manipur

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The Integrated Farming System (IFS) is a cohesive strategy for sustainable agriculture in contemporary times. It is the amalgamation of several agricultural operations or activities, including crops, livestock, poultry, aquaculture, agroforestry, horticulture, vermicomposting, mushroom cultivation, and apiculture, into a singular farming system. IFS is regarded as an effective instrument for improving the profitability of agricultural systems, particularly for small and marginal farmers. The objectives of the IFS include: enhancing productivity per unit area, managing agricultural waste, promoting soil health and conservation, generating diversified year-round income, reducing chemical usage, increasing the yield of all integrated components, and ensuring food security. These ventures not only augment the farmer's revenue but also enhance family employment generation. The judicious integration of various agricultural firms enhances the socio-economic position of the farmers. ICAR KVK Tamenglong,

Manipur underscores the necessity of Integrated farming system approach in the Noney district of Manipur. Four integrated farming system models were developed and demonstrated in various land situations and ecologies of Khoupum area, Noney district: Model 1: Agri: Horti: vermicompost: Apiculture, Model 2: Horti: Fishery: Duckery: Apiculture Model 3: Agri: Horti: Mushroom Unit: vermicompost: Apiculture, Model 4; Agri: Horti: duckery and poultry unit: Fishery: Mushroom Unit: vermicompost: Apiculture. The performance in terms of component wise productivity, profitability and sustainability value index (SVI) were evaluated. The combinations of subsidiary components in Model 4; Agri: Horti: duckery and poultry unit: Fishery: Mushroom Unit: vermicompost: Apiculture in IFS model (model–4) gave the highest net returns of Rs.3,60,087/- and BC ratio of 2.93:1 whereas Model 1: Agri: Horti: vermicompost: Apiculture gave the lowest net profits of Rs. 1,34,500/- and BC ratio of 2.45:1. Based on sustainability values index (SI) derived from different IFS models, maximum SVI values were recorded in model-4 (0.679) and system economic efficiency (SEE) of Rs. 986.54/- per day whereas minimum SVI values and system economic efficiency (SEE) was obtained with model-1 with 0.052 and Rs. 368.49/- per day respectively. Therefore, the intensification of IFS model with Agriculture, Horticultural crops, duckery, poultry, fishery: mushroom, vermicompost, apiculture should be popularized among the small and marginal farmers on a larger scale, as model 4 provides higher returns of, year-round employment and sustainable livelihood in longer perspectives of Khoupum Area, Noney District Manipur.

Keywords: Integrated farming system, Net returns, Sustainable value index

Theme 4: 209

Efficacy of *Trichoderma* Species from the Mid Hills of Meghalaya Against *Sclerotinia Sclerotiorum*

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The mid-hill region of Ribhoi district in Meghalaya is predominantly dependent on an agrarian economy, with vast areas under lowland paddy cultivation. Vegetables are commonly intercropped in terraces, and citrus cultivation is practiced along the slopes of the hills. Survey conducted in the Umian circle revealed the presence of numerous beneficial soil microbiota. *Trichoderma* species were primarily isolated from agricultural lands, whereas little to no isolation was possible from grasslands or vacant areas. A total of 11 *Trichoderma* spp. isolates were obtained from agricultural soils across seven villages within the Umian circle. These isolates exhibited more than 50% antagonistic activity against the white mold pathogen *Sclerotinia sclerotiorum*. Among them, isolates UM5, UM10, and UM11 showed the highest antagonistic potential ranges from 72% to 85% of inhibition through dual culture. Biochemical test has been conducted and found Isolates UM1, UM2, UM7, UM9, and UM11 demonstrated strong hydrogen cyanide (HCN) production. All isolates tested positive for indole-3-acetic acid (IAA) production. Isolates UM1, UM3, UM5, UM7, UM9, and UM11 also produced amylase. Furthermore, all isolates showed ammonia production. Zinc solubilization, indicated by the formation of halo zones, was observed in isolates UM1, UM2, UM3, UM5, UM7, UM8, and UM11. Phosphate solubilization was observed in isolates UM3 and UM8. The various activities of *Trichoderma* isolates, including the production of enzymes, secondary metabolites, and volatile compounds, along with its ability to compete effectively for nutrients and space, help limit the growth of *Sclerotinia sclerotiorum*. Additionally, *Trichoderma* promotes plant health by producing growth-promoting compounds such as IAA, phosphate solubilization, and siderophores. These combined actions make *Trichoderma* a promising and eco-friendly biocontrol agent.

Keywords: Trichoderma, Biocontrol agent, Vegetables

Theme 4: 210

Livelihood Dependency and Living Standards of Farmers in Scheduled Area of Madhya Pradesh

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The livelihood dependency of tribal farmers has been assessed in scheduled areas of Madhya Pradesh *i.e.* Barwani district was selected randomly for the present study under externally funded project. Two types of respondents as sample *i.e.* sole farming respondents and diversified farming with allied activities respondents (tribal farmers) were selected. Opinion regarding livelihood dependency of about 80 per cent respondents of diversified farming with allied activities group and sole farming group agreed that their livelihoods were not depending on merely sole farming, whereas majority of both respondent groups agreed that livelihood depending on diversified farming with allied activities. Most of the respondents of diversified farming and allied activities group are strongly agreed about living quality standard in case of 'surviving and health indicator' and 'social reputational indicators' than respondents of sole farming group. The constraints recognized in the current study include increased expenditures on smoking or alcohol consumption, insufficient scientific understanding of agricultural practices, inadequate farming infrastructure, absence of extension or awareness programs, lack of knowledge regarding government subsidy-based initiatives, and reliance on traditional lifestyles.Recommendations suggested are raising awareness, facilitating technology transfer, enhancing infrastructure development, and addressing general needs.

Keywords: Livelihood, Living Standard, Sole farming, Diversified farming, Scheduled area

Theme 4: 211

Olericulture - A Sustainable Micro-enterprise for Livelihood of Tribal Farmers of Mokokchung, Nagaland

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Longkhum a well-known village under Mokokchung district is fondly called as the vegetable capital of Nagaland. It is located 17 km south-west of Mokokchung Headquarter at an altitude of 1846 m above sea level. The tribal farmers of this village are hard working and also known for exquisite handicrafts and handloom items. They depend largely on agriculture production for their subsistence and livelihood. In recent years the farming practice of the village have seen a paradigm shift from traditional paddy cultivation to adopting modern technologies of vegetable farming, which has open up opportunity to grow a number of different vegetable crops all year round. An approximate production of 300 MT in case of Tomato, 33 MT of Chilli, 32 MT of Potato and 71 MT of Cabbage have been recorded. Longkhum village which leads in Tomato production exports it to the neighboring district like Kohima, Wokha, Dimapur and even to the state of Assam. The present study highlights that dissemination of proven technologies on vegetable farming undertaken by Krishi Vigyan Kendra through frontline demonstrations increases the yield and income of the farmers, and that year round vegetable farming can be leverage as a sustainable micro-enterprise for their livelihood . The finding reveals that 80% of tribal farmers are involved in vegetable farming and earning their livelihood.

Keywords: Olericulture, Micro-enterprise, Livelihood, Tribal farmers

Theme 4: 212

Liver Tumor Caused by *Fasciola Hepatica* and *Dicrocoelium Dendriticum* in Goat of Jammu Region: A Study

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Hepatic distomiasis is a trematode parasitic infestation caused by *Fasciola hepatica* and *Dicrocoelium dendriticum* in human and animals. Oncogenic potential of certain parasites are reported in different period of time. The involvement of liver fluke, Dicrocoelium dendriticum, Fasciola hepatica in progression of tumor has been poorly investigated so far, but a large amount of findings suggest that other trematodes can favour cancer in both animals and humans. The present paper discussed pre-carcinogenic histologic characteristics in liver of goat, severely affected with *Dicrocoelium dendriticum* and *Fasciola hepatica*. The study of two liver sample of goat collected at slaughter house showed moderate to severe jaundice along with some nodular swelling in one case. Atypical bile duct hyperplasia, peri-cholangitis, and severe chronic chloangiohepatitis were common histological feature produced by the parasite, showing it presence in bile duct even with an aberrant localization in blood vessels observed for *D. dendriticum*. There were development of adenomatous hyperplasia and periductal fibrosis besides inflammatory cellular exudation of lymphocytes. Cholangitis and pericholangitis were more severe in the case of *Fasicola* along with prominent multinodular lobulation. Abundant fibrous connective tissue proliferation with formation of lymphoid follicle showed severe chronicity of the lesion. Adenomatous hyperplasia and cholangiofibrosis in bile duct may arise of dysplastic changes from lining cell which may get neoplastic transformation. It is concluded that long standing irritation of flukes in bile duct produce marked alteration in bile duct and may leads dysplastic transformation to neoplasia.

Keywords: Liver Tumor, Goats, Parasitic infestation

Theme 4: 213

Cultivation of Celery and Lettuce under NEFT-Hydroponics System for sustainable and higher returns

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A field study was conducted at Horticulture Farm, ICAR Research Complex for NEH Region, Umiam, Meghalaya to standardize the cultivation of leafy vegetables viz., celery (var. Giant Pascal) and lettuce (var. Giant Lettuce) under NFT-Hydroponic system. The nursery of these crops was raised in portrays using growing media (coco peat, perlite and vermiculite in 3:1:1 ratio) inside protected structure during mid of January 2024 and 25 days old seedlings were transplanted under the hydroponics system using coco peat as substrate. This hydroponic system has the capacity of accommodating 1024 total no. of plants (area 108m^2). The nursery of both the crops was transplanted in such a way that each crop occupies 50% of the total capacity of the system. Nutrient solution supplied to the hydroponic system carried all essential nutrients for leafy vegetables with pH ranging from 6.5 to 7.5 during the experiment and Electrical conductivity (EC) of 1800±100ppm. Electrical conductivity (EC) and pH of nutrient solution were checked by using potable pH Meter and EC Meter. Data were recorded randomly on 100 no.s of plants each in both the crops. In lettuce the days to harvest ranges from 21-25 days;

leaf length 16.6 to 32.7 cm; leaf breadth 11.1 to 21.8 cm; total no of leaf per plant 11.0 to 25.0; plant height 27.1 to 45.2 cm; root length 26.1 to 45.1 cm and biological yield per plant 150.8 to 171.6 g while, in celery the days to harvest ranges from 20-22 days; leaf length 8.9 to 38.9 cm; leaf breadth 10.6 to 23.5 cm; total no of leaf per plant 8.0 to 19.0; plant height 21.2 to 44.6 cm; root length 11.5 to 37.5 cm and biological yield per plant 91.8 to 118.1g. The results of the study revealed early harvest and higher biological yield as compare to the conventional system of cultivation under open conditions. Another key advantage of hydroponics technology is the efficient vertical space utilization with substantial water saving due to reuse and recycling. This technology also offers round the year production possibility despite the disparity of weather conditions.

Keywords: Celery, Lettuce, NEFT-Hydroponics System, Technology

Theme 4: 214

Green Technologies for Hill Farm Women of Himachal Pradesh

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In the ecologically sensitive hill regions of India, women are central to agricultural and household activities, often engaging in labor-intensive and environmentally embedded practices. Traditional knowledge systems, including the use of plant fibres and natural colours, represent a rich heritage of sustainable living. With growing global emphasis on eco-friendly practices, plant fibre-based and natural colour-based green technologies offer promising avenues for sustainable livelihoods. These technologies not only reduce environmental degradation but also add value to local resources, enabling hill farm women to generate income through artisanal and eco-conscious products. This paper explores the development and dissemination of green technologies, to hill farm women with a focus on their potential for socio-economic empowerment and ecological sustainability. Himachal has a rich heritage of natural plant fibres like *Biul* (*Grewia optiva*) and *Ram-ban* (*Agave cantula*) for fibre extraction of fibre and product development. These plant fibres can be utilized for the development of handicrafts as well as woven enterprise by improving their texture and quality. Different steps including fibre collection, retting (water and mechanical), scouring, bleaching are beeing carried out before value added product development. Natural colourants obtained from leaves, barberries roots, beet roots, rhododendron flowers, myrobalan etc. with natural base / powder can be utilized for preparation of eco *gulals* as its preparation methodology, tools and processing were found women friendly. Cotton, wool and silk fabric can be dyed using natural dye sources viz Litchi (*Litchi chinensis*), Kali basunti (*Eupatorium adenophorum*) leaves, Lumb (*Biden pilosa*) whole plant and Kasmal (*Indian barberries*) roots to develop value added products. Trainings and hands on demonstrations were imparted to hill farm women. Women gained profiency in extracting plant fibres and colour extraction methods from local sources and its use in product development. Overall gain in knowledge and confidence was observed. The integration of plant fibre and natural dye-based green technologies holds significant potential for empowering hill farm women by combining traditional knowledge with sustainable innovation. These eco-friendly practices not only promote environmental stewardship but also open pathways for income generation, skill development, and cultural preservation. By reducing dependence on synthetic materials and promoting the use of locally available resources, these technologies support a circular economy that benefits both communities and ecosystems. For long-term impact, it is essential to ensure access to training, market linkages, and institutional support, enabling women to become key agents of green entrepreneurship and rural resilience in hill regions.

Keywords: Green technologies, Plant fibre, Natural colour, Entrepreneurship

Theme 4: 215

Conservation Agriculture in North-Eastern Hill Region of India: Advancing Food Security and Climate Resilience

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The North-Eastern Hill Region (NEHR) of India, with its diverse agro-climatic conditions and complex topography, is highly susceptible to land degradation, soil erosion, and declining agricultural productivity. Conventional farming practices, such as mono cropping and slash-and-burn agriculture, further exacerbate soil depletion, poor water retention, and reduced crop yields. To address these issues and enhance food security, Conservation Agriculture (CA) offers a promising solution. CA, emphasizing minimal soil disturbance, residue retention, crop diversification, and no-till farming, has demonstrated significant potential in improving soil health, water conservation, and overall productivity in hill ecosystems. In the NEHR, CA-based strategies, such as contour cultivation, hedgerow planting, and agroforestry, are essential for conserving natural resources and promoting sustainable agricultural practices. CA benefits include increased soil organic carbon, improved water retention, and enhanced nutrient availability, leading to a 10-50% increase in crop yields. No-till systems, in particular, conserve soil moisture and improve soil aggregation. Additionally, integrated farming systems, such as agro-horti-silvi-pastoral models, promote resource use efficiency, biodiversity, and farm income. However, CA adoption in the NEHR remains limited due to challenges such as inadequate machinery (especially lightweight tools for hilly terrains), low farmer awareness of CA principles, and socio-economic constraints like poor infrastructure, limited market access, and reliance on traditional practices. Overcoming these barriers requires region-specific strategies, including targeted research, farmer education, and policy support. Promoting CA in the NEHR can significantly enhance food security, resilience to climate change, and the long-term sustainability of farming systems. A holistic approach, combining scientific research, practical demonstrations, and institutional support, is essential for the widespread adoption of CA, ultimately contributing to the achievement of sustainable development goals like zero hunger and environmental conservation.

Keywords: Climate resilience, Conservation agriculture, Food security, Hill ecosystem, Resource conservation

Theme 4: 216

Role of Plastics Mulch Tecnology in Horticulture Based Farming System for Improving Socio-Economic Status of Hill Women: A Case Study

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India ranks as the second-largest producer of vegetables globally; however, its production and productivity levels remain significantly low, largely attributed to unpredictable climatic conditions. Consequently, even required 300g per capita per day vegetable is not available. High yielding hybrid varieties of vegetables and protected cultivation technologies have shown great potential in different climatic conditions. However, such findings are very scanty in plain conditions of India. Therefore, present experiment was conducted on the farming in hills suffers from scattered traced land, erratic climate, rainfed conditions. Majority of (75%) male migrate from hills to metro city in search of employment. Therefore, the hill farming is largely dependent on women. Women are also involved in other responsibilities, as a house wife, mother, farming and social activities, with all these

commitments, women workers are very hard pressed which affect their health. Therefore, there is an urgent need for women friendly technologies which could save their time and energy. To alleviate the situation, we conducted 20 trials/FLDs on plastics mulch technology (UV stabilized 40-50 micron thick black colour) for off-season high value vegetable crops (Solanaceae, Cole group and Cucurbits) and compared with traditional farming system at different village level during 2006-2009 at Champawat district of Uttarakhand through Research and Extension Center (KVK), Lohaghat under the administrative control of GBPUA&T, Pantnagar. All GAP, INM, IPM protocols were used under study and it revealed that plastics mulch technology saved 90% time of labour spent on weeding, 25% fertilizer, 50% irrigation/water or moisture losses through evapo-transpiration, 50% soil fertility erosion, 50% expenditures, 60% crop mortality. This technology has enhanced 50% more qualitative yield and return per unit area per unit time as compared to traditional farming methods during all the years. Mulching technology also saved forest pruning ensuring environment security, risk of life hazard, time and money. Plastics mulch technology as compared to traditional farming save 50% time of women farmers which they can utilize in other activities. Mulching technology, a part of protected technology was found to be very cost effective (Rs.5/m^2), easy adoptable in field. This technology can play a key-role in organic mode of vegetable production, drudgery reduction, and livelihood security of women in hills. This is a proven technology especially for hills easy to adopt where limited resources of man power is available for agricultural operations and it give a higher return in many of horticultural crops under small land holding for poor resource woman farmer community.

Keywords: Plastics mulch technology, Horticulture hill women

Theme 4: 217
Multi-objective Model for Optimization of Integrated Farming System

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Agricultural farming systems in North East India is subsistence in nature characterized by limited use of external inputs, use of traditional methods, local varieties and lack of proper farm planning and management, which results in low productivity. Resource poor farmers in the region follow some form of integrated farming in the sense that they usually have farms with mono cropping of rice or maize, a kitchen garden in their homestead for vegetables along with few livestock or poultry. Nevertheless, due to insufficient planning, farmers do not achieve optimal performance concerning their agricultural goals, which include maximizing net income, minimizing costs, enhancing crop diversity, and reducing soil degradation. The farmers are faced with a complex situation where they need to make decisions which will optimize these conflicting objectives and reap the whole benefits of Integrated farming system in all its essence. The present study aims to solve this problem by using Compromise Programming, a variant of linear programming, which will give a set of solutions closest to the ideal point. The model will capture the farmer's resource availability, farm efficiency, enterprise preference and multiple farming objectives. The present study provided an optimized plan for a farm of 0.3 ha, which followed integrated farming with 8 numbers of crop components cultivated throughout the year and animal component including cattle, pig and poultry. The objectives of the farm were more income, more food security and minimization of soil loss. The proposed model revealed a compromise solution which demonstrated 434% increase in net income, 0.0005% decrease in food energy production and reduction of soil loss by 11%. The optimized plan may be potentially used for a farm with similar size, topography and resources for increased income and food security and a minimum soil loss.

Keywords: Multi-objective Model, Farmers, Optimization, Integrated Farming System

Theme 4: 218

Digitally Driven Livelihood Resilience: Evaluating the Socio-ecological Impact of the PM-KISAN Scheme

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Digital financial platforms are playing an increasingly transformative role in enhancing agricultural resilience and promoting sustainable livelihoods. The Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme launched in 2019, indicates India's efforts to harness digital tools for direct income support to farmers. By transferring Rs. 6000 annually in three equal installments to eligible farmers through Direct Benefit Transfers (DBT), the scheme has disbursed over Rs. 2.8 lakh crore to more than 11 crore farmers as of early 2024. This study examines how PM-KISAN functions not just as an income supplement, but as a catalyst for environmentally sustainable and climate-resilient agriculture. According to the NITI Aayog (2021), over 75% of beneficiaries used the funds for agricultural inputs and nearly 60% reported improved capacity to manage climate-related risks. Reports also show a 22% increase in access to formal credit among PM-KISAN recipients reduced dependence on informal lending and enabling investment in longer-term ecological practices such as crop diversification, water-saving techniques and organic inputs. However the program also highlights the digital divide: nearly 30% of eligible farmers face challenges in accessing benefits due to lack of digital literacy, Aadhaar linkage issues or banking infrastructure gaps. Furthermore, the integration of PM-KISAN with complementary programs such as the Soil Health Card Scheme and Paramparagat Krishi Vikas Yojana (PKVY) remains limited in practice. This study argues that when paired with digital education, ecosystem-based policies and multi-stakeholder collaboration, scheme like PM-KISAN can move beyond welfare to become engines of socio-ecological transformation.

Keywords: Direct Benefit Transfer (DBT), Sustainable agriculture, Livelihood resilience, Social ecology

Theme 4: 219

Assessing the Effectiveness of Seed Hub Project in Enhancing Quality Seed Production in Lalitpur District

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To ensure the availability of location-specific high-yielding varieties and quality seeds, pulse seed hub program was sanctioned to Krishi Vigyan Kendra, Lalitpur, Uttar Pradesh in 2016-2017. With the active participation of the farmers via buy back policy, KVK successfully procured 1120.8 quintals of Fieldpea, 281.16 quintals of chickpea, 59.44 quintals of Blackgram, Greengram 51.34 quintals and 19.4 quintals of Lentil during the period of 2018-19 to 2021-22. This resulted in the production of 1532 quintals of seed, covering 2083.5 ha. of land in the district. Buy-back agreements were signed between KVK and the farmers for their participation in the project. Selected farmers received training in good agronomic practices. Over the course of four years, the seed hub program generated a gross profit of INR 6628627.25 and a net profit of INR 3614893 for KVK. Profits from seed sales were reinvested into building additional facilities to enhance the seed production program. The buy-back policy has significantly improved the socio-economic status of the participating farmers compared to traditional cultivation methods.

Keywords: Seed hub, Quality seed, Participatory seed production and Pulses

Theme 4: 220

Organic- and Natural Farming Performance under Sikkim Mid Hill Ecosystem: A Long-term Experimental Experience

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Under natural farming systems, significantly higher yields were recorded with the application of 100% nitrogen (N) equivalent through organics across multiple cropping systems. In the Maize + Ginger – French bean system, maize yield (3.30 t/ha) and maximum ginger (7.03 t/ha) and French bean (6.16 t/ha) yields were observed under 100% N organic application, outperforming farmer practices and lower N levels. The highest maize equivalent yield (MEY) of 13.42 t/ha was also noted under this treatment. Similarly, in the soybean cropping system, 100% N through organics resulted in a significantly higher yield (1.83 t/ha) compared to farmer practices. Buckwheat also showed superior performance (1.70 t/ha) with 100% organic N. In the Maize + Turmeric – Rajmash system, highest yields of maize (3.32 t/ha), turmeric (13.16 t/ha), and rajmash (1.80 t/ha) were achieved with 100% N through organics. In the Maize – Blackgram – Toria system, 100% N organic application yielded the highest maize (3.16 t/ha), pahenlo dal (1.00 t/ha), and toria (1.16 t/ha), with an MEY of 9.32 t/ha. Intercropping trials showed that the AI-NPOF package (T3) led to the highest yields in soybean + maize (26.50 q/ha) and vegetable pea + coriander (72.98 q/ha), followed by complete natural farming (T2). Overall, 100% N equivalent through organics consistently outperformed other nutrient sources, supporting its effectiveness in natural farming systems.

Keywords: Organic farming, Natural farming, Sikkim, Soil, Manure, Maize, Soybean

Theme 4: 221

Effect of Different Strains of Rhizobacteria on the Growth Performance of Chickpea (*Cicer Arietinum* L.) and Nutrient Uptake

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This research was carried out to evaluate the effects of combined inoculation with plant growth-promoting rhizobacteria from two genera including Azotobacter and Rhizobacteria on nutrient uptake, growth and yield of chickpea plants under field conditions. Nodulation and nutrient concentration in shoots were significantly affected by the treatments at the beginning of flowering stage. The maximum of root nodules, plant height, was recorded by applying the combined seed inoculation with Azotobacter and Rhizobium. All inoculants were statistically superior over inoculated control with respect to nitrogen concentration of shoots. The treatments containing Azotobacter +Iron and Boron significantly improved phosphorus concentration in shoots. Grain yield, biomass dry weight and nitrogen & phosphorus uptake of grains were statistically improved by applying every inoculation treatment in comparison with control plants. Group comparisons between treatments showed that the occurrence of (T_6RDF 100%+ Azotobacter+Iron0.25%+Boron0.5%) inoculants in the treatment composition caused an expressive improvement in grain yield and plant biomass. In conclusion, application of very inoculation treatment studied here, especially treatments which contained Azotobacter may stimulate growth and yield of chickpea as compared with uninoculated plants.

Keyword: Rhizobacteria, Azotobacter, Biofertilizer, Iron, Boron

Theme 5: 222

Impact of MOVCD-NER on Livelihood Enhancement in Agriculture in North East India

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The Mission Organic Value Chain Development for North Eastern Region (MOVCD-NER) is a strategic initiative launched by the government of India in 2015-16 to promote organic farming and enhance agricultural value chains in the North Eastern Region (NER) of the country. The implementation of MOVCD-NER has significantly improved the economic well-being of farmers in North East India. MOVCD-NER promotes diversification of agricultural activities, which reduces dependence on a single crop and spreads risk. Previous studies have found that by providing training, certification, and marketing support, MOVCD-NER has empowered small and marginal farmers to adopt organic farming practices and integrate into the value chain. The scheme has provided women with opportunities to participate in organic farming, value chain development, and entrepreneurship, thereby enhancing their economic and social status. The scheme has contributed to the improvement of livelihoods and food security in the North East, where food security is a significant challenge due to the region's rugged terrain and limited infrastructure. The scheme has also encouraged collective action among farmers, with many forming producer groups and self-help organizations to manage the value chain. By promoting organic farming, enhancing market access, and empowering rural women, the scheme has contributed to the improvement of rural livelihoods and food security. However, challenges such as limited market access, high initial investment, and lack of awareness need to be addressed to fully realize the potential of the scheme. Overall, MOVCD-NER has played a crucial role in promoting sustainable agriculture and enhancing the socio-economic well-being of farming communities in North East India.

Keywords: MOVCD-NER, Livelihood, Value chain, Organic farming, Food security

Theme 5: 223

Front Line Demonstration on Rabi Maize: An Effective Approach for Increasing Productivity and Profitability of Tribal Farmers of Pratapgarh in Rajasthan

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Maize is an important staple food of the tribal district of Pratapgarh in Rajasthan. Farmers can obtain higher yield and returns in rabi maize than kharif maize. Lack of suitable high yielding varieties as well as poor knowledge about rabi maize production practices are ascribed as main reasons for low productivity of maize in the district. Front line demonstration is an effective and appropriate tool to demonstrate recommended technologies to the farmers. To popularize rabi maize production, Krishi Vigyan Kendra, Pratapgarh conducted 350 demonstrations on rabi maize from 2019-20 to 2023-24 in five adopted villages. The critical inputs were identified in existing production technology through meetings and group discussions with the farmers. The five years data revealed that an average yield of demonstration plot was obtained 67.30 q/ha over local check (58.65 q/ha) with an additional yield of 8.65 q/ha and average productivity increased by 14.75%. The average technology gap and technology index were observed 16.70 q/ha and 19.88%, respectively.

Keywords: Rabi maize, Front line demonstration, Technology gap, Technology index

Theme 5: 224

Economic and Rural Impact of Agro-processing Centers in Punjab

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Post-harvest losses in India range from 4.58% to 15.88%, mainly due to improper harvesting, handling, transportation, and storage. Agro-processing plays a crucial role in reducing these losses by transforming raw agricultural produce into value-added products. While processing levels are high for paddy (92%) and wheat (78%), they remain moderate for oilseeds (49%) and meat (34%) and significantly lower for milk (21%), fruits (4%), and vegetables (3%). The organized sector dominates processing, leaving significant potential for the unorganized sector, especially at the farm level. Agro-Processing Centers (APCs) address this gap by providing primary and secondary processing, storage, and handling facilities at production catchment areas on a rental or service basis. These centers contribute to reducing post-harvest losses, increasing farmer incomes, generating employment, and fostering rural economic growth. ICAR-CIPHET, through its All India Co-ordinated Research Project on Post-harvest Engineering and Technology, has established around 300 APCs across India, out of which 82 are in Punjab. An assessment of the impact of APCs in Punjab estimates that each center generates a net annual return of Rs. 5.47 lakh while providing employment opportunities for five individuals. Additionally, projections indicate that the establishment of APCs could contribute an additional Rs. 538.58 crore per year to the state's agricultural sector, emphasizing their significant role in enhancing economic sustainability, rural livelihoods, and overall agricultural development.

Keywords: Post-harvest losses, Agro-processing centers, Value addition, Rural economic growth

Theme 5: 225

Role of FPO in Agriculture Marketing and Livelihood of Farming Community

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Farmer Producer Organizations (FPOs) play a crucial role in agricultural marketing by facilitating access to markets, reducing transaction costs, and enabling farmers to realize better prices for their produce, ultimately boosting their income and promoting sustainable farming practices. In Bhilwara district, MEEV Kisan Bazar Farmers Producer Organization Limited developed by Krishi Vigyan Kendra Bhilwara in Kotri and Suwana block. In which 750 Farmers and Farm women registered as member, Directors and CEO. The activities of above FPO like capacity building of farmers, value addition and processing of oilseed crops (Mustard and Groundnut). Besides this, almost 70 domestic products ready for consumers. The FPO helps directly farmers regarding improved seed and cattle feed on suitable cost. The turnover of FPO is Rs. 70 to 75 lacs per year. This FPO is role model of farming community due to timely purchase of agriculture input of farmers on minimum support price at farmers door and also it saves the time and labour of farming community. This FPO working on market access and linkages, reducing transaction costs, value addition and processing, supply of quality inputs, capacity building and training, promoting sustainable practices, enhancing income and socio-economic development etc.

Keywords: FPO, Livelihood, Marketing and Agriculture

Theme 5: 226

Harnessing the Potential of Underutilized Star Gooseberry through Value Addition in Churachandpur District, Manipur

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The star gooseberry *(Phyllanthus acidus*), plentiful in Churachandpur district, Manipur, is underutilised due to its three-day shelf life and low public awareness of its economic and nutritional importance. Though rich in antioxidants and therapeutic characteristics, this pale-yellow tropical fruit is generally wasted. ICAR-KVK Churachandpur started value-added training-cum-demonstration programs to help local farmers make sweets, pickles, and RTS drinks from the fruit. Value addition has transformed candy and pickle shelf life to 365 and 550 days, respectively, and increased the benefit-cost (BC) ratio to 2.8 and 2.4 from 1.3 for fresh fruit. These initiatives can boost farmers' revenue by about Rs. 8,500 every season, improving their livelihoods and minimising post-harvest losses. Processed star gooseberry goods can reach more markets, boosting the rural economy and encouraging women and youth entrepreneurship. This project promotes income generation, sustainable agriculture, and food security. Strategic processing of star gooseberry's nutritional and therapeutic potential can improve local health and nutrition while empowering the economy. By raising awareness, developing skills, and connecting markets, star gooseberry can become a viable crop. The Churachandpur model can be replicated elsewhere, encouraging government, entrepreneurs, and farmers to explore this unique fruit's possibilities.

Keywords: Star gooseberry, Livelihood, Value Addition

Theme 5: 227

Role of Farmer Producer Organizations in Strengthening Tribal Millet Farmers

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The socio-economic development of tribal millet farmers in India has historically been hindered by low productivity, poor market access and limited institutional support. This study examines the role of Farmer Producer Organizations (FPOs) in improving the annual income of tribal millet farmers in Chhindwara district, Madhya Pradesh. Focusing on the Patalkot Farmers Producer Company Limited in Tamia block, the research investigates income differences between FPO member farmers and non-members. A total of 110 respondents comprising 55 members and 55 non-members millet farmers were selected through a random sampling method. The findings revealed that member farmers experienced significant increases in annual income due to collective marketing, access to quality inputs, better price realization and reduced dependence on intermediaries. FPO membership also contributed to enhanced knowledge of scientific farming practices, improved value addition through processing support and greater economic resilience. The study highlights the pivotal role of FPOs in strengthening the economic foundation of tribal farmers by fostering collective action, promoting entrepreneurship and supporting sustainable agriculture. The insights generated offer valuable inputs for policymakers, NGOs and development agencies working to enhance rural incomes through farmer collectivization, especially among marginalized tribal communities cultivating climate-resilient and nutritious crops like millets.

Keywords: Tribal millet farmers, Farmer producer organization (FPO) and sustainable agriculture

Theme 5: 228

A Critical Assessment of the Sustainability Trajectory of Farmer Producer Companies

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Agriculture in many Asian countries, including India and China, is predominantly driven by smallholder farmers. To commercialize these small farms and enhance their incomes, Farmer Producer Companies (FPCs)-a specialized form of Farmer Producer Organizations (FPOs)-have emerged in India as collective institutions. This study critically examines how members perceive the sustainability of their FPCs and identifies the key factors influencing it. The present study was conducted in eight FPCs across Bihar, where over 97% of farmers are smallholders. The selected FPCs represented different stages of functioning: Nascent Stage (1–3 years), Growth Stage (3–5 years), and Mature Stage (over 5 years). A total of 320 member-farmers were surveyed using an interview schedule. Additionally, the sustainability of FPCs was indexed based on member perceptions across six dimensions: growth, business planning and outlook, governance and management, value and credibility, brand and promotion, and collaboration and innovation. Multivariate analyses were employed to explore how member and organizational attributes influenced sustainability. Multiple regression analysis revealed the direct impact of various variables, while path analysis uncovered indirect and intermediary effects. The findings indicate that older and more diversified FPCs were perceived as more sustainable and effective across all organizational parameters compared to newer FPCs or those focused on a single commodity, especially food grains. Path analysis revealed that multiple attributes impact FPO sustainability through both direct and indirect pathways. The variables like group dynamics, functional efficiency, and members' satisfaction directly affected FPC's sustainability, while members' empowerment, attitude, and progressiveness caused an indirect effect on it. Government intervention and support are crucial, particularly during various stages of FPC development, to strengthen internal capacity and member-centric processes. This can enable FPCs to progress toward sustainability and enhance the profitability of smallholder farmers.

Keywords: Farmer Producer Companies (FPCs), Sustainability dimensions, Multivariate analyses

Theme 5: 229

Impact of E-commerce on Agricultural Marketing in India

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E-commerce in India has significantly transformed the agricultural marketing sector. This paper aims to explore the impact of e-commerce in the realm of agricultural markets, along with focusing on the role of digital platforms in shaping traditional practices, enhancing access to markets and improving efficiency. A wide number of farmers, traders and consumers are adopting online platforms to reduce the involvement of intermediaries in the transaction process and facilitate direct transfer between the producers and the consumers. It is benefiting the small-scale farmers by providing them with a broader market and a better price for their produce. The information, such as where to sell, when to sell, how to sell and at what price to sell, has become easy and handy.

This paper highlights the use of digital marketing tools such as social media platforms and mobile apps by farmers and traders for expanding their outreach in the national and global markets. Furthermore, it also highlights the role of technology in the form of digital payment systems and data analytics for enhancing market efficiency in the delivery of produce from farms to consumers, thereby improving incomes. Keeping in mind that there are always two sides to a coin, the disadvantages have also been dealt with in this paper. The challenges and limitations that are faced by farmers in terms of efficient procedures are also addressed. The dire need of digital literacy, robust and inclusive infrastructure for ensuring trustworthy and transparent online transactions has been highlighted. The paper concludes with suggestions, policy recommendations and strategies required to enhance the integration of e-commerce in the agricultural marketing sector. The study emphasises fostering collaboration between the government and e-commerce platforms for their effective contribution in strengthening rural development and economic growth, with the aim of providing a safe and sustainable digital marketplace to the farmers of our country.

Keywords: e-commerce, Agricultural marketing, Digital platforms, Farmers, Market access, Rural development

Theme 5: 230

Vegetables Processing in India: Progress, Problems and Prospects

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India is the second largest producer of vegetables, but its vegetable processing industry is still in its nascent stages, with only about 2% of produce being processed. India processes a diverse range of vegetables including root vegetables *viz.*, potatoes (dried frozen or preserved), onions (preserved, picked or dehydrated or garlic (dehydrated powder, flakes or dried); leafy greens and crucifers including cabbage, cauliflower and asparagus (dehydrated or frozen); mushrooms and legumes including button mushrooms, oyster mushrooms, green peas (frozen or dehydrated) and grams (split or whole) and other vegetables like sweet corn (frozen or canned), cucumber and gherkins (preserved or pickled), green pepper (in brine). In spite of being second largest potato producer, India processes only 7% of potato produce. The potato processing industry offers a wide range of products including frozen products (french fries, frozen potato variants), dehydrated products (Potato flakes, powder granules and flour) and processed snacks (Potato chips, wafers and other savory snacks). Indian tomato processing market reached $ 1400.2 million in 2024 and is expected to grow at a CAGR of 5.14% to $ 2250.7 million by 2033. About 20% of tomato production is processed into products like tomato paste, puree, ketchup and sauces. India's green pea processing industry primarily focuses on frozen green peas. Jackfruit is processed into canned jackfruit, frozen jackfruit, jackfruit powder, jackfruit chips, jams, flour, juice and ready-to-eat meals. India exported 163222.63 MT of processed vegetables, worth Rs. 199219.57 lakh during 2023-24. Although there exists a vast potential for vegetables processing industry in India, there are certain constraints too which hamper the growth of this industry. But despite bottlenecks, future of vegetables processing industry appears to be bright. Vegetables cultivation being labour intensive is more suitable for states like Bihar, West Bengal, Odisha, eastern Uttar Pradesh and other parts of the country where land holding size is very small with rampant rural unemployment. The Govt. has taken an initiative through *Pradhan Mantri Kisan Sapada Yojana* to promote the vegetables processing industry. With abundant raw materials and right policies, the industry is poised for growth, driven by increasing demand for processed foods.

Keywords: Industry, Processed Foods, Prospects, Vegetable processing

Theme 5: 231

Construction of An Attitude Scale for Members of the Farmer Producer Organization (FPO) in Jammu and Kashmir

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Farmers Producer Organizations (FPOs) have emerged as a critical institutional innovation in Indian agriculture aimed at empowering small and marginal farmers through collective action. As per the Ministry of Agriculture and Farmers Welfare, over 10,000 FPOs have been registered across India under various schemes, including the Central Sector Scheme launched in 2020, which aims to promote and support 10,000 new FPOs by 2027. These organizations are intended to enhance farmers' income, reduce dependence on middlemen, improve access to markets, and facilitate input and credit support. Understanding farmers' attitudes toward FPOs is essential for evaluating their effectiveness and encouraging wider participation. An attitude is a personal disposition common to individuals, but possessed to different degrees, which implies them to react to objects, situations or propositions in ways that can be called favourable or unfavourable. To measure the attitude of farmers towards Farmers Producer Organizations (FPOs) in Jammu and Kashmir, a Likert-type summated rating scale was developed, following the methodology proposed by Likert (1932) and Edwards (1957). Initially, 50 statements were generated and evaluated by the subject matter experts. Based on their responses, the Content Validity Ratio (CVR) was calculated, resulting in the retention of 31 statements. These statements were then administered to farmers from non-sampled areas, and t-values were computed. Statements with a t-value greater than or equal to 1.75 were retained, leading to a final pool of 25 items, comprising 19 positive and 6 negative statements. The reliability of the scale was assessed using Cronbach's Alpha, which yielded a coefficient of 0.70, indicating an acceptable level of internal consistency. The scale was specifically constructed for farmers in Jammu and Kashmir who are members of FPOs. Overall, the developed scale was found to be both valid and reliable for assessing farmers' attitudes toward FPOs.

Keywords: Farmer producer organizations, Income, Markets, Attitude

Theme 5: 232

Importance of Value Added Products of Jaggery for Income Enhancement

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India has emerged as a major producer, leading trader and exporter of jaggery. The importance of jaggery has been well defined in the *Ayurveda* and is also well understood by the millions of people. The practice of consuming jaggery daily, definitely draws its principle from the concept of prebiotics. In this paper, efforts have been made to discuss various value added products of jaggery, developed at ISRI, Lucknow. Jaggery is very nutritious substance, containing fair amount of calcium, magnesium, phosphorus, sodium, iron, manganese, zinc, chloride and copper. Though jaggery itself is rich in natural nutrients of sugarcane juice, but combination of jaggery with various spices and condiments enhances market value of the product. Jaggery added with spices and dry fruits being sold as sweets at premium prices. When the slurry of jaggery is boiled and is in semisolid form, just before pouring into moulds, several beneficial ingredients like spices and condiments can be added for improving nutritional & medicinal properties and taste of jaggery. Efforts have been made at ICAR-Indian Sugarcane Research Institute to prepare various value added products. Several value-added products of jaggery have been prepared by adding dried ginger powder, black pepper, nigella seeds, sesame seed, turmeric powder, carom seeds, etc. Jaggery chocolate developed under AICRP on Jaggery Scheme shows great market potential. Jaggery can also be used in making bakery products, confectionary and beverages. Apart from commonly available soild jaggery, jaggery is also produced in granular and liquid form, which have the additional advantage of using for making food recipes without making any change in form along with better storability and longer shelf life. These value added products of jaggery fetches higher prices and are helpful in enhancing the income of jaggery entrepreneurs, in spite of improving overall health of millions of jaggery consumers.

Keywords: Jaggery, Sugarcane, Value added products, Entrepreneurs

Theme 5: 233

Performance Analysis of Cauliflower Hybrids under Actual Field Condition of Jammu Division of J&K (UT)

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Cauliflower is one of the most important vegetables grown nationwide, contributing to nutritional benefits and economic returns for farmers. Currently, India ranks as the second-largest global producer and exporter of cauliflower, trailing only China. In India, the Union Territory of Jammu and Kashmir (J&K) stands out for its exceptional cauliflower productivity, reaching 31t/ha, surpassing both the national average (19.2t/ha) and other states. Keeping in view the highest productivity of cauliflower crop in J&K (UT), a descriptive study was conducted in the Jammu division of J&K (UT) in the year 2020-21, to ascertain the performance of various cauliflower hybrids under actual field conditions. The study employed a multistage sampling design, selecting 160 cauliflower growers and a pre-tested interview schedule was used for the data collection. Statistical techniques such as percentage, arithmetic mean, standard deviation, multiple regression and ANOVA were used to analyze the data. The findings indicate that farmers in the study area adopted non-conventional types of cauliflower hybrids, which are not in any institutional recommendations, namely Girja, Maharani, Garima, White Excel and other hybrids. Among these, Garima emerged as the leading hybrid with the highest average productivity of 466 q/ha. The proper application and adoption of production and protection technologies, such as FYM and herbicide application in nursery, FYM application in main field and the application of Nitrogen, Potassium and Pesticides in the main field significantly influenced the productivity of Girja, Maharani, Garima and White Excel cauliflower hybrids with R^2 value of 0.206, 0.243, 0.473 and 0.755, respectively. This clearly highlights the gap between the recommendations provided by agricultural universities and departments and the actual practices being adopted by farmers at the grassroots level. This underscores the need to strengthen research-extension-farmer linkages, thereby enhancing the effectiveness of extension services to bridge this critical gap.

Keywords: Cauliflower hybrids, Productivity, Extension gap, Adoption, Cauliflower performance

Theme 5: 234
Strengthening Agricultural Extension through Effective Policy Frameworks

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Training needs for extension functionaries can be defined in terms of the gap between job requirements and job performance. A training need is the shortage of skills and abilities which could be reduced by education and development. Lack of knowledge at the level of extension functionaries may affect directly or indirectly the empowerment of the farmers. It is not necessary that the entire client may have a common need for learning and trainings. The trainings of the extension functionaries vary from individual to individual, crop to crop, agro climatic zones and also changes from time to time due to rapid changes in technology and information delivery systems. The approach of training needs assessment will help specialists and human resource development personnel in targeting the critical needs of training in relation to the subject matter topics, professional development and technology. Such a proactive approach to in-service training will enhance the abilities of the extension functionaries to do their job and keep them up to date. It also helps to identify present problems and future challenges to be met through capacity building. Training is one of the effective and tested tools for performance enhancement, as well as up upgradation of knowledge and skills of the personnel. Increased knowledge and skill make the employees more productive in their workplace and thus more valuable to the organization. The ability of extension functionaries to guide farmers from the awareness stage to sustained adoption of agriculture and horticulture innovations depends on their trainings, experience and skills using extension methods. Thus, training needs identification is the first and most important task of the steps and process that must be performed before the beginning of training. Hence, training needs assessment is based on the requirements of the client system, vital for designing the training programmes.

Keywords: Training needs, Human resource development, Knowledge and skill

Theme 5: 235
Sustainability of Farmer Producer Organizations (FPOs) in North East Hill Region of India: a SWOT Analysis

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Farmer Producer Organizations (FPOs) serve as a gateway for improving the livelihoods of small and marginal farmers in India. The North East Hill Region of India is dominated by small and marginal farmers (80%) with vulnerable agricultural production systems as a principal force, which has deteriorated the livelihood of the farmers. In spite of these challenges, the region is considered as the Region possess numerous opportunities with a diverse range of fruits, vegetables, plantation crops, aromatic and medicinal plants and many high value distinct crops, some of which have received the Geographical Indication tag. Collectivisation of these farmers into FPOs is deemed to be one of the best approaches for improving their livelihood. FPOs play a crucial role in providing core services like input supply, marketing, technical, and financial support, as well as auxiliary services such as social capital and consultancy, which are linked to better and sustainable farm income for the member farmers. At present, there are more than 750 FPOs in the region. Through an extensive review of

available literatures, an attempt is being made to carry out SWOT analysis of the FPOs exploring its capacity to sustain itself and the livelihood of member farmers, The review highlights current strength, challenges, opportunities and threat within the FPO system. The abundance of forest and mineral resources are great strength, and lack of a sound transportation and communication system is a foremost weakness of this region. As nearly 98 percent of the border of NE region is covered by foreign countries, this region has great opportunity of border trade. The findings offer valuable insights into the transformative potential of FPOs and inform strategic policy recommendations to ensure their sustainability in North East Hill Region agricultural sector.

Keywords: Farmers, Farmer producer organization, Market, NEH region, SWOT analysis

Theme 5: 236

Marketing Practices and Problems Faced by Flower Growers of Punjab

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Flower cultivation is the fastest-growing enterprise in agriculture, and flower production is ceaseless to blossom in the Indian context. Area under flower crops in India during the year 2020-21 is 3.22 lakh ha with production of 21.52 lakh mt loose flowers & 8.28 lakh mt cut flowers. The present study was planned to analyse the marketing pattern and problems faced by flower growers in Punjab state. Being the prominent crops, gladiolus and marigold were purposively selected for the present study. From the list of flower growers of the Punjab state, 40 farmers cultivating each flower crop were selected through a simple random sampling technique. Data were collected from 80 respondents with the help of a structured interview schedule. The findings revealed that the majority of respondents belonged to the age group of 36–50, studied up to secondary, belonged to the nuclear families, had operational land holding of 2-4 hectares and had 12-19 years of farming experience. Study further revealed that flower growers adopted a three-stage marketing channel (Producer → Wholesaler → Retailer → Consumer) before reaching to consumer. Most of them marketed their produce to other districts, and only 23.75 per cent of respondents market the flowers outside the Punjab. It was also found that wholesalers were the major source of market information for the marigold as well as the gladiolus flower growers. The majority of the flower growers faced problems of insect and pest, high input and labour cost, storage problems and lack of advanced flower cultivation techniques and post-harvest technology. Marketing problems with a mean score of 60.75 were the leading impediments in flower cultivation.

Keywords: Adoption, Marketing, Problems, Flower cultivation

Theme 5: 237

Empowering Farmers Through Agro-processing: A Study on Status, Challenges, and Opportunities for FPOs in North India

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Farmer Producer Organizations (FPOs) have emerged as a key strategy to improve market access, reduce transaction costs, and promote value addition for smallholder farmers in India. In North India, despite a significant number of FPOs being registered under various schemes, their role in agro-processing and marketing remains inadequately documented and underleveraged. This study was undertaken to assess the status and

performance of FPOs engaged in agro-processing and marketing in North Indian states, using exclusively secondary data from sources such as NABARD, SFAC, Ministry of Agriculture, State Agriculture Departments, and evaluation reports from implementing agencies. Descriptive statistical tools were used to analyze the status of the FPOs, their engagement in value chain activities, processing infrastructure and market linkages. The analysis revealed that out of approximately 3,400 FPOs registered in North India by 2023, less than 30% are actively involved in agro-processing. Uttar Pradesh, with over 1,100 FPOs, shows only 22% engaged in processing and marketing functions. Factors contributing to this include limited access to formal credit, poor processing infrastructure, and insufficient exposure to marketing channels. Additionally, women's participation remains below 10% in board representation and enterprise leadership, indicating gender exclusion in FPO governance. The study recommends the promotion of cluster-based processing units aligned with local cropping patterns, easing credit access through targeted subventions under AIF and NABARD refinance schemes, strengthening market intelligence and digital platforms for FPOs, and mainstreaming women-centric FPOs with dedicated support under NRLM and PMFME. These measures are essential to enhance the viability and inclusivity of FPOs as drivers of rural agro-industrial growth in North India.

Keywords: Value addition, Rural entrepreneurship, Women empowerment, Secondary data

Theme 5: 238

Progress, Problems and Prospects of Fruits Processing in India

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India is the second-largest producer of fruits in the world, yet only around 1% of that produce is processed. Main processed form of mango are pulps, juice, concentrations, pickles, *amchur*, jelly, cereal flakes, vermouth, jam, slices, nectar, syrup, preservative etc. Guava is utilized for processing in the form of jelly, canned cups, juice and nectar, cheese, toffee, bar powder, flakes and strained baby fruits besides commercial pectin. A ready to serve papaya juice drink, papaya candy or tutti fruite are some of the major processed products of papaya, besides papain. Banana is processed as aseptically packed pulp, puree, chips and flour. Major processed form of apples are jam, *murabba* and juices. Orange is primarily processed for juice and Litchi is mainly processed for squash. Grapes, particularly Bangalore Blue are processed for juice and poor quality wine. Several products can be prepared from ber such as candy, *murabba*, dehydrated ber, ber pulp, jam, jelly and ready to serve beverages. Pomegranate fruits are used for preparation of products like Anardana. India exported 201803.63 metric tonnes of processed fruits and juices, worth Rs. 231915.91 lakh during 2023-24. Although there exists a vast potential for fruit processing industry in India, there are several constraints which hamper the growth of this industry like inadequate production technology, price risk involved in fruits production, infrastructural constraints like lack of refrigerated transport and cold storages, land ceiling act and current taxation policy etc., sub-standard packing, informal grading etc. However, the future of fruit processing industry in India appears to be bright. The fruits processing in India derives its significance from its high potential for employment at low capital cost, use local resources, possibilities for forward and backward linkages and its scope for earning foreign exchange.

Keywords: Fruits, Processing, Cold storage, Technology

Theme 5: 239

Impact Assessment of FPOs in Relation to Commodity-based Income Generation Activities

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FPOs have to deal with varied business activities related to the farm produce and work for the benefit of the member producers. In this direction, the central Govt. brought the Central Sector Scheme for" Formation and Promotion of 10,000 FPOs". The overall aim is to improve the economic status of farmers, production of quality seed for better crop production and raising of livelihood of the farming community. Quality seed is very important thing for increasing the production and income of FPO members. It is necessary to maintain the varietal characteristics of seed and management of seed-borne diseases for the production of quality seed. The study was carried out in the Jabalpur district of Madhya Pradesh. A total of eight FPOs are functioning out of them; only two FPOs were purposely selected for assessment on seed production activities. A total of 120 members, 60 for each are belong to the seed production of Paddy and Wheat, respectively, under commodity-based FPOs income generation pertaining to seed production of the dominant crops of the district. The assessment study reveals that the highest percentage of youth having an education qualification of graduation and belonging to medium income group. They are having good market linkages (66 numbers) and high seed replacement ratio (52.00%) and producing seed of Paddy and Wheat in a better manner. Paddy growers have higher knowledge of transplanting 68 (56.67%) and rouging of Wheat 51 (42.50%). However, Paddy growers are lacking in knowledge of Soil health and IPM. Whereas, wheat producers have having least knowledge of weed control methods 24 (20.00%). They are earning NMR of Rs. 68593 and 75466/ha from Paddy and Wheat seeds with net additional income of Rs. 32246 and 47774/ha, respectively.

Keywords: Knowledge, Commodity-based income, Seed production, FPO members

Theme 5: 240

Why Farmers Avoid Selling Surplus Wheat at Procurement Centres: A Study of Jammu Region

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The procurement policy is part of the national commitment to make the Minimum Support Price (MSP) policy effective. The procurement operations aim at enabling farmers to get remunerative prices for their produce and prevent distress sales. The Food Corporation of India (FCI), under the Department of Food and Public Distribution (DF&PD) and other designated state agencies, undertake the procurement of cereals (wheat). In the Union Territory (UT) of Jammu and Kashmir (J&K), there was no policy for wheat procurement before 2010. To avoid distress sale in case of wheat, the government of J&K in collaboration with the Directorate of Consumer Affairs and Public Distribution (CAPD) Jammu, FCI and Department of Agriculture (DoA) established seven procurement centres (PCs) for wheat procurement in *rabi* marketing season (RMS-2013-14) in Jammu,

Samba and Kathua districts which were selected purposively as the PCs were established in these districts only and the total wheat procurement at these PCs was 92499.45q. The number of PCs were increased to eleven in 2022-23, but wheat procurement has declined to 2523q (97.3%) as farmers do not sold wheat at PCs. Out of sixty-six farmers who sold their produce in 2022-23, majority (89%) of the farmers adopted open market (OM) as their preferred marketing channel for selling wheat surplus and only 11 per cent of farmers sold their surplus wheat at PCs. The present study analyzed the reasons for not selling wheat at PCs in RMS-2022-23. The data were collected using personal interview method and the reasons reported were: majority (54%) farmers were not satisfied with the service that PCs were offering to the farmers followed by lengthy procedure (51%), easy access to OM (41%), limited number of PCs, high quality standards of PCs (34%), better price in OM (27%), far distance of PCs (23%), low price of produce at PCs (16%) and private dealers lift produce from the field (8%) causing farmers of Jammu region to sell wheat at OM.

Keywords: Procurement centres, Open market, Jammu region, Wheat crop

Theme 5: 241
Agricultural Marketing in India: Problems and Prospects

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Agricultural marketing in India faces several challenges. Lack of proper warehouses is a major challenge, compelling farmers to store their farm produce unscientifically, causing huge post- harvest losses. Lack of grading and standardization is another bottleneck, depriving farmers' better price. The large number of middlemen in the supply chain leads to a reduction in farmers' share in the consumers' rupee. Lack of speedy and refrigerated transport facilities compel the farmers to sell their produce in local markets, where farmers do not get better price. *Arhatiyas* and brokers, present in unregulated markets ask farmers to pay *arhat* (pledging charge) to the *arhatiyas*, "*tulai*" (weight charge) for weighing the produce, "*palledari*" to unload the vehicles and for doing other miscellaneous types of allied works, "*garda*" for impurities in the produce, and a number of other unspecified charges. Inadequate information about the prices prevalent in different agricultural *mandis and* inadequate credit facilities also acts as constraints, compelling farmers to sell off the crop immediately after harvesting of the crop, when prices are low. Different and unstandardized weight and measures is also another constraint. Farmers face uncertainty due to price fluctuations, making it difficult to plan their farm activities. Many farmers lack access to modern technology, including e-marketing platforms which can help in improving price discovery, reducing transaction costs and enhancing transparency. Low marketable surplus with small farmers is also a major obstacle. Indian agriculture faces challenges related to sustainability, climate change and environmental degradation, which can impact long-term yield and profitability. Implementing e-marketing, investing in infrastructure such as storage, roads and logistics, providing training and access to credit and market linkages, increasing marketable surplus, market-led production, unification of national market, creation of FPOs and promoting cooperative marketing can address the above mentioned challenges and help the farmers to improve their livelihoods and sustainability by providing farmers better price of their farm produce.

Keywords: Marketing, Middlemen, Price fluctuations, FPOs

Theme 5: 242

Prospects and Challenges of Agricultural Marketing in India: Towards a More Inclusive and Efficient System

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Agricultural marketing in India stands at a critical juncture, influenced by ongoing reforms, technological advancements, and the growing need for sustainable rural livelihoods. As agriculture supports nearly half of the Indian population, efficient marketing mechanisms are essential not only for enhancing farmers' income but also for ensuring food availability and price stability across the country. This paper examines the evolving landscape of agricultural marketing in India, highlighting the emerging opportunities and persistent challenges that define its trajectory. The expansion of digital platforms, increased focus on Farmer Producer Organizations (FPOs), and initiatives such as the National Agriculture Market (e-NAM) present significant prospects for improving market access and transparency. These reforms aim to reduce the role of intermediaries, promote fair pricing, and integrate fragmented markets. Moreover, advancements in supply chain logistics, cold storage facilities, and agri-startups are contributing to a more responsive and efficient marketing ecosystem. Despite these developments, several structural and operational challenges persist. Limited awareness among farmers, inadequate rural infrastructure, price volatility, and dependence on traditional markets restrict the effectiveness of current interventions. The uneven implementation of agricultural reforms and the lack of market intelligence further hinder the realization of fair market practices. Additionally, small and marginal farmers often face difficulties in meeting quality standards, accessing institutional credit, and negotiating favourable prices. This paper proposes a comprehensive approach that includes investment in infrastructure, farmer education, and greater collaboration among the government, private sector, and civil society. Strengthening rural institutions and enabling policy consistency are crucial for building a more inclusive and competitive agricultural marketing system. By addressing these challenges and capitalizing on the available opportunities, India can move towards a more equitable and resilient agricultural economy.

Keywords: Agricultural marketing, India, Farmer Producer Organizations (FPOs), e-NAM, market access

Theme 5: 243

Infrastructure and Agricultural Productivity in North Eastern India: Insights from a Panel Data Approach

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The term *infrastructure*, derived from the French word *infra* (meaning 'below') and *structure* (meaning 'building'), first emerged in the late 19th century. Historically referred to as Social Overhead Capital, infrastructure encompasses essential public services and facilities such as education, health, law and order, transport, communication, energy, water supply, and irrigation (Hirschman, 1958). In the context of agriculture, infrastructure is critical at every stage from the supply of inputs and crop cultivation to post-harvest handling and market access. Strategic and planned investments in agricultural infrastructure are crucial for enhancing productivity, minimizing post-harvest losses, and fostering capacity development and income growth. In India, post-harvest losses remain significant due to infrastructure deficits, especially in storage, supply chain logistics, and packaging facilities. This study aims

including (i) assess the status of agricultural infrastructure in North-East India, and (ii) evaluate its impact on agricultural output. The analysis covers the period from 2010–11 to 2019–20, utilizing graphical and tabular methods, Compound Annual Growth Rate (CAGR), and panel data regression techniques. Findings indicate positive growth trends in most infrastructure variables, except for fertilizer consumption. Transport infrastructure exhibited the highest annual growth rate at 10.76%. Panel data analysis identified the fixed effect model as the most appropriate, confirmed by the Hausman and Redundant Tests. Among the variables, roads, transport, and power supply were statistically significant, while storage infrastructure was not. The fixed effect model accounted for 96% of the variation in agricultural output, highlighting the pivotal role of physical infrastructure in agricultural performance. Based on these findings, the study recommends increasing investment in both public and private storage facilities, which is essential for strengthening the post-harvest management system and improving the warehousing sector in the region.

Keywords: CAGR, Panel data analysis, Fixed effect method, Redundant test, Hausman test

Theme 5: 244

Successful Cases of Waste-to-Wealth Enterprises for Promoting Agri-Entrepreneurship and Environmental Sustainability

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With the launch of the flagship scheme "*Swachh Bharat Mission*" by the Government of India in 2014, the Indian Council of Agricultural Research (ICAR) took a proactive initiative to address agricultural waste management. The goal was to convert waste generated from farming activities into products beneficial for humans, animals, or farmland. In response, Krishi Vigyan Kendras (KVKs) under the Agricultural Technology Application Research Institutes (ATARIs) prioritized this mission and developed a range of technologies to transform agricultural waste into valuable resources, thereby promoting employment generation and social entrepreneurship. Several case studies from KVKs under Zone-IV highlight the success of these initiatives. KVK, Rohtas has efficiently processed waste paddy straw into paddy bales for livestock feeding KVK Jehanabad has created employment opportunities through the production of handicrafts from agricultural waste. KVK, Ranchi has innovatively utilized cow dung, urine, fodder waste, and other farm residues to design a "Low-Cost, Locally Resource-Based Organic Farming" technique, promoting chemical-free farming practices. Many KVKs have engaged in vermicompost production using dairy waste, enabling annual incomes of Rs. 72,000 - Rs. 84,000 from compost sales (at Rs. 6/kg) and Rs. 60,000 - Rs. 80,000 from worm sales (at Rs. 500/kg). KVKs in Samastipur and Dhanbad have utilized local agricultural waste – including spinach, beetroot, neem leaves, undesirable seeds, non-edible plant parts, and forest flowers – to produce eco-friendly gulal (natural colors). In Vaishali district, the initiative to utilize banana plants for producing banana fiber, organic fertilizer, vermicompost, and handicrafts has significantly empowered rural communities. Through this effort, rural youths are earning Rs. 40–45 lakh annually, and women are generating monthly incomes of Rs. 6,000 - 8,000 at the village level. These case studies clearly demonstrate that agricultural waste holds tremendous potential to be transformed into valuable assets, leading to significant social and environmental benefits, while simultaneously creating new income and employment opportunities.

Keywords: Waste, Wealth, KVK, Empowerment

Theme 5: 245

Evolving Trends and Gaps in Agricultural Extension Research in India: A Bibliometric and Thematic Analysis

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Extension services in agriculture and related sectors are essential for delivering knowledge to farmers across India, significantly aiding productivity and sustainable farming. However, challenges such as climate change, market volatility and technological complexities necessitate a re-evaluation of agricultural extension research. At the same time, various literatures available in international database revealed inconsistent use of terminology, such as Agricultural Extension Education, Agricultural Extension and Extension Services, highlighting the need for greater clarity and standardization in the field. Therefore, this study conducted a bibliometric analysis of agricultural extension research in India from 2015 to 2025, using Scopus data and R software, focusing on trends in these three areas. The analysis revealed distinct emphases: Agricultural Extension Education centres on training professionals to disseminate agricultural knowledge; Agricultural Extension involves the broader system linking research to practice; and Extension Services provide on-ground assistance to farmers through direct interventions like demonstrations and consultations. The result also revealed that research output has steadily grown over the decade, with Extension Services showing the highest growth, peaking in 2023. Recent trends focused more on climate change and agricultural labour welfare than on farm cultivation techniques and technology adoption. Notably, the study found limited focus on digital tools, participatory approaches and indigenous knowledge systems. Hence, the study recommends strengthening educational research, encouraging interdisciplinary efforts, leveraging digital outreach and aligning research with local needs to build more inclusive and resilient extension systems in India.

Keywords: Extension services, Scopus data and R software, Literatures

Theme 5: 246

Developing a Conceptual Framework for Price Setting Scenario in Pineapple Marketing: A Qualitative Approach using MAXQDA"

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Meghalaya's pineapple crop had been economically profitable and contributed about 8% of all pineapples produced in India. However, pineapple marketing is laborious, costly, and skill-intensive, with various factors influencing farmers' decisions in setting prices for the market. Additionally, due to the perishable nature of pineapples, producers had to sell their produce immediately to wholesalers, who also acted as village-level traders. As a result, farmers frequently sold their produce under unfavourable terms and circumstances. This study employed a qualitative research methodology to explore the price-setting environment in pineapple marketing in Ri-Bhoi, Meghalaya. The methodological flow began with data collection through in-depth interviews with pineapple farmers, capturing rich verbatim accounts. Subsequently, thematic analysis was conducted within MAXQDA by examining coded segments to identify patterns and relationships among variables influencing price setting. Visualization tools such as code maps were used to represent these relationships, aiding conceptual clarity. The conceptual framework revealed five interlinked domains influencing price determination and reflected

the complex interplay of community norms, market intermediaries, technological barriers, logistical constraints, and missed value-addition opportunities in shaping the price-setting environment for pineapple farmers. The study also identified a "survival-oriented mindset," where pineapple farming was primarily viewed as a means to cover basic household expenses rather than generate profit. Qualitative data illuminated a deep dependence on middlemen, cultural norms that discouraged price experimentation, and gendered exclusion from market decisions. These challenges could be addressed through simulation-based training, enhanced digital literacy to improve market access, and strengthened collective marketing channels.

Keywords: Pineapple, Marketing, MAXQDA software, Qualitative research, Price setting

Theme 5: 247

From Engineer to Agripreneur: A Case Study in Sustainable Agricultural Transformation

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In the context of agricultural development, success stories serve as essential instruments for driving innovation, fostering behavioural change, and influencing policy and practice. As agriculture continues to face multifaceted challenges such as climate variability, land degradation, youth disengagement, and post-harvest losses, the documentation and dissemination of successful farming models become increasingly important. These stories provide evidence-based illustrations of best practices, demonstrating how innovative approaches and technologies can be effectively implemented at the grassroots level. In this study success story of Mr. Abhishek Dhama, a trained electronics and communication engineer from Palla village in Delhi, represents a new generation of agripreneurs who are redefining Indian agriculture through innovation and sustainability. After leaving a corporate career, he began his farming journey in 2015 with a small kitchen garden focused on organic vegetable cultivation. Over the years, he expanded his operations to over 30 acres, employing modern agricultural techniques such as multi-cropping, organic soil management, and direct-to-consumer (D2C) marketing. His model bypasses conventional market chains, allowing him to supply high-value crops–including *broccoli, chamomile, red lettuce, tulsi, and geranium*–directly to urban consumers, restaurants, and retail stores across Delhi-NCR. His adherence to organic principles, using natural inputs like jeevamrut, panchgavya, and vermicompost, has led to high-quality, export-oriented produce. Mr. Dhama earns a monthly income of Rs. 8–10 lakhs and provides employment to approximately 30 rural workers, demonstrating the socio-economic potential of sustainable agriculture. To address challenges related to water efficiency, transparency, and post-harvest losses, Mr. Dhama integrated AgroTrace, a smart irrigation and fertigation management system. AgroTrace enables precision monitoring of soil moisture and temperature at various depths, optimizing the timing and quantity of water and fertilizer application. This not only reduces resource wastage but also enhances crop health and productivity. Additionally, to mitigate spoilage and extend shelf life–especially during power outages–he adopted the Pusa Farm SunFridge, a solar-powered, battery-free cold storage solution developed by the Indian Agricultural Research Institute (IARI) in collaboration with Michigan State University. Capable of storing up to two tons of fresh produce at optimal temperatures, this innovation has helped him reduce post-harvest losses from 15–20% to less than 5%, while stabilizing supply and revenue across seasons. Mr. Dhama's farming enterprise serves as a model for integrating traditional knowledge with advanced agri-technologies, highlighting a pathway toward resilient, climate-conscious, and economically viable farming in India.

Keywords: Agricultural innovation, Sustainable agri-technologies, Organic farming practices

Theme 5: 248

Knowledge Enhancement Through FPOs: A Case of Tribal Millet Growers in Madhya Pradesh

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Despite their nutritional richness and adaptability, millets are often underutilized due to lack of awareness and knowledge among farmers. This study investigates the impact of Farmer Producer Organizations (FPOs) in enhancing knowledge related to millet cultivation technologies among tribal millet growers in Chhindwara district of Madhya Pradesh. With a focus on the Patalkot Farmers Producer Company Limited in Tamia block, the research evaluates how FPO membership influences farmers' understanding of improved agricultural practices. A total of 110 millet-growing farmers were surveyed in which 55 FPO members and 55 non-members by using a structured interview schedule. The results revealed that FPO members possess a significantly higher level of knowledge than the non-members regarding seed treatment, pest management, nutrient application, water conservation techniques and post-harvest handling of millets. Regular training sessions, peer learning and exposure to expert advice facilitated through FPOs contribute to this knowledge gap between members and non-members. This study underscores the role of FPOs as a grassroots-level extension mechanism that bridges the information gap in remote tribal areas. It further highlights the synergy between collectivized farming and capacity building, which is crucial for sustainable agricultural development.

Keywords: Tribal millet growers, Knowledge enhancement and farmer producer organization (FPO)

Theme 5: 249

Policy Frameworks for Mushroom Entrepreneurial Ecosystems for Inclusive Agri-entrepreneurship: Insights from a Delphi Study

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The rising prominence of mushroom cultivation as a sustainable agri-enterprise in India emphasizes the necessity of a well-structured entrepreneurial ecosystem to facilitate its growth, particularly in tribal and hilly areas. This study employed the Delphi technique to identify and prioritize key attributes critical to the performance of a mushroom entrepreneurial ecosystem, drawing insights from a panel of 30 experts including agricultural extension scientists, KVK specialists, progressive entrepreneurs and institutional personnel. A three round iterative Delphi process was used, beginning with open-ended responses to elicit ecosystem components, followed by successive rounds of quantitative rating and consensus refinement using median, IQR and QD values. The study categorized 36 finalized attributes under six key dimensions: financial access, institutional support, entrepreneurial culture, infrastructure, human capital and market linkages. The findings offer a validated framework for policymakers, development agencies and incubation centres to target interventions, build digital infrastructure and promote inclusive entrepreneurship in the mushroom sector. It is recommended that ecosystem strengthening strategies prioritize participatory platforms, convergence of support services and skill-based capacity-building to sustain mushroom entrepreneurship in marginalized agroecological zones.

Keywords: Mushroom, Entrepreneurship, Ecosystem, Policy framework

Theme 5: 250
Impact of Millet Farmer Producer Organizations (FPOs) on Farmers

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Farmer Producer Organizations (FPOs) are legally registered collective entities formed by small and marginal farmers to strengthen their economic position and improve access to markets. These organizations address key challenges faced by individual farmers, such as limited bargaining power, high input costs, and poor market linkages. By facilitating collective procurement of inputs, value addition, access to credit, and direct marketing channels, FPOs contributed significantly to enhancement in farm incomes. The Government of India has been actively promoting FPOs through the "10,000 FPO Formation and Promotion Scheme" (10K CSS FPO scheme) with implementing agencies like SFAC, NCDC, WDD, NABARD, NFSM etc., and Cluster Based Business Organizations (CBBOs) to boost farmers' incomes, ensure better price realization, and empower rural communities. ICAR-IIMR, Hyderabad is acting as CBBO in promotion of 40 millet based FPOs in India, viz., Andhra Pradesh, Telangana, Karnataka & Madhya Pradesh. To understand the socio-economic impact of millet-based FPOs, a study was conducted during 2024–25 across the states of Telangana, Andhra Pradesh, and Karnataka. The research covered a sample of 360 respondents and compared key socio-economic indicators before and after joining the FPOs. Parameters such as occupational days, annual income, monthly savings, monthly expenditure, access to credit, and debt status were analyzed. The statistical findings revealed a significant improvement in all areas, with changes validated at the 1% level of probability. Results showed significant impact on the number of occupational days, average annual income, monthly savings and access to credit. The study highlighted the transformative potential of FPOs in uplifting the economic conditions of small and marginal farmers. The study also concluded that joining in FPOs has created direct access to resources and markets, financial stability, rural employment, and community engagement. These organizations contributed to sustainable agriculture and rural development in India.

Keywords: Millet FPOs, Small & marginal farmers, Development, Impact, Agriculture

Theme 5: 251
Post Harvest Management and Value Addition of Dragon Fruit

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Dragon fruit is widely popular in Mizoram in recent years due to its high nutritive value in the form of bioactive compounds that provides many functional properties which helps preventing chronic diseases. The fruit is highly perishable having shelf life of about one week and several physiological disorders associated with improper handling, temperature maintenance, pest damage, inadequate packaging and longer period of transportation. Therefore, it requires proper post harvest management. Apart from that, value addition of dragon fruit including juice, ready to drink, jam and wine can be done which not only cause food fortification but also can source of additional income during off season. Efforts have been initiated to cater these acute problems of the farmers in the form of preparing juice and wine. An amount of Rs. 100/- could be recovered from processing 1 kg fruit for juice and Rs 1400/- from processing wine. Shelf life of dragon fruit juice was found to be acceptable till the 8th month while quality of wine increased with time.

Keywords: Dragon fruit, Perishable, Value addition, Ready to drink juice, Wine

Theme 5: 252

Empowering Rural Livelihood through Farmer Producer Organizations– A Journey from Individual Farmers to an Informed Group

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Farmer Producer organizations are the grass-root level clusters of farmers which were formed by themselves for the benefits of farmers. In North Eastern Region, the marketable produce have hardly been crossed the state boundary and it has been marketed at the local level through various market intermediaries. But the actual and the remunerative price which is supposed to reap by the producer is still hanging and wrap in the hands of the intermediaries. Unfortunately, farmers in the region are hampered by high transaction costs & low access to credit and agricultural produce markets. Initiatives of the various stakeholders including the policy makers have shifted the gear from individual farmer to the groups and clusters approaches. A case study of the Farmer Producer Organizations (FPOs) which were formed and promoted by the ICAR Krishi Vigyan Kendra in Imphal West district of Manipur, India showed that the FPOs which were registered during the year, 2020 as the Agro Farmer Producer Company Ltd. (AFPCs). These FPOs are composed of different promoters i.e., SHGs, FCs and JLGs having more 500 member shareholders with the basic numbers of women BODs in every producer companies. The composition of AFPCs shareholders shows the presence of the maximum numbers of small & marginal; tenant/landless and SC/ST member farmers. It was also found that the newly formed producer companies did not have well infrastructures. However, all the 3 producer companies have good FPOs practices such as innovation in farmers' mobilization, good governance & convergence with various stakeholders, group dynamic features and concrete business development plan implemented for execution of the company milestones. The producers companies have good outreached and institutional linkages from the different public and private sector banks with an average credit amount of Rs. 1.9 crores facilitating to 965 beneficiaries from the 3 producer companies.

Keywords: FPOs, SHGs, BODs, AFPCs and SC/ST

Theme 5: 253

Impact of Farmer Producer Organization (FPOs) on Economic Empowerment of the Member Farmers

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In India, approximately 86.08% of total land holdings are owned by small and marginal farmers, and this number continues to rise annually due to ongoing land fragmentation. These farmers face numerous challenges such as high cultivation costs, limited access to quality inputs, credit facilities, modern technology, extension services, and marketing opportunities. Frequent crop failures further increase their dependence on middlemen and moneylenders. To address these issues, it is essential to organize farmers into producer groups and establish Farmer Producer Organizations (FPOs). The present study was conducted in Gomati district of Tripura. Data was collected from 10 numbers of randomly selected FPOs. A total 120 member farmers were selected with

a proportionate random sampling method. Ex-post facto research design was followed. It was found that the majority of the farmers belonged to the male farmers followed by middle age category, having primary level of education, with a small family size, having 1 to 1.5 acre of land holding, mostly involved in agriculture and allied activities. The study also revealed that most of the farmers have a medium level of participation in FPOs, risk orientation, economic motivation, and market orientation. In the economic impact of FPOs on the member farmers, there was 62.5 per cent increase in income followed by 42.5 percent increase in saving, 27 percent increase in savings and 12 per cent change in debt after joining as a member in FPOs. It was also found that family type, family size, gender, occupation, participation in FPOs, and market orientation had a positive correlation with the overall economic empowerment of the farmers.

Keywords: Ex-post facto research design, Economic motivation, Risk orientation, Market orientation, FPOs

Theme 5: 254

Enhancing Livelihoods and Sustainability through Pond-Based Integrated Farming Systems in the Eastern Himalayas

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Agriculture in the eastern Himalayan region of India, particularly in Meghalaya, is constrained by climatic variability, limited resource availability among small and marginal farmers, and low adoption of advanced farming technologies. To address these challenges, a field-based study was conducted from February 2021 to March 2024 in Khweng village, Bhoirymbong block, Ri-Bhoi district, Meghalaya. The study evaluated the impact of Pond-Based Integrated Farming Systems (IFS) using ten experimental models implemented over 5.0 hectares through participatory approaches. The village, comprising 105 households and a population of 695 with a literacy rate of 61.89%, predominantly relies on agriculture for livelihood. Two major IFS models were examined: Poultry-based and Piggery-based systems. The Poultry-based IFS integrated 1000 Indian Major Carp, 60 Vanaraja poultry birds, and diverse vegetable crops (broccoli, cabbage, tomato, potato, and French beans). The Piggery-based IFS substituted poultry with three pigs (one male and two females) while retaining identical fishery and horticultural components. The Poultry-based IFS exhibited superior economic performance, recording a Gross Return (GR) of Rs. 284,304 and Net Return (NR) of Rs. 159,482, compared to the Piggery-based IFS (Rs. 270,503 GR and Rs. 145,871 NR) and the conventional Farmers' Practice (Rs. 13,200 GR and Rs. 4,700 NR). The Benefit-Cost Ratio (BCR) was highest for the Poultry-based IFS at 2.28, indicating greater profitability. Furthermore, it generated higher labour employment (227 man-days), demonstrating its labour-intensive nature and potential to enhance rural livelihoods. Both IFS models promoted ecological sustainability through nutrient recycling techniques such as vermicomposting and manure integration, reducing reliance on external inputs. Energy flow analysis indicated favorable energy efficiency ratios for both systems: 2.31 for Poultry-based and 2.33 for Piggery-based IFS. Overall, the Poultry-based IFS proved more profitable and employment-generating, while the Piggery-based system served as a suitable alternative for pig-rearing households, thereby contributing to improved economic resilience and agro-ecological sustainability.

Keywords: Integrated farming system, Fishery, Poultry, Piggery, Economics and Energy flow

Theme 6: 255

Women in Agri-value Chains in Maharashtra: From Producers to Agripreneurs

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In rural India, agriculture remains a vital source of livelihood, but women's roles have historically been confined to subsistence farming and household duties. Over time, however, rural women have emerged as key players in the agricultural value chains, not only as producers but also as entrepreneurs driving innovation in post-harvest processing, marketing, and value addition. This study examines the evolving roles of women in the agricultural landscape of Osmanabad, a drought-prone district in Maharashtra, where agricultural distress is prominent. In Osmanabad, women are leading change through their active involvement in Self-Help Groups (SHGs), Farmer Producer Organizations (FPOs), and small-scale agri-enterprises. These initiatives span across various sectors, including food processing, dairy production, and organic farming, transforming women from traditional agricultural producers to Agripreneurs. The research highlights several successful initiatives led by women, such as community-based processing units for millets and pulses, which have enhanced food security while boosting local economies. Furthermore, women in Osmanabad increasingly utilise digital tools to market their products, reaching broader consumer bases and improving profitability. Despite facing challenges such as water scarcity, poor infrastructure, and limited access to financial resources, these women are overcoming barriers through collective action and localized solutions. The study analyses the key factors that have contributed to their success, including targeted training programs, access to microfinance, and strengthened market linkages. The paper underscores the need for gender-sensitive interventions, capacity building, and supportive institutional frameworks to enhance the economic empowerment of women in agriculture

Keywords: Women empowerment, Agri-value Chain, Agripreneurship, Rural development

Theme 6: 256

Role of Media to Attract Youth in Agriculture

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The agricultural sector faces key challenges viz. low youth involvement in farming, and a growing trend of urban migration, which threatens its sustainability. Despite its crucial role in global food security and economic development, agriculture struggles to attract younger generations. Media, in its various forms - digital, print, and broadcast, has the power to reshape perceptions about agriculture and make it more appealing to youth. By showcasing innovations like agri-tech, precision farming, and sustainable practices, media can present agriculture as an exciting, innovative, and future-oriented field. This study explores how media can play an important role in engaging youth in agricultural profession. Platforms such as social media, news portals, mobile applications and blogs can reach a broad audience, offering insights into the diverse career opportunities within the sector. By highlighting success stories, technological advancements, and innovations media can help break down the stereotypes that portray farming as a low-status, labor-intensive job and low income sector. Study further discusses how media campaigns can abreast youth in making agriculture more accessible and attractive. The change in perceptions and emphasis the sector's potential for innovation and sustainability, media can encourage youth to see agriculture not just as a career, but as an essential, dynamic, and willful field for the future generations.

Keywords: Information, Media, Youth, Agriculture and profession

Theme 6: 257

Impact of Long-term Skill Development Course on Dairy Farming in Punjab

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This study evaluates the effectiveness of a long-term agricultural skill development course in enhancing employment, entrepreneurship, production, and income among farming communities in Punjab. The research focused on 280 trainees enrolled in the Three-Month Young Farmer Integrated Crop Production Training Course at Punjab Agricultural University (PAU), Ludhiana, between 2016 and 2019. A random sample of 200 respondents was analyzed using statistical tools, including paired t-tests, to compare pre- and post-training data. The findings indicate that the training significantly improved scientific dairy farming practices, particularly in areas such as breed improvement, nutritional management, herd health, and clean milk production. Economically, participants reported increases in herd size, milk yield, gross returns, and net profits, alongside a higher benefit-cost ratio. These results suggest that long-term skill development programs not only uplift the socio-economic status of farmers but also contribute to the production of higher-quality dairy products. The study provides robust empirical evidence on the positive impact of structured agricultural training, underscoring the importance of continued education and supportive policies in rural development.

Keywords: Impact, Trainees, Long-term skill development course, Dairy farming, Farming practices

Theme 6: 258

Empowering Tribal Women through Value Addition: A Research Investigation under TSP

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Tribal women, despite playing a critical role in agriculture and allied activities, often remain marginalized in terms of knowledge access, economic participation, and entrepreneurial opportunities. This study explores the potential of value addition in agricultural products as a pathway for economic empowerment of tribal women. Conducted in the Gadarpur and Khateema blocks of Udham Singh Nagar district in Uttarakhand, the research involved 250 tribal women who underwent structured training on food processing, branding, storage, and marketing of products like organic jaggery, honey, millets, vermicelli, and pasta. A pre- and post-training knowledge test was conducted to assess the impact of the program. The results revealed a significant increase in knowledge across key areas, with average gains of 60 per cent observed in most topics. The participants demonstrated improved understanding of nutritional benefits, processing techniques, branding strategies, storage practices, and entrepreneurship opportunities. These findings affirm that targeted capacity-building initiatives can effectively enhance the knowledge and skills of tribal women, enabling them to engage in value-added agriculture and improve their livelihoods. The study concludes that value addition, supported by training and market linkages, holds great promise for empowering tribal women, promoting self-reliance, and driving inclusive rural development.

Keywords: Tribal, Women, Enterprise, Value addition

Theme 6: 259

Dragon Fruit Cultivation as an Emerging Agri-Startup Opportunity in Jammu: A Case Study on Socio-Economic Impact and Sustainable Farming Practices

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The diversification of agriculture towards high-value crops is gaining momentum as a means to boost farmers' income, ensure sustainability, and promote agri-entrepreneurship. This study explores *Dragon Fruit (Hylocereus spp.) cultivation* as a viable agri-startup opportunity in the Jammu region, where climatic conditions and soil quality are well-suited for non-traditional fruit crops. The research adopts a case study approach to evaluate the socio-economic impact and sustainability of dragon fruit farming, with a particular focus on a successful cultivation initiative at *Agra Chak, R.S. Pura, Jammu*. The case study highlights the journey of a progressive farmer in Agra Chak who transitioned from traditional wheat and rice cultivation to dragon fruit farming on a 4-acre plot. With technical guidance and limited initial investment supported by agricultural extension services, the farmer achieved his first harvest within 16 months, generating a significant increase in income—nearly three times higher than previous earnings from conventional crops. The crop's low water requirements, pest resistance, and suitability to organic practices further reduced input costs and environmental impact. Interviews and field observations across the region reveal a growing interest among small and marginal farmers, especially the youth, in adopting dragon fruit cultivation as an agri-startup. The study also examines the role of government schemes, market linkages, and training programs in facilitating this shift. Challenges such as initial setup costs, limited local expertise, and lack of cold storage facilities are acknowledged, with recommendations for targeted interventions. Overall, the findings suggest that dragon fruit cultivation can be a transformative opportunity for regions like Jammu. The Agra Chak case serves as a replicable model demonstrating how innovation in crop selection, combined with institutional support, can lead to sustainable livelihoods and promote rural entrepreneurship.

Keywords: Dragon fruit, Agra Chak, R.S. Pura, Agri-startup, Sustainable farming, Jammu, Socio-economic impact, Horticulture, Crop diversification

Theme 6: 260

Empowerment of Rural Women through Skill Development Trainings under ARYA Project a Case Study

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Apart from giving various farm trials, demonstrations, inputs, technology, services, knowledge, Krishi Vigyan Kendra also providing Skill development trainings to farmers and farm women for improving their quality of life. This paper is emphasizing the impact of ARYA project running at KVK Barnala and various skill development trainings is organized under community science component from 2020-21. The objectives of ARYA project are: empowering and involving rural youth in various agricultural and allied sector entrepreneurial activities and to generate employment and ensure sustainable income of rural youths. The four enterprises namely Bee keeping, Mushroom cultivation, Back yard poultry farming and value addition of milk and meat product were identified under the project at KVK Barnala. Under Home science component, enterprise selected for trainees was processing

of milk and meat products. A total of 36 trainees who have trained in training programme were selected as respondents of the study. The findings revealed that majority i.e., 73.0% respondents were belonging to productive age group & only 10% respondents were illiterate and rests were educated. Majority (90%) of respondents were married. Less than half of the respondents' belonged to landless families (46.66%) and 13% were from schedule caste families. Majority of the trainees had adopted the preparing of milk products at domestic level learned under vocational training. Four units of milk processing have been established in different villages after vocational training under ARYA. Two units are running by women group, providing income to other women in the village, two units are successfully running by two males in Barnala district after taking training from KVK Barnala. Almost all dairy products like, Khoa, goat paneer, lassi, dahi mishti, whey drinks, murkichanna, paneer pickle are being prepared by these entrepreneur. On an average size of one processing unit is 50 lit. milk per day and average net income earned by one unit is rupees 8,13,600/- per annum. Regarding future training needs, Majority of respondents (90%) willing to attend advance training on milk and meat products & packaging and marketing including FSSAI number. Training is better way for them to make themselves independent economically and socially. The suggestions given by the trainees can be a good feedback for the extension personnel for planning of training programmes in future.

Keywords: Adoption, Impact, Training programme

Theme 6: 261

Changing Role of Women in Agriculture in the Light of Male Out-Migration in Western Odisha

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As rural development and transformation take place, employment in the agricultural sector would decline, while employment in other sectors for both men and women will increase. However, in many developing nations, women remain in agriculture or leave far more slowly than males do, and their responsibilities in the sector may even grow. Women take on the productive jobs in addition to their reproductive responsibilities and prior farm roles. These shifts are frequently referred to as the "feminization of agriculture," regardless of whether women are making up a greater proportion of the agricultural workforce or managing smallholder farms. This study aims to delineate the factors affecting the feminisation of agriculture in terms of farm decision making and participation in agriculture activities in Western region of Odisha. By utilising forward stepwise regression (R^2 =0.768, adjusted R^2 = 0.745) method it was found that factors like age, access to market, cosmopolite sources, access to credit and number of crops along with wife being head of the family were having positive affect in farm decision making. Factors such as farm asset, localite sources, family size and land holding were negatively affecting the decision making of the women. Similarly, for labour participation the forward stepwise regression method showed that (R^2 =0.461, adjusted R^2 = 0.447) age, access to market, social participation, access to cosmopolite sources and female head of the house had positive effect and mass media access, family size had negative effect. Based on the findings of regression results it was concluded that migration of husband does not have a direct bearing on the decision making or labour participation of left-behind women, rather it only happened when the women assume the headship of the household. As factors like access to market, cosmopolite sources, credit and social participation had a positive effect on participation of women in agriculture; government initiatives need to be strengthened in these areas to support the farm women.

Keywords: Feminization of agriculture, Male out-migration, Decision making, Small holder farms

Theme 6: 262
Gender-Responsive Budgeting and Financing in Agricultural Schemes: Gateway to Empowering Farm Women

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The Gender disparities in agriculture present a critical challenge to achieving inclusive growth and sustainable food systems which helps in mobilizing and empowering the farm women. Gender Budgeting and financing is one of the major tools for gender equality. Women, who constitute a significant portion of the agricultural workforce, often face limited access to financial resources, agricultural inputs, and decision-making opportunities. Gender Responsive Budgeting and financing in Indian agriculture aim to address these inequities by integrating gender perspectives into budget planning, resource allocation, and policy frameworks. Over the years from 1985 to 2024, the gender budget contribution to Ministry of Agriculture and Farmers Welfare has shown significant changes. Currently, the Gender Budget Statement clearly outlines, Part A, Part-B and Part-C criteria. All Indian states have implemented Gender Budgeting through various agricultural schemes and established Gender Budget Cells to monitor and support financial inclusion efforts for women. Notably, Maharashtra and Manipur demonstrate high fund utilization rates of 85% and 75%, respectively for agriculture from the total Gender Budget of the States, while states such as Punjab and Meghalaya report minimal allocations. These disparities highlight the need for targeted interventions and policy reforms which directly or indirectly empowers and mobilizes farm women. The five-step framework for gender budgeting and the identification of key agricultural programmes have been instrumental in advancing gender mainstreaming efforts across ministries. Despite progress, challenges persist in mainstreaming gender-responsive financing due to limited gender-disaggregated data, policy implementation gaps, and socio-cultural constraints. Achieving gender equality through responsive budgeting and financing is not only a moral imperative but also an economic necessity for building resilient and sustainable agri-food systems.

Keywords: Gender disparities, Gender budgeting, Gender equality, Empowerment of farm women

Theme 6: 263
KVK KISAN MALL: Boon for Self Help Group's Women in Gangetic Region

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About 260 self-help groups have been created in Kalakankar block with the support of Krishi Vigyan Kendra and the State Livelihood Mission. Most of these groups have taken the shape of federation as Kalakankar women federation with technical support of Krishi Vigyan Kendra. The Kalakankar women federation is common platform and resource center to provide input and formulate the strategy for the marketing with the prime minister slogan vocal for local. The federation has organized the shgs in order to supply products day to day requirement of local area. The biggest problem for women is that they have to perform house hold chores along with the occupational work. Keeping this problem in point of view KVK provided facility so that they can do their professional work from the house only. Anand women SHG is one which is producing cotton

wick and food products (murmure, namkeen, khurma,) with annual income of Rs. 1.5 lakh, Kalakankar women interest group another SHG is producing agarbatti, honey processing, with annual income of Rs. 4 lakh, Akash Women SHG is producing dona pattal with annual income of Rs. 2 lakh, Shristi Women shg is producing agarbatti with annual income of Rs. 3 lakh, Adarsh Women shg is producing wheat dalia, candle making with annual income of Rs. 4 lakh. Other shgs are involving in seasonal activity like papad, chips, eco-friendly color in Holi festive and diya, gift hampers, handicrafts in Diwali festive and rakhi in Raksha Bandhan festive. Few groups are producing vermin composting and fruits and vegetables production. With the help of Kalakankar Women Federation, its becomes easier for the women of the group to buy raw materials, marketing and packaging collectively and it saves both time and money. This is the best way to empower women without sacrificing their home responsibility. Federation has proved that this is a business in which investment is very less and results are good in short span. While describing the sentence of Prime Minister, it would not be wrong to say that self help group women has become self reliant with the technical support of State Livelihood Mission and KVK. Simultaneously, the groups of federation are creating opportunities for other groups as well.

Keyword: Reliant, Annual income, KVK, Livelihood Mission and self-help groups

Theme 6: 264

Empowerment of Women Farmers through Improved Oilseed Production Technologies under Oilseed Model Village Project in Assam

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Oilseed Model Village is a special CFLD project of ICAR under NMEO-OS which aims to achieve self sufficiency in edible oilseeds through institutional and technological innovations with a focus on enhancing oilseed production and reducing import dependency. Krishi Vigyan Kendra, Dhubri has initiated its primary step of building an Oilseed Model Village in the financial year 2024-25. Toria var TS-38 was selected for the program which was implemented in the village of Gutipara under the block Nayer Alga of Dhubri district. A total area of 200 hectares was covered under the program benefitting 500 number of farmers and farm women, out of which 448 were farmers and 52 were farm women. As part of the technology foundation seed of toria, vermicompost, enriched vermicompost, micronutrients *viz.,* borax and zinc, plant growth promoter/ biostimulant and fungicide were distributed as technological inputs to the beneficiaries. All the demonstrated plots were identified through a baseline survey, geo-tagged and uploaded in the Krishi Mapper Application. Dhubri district in Assam is a major rapeseed-mustard growing area, with the crop occupying a significant portion of the total oilseed area and production in the state. By thorough guidance and numerous extension activities like training programs, awareness camps field days KVK, Dhubri has motivated the farmers of the village to adopt the high yielding variety TS-38. The average productivity of the variety in the village was recorded to be 9.14 q/ha against the local check yield of 8.4 q/ha. The farmers were able to obtain a net return of Rs. 25,575.00/ha with a cost involvement of Rs 17,800.00 /ha resulting a Benefit Cost ratio of 2.14. The implementation was a success and the farmers expressed satisfaction over the performance of the variety as the yield of TS-38 was found to be higher than the local variety. The women farmers are now looking forward enthusiastically for the cultivation of the crop and the variety in the upcoming season.

Keywords: CFLD, Women farmers, Oilseeds demonstration, Oilseed model village, Women empowerment

Theme 6: 265
Flock Forward: Women's Invisible Role in Sheep Farming in Jammu and Kashmir

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Sheep farming in Jammu and Kashmir is an age-old tradition having a deep-rooted cultural essence. It is a main source of earning for many rural families who rely entirely on it for their livelihood especially the tribal population in the region. Besides men, women too are known to play a crucial role in sheep farming here which makes it a more accessible and inclusive livelihood option across genders being less capital-intensive and requiring less physical drudgery. Their indispensable role spans a wide range of sheep farming related activities that includes participation and decision-making like feeding, cleaning, management, grazing, herding, breeding, marketing, slaughtering, meat processing, wool processing, etc. This paper explores the multifaceted aspects of gender roles involving women's participation, decision-making, access, ownership and control over resources in various sheep farming activities. Moreover, it examines their underrepresentation in particular activity and the roadblocks therein which hampers their role in sheep farming. This paper explores the existing disparities and by bringing forth these disparities that persist in sheep farming it advocates for bridging the gaps through much needed policy interventions for integration of women in all aspects of sheep farming. This can be done through promotion of gender sensitive training programs which ultimately calls for policy reforms measures, use of technology driven solutions, accessible online marketing platforms that ensure equitable resource distribution and mobilization of women in sheep farming as well as their representation in rural economies.

Keywords: Sheep farming, Jammu & Kashmir, Women, Gender roles, Mobilization

Theme 6: 266
Constructing an Entrepreneurial Ecosystem Index (EEI) for Agriculture: A Strategic Framework for Fostering Agri-Startups in India

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The agri-food industry is undergoing rapid change, with entrepreneurship emerging as a key factor in encouraging young participation in agriculture, fostering inclusive rural development, and advancing technology adoption. Nonetheless, the robustness of the entrepreneurial ecosystem in which Agri-startups and entrepreneurial ventures operate is crucial to their success. Strong connections among stakeholders, fragmented support networks, and inconsistent policy implementation can hinder business growth, especially in regions heavily dependent on agriculture. Therefore, establishing a comprehensive, context-specific Entrepreneurial Ecosystem Index (EEI) has become essential for evaluating, monitoring, and enhancing the environment that supports agribusiness. Innovation, startup success, and sustainable agricultural change all depend on a robust entrepreneurial ecosystem. To assess the supportive environment for Agri-startups across key aspects, this study aimed to develop an Entrepreneurial Ecosystem Index (EEI), acknowledging the multifaceted nature of agripreneurship. Seven main pillars formed the foundation for the index's creation: infrastructure, government policy, support networks, human capital, market access, financing, and entrepreneurial culture, which were considered based on Isenberg's entrepreneurial ecosystem. An initial universe of 122 items, categorized under seven ecosystem dimensions, was generated, and their relevance was evaluated by 80 expert respondents representing academia, industry, and policy institutions. Relevancy Percentage (RP), Relevancy Weightage (RW), and Mean Relevancy Score (MRS) criteria were employed to filter items based on their ratings. Only the most valid and discriminative items were retained for the final formulation of the Entrepreneurial Ecosystem Index (EEI) after conducting statistical item analysis using the Likert Summated Rating Technique. The index underwent further testing for content validity and internal reliability to ensure consistency and robustness. The resulting EEI provides a solid analytical framework to identify ecosystem strengths and gaps and is suitable for evaluating the conduciveness of Agri-startup environments. This index can serve as a strategic tool for researchers, policymakers, incubators, and ecosystem enablers to design evidence-based interventions that foster robust agripreneurship. The methodology is replicable and scalable to other regions, enabling comparative benchmarking across states and sectors.

Keywords: Entrepreneurial ecosystem index, Agripreneurship, Agri-startups, Ecosystem assessment, Item analysis, Sustainable development

Theme 6: 267

Entrepreneurship and Agribusiness Opportunities for Women in Agriculture in Western Rajasthan

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Western Rajasthan's arid climate and semi-desert landscape pose significant agricultural challenges, yet they also create unique opportunities for agribusiness innovation. This paper explores high-potential agribusiness avenues including sustainable and water-efficient farming, livestock and dairy enterprises, agri-processing, agri-tourism, digital agriculture, and renewable energy applications. Emphasis is placed on techniques such as drip irrigation, hydroponics, and cultivation of drought-resistant crops, alongside traditional livestock rearing and value-added processing of regional products. Government support, self-help groups, and rural skill development programs are vital enablers, while challenges like water scarcity and market access can be mitigated through technology and financial inclusion. The study concludes that with strategic investments and skill development, agribusiness in Western Rajasthan can drive rural prosperity and sustainable economic growth. Western Rajasthan, despite its arid climate and limited water resources, is emerging as a hub for innovative agribusiness opportunities driven by sustainable practices and government support. The region's potential lies in adopting water-efficient technologies like drip irrigation and hydroponics, cultivating drought-tolerant crops such as millets, guar, and medicinal herbs, and expanding desert horticulture with high-value fruits like pomegranate and dragon fruit. Livestock-based ventures, especially camel and goat farming, along with value-added dairy production, present profitable prospects. Agri-processing units focused on traditional Rajasthani foods, organic oils, and herbal products offer significant local and export market potential. Agri-tourism is also gaining momentum, combining eco-friendly farm stays with cultural experiences to attract domestic and international tourists. The digital transformation of agriculture-through mobile apps, e-commerce platforms, and social media marketing-is bridging market gaps and empowering rural youth. Moreover, renewable energy solutions like solar-powered irrigation and biogas are making farming more sustainable. With access to government schemes, startup support, SHGs, and FPOs, the rural population, particularly women and youth, can turn agriculture into a profitable and resilient livelihood.

Keywords: Western Rajasthan, Entrepreneurship, Agribusiness, Agri-tourism, Resilient livelihood

Theme 6: 268
Heralding the Path of Agri-preneurship: Experiences of ARYA Project

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For Agri-preneurship development goatry, poultry and mushroom cultivation enterprise have pivotal role. In rural part of our country poultry farming and goatry makes an important source of livelihood and nutritional security because of its low capital investment and assured quick return among all livestock based venture. These enterprises have the potential to emerge as a very good source of income and employment for the rural youth. Realizing the importance of rural youth in agricultural development especially from the point of view of food security of the country and to empower rural youth, Indian Council of Agricultural Research has started, Attracting and Retaining Youth in Agriculture (ARYA) project in 2015 with aim to economic empowerment of rural youths across the nation in diverse agriculture field. In order to generate sustainable income and meaningful employment at the village level, the focus has been on providing skill training and technological support to rural youth for establishment of entrepreneurial unit. This paper aims to evaluate the performance of ARYA project in U.P. for these major enterprise namely Goatry, Poultry and Mushroom cultivation. ARYA project is running in 10 Districts of Uttar Pradesh and trained 967 rural youths during 2023-24 in 8 different enterprises of their preferences. Among these enterprises, highest number of rural youth received training for goat farming (266) followed by Poultry Farming (185) and Mushroom Production (156) led to establishment of 317 new entrepreneurial units altogether. The highest average net income (Rs./unit/year) was received from goatry followed by mushroom cultivation and poultry farming. The similar trend was followed for the Average income generation for the employee (Rs/person/month). The highest B:C ratio was obtained in case of goatry (2.58) followed by followed by mushroom cultivation (2.49) and poultry (1.55). It was also observed that the KVK having ARYA project are actively providing skill training, technical and input support on different enterprises as per youth preference. Overall, it reveals that goatry was the most popular and Profitable entrepreneurial activity among the all livestock enterprise and successfully functioning continuously.

Keywords: Agri-preneurship, ARYA, Goatry, Rural youth

Theme 6: 269
Entrepreneurial Skills of Women Vendors in Ima Keithel

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Ima Keithel, nestled in the heart of Imphal the capital of Manipur, India. It is a vibrant and historically rich marketplace renowned for its cultural significance. The name beautifully translates from the Manipuri language as "Mother's Market," with *'Ima'* meaning mother and *'Keithel'* meaning market. Ima Keithel is a vibrant marketplace in Imphal, where over 3,000 women run their businesses daily. This unique all-women market is not only a thriving hub of commerce but also a reflection of Manipur's rich cultural heritage. It stands as a powerful symbol of women's empowerment, resilience, and their central role in the community. The objective of this study is to evaluate the entrepreneurial abilities of these women vendors. A total of 100 participants were randomly selected for the research. Data was gathered using a structured interview schedule, conducted through

personal interviews. The analysis employed statistical tools such as frequency, mean, standard deviation, and variance. The study reveals that majority of the women vendors have medium level of Innovativeness (60.00%), Self-confidence (67.00%), Achievement motivation (72.00%), Economic motivation (72.00%), Leadership skill (70.00%), Decision making ability (73.00%), Risk taking ability (70.00%), Managerial skill (58.00%), Business / marketing skill (72.00%), Problem recognition and Solving skill (62.00%). Overall, they are having medium level of Entrepreneur skill (66.00%). Despite of facing different challenges like low return from market, not being able to spend quality time with the family and bandh/strikes etc. they run their respective enterprises and support their families financially at the same time help in the economy of the state. To enhance their livelihoods, it is essential to implement effective extension strategies that raise awareness among women vendors socially, politically, technically, and educationally. Additionally, government agencies must take proactive measures to support and foster the development of women entrepreneurs at Ima Keithel, ensuring they receive the necessary resources and opportunities to thrive.

Keywords: Ima Keithel, Women entrepreneur, Business skill, Leadership skill, Entrepreneurial skill

Theme 6: 270

Disenchantment of Rural Youth from Agriculture: Causes, Consequences and Potential Strategies for Re-engagement

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In spite of being the backbone of Indian economy, the agriculture sector is facing a serious problem these days. The disenchantment of rural youth from agriculture is a pervasive concern with far-reaching implications. There are profound consequences of this challenge including aged farming population, loss of traditional knowledge in modern times and decreased agricultural productivity. Furthermore, social and economic instability will occur due to continuous migration of rural youth from rural to urban settings looking out for better future opportunities for themselves. A comprehensive analysis of existing literature reveals that factors such as limited future prospects, lesser technological integration, lower and late income as well as societal perception of regarding agriculture as a lower level of occupation contribute as pressing reasons for the disillusionment of rural youth from this sector recently. For immediate and quick addressal of this issue, potential strategies like promotion of entrepreneurship in the agricultural sector, integration of technology in farming practices, education regarding opportunities and growth in this sector and policy interventions such as credit facilities, subsidies and market support should be fostered so that the youth considers agriculture as a viable career option. Social media platforms like YouTube, Facebook and Instagram can significantly impact and attract youth towards this sector and also retain them by keeping them highly motivated and engaged to continuous learning opportunities. This paper highlights the strategies for re-engaging rural youth to this sector and leverages existing data to investigate the alarming trends of urban poverty. There certainly is a need of a multi-faceted approach to address the complex issues associated with the youth who are disillusioned from agriculture. By critically understanding the causes and consequences of this trend, educators and policymakers can improvise strategies for aligning the needs of rural youth with the existing farming scenario and strengthen the agricultural sector by empowering the young minds.

Keywords: Youth, Disenchantment, Social media platforms, Engage, Attract, Retain

Theme 6: 271

Youth in Agriculture: Harnessing Innovation and Entrepreneurship to Engage Youth in Agriculture

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The agricultural sector is increasingly challenged by youth disengagement, driven by perceptions of agriculture as laborious and unprofitable. To revitalize the sector, it is crucial to tap into the potential of youth, whose innovation and digital proficiency can reshape agriculture into a more productive, sustainable, and economically viable enterprise. This policy paper explores key strategies to attract youth to agriculture, with an emphasis on technology adoption, entrepreneurship, and skill development. The role of digital innovations–such as precision farming, mobile applications, IoT, drones, and AI–is highlighted as a transformative force, enabling data-driven decision-making, automation, and resource efficiency. These smart farming approaches make agriculture more appealing by reducing manual labor and enhancing productivity. The paper also underlines the significance of agri-entrepreneurship and value addition through initiatives like organic farming, farm-to-fork models, and food processing units, which create income-generating opportunities for youth. Furthermore, education and training–both formal and informal–are vital in equipping young people with practical skills to adopt modern agricultural practices and manage agri-businesses. Supportive policies, including financial incentives, credit access, incubation support, and infrastructure development, are essential to foster youth-led agricultural ventures. This paper proposes an integrated policy framework that blends digital innovation, enterprise development, capacity building, and enabling policies to reposition agriculture as a dynamic and desirable career path for the younger generation.

Keywords: Youth in agriculture, Smart farming, Agri-entrepreneurship, Digital innovation, Policy framework

Theme 6: 272

Impact of Skill-based Training on Quality Seed Production Among the Rural Youth at KVK Jalaun

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The present study shows the impact of Skill based training in attaining rural youth in agriculture through quality seed production. To promote rural entrepreneurship and improve the availability of quality seeds, Krishi Vigyan Kendra (KVK) Jalaun, in collaboration with the Agricultural Skill Council of India (ASCI), conducted a comprehensive skill-based training program on "Quality Seed Production" during 2020–21 and 2021–22. The 200-hour certified training targeted 40 rural youth, providing both theoretical and practical exposure in areas such as seed selection, treatment, certification, storage, and enterprise development. The outcomes of the training were notably impactful. Out of the 40 trained participants, 15 ventured into seed production activities. Among them, three were actively participated and served as director in Farmer Producer Organizations (FPOs) with a focus on seed production, while another three got employment in formal seed production agencies. The remaining nine initiated seed production enterprises by involving other fellow farmers and collaborated with reputed organizations including the National Seeds Corporation (NSC), KRIBHCO, State Seed Corporation, and KVK Jalaun. These efforts collectively led to the production of 4,050 quintals of certified seed, which included 2,400

quintals of wheat seed, primarily of the HD-2967 and DBW-187 varieties and 1,650 quintals of pulses comprising improved varieties released within the last ten years. The initiative resulted in a significant improvement in local agricultural productivity, with an average increase of 21% and an additional estimated economic benefit of [1] 22,000 per hectare per farmer. The horizontal expansion of this seed production activity reached approximately 4,050 hectares, directly benefiting 10,125 farmers based on acre conversion. The program effectively bridged the gap between skill development and entrepreneurial application, enhancing seed quality, boosting rural incomes, and contributing to the broader goal of agricultural sustainability. The training has thus proven to be a highly replicable model for rural development, showcasing how focused capacity building can drive both employment generation and agronomic advancement in underserved regions.

Key words: Quality seed production, Skill training, Impact, Employment generation

Theme 6: 273

Mobilizing and Empowering Rural Youths and Women in Rural Economies through STRY Program

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Agriculture is the cornerstone of rural economies, ensuring livelihoods, food security, and income for the majority of rural populations, especially in emerging economies. It supports employment directly and indirectly by strengthening allied sectors like agro-processing, marketing, and input supply. Beyond economics, agriculture preserves traditional knowledge, fosters environmental stewardship, and contributes significantly to poverty reduction. Strengthening this sector through infrastructure, technology, and inclusive policies is key to curbing rural-urban migration and building resilient, self-reliant communities. Youth and women are pivotal to agricultural transformation. Despite their vital contributions, they often face restricted access to land, credit, training, and leadership roles. Empowering these groups is essential for sustainable development, food security, and equitable rural growth. Their engagement, when supported with skills, technology, and enabling policies, can lead to innovative, productive, and inclusive agricultural systems. This study evaluates the impact of the Skill Training of Rural Youth (STRY) program under the National Mission on Agricultural Extension and Technology (NMAET), with a focus on nursery management. The program aimed to enhance the technical and entrepreneurial capacities of rural youth and women through practical training in plant propagation, nursery techniques, pest management, and business planning. Post-training assessments revealed significant improvement in technical proficiency, confidence, and awareness of sustainable nursery practices. Participants reported increased self-employment opportunities, income generation, and active engagement in agri-business. The findings emphasize the effectiveness of skill-based training in empowering marginalized groups and promoting agri-entrepreneurship. Scaling such initiatives is critical for sustainable rural livelihoods and inclusive agricultural development.

Keywords: Rural youth, Women empowerment, Skill training, Agri-entrepreneurship, Nursery management

Theme 6: 274

Empowering Farm Women through Ergonomic Interventions: Reducing Drudgery and Enhancing Occupational Well-being in Agriculture

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Farm women play a vital role in Indian agriculture, contributing significantly to various farming activities. However, they often operate in physically demanding environments, leading to drudgery, musculoskeletal disorders, and reduced work efficiency. This study was conducted in the Raebareli district of Uttar Pradesh to evaluate the effectiveness of ergonomic interventions in reducing physical strain and improving occupational health among farm women. A total of 100 women engaged in regular farm work were selected for the study. The intervention involved the introduction of ergonomically designed tools, including wheel hoe weeders, serrated sickles, foldable stools, and shoulder-supported water pots, tailored to reduce physical discomfort and enhance task efficiency. Data were collected using structured questionnaires, personal interviews, and focus group discussions to assess pre- and post-intervention conditions. Pain and discomfort were measured using a standardized body map and rating scales. The results showed a statistically significant reduction in musculoskeletal pain scores ($p < 0.001$), a noticeable decrease in the time required to complete agricultural tasks, and a high level of user satisfaction with the introduced tools. Women reported improved posture, reduced fatigue, and increased ease of performing repetitive tasks. The study highlights the critical role of ergonomic interventions in improving the health, productivity, and overall well-being of rural farm women. It emphasizes the need for gender-sensitive tool design and awareness programs to mainstream ergonomic solutions in agricultural extension services and rural development initiatives.

Keywords: Ergonomics, Farm women, Drudgery reduction, Occupational health, Agricultural tools, Rural women, India

Theme 6: 275

Breaking Barrier: Empowering Women in North-East India through ARYA

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Women in agriculture, despite forming a significant part of the agricultural workforce, often lack access to decision-making and essential resources. They globally face persistent inequalities in agriculture, that includes limited access to resources, education, training and financial services. These challenges, rooted in deep seated societal norms and gender roles, hinder their productivity and full participation in agricultural development. In India, empowering women and youth in agriculture is critical not only for boosting food security and productivity but also for promoting gender equality. However, multiple studies have demonstrated that women's participation in agri-entrepreneurship contributes significantly to achieving economic independence, enhancing the resilience of food systems and promoting the development of inclusive and sustainable rural communities. In this context, the Attracting and Retaining Youth in Agriculture (ARYA) project, was launched by ICAR during 2015–2016, with the aim to empower rural youth by fostering sustainable livelihoods through entrepreneurial activities. Although ARYA primarily targets youth engagement, the present study specifically explores its potential to contribute to women's empowerment within the agricultural sector. To evaluate the impact of such empowerment initiatives, the study focused on ten purposefully selected female entrepreneurs participating in the ARYA program, implemented by ICAR-ATARI Zone-VI in Guwahati. Empowerment was measured using the revised Project-level Women's Empowerment in Agriculture Index (Pro-WEAI) with the 3DE approach, based on Kabeer's definition of empowerment as expanding the ability to make strategic life choices in previously constrained environments. The findings affirm that with targeted support like ARYA, women in Northeast India are empowered (e(K)>80%), overcoming barriers and emerging as dynamic agents of change enhancing agricultural productivity, strengthening rural livelihoods and advancing gender inclusive development. However, barriers such as limited asset ownership, entrenched norms and the gendered division of labour continue to pose significant challenges.

Keywords: Women empowerment, ARYA, Northeast India, Gender

Theme 6: 276

Entrepreneurial Behaviour and Situation Analysis of Mushroom Growers: A case of Small-scale Mushroom Growers of Meghalaya

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Mushroom farming is emerging as a profitable agri-business venture, offering a sustainable and income generating alternative for the rural population, particularly in developing countries. Meghalaya state of North-East India is endowed with agro-climatic conditions that are highly conducive to mushroom farming. Recognizing this potential, the Government of Meghalaya has taken up various interventions to popularize mushroom cultivation and mushroom based enterprises for increasing the income of the farmers. The present study was taken up in the two districts which has the highest production of mushroom in the state viz., East Khasi Hills and Ri-Bhoi with few objectives viz., 1) To study the entrepreneurial behaviour of mushroom growers, 2) To study the relation of entrepreneurial behaviour of mushroom growers with selected variables and 3) To carry out situation analysis of mushroom enterprises. From each of the two districts, 30 mushroom growers were sampled as respondents of the study. Primary data were collected from the respondents through well-structured interview schedule. Chi square test of association and ordinal logistic regression analysis were used to analyze the relationship of EB with selected variables while SWOT analysis was employed for situation analysis. It was found that majority of the respondents belonged to lower medium (28.33 %) to upper medium (21.67%) EB categories. The variables experience in mushroom cultivation, trainings attended on mushroom, extension contact and usage of internet were found significantly contributing to EB of the respondents. The strength having the highest score was "climatic condition of the state is congenial for mushroom" and weaknesses having the highest score was "Short post-harvest shelf life/perishable nature of the mushroom". For opportunities "Mushroom enterprise generates more employment opportunities" has the highest score and for threats "unavailability of spawn" had the highest score. The study suggests establishment of mushroom based co-operatives / FPOs for ease of access to inputs and market for small-scale producers, facilitation for development of local spawn entrepreneurs for accessible and timely supply of quality spawn and creation of ICT based platform for reaching out to various backward and forward actors.

Keywords: Mushroom, Entrepreneurial behaviour, Situational analysis, Meghalaya

Theme 6: 277

Barrier Faced by Women in Adopting Agro-Based Enterprises: A Social and Economic Analysis Using Garratt's Ranking Technique

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The adoption of agro-based enterprises is influenced by several factors, including self-interest, education, confidence, and family support. To achieve the goal of women's empowerment, both economically and socio-culturally, and to make agriculture more appealing and profitable, women farmers need to be made aware of, motivated for, trained in, and experienced in managing various agripreneurial opportunities. This study was conducted in the Samastipur district of Bihar at Krishi Vigyan Kendra, Birauli. It aims to explore the challenges faced by women in adopting agro-based enterprises in Samastipur. To rank the constraints perceived by the women, Garrett's Ranking Technique was used, which converts the order of constraints and benefits into numerical scores. Women participants were asked to identify the major constraints they faced and to rank them in decreasing order of significance (i.e., Rank I for the most important constraint and Rank XIII for the least important). The findings revealed that the difficulty of managing dual duties (Garrett's score = 78.63) was ranked first and identified as the most significant constraint. Conversely, the lack of training, with the lowest Garrett's score of 19.56, was ranked thirteenth. Thus, there is an urgent need to improve the conditions of women farmers, as they constitute nearly half of the total population and form a crucial part of society. To provide professional expertise, line departments and KVKs in the villages may organize training programmes on mushroom cultivation techniques, production technology, and the preparation of value-added products from horticultural commodities.

Keywords: Agro-based, Birauli, Garrett's ranking technique, KVK, Production technology training, Training programme

Theme 6: 278

A Study on Factors Affecting Teaching Learning Environment at Indian Agricultural Universities

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The most crucial tool for bringing about the desired societal transformation is education. The Sustainable Development Goal 4 (SDG-4) of the United Nations (UN) emphasizes "ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all" in recognition of the significance of education. Ten agricultural universities from the North, South, East, West, and North-East zones were chosen at

random to participate in the current study. A sample size of 1100 students, including undergraduate, graduate, and faculty, were included in the study. A pre-tested structured questionnaire was utilized to gather quantitative data for the descriptive study design. All ten universities have an overall teaching effectiveness index of 0.607, which indicates above-average teaching effectiveness. Overall, it was discovered that most educators and learners (51.01%) classified the effectiveness of their instruction as medium. Overall teaching effectiveness was found to be significantly correlated with all eight attributes: teachers' preparedness, teaching pedagogy, availability to students, course characteristics, attitude toward students, attitude toward teaching, creativity, and fairness. Teaching effectiveness was found to be significantly and positively correlated with several teachers' related variables, including educational background, job commitment, attitude toward the profession, self-confidence, value expectancy, personal attributes, professional productivity, instructional skills, classroom interaction, job experience, achievement motivation, verbal, and nonverbal immediacy. Academic performance, self-confidence, and accomplishment motivation were among the student-related characteristics that showed a substantial and positive correlation with the efficacy of the teacher. Among institutional factors, teaching performance was substantially and favourably connected with HRD activities, teaching infrastructure, and feedback mechanisms. To better prepare graduates for the demands of the business, the findings are anticipated to offer insightful information for curriculum development, policy creation, and instructional tactics in agricultural education.

Keywords: Teaching effectiveness, Agricultural education, Factors, learning environment

Theme 6: 279

Impact of SHGs on empowerment of farm women in Longleng district of Nagaland

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Women's empowerment is a transformative process that enables women to challenge existing socio-cultural norms and enhance their well-being. Participation in Self-Help Groups (SHGs) plays a crucial role in fostering both social and economic empowerment, particularly among marginalized communities. This study examines the socio-economic impact of SHGs on tribal farm women and identifies key challenges faced by these groups in Longleng district, Nagaland. Data was collected from 120 randomly selected SHG members across two blocks (Longleng and Sakshi) using a pre-tested semi-structured schedule and personal interviews. The findings reveal that most SHGs had been operational for 8–10 years, with 40% of group leaders possessing only a high school education. About 61.70% of SHGs consisted of 10–15 members, while 43.30% conducted monthly meetings. Additionally, 44.20% maintained monthly savings, and 53.30% kept updated records. The study highlights significant improvements in self-confidence, decision-making ability, skill enhancement, social awareness, household income, savings, and employment levels after joining SHGs. However, key challenges included a lack of technical knowledge for income-generating activities (ranked I), insufficient training facilities (ranked II), and limited marketing opportunities (ranked III). Addressing these barriers is essential to strengthening SHGs and maximizing their impact on women's empowerment in tribal regions.

Keywords*:* Women's empowerment, Self-Help Groups (SHGs), Tribal Farm Women, Socio-Economic Impact, Nagaland.

Theme 6: 280
Gender Dynamics in Chilli-Based Farmer Producer Organisations: A Study from North Tripura District

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Chilli is a labour intensive crop that requires labour for sowing; harvesting; drying and that activities are mostly carried by women farmers. Though women play an important role in agriculture, which is 70% of all agricultural activities and labour intensive works in vegetable and chilli cultivation etc., but rarely, their works are undervalued and remain unappreciated. In this context study on "Gender Dynamics in chilli-based Farmer Producer organizations was conducted in North Tripura District" to analyze disparities between men and women farmers within the Farmer Producer organization. Two chilli-based FPO's from North Tripura were selected selectively. Data was collected through a semi-structured interview schedule; focused group discussion and field observation; 60 number farmer members were administered for the study. The study reveals that farming activities are controlled by men farmers in land preparation, irrigation, pesticide application and price negotiation and are also more involved in decision-making and leadership compared to their women counterparts, whereas labour intensive works are carried out by women farmers. The current finding also revealed the need for gender-sensitive capacity building, leadership opportunities that can recognize and empower women contribution.

Keywords: Farmers producer organisations, North Tripura, Gender dynamics

Theme 6: 281
A Fascinating Journey of Rural Farm Women to a Successful Food Processing Entrepreneur

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Agriculture is a crucial sector for human survival, and women's contribution to it is undeniable. Women play a crucial role in agriculture, both in small and big farms, producing food for their households, communities, and beyond. According to a report by National Sample Survey Office (NSSO), in India, about 46.0% of the agricultural workforce is female, but only 13.0% of rural women are engaged in entrepreneurship. While there is no specific data available on the percentage of women entrepreneurs related to agriculture in India, it is estimated that a significant number of women entrepreneurs in rural areas are involved in agriculture-related businesses such as farming, food processing, and handicrafts. In India, women have made significant progress in various fields, including entrepreneurship. Even though they have had to deal with a lot of problems, like cultural differences, lack of access to funding and resources, and bias based on gender, women entrepreneurs in India have kept going and have had a lot of success. Today, more and more women are breaking through these barriers and launching their businesses, contributing to the growth of the Indian economy and paving the way for future generations of women entrepreneurs. This paper explores the stories of some successful women food processing entrepreneurs Mrs Thuampuii and Mrs Lalsiampuii, who resides at N. Vanlaiphai Village, Serchhip District, Mizoram and talk about how they start food based processing with underutilized food crop in Mizoram, how they promote zero waste processing and how they influence other farm women to lighten the spirit of entrepreneurship within the village and how they achieved the rise of Women entrepreneur.

Keywords: Women empowerment, Entrepreneurship, Mizoram, Food processing

Theme 6: 282
Attracting Youth in Agriculture: Innovation and Strategies

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The future of agriculture hinges on the active participation of youth, who bring innovation, energy, and a fresh perspective to the sector. In India, where agriculture remains a primary livelihood for a significant portion of the population, engaging the younger generation is crucial to ensure sustainability and growth. Recent initiatives, such as the Attracting and Retaining Youth in Agriculture (ARYA) project, have demonstrated success, with 30,000+ youth trained in agri-entrepreneurship, leading to a 25% increase in youth-led agribusinesses in pilot districts (NABARD 2021). The adoption of digital agriculture-including precision farming (projected to grow at 12.7% CAGR, reaching $12.9 billion by 2027, Markets and Markets) and AI-driven mobile applications—has enhanced efficiency, reducing input costs by 15-20% while increasing yields by 10-15% (FAO 2022). Moreover, the rise of digital agriculture has opened new avenues for youth engagement. Innovations such as precision farming, smart mobile applications, and online platforms are transforming traditional farming practices, making them more efficient and accessible. These technological advancements not only enhance productivity but also attract tech-savvy youth to the agricultural field. Educational institutions and extension services play a pivotal role in this transformation by offering training programs that equip youth with the necessary skills and knowledge. Collaborations between government bodies, educational institutions, and the private sector can further strengthen these efforts, providing mentorship, financial support, and market linkages to aspiring young agripreneurs. A multidimensional strategy combining policy support, technological integration, and skill development is essential to incentivize youth participation. By fostering an ecosystem that promotes innovation and entrepreneurship, agriculture can leverage youth potential to achieve UN SDG 2 (Zero Hunger) & ensure long-term sectorial resilience.

Keywords: Entrepreneurship, Innovations, Digital agriculture, Transforming, Educational institutions

Theme 6: 283
Effect of Gender Disparities on Technology Adoption in Citriculture

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Women constitute 43% of global agricultural workforce, remain largely undocumented and scientifically untold in several sectors, especially, citrus farming (citriculture). Though citrus fruits are cultivated commercially in more than 150 countries, significant gender disparities exist in citriculture like women facing drudgery, lack of access to resources, advisories, technical information and opportunities for capacity development. This study was conducted by interviewing 100 women citrus growers of Nagpur, India. Only 20% of respondents had high Technology Adoption Score (3-5) and socio-economic parameters like age, education and size of citrus orchards of women farmers were found to be significantly associated (χ^2 value significant at 0.05 level) with citrus based technology adoption. Further, respondents with sound technical know-how of citriculture were found to face lesser degrees of socio-personal gender disparities (t-value=2.02 significant at 0.05 level) than those who lacked technical knowledge. Friedman Ranking method was used to rank 10 major gender disparities which were classified into 3 broad categories. Systematic strategies for women empowerment were outlined based on macro analysis that can lead to enhanced impact of agricultural technologies, improved livelihoods, sustainable citriculture and social development through achievement of Sustainable Development Goals.

Keywords: citriculture, gender gap, technology gap, women empowerment strategies

Theme 6: 284
Promotion of Scientific Mushroom Cultivation for Livelihood Enhancement in Champhai District, Mizoram

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Mushrooms have been a traditional seasonal food source for communities in Champhai District, Mizoram, where wild varieties are collected from forests for consumption and sale. However, recurring cases of mushroom poisoning—sometimes with fatal consequences—have highlighted urgent public health concerns. Despite these risks, demand for wild mushrooms remains high during peak seasons. To mitigate health hazards and meet the need for safe, high-quality mushrooms, Krishi Vigyan Kendra (KVK), Champhai, introduced scientific mushroom cultivation techniques, particularly the high-yielding Chinese method. Through extensive training, demonstrations, and frontline initiatives, KVK Champhai has successfully promoted sustainable mushroom farming. A key example is Pu C. Lalhmingliana from Khawzawl village, who, after receiving KVK training, established a 350 sq. ft. mushroom unit with financial assistance. From earning Rs. 32,500 per season in 2015, his production has now increased to 250 kg per season, generating Rs. 75,000 per cycle and an annual income of Rs. 3,20,000. His success story, featured on LPS (a local TV channel), sparked widespread interest, with residents from 20 villages seeking training. The initiative has since expanded, with self-help groups like Lily SHG, Vengthar Women SHG, and Ruthi SHG adopting mushroom farming, significantly boosting rural incomes. The Chinese method has doubled earnings compared to traditional collection, proving both economically and nutritionally beneficial. KVK Champhai's intervention has not only reduced poisoning risks but also fostered agricultural entrepreneurship, enhancing food security and livelihoods in Mizoram.

Keywords: Mushroom cultivation, Food safety, Rural entrepreneurship, KVK intervention, Sustainable agriculture.

Theme 6: 285
Empowering Rural Youth through Horticulture: The Journey of a First-Generation Farmer in Punjab

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The shift from traditional farming to high-value horticulture presents immense opportunities for income growth and sustainability, especially when backed by scientific guidance and extension support. Amninder Singh, a progressive farmer from Punjab's Sangrur district, began his agricultural career with no prior experience in diversification. Starting with conventional paddy-wheat cultivation, he later experimented with flowers and vegetables but faced challenges due to limited technical knowledge. Seeking improvement, he approached Punjab Agricultural University (PAU), Ludhiana, and Krishi Vigyan Kendra (KVK), Sangrur, where experts trained him in advanced techniques like nursery management, drip irrigation, fertigation, and protected cultivation. By 2013, Amninder initiated contract farming for flower seeds on two acres. Gradually, he expanded into cut flowers (rose, marigold, gladiolus) and diversified further, cultivating 6.5 acres by 2019-20. He also established an on-farm outlet, FARM 77, selling vegetable and flower nurseries directly to customers. Today, he manages 14 acres in Rabi and 3.5 acres in Kharif, specializing in high-quality seedling production using plug trays and raised

beds. In 2024, his enterprise earned Rs. 17.45 lakh from Rabi nurseries, Rs. 3.75 lakh from Kharif sales, Rs. 1.70 lakh from fresh vegetables, and Rs. 3.50 lakh from seed production. His success has inspired 15 neighboring farmers to adopt similar practices. Leveraging social media (YouTube, Facebook, Instagram), Amninder has attracted global attention, including interest from scientists and dignitaries. His journey underscores how scientific interventions and innovation can revolutionize farming, ensuring profitability and sustainability.

Keywords: High-value horticulture, Scientific intervention, Protected cultivation, Nursery management, Farmer entrepreneurship.

Theme 6: 286

Fostering Women Entrepreneurship for Sustainable Development in the NE Region

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The Government of India defines women entrepreneurs as those who own and control enterprises with at least 51% capital investment and generate 51% of employment for women. Northeast India, rich in biodiversity and agro-climatic advantages, holds significant potential in agriculture and allied sectors. With evolving economic dynamics, agriculture has transformed into an integrated ecosystem from farm to fork, offering immense scope for grassroots development. Women's economic participation is vital for sustainable growth, gender equity, and poverty reduction. According to McKinsey, India could add USD 0.7 trillion to its GDP by integrating 68 million more women into the workforce, while the World Bank notes GDP could grow by 1.5 percentage points by including 50% of women. Women in Northeast India have long engaged in entrepreneurship, generating employment, preserving traditional knowledge, and promoting sustainability. Initiatives by the government, NGOs, and self-help groups have nurtured their growth, though challenges like digital literacy, market access, and policy support remain. Strengthening institutions, mentorship, and financial inclusion is essential. Notable women-led ventures include Naara Aaba (Arunachal Pradesh), Sanajing Sana Thambal Pvt. Ltd. (Manipur), Ngayam Foods (Manipur), Agrithink Service LLP (Assam), Vedam Agro Enterprises (Manipur), Googoo Foods (Manipur), Green Biotech Eco solution Pvt. Ltd. (Manipur), Meira Foods (Manipur), *Naro Ki* – A House of Fresh Flowers (Nagaland), Kouna Manipur (Manipur), Easy Haat Pvt. Ltd. (Assam), ECO Far (Mizoram), Binita Mushroom Centre LLP (Manipur) who have overcome the traditional social hurdles and barriers of patriarchy and have come outside the dominion of the humble home to change not only their own lives but also the trajectory of the socio-economic growth and development of the nation. Out of over 2.8 million registered women-owned MSMEs in India, 40,163 are from the Northeast. Promoting women as agripreneurs is key to inclusive growth and reshaping societal attitudes toward gender equality.

Keywords: Women entrepreneurs, North East, Agribusiness, Startups, sustainability

Theme 7: 287

Impact of Soil Health Card on Productivity of major foodgrains in Assam

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The Soil Health Card (SHC) scheme, launched by the Government of India on 19th February 2015 at Suratgarh, Rajasthan, is a flagship initiative under the Department of Agriculture and Farmers' Welfare. The scheme aims to provide crop-specific nutrient management recommendations based on soil testing, thereby helping farmers enhance soil fertility and increase crop productivity. Against this background, the present study assessed the impact of SHC adoption on the productivity of major food grains in Assam, with a focus on summer rice, winter rice, lentil, and peas. A multistage sampling technique was used to select 160 farmers from Barpeta and Chirang districts–comprising 80 SHC adopters and 80 non-adopters. From each district, two blocks and two villages per block were randomly chosen. The regression adjustment method was employed to estimate the productivity gains of SHC adopters over non-adopters. The results revealed that SHC adopters experienced a significant increase in yields: summer rice yields were higher by 3.62 quintals per acre, winter rice by 1.94 quintals per acre, lentil by 0.082 quintals per acre, and peas by 0.511 quintals per acre. The findings indicate that the SHC scheme has positively influenced the productivity of major food crops in Assam, with a greater impact observed in cereal crops (rice) than in pulse crops (lentil and peas). This underscores the importance of expanding and strengthening SHC adoption to improve agricultural outcomes and promote sustainable nutrient management practices in the region.

Keywords: Soil health card, Nutrient management, Crop productivity, Assam, Cereal crops, Pulse crops

Theme 7: 288

Biodiversity of Underutilized Vegetable Crops of Manipur

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India harbors immense genetic variability and diversity in horticultural crops, reflected in morphological, physiological, and adaptive traits, as well as resistance to pests and diseases. With vegetables forming a vital component of the human diet, the sector has gained prominence in Indian agriculture. Given that India houses 16% of the world's population, enhancing vegetable production and incorporating underutilized crops is essential to meet nutritional needs and reduce the gap in per capita consumption. This study aimed to document indigenous and underutilized vegetable species from markets across Manipur, highlighting their nutritional and medicinal significance. Primary data were collected from 400 women vendors through personal interviews, and product profiling was carried out by recording scientific names, local names, families, and economic uses. A total of 34 plant species belonging to 26 families were documented, with the Apiaceae family (4%) being the most dominant, followed by Nymphaeaceae (3%). Vegetables sourced from wholesalers accounted for the highest share of the market, with an average contribution of 88.62%. Among the underutilized vegetables, *Thangjing* (fox nut) was most in demand, followed by *Ekaithabi* (water sensitive plant) and *Swgri* (Deccan hemp). The increasing demand for these vegetables reflects growing public awareness of their seasonal nutritional benefits and potential for enhancing food security.

Keywords: Underutilized vegetables, Indigenous crops, Manipur, Women vendors, Nutritional diversity

Theme 7: 289
Evaluation of Bioformulations on Different Crops in Ri-Bhoi District of Meghalaya

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India is a country with a diverse climate and natural resources; thus, it mainly relies on agriculture to deal with the current demographic issue. With regards to agriculture in particular, natural resources must be conserved without being squandered. Indigenous agricultural practices are based on the principles of agro-ecology, which emphasizes minimizing stress on the production system and using eco-friendly practices, both plant and soil health for long-term results without affecting soil quality, biodiversity, or the overall quality of environment. The study investigates the effects of four different treatments on the growth and yield of four crops (M1- Buckwheat, M2- Garden pea, M3- Linseed, and M4- Potato) during two consecutive rabi seasons. The experiment was conducted with four distinct treatments: [S1- *Beejamrutha* + *Jeevamrutha* + Bioenhancer], [S2- *Beejamrutha* + *Jeevamrutha* + *Acchadana*], [S3- *Beejamrutha* + *Jeevamrutha* + *Acchadana* + Bioenhancer and S4- Control]. Each treatment was applied to the crops across both the cycles, allowing for a comparative analysis of their performance. Among the four treatments S3 has shown significant difference in soil parameters (available N, P, K; micronutrients Fe, Mn, Cu and Zn; 338.5±3.8 kg ha^{-1}, 45.1±0.75 kg ha^{-1}, 288.7±5.33 kg $ha^{-1}$and 18.7 ± 1.9 mg kg^{-1}, 3.2 ± 0.2 mg kg^{-1}, 0.42 ± 0.03 mg kg^{-1}, 0.01 ± 0.00 mg kg^{-1}) and in all the four different crops recorded highest yield in both the seasons (M1- 10.5 q ha^{-1} and 12 q ha^{-1}, M2- 13 q ha^{-1} and 14.5 q ha^{-1}, M3- 9.5 q ha^{-1} and 11 q ha^{-1}, M4- 210 q ha^{-1} and 225 q ha^{-1}) compared to the rest of the treatments. The results of the study provide insights into optimizing crop and soil management strategies for the rabi season, with recommendations for best-performing treatments and crops. Hence the addition of bioenhancer to the natural farming components shows effective result on soil quality and yield of different crops.

Keywords: Biodiversity, Bioenhancer, Natural resources, Soil quality

Theme 7: 290
Impact of Biofertilization on Soil and Crop Quality of Sequence Crops

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Soil fertility decline is a major concern in prevalent climate change and excess chemical input use, a concern has risen for the need to promote agroecosystems that are more sustainable in order to improve the deteriorating soil health as well as reversing the yield plateau of crop. An intercropping system integrated with natural farming components and native isolates of bio-inputs serve as a sustainable agricultural practice in enhancing land use efficiency, soil fertility and overall crop productivity. The study aims to evaluate the effect of natural farming components and native biofertilizer isolates on soil quality, nutrient uptake and yield of intercrop (finger millet, rice bean, French bean) and mono crop (Maize) during Kharif season of 2023 and 2024, respectively. The findings indicate that while biofertilizer treatment showed better soil quality and crop yield, however, combination of natural farming components with native biofertilizer, significantly enhance the total system of soil quality and crop yield, which improve soil nutrient availability, microbial biomass, enzyme activities and plant nutrient uptake.

Combination of 2% native biofertilizer with 10% *jeevamrutha* and *beejamrutha* for seed treatment was effective in improving soil quality and crop yield. The results confirm the superiority of combine natural farming components and native biofertilizers for both the cropping system. It demonstrates the effectiveness of biological inputs in enhancing both quantitative and qualitative traits of soil and crop yield, respectively. This research significantly contributes to the field of sustainable agriculture, in mitigating climate change and in the context of field crops research. It underscores the benefits of integrating natural farming components with native biofertilizer inputs along with crop residue incorporation and intercropping of legumes with cereals in systems, paving the way for innovative agricultural practices that can meet the dual challenges of food and nutritional security and environmental sustainability.

Keywords: Biofertilizers, sustainable agriculture, soil fertility, natural farming

Theme 7: 291

Hill Ecosystem: A Long-term Experimental Experience

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Significant higher maize yield (3.30 t/ha) was recorded under 100 % N equivalent through organics in Maize + Ginger – French bean cropping system as compared to 50 % N equivalent through organic and farmer practices but it remained at par with 75% N equivalent through organics. However significantly maximum Ginger and French bean yield (7.03 and 6.16 t ha^{-1}) was noticed under 100% N equivalent through organics in Maize + Ginger – French bean cropping system as compared to other nutrient sources. The highest MEY (13.42 t ha^{-1}) was recorded with 100% N through organics as compared to other remaining nutrient sources, respectively. Significantly higher soybean yield (1.83 t ha^{-1}) was noticed with the application of 100% N equivalent through organics as compared to farmer's practices but remained statistically at par with other nutrient sources, respectively. Higher grain yield of buckwheat (1.70 t ha^{-1}) was recorded under 100% N equivalent through organics compared to other treatments, respectively. In maize + Turmeric – Rajmash cropping system highest maize yield (3.32 t ha^{-1}) was observed with application of 100 % N equivalent through organics which was statistically at par with 75% N through organics and significantly higher than remaining treatments, respectively. Compared to other nutrient sources, significantly higher turmeric yield (13.16 t ha^{-1}) was registered under 100% N equivalent through organics. Higher rajmash yield (1.80 t ha^{-1}) was noticed under 100% N equivalent through organics as compared to farmers practices. Significantly higher maize and Pahenlo dal grain yield (3.16 and 1.00 t ha^{-1}) was recorded under 100% N equivalent through organics compared to other nutrient sources but produced statistically similar result with 75% N equivalent through organics in Maize – Blackgram –Toria cropping system. Higher Toria yield (1.16 t ha^{-1}) was noticed under 100% N equivalent through organics as compared to farmers practices. Higher value of MEY (9.32 t ha^{-1}) was found with application of 100% N equivalent through organics when compared to other nutrient sources but remained at par with 75% N equivalent through organics. The result for the different natural farming practices in soybean +maize intercropping revealed that the maximum sole yield was recorded under (T_3) AI-NPOF packages with (26.50 q/ha) followed by (T_2) complete natural farming with (20.30 q/ha). The result for the different natural farming practices in vegetable pea + coriander intercropping revealed that the maximum sole yield was recorded under (T_3) AI-NPOF packages with (72.98 q/ha) followed by (T_2) complete natural farming with (60.14 q/ha).

Keywords: Organic farming, Natural farming, Sikkim, Soil, Manure, Maize, Soybean

Theme 7: 292
Utilisation of Ecosystem Services of Loktak lake by the Local Communities: A Scoping Study

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Ecosystem services represent the multiple benefits that people derive from ecosystems, including provisioning, regulating, cultural, and supporting functions. Loktak Lake, the largest freshwater lake in Northeast India and the lifeline of Manipur, is globally recognized for its unique floating "phumdi" and rich biodiversity, securing its designation as a Ramsar Wetland. However, ongoing ecological degradation has placed the lake on the Montreux Record, signaling threats to its environmental integrity and the livelihood security of dependent communities. This study aimed to map the ecosystem service utilization of Loktak Lake by local communities, assess the current state of these services, and identify pathways for sustainable management. The research was conducted in Thanga and Ithing villages of Bishnupur district using qualitative methods including semi-structured interviews and focus group discussions. The Rapid Assessment of Wetland Ecosystem Services (RAWES) approach and SWOT analysis were employed to evaluate ecosystem services and contextual dynamics. The study identified 17 key ecosystem services and revealed strengths such as the lake's biodiversity, scenic landscape, and cultural significance. Weaknesses included poor phumdi management and deteriorating water quality, while opportunities lay in tourism development and environmental education. Major threats were linked to dam construction, unregulated development, and deforestation. To ensure the long-term sustainability of Loktak Lake and the services it provides, the study recommends integrated lake basin management involving local stakeholders, policy support for community-based conservation, and the implementation of effective waste and water management strategies. These interventions can help secure both ecological health and community livelihoods.

Keywords: Loktak Lake, Ecosystem services, Phumdi, Community-based conservation, SWOT analysis

Theme 7: 293
Impact of High Intensity Cropping on Soil Phosphorus Fractions under the Foothills of Himalayas

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Phosphorus is a major part of DNA, RNA, and ATP, and is essential for genetic information and energy transfer in cells. Soils contain inorganic, organic, and soil solution P, with organic P being the most common at 20-80%. Phosphorus fractions in soil vary in mobility, bioavailability, and chemical behaviour, and can change in certain conditions. Cropping intensity has significant impacts on nitrogen and phosphorus pools. Present paper studied the impact of intensified cropping systems (with long history of >4 years) under five diverse cropland ecosystems on nitrogen and phosphorus pools in relation to changed substrate availability and fertilizer application. The treatment details include: T_1-Basmati rice-Wheat -Cowpea, T_2- Basmati Rice-Potato—Wheat-Mixed Fodder (Maize+ Cowpea + Charni), T_3-Basmati Rice-KnolKhol-Potato-Greengram, T_4- Basmati Rice- Radish- Green onion-French bean vegetable-Okra and T_5-Rice- Fenugreek- KnolKhol- Green onion-Dry Onion-Black gram. The samples were taken from three depths i.e 0-5, 5-15 and 15-30 cm in *kharif* season. The value of available phosphorus and labile organic phosphorus showed significant difference at 0-5 cm soil depth with the highest value in T_2- Basmati Rice-Potato-Wheat-Mixed Fodder. Moderately labile phosphorus was highest under T_2

(156.08 mg kg^{-1}) at 0-5 cm and at 5-15 cm the highest value was also recorded in T_2 (151.30 mg kg^{-1}). The maximum values of non–labile organic phosphorus was obtained in T_4- Basmati Rice- Radish- Green onion- French bean vegetable-Okra (37.02 mg kg^{-1}) at 0-5 cm soil depth. The maximum values of saloid phosphorus at 0-5 cm soil depth was observed under T_2 (37.02 mg kg^{-1}) with significant difference. Aluminium bound phosphorus content was highest under T_4 (46.73 mg kg^{-1}) while the lowest values were recorded in T_1 (41.26 mg kg^{-1}) at 0-5 cm depth. At 5-15 cm and 15-30 cm, the same trend was followed. The values of iron bound phosphorus content and reductant phosphorus content were maximum in T_4 and the lowest values were recorded in T_1. Highest values of calcium bound phosphorus was found in T_4 (184.95 mg kg^{-1}) at 0-5 cm soil depth. The similar trend was followed at 5-15 and 15-30 cm depth with significant difference at all depths. The values of reductant phosphorus was highest in T_4 (90.13 mg kg^{-1}) while the lowest values were obtained in T_1 at all the three depths. The application of organic manures along with fertilizers and their decomposition released organic acids and boost various phosphorus fractions. The results showed that were in the order Al-P > Fe-P >Ca-P. The major inorganic phosphorus fraction in alkaline soil was calcium bound phosphorus. The combined use of organic manures and fertilizers and their decomposition released organic acids and boost various phosphorus fractions. At regional scale, more diversified cropping system appears to be promising cropping practices that sustains phosphorus availability.

Keywords: Phosphorus, Fractions, Cropping intensity, Ecosystems, Labile Phosphorus

Theme 7: 294

Effective Management Practices of Potato Common Scab and Its Implications in Disease Prevalence in Etah District of Uttar Pradesh

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The widespread occurrence of potato common scab, caused mainly by *Streptomyces scabies*, leads to surface necrosis and deteriorates the quality of tubers, affecting their market value and causing significant economic losses. This disease has notably contributed to the decline in potato quality in the Etah district of Uttar Pradesh. Effective management strategies for this disease require an understanding of farmers' knowledge and practices regarding potato common scab. To gain insights into farmers' knowledge and management practices, a survey was conducted involving 75 randomly selected farmers from the key potato-growing block of Awagarh between October and December during the 2022–23 and 2024–25 growing seasons. The results revealed that most farmers (73.7%) identified potato common scab based on visual symptoms, specifically raised, rough, and often dark brown corky lesions on tubers. Additionally, 30.9% recognized tuber rot, although this symptom is common to many plant diseases. Regarding the perceived cause of the disease, 59.6% of farmers believed it to be seed-borne, while 31.6% attributed it to infested soils. The most preferred potato variety was Kufri Bahar (3797). A majority of farmers (80.3%) used seeds saved from their own farms, whereas only 5.9% used certified seeds. The findings of this survey highlight a gap in farmers' understanding of the relationship between infection sources and disease management. It is recommended that potato breeders consider marketability traits along with pest and disease resistance when developing new varieties. Furthermore, there is a clear need to educate farmers on the diagnosis, epidemiology, and management of potato common scab to improve tuber quality and reduce economic losses.

Keywords: Common scab, Disease, Potato, Seed borne

Theme 7: 295

From Awareness to Acceptance of Improved Feeding Practices among Dairy Farmers

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A pre-evaluation study conducted among dairy farmers in Hamirpur village, Bareilly district, Uttar Pradesh, revealed that while a high percentage of farmers were feeding green fodder (88%), sugarcane tops (85%), and other local inputs like vegetable waste (12%), mineral mixture (10%), salts (4%), and homemade probiotics (3%), none adopted scientifically recommended practices such as bypass fat, herbal anti-methane supplements, or urea-treated straw. This knowledge gap necessitated a sensitization program aimed at promoting improved feeding practices. The program involved assessing the farmers' knowledge before and after the intervention. Post-intervention results showed significant improvement in awareness and acceptance: 95.94% of farmers agreed to regularly incorporate salt, 91.41% were willing to adopt high-yielding green fodder varieties, and 88.38% accepted the idea of supplementing sugarcane tops with mineral mixtures. Additionally, there was notable willingness to adopt mineral mixes (78.47%), fresh vegetable waste (74.49%), herbal anti-methane products (72.44%), probiotics (64.28%), and bypass fat (56.66%). However, lower acceptance was observed for hay production (40.52%), urea-treated straw (39.88%), and silage production (33.5%). These findings underscore the effectiveness of sensitization efforts in bridging knowledge gaps and fostering the adoption of improved feeding practices among dairy farmers.

Keywords: dairy farmers, feeding practices, awareness, adoption, sensitization program

Theme 7: 296

Carbon Footprint of Diets: Shifting to Plant-Based for Climate and Nutritional Goals

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In recent years, the intersection of dietary choices, environmental sustainability, and human health has gained significant attention. Among the most pressing concerns is the carbon footprint of diets, which refers to the total greenhouse gas emissions (GHGE) generated during the production, processing, transportation, and consumption of food. Animal-based foods, particularly red meat and dairy, are associated with disproportionately high emissions, while plant-based diets are increasingly recognized as environmentally sustainable and nutritionally adequate alternatives. This paper explores the potential of shifting to plant-based diets as a strategy to address both climate change and nutritional security. Diets rich in whole grains, legumes, fruits, vegetables, nuts, and seeds not only support human health by reducing the risk of non-communicable diseases (NCDs) such as obesity, diabetes, and cardiovascular conditions, but also result in significantly lower environmental impacts. Studies have shown that plant-based diets can reduce food-related greenhouse gas emissions by up to 70%, while conserving water and land resources. Furthermore, the adoption of plant-based diets supports the United Nations Sustainable Development Goals (SDGs), particularly those related to zero hunger, good health and

well-being, climate action, and responsible consumption. Emerging dietary models such as the EAT-Lancet Planetary Health Diet provide a practical framework for balancing human nutritional needs with planetary boundaries. However, transitioning to plant-based diets requires careful planning to ensure nutritional adequacy, cultural acceptability, and accessibility, particularly in low-income and rural populations. Value addition in plant-based foods through fortification, bio-enrichment, and food processing innovations can help address nutrient gaps and increase consumer acceptance. In conclusion, shifting toward plant-based dietary patterns offers a holistic solution to mitigate climate change and improve public health. Multidisciplinary collaboration across agriculture, nutrition, policy, and education sectors is essential to promote sustainable dietary transitions at both community and national levels.

Keywords: Plant-based diets, Carbon footprint, Sustainable nutrition, Climate-smart Eating, Environmental impact of food

Theme 7: 297

Indian Barberry Possesses *in vitro* Cytotoxic Efficacy Against Human Cancer Cell Lines

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Cancer is one of the most life threatening diseases, which represents a substantial burden in the community and appears to be a prime cause of concern. Multidisciplinary scientific investigations are making best efforts to combat the disease, but the sure-shot, perfect cure is yet to be brought into the world of medicine. Chemotherapy is a major treatment modality for cancer, but most of the drugs used in cancer chemotherapy exhibit cell toxicity and can induce genotoxic, carcinogenic and teratogenic effects in non tumor cells. Therefore, the research for alternative drugs of natural origin, which are less toxic, endowed with fewer side effects and more potent in their mechanism of action, is an important research line. In the search of potential anticancer agents from natural products, the present investigation was carried out to evaluate the *in vitro* anticancer efficiency of *Berberis lycium* (Indian barberry) from Jammu region. Systematic bioassays were performed on different human cancer cell lines from breast, colon, lung, pancreatic, prostate origin *via* SRB process. The SRB assay is simpler, faster and more sensitive. It provides better linearity with cell number and was less sensitive to environmental fluctuations. Cells were allowed to grow for 24 h on 96-well flat bottom tissue culture plates and cells were further allowed to grow in the presence of test material for 48 h. Cell growth was terminated by addition of 50% (w/v) tricarboxylic acid and cells were stained with SRB dye. Excess dye was removed by washing with 1% (v/v) acetic acid and bound dye was dissolved in Tris buffer. OD was taken at 540 nm and growth inhibition of 70% or above in case of extracts and growth inhibition of 50% or above in case of compound was considered active for our bioassay purpose. Results revealed that the chloroform extract of *B. lycium* root demonstrated significant *in vitro* anticancer activity, leading to the isolation of an active ingredient namely berberine that exhibited potent anticancer effects, particularly against HCT-116 colon cancer cells, with mechanistic assays confirming apoptosis induction. Berberine‘s potent anticancer effects warrant further research on its therapeutic potential, formulation development and clinical applications.

Keywords: *Berberis lycium*, Indian barberry, in vitro cytotoxicity, SRB assay, Cancer cells

Theme 7: 298

Agroecological Factors Affecting Fall Armyworm and its Management through Novel Insecticides

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Maize (*Zea mays* L.) is one of the most important cereal crops grown worldwide and has better adaptability to diverse environmental conditions. It is used as food, feed, fodder, edible oil, biofuel, and for other industrial purposes. It is infested by various insect pests at different crop growth stages, and a few pests reduce the yield drastically. Among them, Fall armyworm, *Spodoptera* frugiperda, native to the neotropical Americas, is the most challenging one and is of global concern. A research was conducted to study the agroecological factors affecting the population fluctuation of fall and its management through some novel insecticides. It was observed that the larva was first noticed during the 30th SMW (0.20 larvae per plant), followed by adult moths during the 31st SMW (2.00 moths per trap). The larval population as well as moth catches per trap reached its first peak during 37th SMW (1.45 larvae per plant and 4.50 moths per trap, respectively) during the vegetative stage and a second peak was observed during 40th SMW (1.35 larvae per plant and 4.50 moths per trap, respectively) during the reproductive stage of crop. Both larvae per plant and moth catches per trap had a positive and significant relationship with morning ($r = 0.566^*$ and 0.497^*, respectively) and evening ($r = 0.570^*$ and 0.529^*, respectively) relative humidity and a negative and significant relation with bright sunshine hour ($r = -0.509^*$ and -0.564^*, respectively). The number of moths per trap had a positive and significant correlation with evaporation ($r = 0.574^*$) while the larvae per plant had a negative correlation with evaporation ($r = -0.748^{**}$). The predator population in the maize ecosystem showed a positive and significant correlation with both trapped moths and larval population. It was observed that per cent plant infestation as well as cob infestation was significantly lower in plots where crops were sprayed with combi-formulation i.e. Chlorantraniliprole 9.3% + Lambda cyhalothrin 4.6 % ZC@ 0.5 ml per litre of water and Novaluron 5.25% + Emamectin benzoate 0.9 % w/w SC @ 2 ml per litre of water as compared to plots where crops were sprayed with sole formulations of insecticides. Combi formulations of insecticides were proven to be better at managing the insect pest as compared to the sole formulation of insecticides. This may aid in delaying the development of resistance in target insect pests against a specific insecticide molecule.

Keywords: Combi formulation, Efficacy, Plant infestation, Cob infestation, Davis score, Yield

Theme 7: 299

Subhash Palekar Natural Farming: A Path Toward Sustainable Agriculture for Smallholders

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Agriculture has long been the backbone of India's economy, supporting nearly half the population and contributing significantly to the nation's gross value added. While the Green Revolution improved food security through high-yielding varieties and chemical inputs, it also led to adverse environmental consequences, such as soil

degradation, loss of biodiversity and increased input costs. These issues have spurred interest in sustainable alternatives like Subhash Palekar Natural Farming (SPNF), a low-cost, ecological model rooted in traditional practices. This study assesses the economic implications of SPNF in Himachal Pradesh, focusing on input cost reduction, soil health improvement and long-term sustainability. Conducted in Solan district using a multistage sampling technique, data were collected from 90 SPNF farmers practicing tomato and capsicum cultivation. The cost and return analysis revealed net incomes of Rs. 60,129.03/acre for tomato and Rs. 57,642.94/acre for capsicum, with output-input ratios of 3.13 and 3.01, respectively, indicating economic viability. However, challenges such as initial yield reduction, high labour requirements, difficult weed management and market-related constraints were identified. Despite these barriers, farmers reported improvements in soil quality and pest resistance, with increasing adoption of SPNF practices supported by state initiatives like the *Prakritik Kheti Khushhal Kisan Yojna*. The study concludes that SPNF holds promise as a sustainable farming approach, especially for smallholders, though policy support, market incentives and technical guidance are critical for broader adoption.

Keywords: Subhash Palekar Natural Farming, Cost reduction, Cost and return analysis, Prakritik Kheti Khushhal Kisan Yojna

Theme 7: 300

Varietal Diversification in Wheat Crop under Rain-fed Condition of Samba, Jammu Kashmir

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The present study was conducted to assess the varietal diversity of wheat crop in the rain-fed areas of Samba district of Jammu & Kashmir. A sample of 100 farmers was selected randomly from purposively selected two blocks of Samba district. It was found that the replacement rate for WH-1080 and HD-3086 varieties was 2.59 and 1.91 years, respectively in comparison to other varieties except HD 2967 (5.6 years). Four wheat varieties were dominant varieties cultivated by farmers covering a crop acreage of 90.23 per cent with a varietal diversity index of 0.257. Majority of the farmers (66%) have moderate level of diversification Two crops, wheat and mustard, accounted for 4/5th of the area under rain-fed cropping, out of which wheat crop have an area of 68 percent. Among small, medium and large farmers, only one variety was cultivated by eight small farmers, 25 farmers each having small and medium farm size cultivated two varieties while three varieties were cultivated by only nine large farm sized farmers. Overall, this study revealed that there is the prevalence of monoculture in the rain-fed areas and wheat is the prominent crop in rabi season and very less percentage of area was under other crops. The probability of damage to wheat crop from external factors such as sudden weather changes or the spread of diseases will increase and it will lead to production risks that will cause food insecurity in the future. To combat the threat to food security due to biotic and abiotic stresses, mixed varietal arrangements have a positive influence and are more robust.

Keywords: Wheat, Variety diversity, Farm size

Theme 7: 301

Preliminary Survey and Checklist of Phototactic Moth Diversity (Lepidoptera: Heterocera) at Banaras Hindu University, Varanasi, Uttar Pradesh, India

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Between 2022 and 2024, survey activities were carried out at the main campus of Banaras Hindu University (BHU), Varanasi, Uttar Pradesh, India, to assess and record moth species richness. These surveys led to the collection, identification, and documentation of 112 moth species, representing 89 genera across 9 families and 31 subfamilies. The families Crambidae and Erebidae were found to be the most dominant, comprising 33 species each, with 28 and 26 genera, respectively. Together, they accounted for 29.72% of the total moth diversity recorded. Following them were the families Noctuidae (15.31% with 17 species and 13 genera), Geometridae (12.61% with 14 species and 11 genera), and Sphingidae (8.12% with 9 species and 5 genera). The lowest species richness was observed in the families Eupterotidae, Nolidae, and Notodontidae, contributing just 4.54% of the total moth diversity. A previous study conducted in 2020 had recorded 99 moth species belonging to 84 genera and 11 families. The current study identified 5 additional genera, though the number of families declined from 11 to 9. The survey also compared earlier findings and attempted to explore potential causes for variations in faunal diversity. Rapid urbanization, light pollution, and environmental degradation were identified as possible factors contributing to the observed decline in moth diversity.

Keywords: BHU, Lepidoptera, Moth, Erebidae, Crambidae

Theme 7: 302

Field Evaluation of Biopesticides for the Management of Rice Planthoppers in South-Western Punjab

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Rice (*Oryza sativa* L.), a staple for nearly half the global population, is frequently threatened by biotic stresses, particularly insect pests. In northern India, brown planthopper (*Nilaparvata lugens* (Stal.)) and white backed planthopper (*Sogatella furcifera* (Horvath)) are major sucking pests that cause significant yield losses. The extensive and indiscriminate use of chemical insecticides has led to resistance development, resurgence, elimination of natural enemies, environmental pollution and pesticide residues. The present study was conducted to evaluate efficacy of biopesticides for managing planthoppers in basmati rice and assess their impact on predatory spiders and marketable yield. The field trials were conducted at PAU, Ludhiana and KVK, Sri Muktsar Sahib during *kharif* 2021 and 2022 using variety Pusa Basmati 1121. Treatments included commercial Azadirachtin 5% @ 150, 175 and 200 ml/ ha, PAU homemade neem extract@ 5.0, 7.5 and 10.0 l/ha, and Braham Astra @ 18.75, 20.0 and 31.25 l/ha, along with Dinotefuran 20 SG@ 200 g / ha as chemical check and an untreated control. The insecticide sprays were applied at economic threshold level (5 hoppers/hill), and hopper and spider populations were recorded at 3, 7, and 10 days after spraying (DAS). Marketable yield was also recorded. Results showed that Azadirachtin 5% @ 200 ml/ha significantly reduced hopper populations and showed 41.55% and 46.72% reduction over control at 10 days after spray in 2021 and 2022, respectively with minimal adverse impact on spider populations. Dinotefuran 20 SG showed the highest efficacy (up to 74.4% reduction)

but caused significant initial decline (3 DAS) in spider populations. However, subsequent observation at 7 and 10 DAS revealed non-significant difference in term of spider count. Marketable yields in Azadirachtin-treated plots were statistically at par with the insecticide check. The study concludes that Azadirachtin 5% @ 200 ml/ha is a promising biopesticide for planthopper management in basmati rice, offering effective control while preserving beneficial arthropods. It can be a valuable component of integrated pest management (IPM) strategies in rice ecosystems.

Keywords: Azadirachtin, Biopesticides, Planthoppers, Rice and Spiders

Theme 7: 303

Impact of Integrated Management Strategies Against Late Blight Disease (*Phytophthora infestans*) in Potato

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The Potato (*Solanum tuberosum* L.) late blight caused by *Phytophthora infestans* is one of the most devastating and threatening pathogenic diseases which resulted in direct crop losses. The disease not only harms the foliar portion in the field but also tuber during storage which absolutely, produces complete crop failure that cause farmers to embrace huge monetary expenses. The disease is responsible for the Irish Famine leading to massive starvation in Ireland and other parts of Europe during the middle of 19thcentury. Different methods of management techniques for prevention against late blight disease has been developed and used worldwide. An appropriate strategy needs to develop for effective management of late blight disease in potato. Therefore, On Farm Trial was conducted at demonstration farm of ICAR-KVK Churachandpur, Manipur for consecutive two years during *rabi* 2022-23 and 2023-24 to test the effectiveness of technology source from ICAR-CPRI, Modipuram, Meerut, Uttar Pradesh, India. The best three treatments from ICAR-CPRI, Modipuram, Meerut and additional one including farmer practice were evaluated. The result revealed that T_1 to T_3 are effective for managing late blight disease in potato upto certain level however lowest average disease severity was recorded in T_3 *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%) before appearance of disease followed by Mancozeb 75% WP (0.2%) at the onset of late light followed by *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%). The treatments T_1 (*Bacillus subtilis*(0.25%)+*Trichoderma viride* (0.7%) 3 spray, & T_2 (*Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%) before appearance of disease COC (0.25%) at the onset of late light followed by *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%) and T_3 = *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%) before appearance of disease followed by COC (0.25%) followed by *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%), were at par significantly reducing disease severity of 50.80% and 52.87% respectively followed by T_4 *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%) before appearance of disease followed by Neem oil based azadirechtin 0.15% (10.0%) at onset of late blight followed by one more spray of *Bacillus subtilis* (0.25%) + *Trichoderma viride* (0.7%) against the farmer practice. Similarly, higher yield was also expected from the treatments.

Keywords: Potato, *Phytophthora infestans,* On farm trial, *Bacillus subtilis, Trichoderma viride*

Theme 7: 304

Agriculture Induced Rural-to-urban Migration among Farmers and its Implications for Urban Policy in Northern India

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Agricultural migration in Northern India has been notably influenced by a range of factors, particularly in the wake of the COVID-19 pandemic. Previous research has primarily focused on the push-pull dynamics of migration, often overlooking the psychological dimensions. To address this gap, the present study investigates migration behavior through the lens of the Theory of Planned Behavior (TPB), incorporating two additional constructs: household decision-making and the participation of women in agriculture. Data from 480 migrant farmers were analyzed using exploratory factor analysis, confirmatory factor analysis, and structural equation modeling to uncover underlying constructs and test hypotheses. The measurement and structural models revealed significant relationships between the traditional TPB variables and the newly integrated constructs. The findings indicate that inter-state migration is prevalent among migrant farmers in Northern India. A comparative analysis of migration behavior suggests that cities need tailored policy responses to meet the specific requirements of seasonal, forced, and voluntary migrant farmers. For seasonal migrants, short-term measures such as improved housing, labor rights, and access to social services are essential. In contrast, forced migrants require targeted interventions for skill development and resilience planning to manage sudden influxes. For voluntary migrants, long-term strategies focusing on inclusive urban development, infrastructure enhancement, and economic integration are crucial to support sustainable urbanization. These insights contribute to building a more resilient and equitable society through sustainable rural development and advancing the Sustainable Development Goals.

Keywords: Migration, Theory of Planned Behavior, Structural Equation Modeling, Sustainable Development Goals, Urbanization

Theme 7: 305

Influence of Cropping Intensity on Soil Nitrogen Pools for Sustainable Agricultural Management

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An experiment was carried out to study the influence of cropping intensity on soil nitrogen pools. The soil samples were taken from a pre-existing experiment consisting of 5 treatments arranged in randomized block design with four replications at Research farm, Chatha, SKUAST-Jammu. The treatment details include: T_1-Rice (Basmati 370)-Wheat (HD-3086)-Cowpea (Lobia Super-60), T_2-Rice (Basmati- 564)-Potato (Kufri Pukhraj)-Wheat (Raj-3765)-Mixed Fodder (Maize+ Cowpea + Charni), T_3-Rice(SJR-129)-KnolKhol (G-40)-Potato (Kufri Sindhuri)-Greengram (IPM 02-3), T_4-Rice (Pusa-1121)- Radish (CR-45)- Green onion(Nasik Red)- French bean vegetable (Anupama)- Okra (Seli Special) and T_5-Rice (IET- 1410)- Fenugreek (JF-07)- KnolKhol (G-40)-

Green onion (Nasik Red)-Dry Onion (Selection-1)-Blackgram (Pant U-19). The samples were taken from three depths i.e 0-5 cm, 5-15 cm and 15-30 cm in kharif season. The available nitrogen at 0-5 cm depth showed significant results with the highest value under T_5 (287.46 kg ha^{-1}). The mean total value of total nitrogen was highest under T_5 (884.58 mg kg^{-1}) and showed significant results at 0-5 cm soil depth. Highest ammonical nitrogen and nitrate nitrogen was recorded in T_5 with significant difference at 0-5 cm soil depth. Highest soil microbial biomass nitrogen (SMBN) was found under T_5 (23.78 μg g^{-1}) at 0-5 cm soil depth and at 5-15 cm the highest values was also found in T_5 (22.23 μg g^{-1}) with significant difference among treatments at 0-5 and 5-15 cm soil depths. The study indicated that intensification of all the cropping systems through leguminous crops is responsible for higher nitrogen fixation and it enhanced the availability of various nitrogen pools. It was also revealed that the continuous intensification may have a detrimental impact on nitrogen availability but with the incorporation of legumes, there was enhancement of nitrogen pools under diversified cropping system. Long term application of various organic and inorganic amendments along with increased cropping intensity not only enhance the status of nitrogen pools accumulation but it also hastens the process of mineralization in soils.

Keywords: Nitrogen, Pools, Cropping intensity, Mineralization, Microbial, Legumes, Diversified

Theme 7: 306

Exploring the Supplemental Feeding of Poultry to Enhance Production in the Context of Climate Change and to Complement Sustainable Farming in Integrated System Approach

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Climate change has had a significant impact on the northeastern region of India, especially Meghalaya. This includes rising mean annual temperatures, unpredictable rainfall patterns, and deteriorating soil health, etc. In spite of these challenges, the locals have followed sustainable agricultural practices that allow for improved adaptation to climate change, reduced environmental degradation caused by agriculture, and better utilization of natural resources. One such approach is the integrated farming system (IFS) of agricultural practice that combine crops, livestock, fisheries, and agroforestry to maximize resource use and diversify farmer's income. The principle of IFS is based on the effective recycling of resources, whereby the waste generated from one component is recycled and used as a resource for the other component. Here, we present the study on the utilisation of locally available weed (Alligator weed) and herb (Pudina) as feed supplement for enhanced production and improved health in grower chickens. The results showed the beneficial effects of supplementation in grower chicken with alligator weed (01%) in winter season and pudina (0.5%) in summer season in Umiam weather condition when the ambient temperature varies with the thermal comfort zone of the poultry birds for its optimal production. The weed and herb are easily grown and available resources in the traditional bun cultivation system of agriculture practice by the state's tribal communities or the bench terracing on hilly slopes by levelling out slopes to enhance water retention and lessen soil erosion. Effective utilisation of plant resources (weed and herb) grown in the cultivation system which otherwise would have compete with other cultivated crops be use for enhancing poultry production is an implementable intervention for ameliorating food security, sustainability, and resilience in integrated system approach of agriculture. Therefore, climate adaptive management can serve to overcome the challenges in promoting sustainable practices in agriculture.

Keywords: Poultry feeding, IFS, Sustainable, Climate adaptive management, Alligator weed, Pudina

Theme 7: 307

Analyzing Constraint and Suggestion of Respondents Regarding Dairy Management Practices in Semi-urban and Rural Areas

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India needs to increase milk production which can be possible by narrowing down the gap between the existing technology and their adoption. Ensuring domestic demand and enduring top most position in the world, India needs to produce 300-400 million tones of milk by 2050 (Vision 2050, 2015). The dairy is a business which provides the continuous source of income to the occupants and in case of landless person who are economically week, livestock farming is a better option. The research was based on a survey done in 2022-23 to analyzing constraint and suggestion of respondents regarding dairy management practices in semi-urban and rural areas of Fatehpur district in Uttar Pradesh. 15-15 respondents from each selected semi-urban and rural villages were randomly selected to constitute 120 samples (60 semi-urban + 60 rural). The perceived constraints have been studies under different aspects like: personal constraints, economical constraints, technological constraints and marketing constraints. The semi-urban respondents has perceived most serious type constraints viz., lack of poor economic condition of farmers, dysfunctional of animal insurance schemes, A.I. and BAIF centers are away from the village, lack of remunerative milk prices. Whereas rural respondents has perceived most serious type constraints viz., lack of interest of other family members, veterinary medicines are very costly for treatment of sick animals, A.I. and BAIF centers are away from the village, poor transportation also affects adversity in proper disposal of milk products. Suggestions as perceived by semi-urban respondents *viz*., 'educational programmes regarding cattle breeds improvement for higher milk production should be initiated' was ranked first whether in case of rural dairy farmers 'government must provide marketing facilities at village level.

Keywords: Constraint, Suggestion, Dairy, Management, Semi-urban, Rural

Theme 7: 308

Improvement of Dairy Management: Strategies for Enhanced Productivity and Sustainability

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Dairy management is a vital component of animal husbandry, directly affecting milk yield, animal welfare, and farm profitability. In many developing and developed regions, sub-optimal management practices result in inefficiencies. The integration of scientific techniques, technological innovations, and sustainable policies offers significant opportunities for improvement. Livestock productivity is a cornerstone of global food security and rural livelihoods. Enhancing productivity involves a multifaceted approach that includes genetic improvement, optimized nutrition, advanced disease management, improved breeding practices, and the adoption of precision technologies. Innovation in livestock is transforming traditional animal agriculture into a more efficient, sustainable, and humane industry including precision livestock farming, genetic advancements, alternative feeds, sustainable practices, animal welfare technologies, veterinary biotechnology, and block chain integration. These innovations not only enhance productivity and animal health but also address environmental concerns and food security.

Keywords: Dairy management, Productivity, Animal health, Food security, Technological innovations

Theme 8: 309

Livelihood and Nutritional Security of Tribal Farmers: Successful Interventions of KVK Pratapgarh

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Agriculture, livestock and allied sector development is the major support system to rural economy, which provides livelihood, nutritional and income security to the farmers. At present the science and technology are developing very fast in terms of quality and quantity. KVKs through advisory services and progress forges to reinforce the farmers capacity to innovate. Role of extension has changed from production intensive to income facilitator, because now a days farming is beyond subsistence, it is more like a business. In the connection KVK, Pratapgarh of Rajasthan is making necessary field level need based low cost technological interventions. Some technologies are being adopted by the farmers namely Azolla, Low cost shade net house, Honey bee rearing, Nutritional gardening and Organic farming. Azolla is protein rich fern which helps in increasing milk productivity (15-20%) of cattles as well as good egg production of poultry and fast weight gain of broilers. Low-cost shade net house is prepared by using bamboos by which a farmer can earn extra income of Rs. one lakh within a year by selling seedlings of different vegetables and fruit crops. Honey bee rearing helps tribal farmers to earn additional income through selling honey. It also increases production of field crops through pollination. Nutritional gardening and organic farming help all farm families to eat fresh organic vegetables & keep themselves healthy.

Keywords: Technologies, Azolla, Low cost shade net house, Nutri garden

Theme 8: 310

Processing of Local Poultry Meat for Food and Nutritional Security

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Poultry meat is important source of animal protein which is very important for the normal functioning of the human body. It is highly perishable, having a shorter shelf life, spoilage commences immediately after slaughtered and a vast array of biochemical and physiological changes take place from the time chicken is slaughtered until it is consumed. Effective utilization of these by-products for the production of value-added meat products is one way to realize maximum returns from the poultry sector. Pickling of meat is an alternative method to develop a low-cost shelf-stable meat product in the market. It helps to improve desirable characteristic like taste, flavor and texture along with the preservative effect. These poultry product will act as dietary supplements of people of different age groups. These products got very high benefit cost ratio**.** The results showed that chicken pickle stored successfully for 180 days at ambient temperature (26±4 °C) without any significant change in the quality attribute after incorporation of vinegar and sodium benzoate as a common preservative. The result showed that the preservation of local chicken pickle with vinegar and sodium benzoate was the best method for extending the shelf life and to retard the growth of microbial load. From the study, it was also found that treatment five got the highest sensorial score in terms of colour, flavour, texture, taste, appearance and overall acceptability than the other four treatments. The value added products from poultry meat could facilitate sustainable livelihood and also help to increase food and nutritional security

Keywords: Processing, Pickling, Poultry meat, Sensory, Shelf life

Theme 8: 311
Development of Dragon Fruit Based Herbal Tea for Food and Nutritional Security

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Dragon fruit is a nutritious tropical fruit loaded with fibre and antioxidant which helps to prevent oxidative damage, cancer, premature aging, lower blood sugar and improve immune system. Dragon fruit tea is fruit based healthy drink prepared by incorporating dried dragon fruit pulp, peel, orange peel, lemon pulp and ginger by mixing in proper proportion. Seeing the nutraceutical properties and health benefits based herbal fruit tea was formulated by using underutilized locally available fruits and analyzed for proximate, phenolic, flavonoid content and antioxidant activities. The sensory quality for consumer acceptance of the fruit tea was analysed by hedonic scale. The statistical analysis was performed in triplicate and data are presented as means ± standard deviations (SD). The fruit tea under this study exhibited higher protein and carbohydrate content (5.6g/100g and 33.3g/100g). The vitamin C content in dragon fruit tea was recorded as 86.29 ±4.2 mg/100 g. The TPC value of dragon fruit tea was found to be 368.9±0.07 mg GAE/100g DW. The flavonoid content dragon fruit tea was found to be 232.2 ±0.12 mg QE/100g DW. The antioxidant activity analysis revealed that dragon fruit tea (129±0.07 mg AAE/100g) in DPPH assay which is very high as compared with other fruit tea available in the market. However, the present fruit tea infusions have shown high sensory quality and infusion time is also directly correlated with sensory quality. Incorporation of these high nutrient rich ingredients have resulted in unique colour, flavour contributing to enhance sensory attribute and overall acceptability of the product. Hence, Dragon fruit tea infusions will not only serve as the beverages but also act as dietary supplements of natural antioxidant and vitamin C of people of different age groups.

Keywords: Dragon fruit, Phenolic content, Flavonoid content, Antioxidant activity

Theme 8: 312
Academia to Agri-Entrepreneurship: A Case Study of Organic Farming and Value Addition in Punjab

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Processing plays a crucial role in enhancing profitability for farmers by adding value to the raw produce. Through processing, agricultural produce such as wheat, barley, sugarcane, pulses and oilseeds are transformed into higher-value products like flour, dalia, jaggery, oils and other derivatives, which fetching higher prices in the market. It not only increases the net revenue for farmers but also reduces dependency on raw produce sales, which are often subject to volatile market prices. This case study explores the entrepreneurial journey of Smt. Harpreet Kaur, who transitioned from academician to an organic farming entrepreneur by successfully established an organic farming and processing enterprise in Sangrur, Punjab. Using a case study research method, data were collected through personal visits to Harpreet's farms and her processing complex, along with observations of routine activities, working pattern, and enterprise records. Harpreet Kaur, driven by a desire for family wellness, self-achievement and community impact, made the strategic decision to shift from teaching profession to organic

farming, starting with a small-scale vegetable cultivation for domestic use in 2015. After conducting market research and receiving technical training from Krishi Vigyan Kendra (KVK) Sangrur, Punjab Agricultural University (PAU), Ludhiana and Punjab Agro, she expanded her operations and registered her organic farm with Punjab Agro in 2018. Her venture, Maan Kudrati Kheti Farm, focused on organic farming and value-added processing of produce and dairy, benefiting local farmers and farm women through quality products, fair pricing and job creation. The study outlined the key challenges, such as lack of experience, proper infrastructure, and navigating bureaucratic processes. With technical support in areas like crop production, and market linkages, she successfully grew her processing business. Her commitment to organic practices and innovative products, including mustard oil, organic wheat flour, organic pulses, pickles, spices, jaggery and dairy products positioned her brand strongly in the market. This research highlighted the significance of processing as a viable opportunity for rural entrepreneurship.

Keywords: Processing, Agri-entrepreneur, Case study

Theme 8: 313

Intercropping of Legumes in Sugarcane for Crop Diversification and Livelihood Security

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Crop diversification encompasses several concepts to accommodate the intercrops with sugarcane in space and time for vertical land productivity. In sub-tropical India, sugarcane is planted at narrow spacing of 90 cm in autumn season, 75 cm in spring season and 60 cm row to row spacing in the summer season, while sugarcane is still planted at wider spacing of 120-150 cm to facilitate the mechanization of cultivation operations in tropical India. Being widely spaced, initially slow growing, long duration and one time income generating crop, sugarcane crop provides ample scope for intercropping with short duration, high value and mid-season income generating pulse crops for food, nutritional and livelihood security especially of small and marginal cane growers. Keeping above points in view, several studies were conducted at ICAR-IISR, Lucknow to identify suitable crops for intercropping in sugarcane for crop diversification, achieving higher productivity, harnessing positive associative complementarity of intercrops and making the system economically more viable and mid-season income generation. The IISR studies have established profitable sugarcane based intercropping systems with inclusion of leguminous crops in sugarcane. In autumn planted sugarcane, rajmash and lentil were found the best intercropping system with 2.54 and 1.73 benefit: cost ratio. In spring planted sugarcane, cowpea and mungbean were identified as the best intercropping system with 1.48 and 1.38 benefit: cost ratio. In winter initiated ratoon, intercropping of berseem, shaftal and lucerne were identified as best fodder based intercropping system with 2.43, 2.35 and 1.96 benefit: cost ratio, respectively. Pulse based intercropping system involving rajmash and lentil have been found the most profitable and sustainable due to additive nutrient synergies in the system and positive associative effects on cane yield. This system helped in improving soil fertility by improving physical, chemical and microbial properties of soil and generating ample income and employment opportunities in sugarcane farming.

Keywords: Intercropping, Sugarcane, B:C Ratio, Income

Theme 8: 314

Impact of Demonstration of Kitchen Garden in Farm Families in Southern Delhi

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As per the National Family Health Survey (2019-21) – 5, it is estimated that a 17% of children under the age of 5 years are stunted due to chronic under nutrition and 66% women under the age group of 15-49 years are anemic in rural Delhi; Micronutrient malnutrition is indeed affecting around 20% with serious public health consequences. The underlying cause may be the unawareness, illiteracy, inadequate availability of vegetables and fruits and low purchasing power of the households. Keeping into consideration the high prevalence of malnutrition especially micronutrient deficiencies and inadequate availability of vegetables, With the purpose of evaluating the nutritional security of farm households, Krishi Vigyan Kendra, Ujwa Delhi has conducted 20 front line demonstrations on development of scientific kitchen garden in South West District of Delhi during 2024-2025 with farm families of 4-6 members were selected purposively. An area of 200 m^2 was taken to establish kitchen garden for each family. The results of the demonstration showed an improvement in availability of vegetables for consumption at both household and individual level. The average per capita availability of vegetables increased from 190 gm/day to 285 gm/day. The awareness on nutrition and technical knowledge on scientific utilization of kitchen garden were also increased due to demonstration and training programme. The nutritional garden encouraged families to include freshly picked vegetables in their daily diets, which helped to improve their families' nutritional condition.

Keywords: Kitchen garden, Vegetables, Per capita availability, Front line demonstrations

Theme 8: 315

Effectiveness of Nutritional Education Intervention in Improving Food Habits among Farming families of Punjab

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Rural farming communities, despite being food producers, often face nutritional challenges due to inadequate dietary practices, limited awareness of food safety, and lack of nutritional literacy. This study investigates the effect of an educational intervention in the form of a comprehensive booklet on the food habits of farming families in Punjab. A pre-post experimental design was employed to assess change in food habits. The sample comprised farming households selected through purposive sampling from eight villages across four districts, encompassing 160 female respondents. Baseline data were collected using a structured questionnaire, followed by the distribution of the educational booklet. After a fixed intervention period, the same tool was administered post-intervention to assess changes. The findings reveal statistically significant improvements across the parameters, with notable shifts in the adoption of safe food handling practices, regular meal patterns, increased inclusion of diverse food groups, and enhanced understanding of nutritional needs. The study contributes to the growing discourse on community-based nutrition interventions and offers scalable insights for policy formulation and rural health planning.

Keywords: Effectiveness, Farming families, Food habit, Nutritional education, Intervention

Theme 8: 316
Valorization of by-products from Peanut Milk Processing for Nutrition Security

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The valorization of by-products from peanut (*Arachis hypogea* L.) milk processing is an innovative approach that can contribute significantly to nutrition security. The production process generates several by-products, including peanut-okara, oil residue, and whey, which are often discarded or underutilized. These by-products are rich in bioactive compounds, proteins, fats, and fiber, offering substantial potential for value-added applications in various industries including food. The study conducted on utilization of peanut milk processing by-products, explores the nutritional and functional benefits of utilizing these by-products for enhancing food and nutrition security with dairy free alternatives. By harnessing the proteins, fibers, and healthy fats present in peanut milk by-products. Peanut okara, a prominent by-product, is a rich source of protein and fiber, which can be used as a high-quality supplement in food formulations, thereby improving the protein intake of vulnerable populations. Similarly, peanut oil residue contains essential fatty acids especially MUFA, that can be incorporated into food products, contributing to overall nutrition. Additionally, these by-products can be processed into functional ingredients such as prebiotics, antioxidants, and emulsifiers, further enhancing the nutritional value of food products. The incorporation of peanut by-products into human diets offers a sustainable solution to reducing food waste and improving nutrition, particularly in regions where protein and healthy fats are scarce. Furthermore, the valorization of these by-products supports a circular economy, reducing environmental impact and contributing to sustainable agricultural practices.

Keywords: By-product utilization, Peanut milk, Nutrition security

Theme 8: 317
Value Added Products of millets for Enhancing Income

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"*Shree Anna*" or millets are comparatively better in nutrient-rich profile compared to major staple foods of rice and wheat, particularly in fiber, protein, and certain micronutrients like iron and magnesium. Like rice and wheat as well as millets also provide carbohydrates for energy, millets excel in weight management, digestion, and blood sugar control due to their higher fiber content and lower glycemic index. Higher fiber content in millets helps indigestion, promotes satiety, and can help manage weight. Millets generally contain more protein than wheat and rice, making them a good source of this essential macronutrient, particularly for the vast majority of the vegetarian population. Millets are generally richer in iron, magnesium, and B vitamins. Millets have a lower glycemic index than rice and wheat, making them a better choice for managing blood sugar levels, especially for patients suffering from diabetes. Millets can be transformed into a wide variety of value-added products. These include breakfast items like *idli, dosa,* and *upma*, snacks like *laddu* and *murukku*, and even beverages and bakery items. Millets can be used to create flours, cakes, breads, and more. Now, there are several value-added products which can be used by us in the breakfast and snacks. In the breakfast, we can have*idli, dosa, idiyappam, roti, puttu,*

upma, museli and other instant mixes prepared from millets. In the snacks, we can have *Laddus*, *murukku*, and other traditional snacks, puffed or popped millets, flakes, and puffs, millet rusks and other bakery products. In the bakery products, we can have bread, cakes, cookies, and health bars, edible biscuit cups, muffins, and other baked goods prepared from millets. In the beverages, we can have malted millet-based beverages, germinated ragi drinks, and multigrain drinks and ready-to-drink millet beverages. Now, we have number of dishes of various millets, which have become very popular among masses. The flour of finger millet is commonly used in various dishes like ragimudde. Pearl millet isnow very popular for making various products like *khichdi, roti*, and *upma*. Little millet isbeing used in a variety of products, including premium flour and multi-millet health mixes. Thus, these value added products of millets will not only improve human health but enhance the income of millet producing farmers.

Keywords: Millets, Value addition, Better Income, Health benefit

Theme 8: 318

Processing of Underutilized Roselle Fruit into Herbal Tea for Food and Nutritional Security

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Herbal tea is prepared from plants, dried fruits, flowers, leaves, root and stems of plants, which helps in boosting immunity, aiding digestion, reducing stress, anxiety and also for improving heart health. Roselle is one of the underutilize fruit which is wildly available in plenty in many parts of North east region of India. It exhibits high natural antioxidants which can scavenge the free radicals which are very reactive and harmful to human health. Seeing the nutraceutical properties and health benefits, Roselle based herbal fruit tea was formulated by using underutilized locally available fruits and analyzed for proximate, phenolic, flavonoid content and antioxidant activities. It is prepared by incorporating roselle, pineapple and ginger by mixing in proper proportion. The sensory quality for consumer acceptance of the fruit tea was analysed by hedonic scale. The statistical analysis was performed in triplicate and data are presented as means ± standard deviations (SD). From the study it was found that Roselle- pineapple blended fruit tea infusions contained high amount of total phenolic content of 664.9±0.31 mg GAE/100 g while flavonoid content of roselle-pineapple tea was recorded as 232.2±0.12 mg QE/100 gm. The antioxidant activity of roselle-pineapple (460.0±0.2mg Ascorbic acid Equivalent/100 g sample) was very high as compared to other fruit tea (129.7±0.07mg Ascorbic acid Equivalent/100 g sample). It also observed that the protein content is 5.0 g, fat content 0.16g and carbohydrate content 23.7g per 100 g. The fruit tea infusions also contained high vitamin C content. However, the present fruit tea infusions have shown high sensory quality and infusion time is also directly correlated with sensory quality of roselle pineapple tea. These fruit tea infusions will be a good alternative for other sweetened drinks. It is mainly designed in order to boost optimum health as well as for reducing the risk of certain diseases like diabetes, heart diseases and cancer. There is a great potential for the commercialization of immune boosting health drink to create market opportunities among start -up entrepreneurs.

Keywords: Herbal tea, Roselle, Pineapple, Flavonoid content, Antioxidant activity

Theme 8: 319

Nutritional Garden: A Sustainable Model for Food Security and Diversity

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Malnutrition is a serious problem in rural areas of India. Nutritional garden is one of the best ways of ensuring access to a healthy diet. Nutritional garden assures adequate and consistent supply of fresh vegetables for all improving the hemoglobin of women & children. It also saves the family thousands of rupees in food and possibly also medical expenses. Community and nutrition gardens can play an important role in enhancing national food security and dietary diversity to combat malnutrition. Thus nutrition gardens can prove to be as sustainable model for providing food security and diversity to combat malnutrition at the household or community level. The study was undertaken by the KVK, Hardoi-I. In villages of Hardoi district, the major problems are poor health status, malnutrition causing growth retardation, reduced work output and high morbidity and mortality rate among the population. In order to improve food and nutritional security of family members, KVK, Hardoi-I demonstrated- FLD on kitchen gardening during 2020-21, 2021-22 and 2022-23. The present study was conducted in 10 villages to improve the nutritional security of the family members of through development of nutrition garden near to their houses. A total of 30 numbers of families were selected constituting 30 farm women. It was found that the production of vegetable of respondents increased by 586.2 per cent resulting increase in consumption of vegetable by 48.81 per cent and subsequently vegetable purchasing decreased by 32.1%. It was also seen that apart from economic saving on vegetable consumption, organic kitchen gardening also provided them a livelihood support enterprise for fighting against malnutrition and poverty by providing them an additional income and empowerment of women. Likewise, intake of energy, protein and iron increased significantly after introduction of organic kitchen garden ($p<0.05$).

Keywords: Nutrition, Health status, Malnutrition, Nutritional garden

Theme 8: 320

Study on Nutritional Value and Shelf Life of Tree Bean Pickle

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Commonly known as Tree bean, and scientifically known as *Parkia timoriana* (DC.) Merr is a plant of the genus Parkia in the family Fabaceae. It is locally known as Yongchak in Manipur, which is a native of Southeast Asia and Northeast India. Tree beans possess a diverse range of nutrients and supplements that can benefit health. It is widely used in local cuisine as Iromba and singju. Since it is a seasonal plant, it is not available throughout the year. Pickling of Tree beans will be one of the methods to preserve in value-added form. The study shows the preparation of the tree bean pickle found in Manipur with other ingredients such as oil, spices, and vinegar. The evaluation of nutrients in the tree bean pickle shows the presence of crude proteins (14.87g), crude fats (7.55g), crude fibre (7.84g) and total crude carbohydrate (65.7g). The quality and shelf life of the pickle was studied by using sensory evaluation (Hedonic rating test) and microbial test (Fungal staining). The study shows that the tree bean pickle has good taste and can be stored in room temperature till 6 months from the date of manufacture. This can be extended to 1year if refrigerated. And can be in refrigerator for another six month. Whole preparation procedure was carried out in a scientific procedure and following hygienic practices. It is concluded that tree bean pickle can be a future scope for cultivator to preserve as more economical and value-added product.

Keywords: *Parkia timoriana*, Pickling, Nutritive, Evaluation, Shelf life, Value added

Theme 8: 321
Value Addition of Pulse Crops Through Processing for Enhancing the Income of Farmers

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India has the distinction of being large pulses producing country of the world, producing crops like chickpea, pigeonpea, mungbean, urdbean, field pea, lentil and rajmash. Most of the pulses are consumed after dehusking since time immemorial. Milling of pulse grains is generally confined to urban areas where medium and large capacity mills are operational. While in the rural areas, there is hardly any cottage industry undertaking pulse milling. Recognizing the need of mini dal mills in rural areas at affordable cost, a mini dal mill has been developed by ICAR-Indian Institute of Pulses Research, Kanpur. With the use of rubber and steel disc kind of mechanism provided in these mills, one can reduce broken and powder percentage. These mills can be a good source of rural entrepreneurs, unemployed youths and farmers. The *dal* recovery may vary depending upon the variety of grains, its quality as well as treatment applied. Finished product recovery obtained under water soaking treatment in case of chickpea and pigeonpea was obtained at 82 and 76%, respectively. Thus, by processing of pulses, farmers can sell finished *dal* instead of selling raw pulse grains, thus, getting better price for their produce. Self-employment potential of IIPR dal mills reveals that an income of Rs. 15,000 to 25,000 per month can be generated by this mill. There exists a wide gap between the price of raw pulse grain and the finished product, majority of profit being shared by middlemen and pulse millers. Therefore, there exists a strong need to change farmers into processor to increase their earning through value addition to their produce. Milling of pulses at farmers' level will not only result in higher returns to farmers, it will also help in reduction of post-harvest losses due to bruchids infestation. Adoption of mini *dal* mills at rural threshold can impact favorably the rural economy as pulse fetches even higher price and profit in the market as compared to rice and wheat.

Keywords: Mini dal machine, Income enhancement, Reduction post-harvest loss

Theme 8: 322
Millets in PDS: A Potential Way Out to Tackle Nutritional Insecurity

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Millets, historically referred to as "coarse grains," have gained renewed prominence as "nutri-cereals" owing to their superior nutritional profile, drought resilience, and potential to contribute to sustainable food systems. India, as the world's largest producer of millets, has witnessed a paradoxical decline in their domestic consumption over recent decades, attributed to policy shifts favouring rice and wheat, changing consumer preferences, urbanization, and marketing bottlenecks. In the context of rising malnutrition, lifestyle diseases, and climate vulnerabilities, reviving millet consumption has become a national priority. This study investigates household

preferences for incorporating nutri-cereals into the Public Distribution System (PDS) in Bundelkhand, a nutritionally and socioeconomically vulnerable region of Central India. A Discrete Choice Experiment (DCE) framework was employed to elicit consumer choices by systematically varying six key attributes: price, quantity, type of millet (e.g., finger millet, pearl millet etc.), frequency of distribution, substitutability with traditional staples (wheat/rice), and the preferred form of supply (grain versus flour). Attribute levels were finalized through an extensive literature review, focus group discussions, and expert validation. Data were collected from 320 randomly selected households across four districts–Jhansi and Chitrakoot (Uttar Pradesh) and Tikamgarh and Chhatarpur (Madhya Pradesh)–representing a cross-section of rural consumers. Econometric modelling was undertaken to analyze trade-offs and estimate marginal willingness to pay (WTP) for each attribute. The findings reveal nuanced preferences, including a stronger inclination towards processed forms (flour), preference for partial substitution over complete replacement, and sensitivity to price and distribution regularity. The study provides critical insights into designing more acceptable and nutrition-sensitive food distribution policies by integrating millets into mainstream welfare programs. It further recommends interventions around awareness creation, supply chain improvements, and tailoring PDS offerings to consumer preferences, aiming to leverage millets for enhancing food and nutritional security while promoting climate-resilient agriculture.

Keywords: Public distribution system, Willingness to Pay, Discrete Choice Experiment, Nutritional security.

Theme 8: 323
Nutrigardens for Sustainable Food and Nutrition Security

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Malnutrition and limited access to diverse, nutritious food remain critical challenges in rural rain fed regions of Samba district of Jammu and Kashmir. A benchmark survey was conducted in three rainfed villages of the Purmandal block in Samba district to assess the ground situation of malnutrition. It was found that majority of the household lack required quantity of vegetables in their diet. To address this issue, nutrigarden initiative was implemented under the Farmer FIRST Programme in the surveyed villages. Twenty model nutrigardens of size 65.2 m^2 each were established on the farms of different households. Each model was divided into 12 plots to grow different seasonal vegetables. The intervention led to significant increase in vegetable consumption due to easy availability of fresh vegetables. Before the establishment of model nutrigardens, the average vegetable consumption per person per day was 205 gm which increased to 317 gm. Thus the mean difference in the consumption of the vegetables is 112 gm. In terms of production the average production of vegetables prior to the intervention was 170 kg. Following the intervention, this increased significantly to 328 kg representing an impressive rise of 92.9% in terms of production. Additionally, the market value of the produce nearly doubled, underscoring the considerable economic benefits resulting from the intervention. Exceeding the Indian Council of Medical Research's recommended intake of 300 g/day which highlights the intervention's substantial contribution in improving nutritional security. These findings underscore the model nutrition garden's effectiveness as a low-cost, sustainable strategy to combat malnutrition, enhance dietary quality, and generate income in resource-poor, rain-fed farming communities. The model presents a replicable approach for improving food and nutritional security across similar agro-climatic zones in Jammu region.

Keywords: Nutrigarden, Production, Consumption, Vegetables

Theme 8: 324

An Overview of Traditional Food Processing Method of Dimasa Tribe of Dhansiripar Village, Nagaland

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The Dimasa tribe of Nagaland is an ethnic tribe having unique culture and food habits. The objective of the study is to explore the traditional food processing methods of Dimasa tribe, how the processed foods are used in different traditional recipes and the challenges faced by them in preserving the traditions. The study was conducted in Dhansiripar Village, Chumukedima district of Nagaland. The collected data was analyzed using thematic analysis based on themes. The results revealed the different techniques of processing and preservation of foods such as popping of maize and sorghum, pounding or milling of foxtail millets and maize, sun drying of local vegetables, meat, fermentation and salting of fish. The traditional processed foods were used for preparation of different traditional recipes such as *Maisi makham, Manglai atta, Manglai akhi, Thabongju hon pitha, Sabai homa, Thangung karain, Theklao mare* etc. Traditional foods were served as a source of energy and protein as a means of food security. However, there is a threat of extinction of the traditional foods with the transition of food habits. The challenges faced by them included the loss of indigenous seeds, banned of jhum cultivation, climate change, deterioration of soil quality & losing of forest areas, and increasing lifestyle pattern of urbanization.

Keywords: Dimasa tribe, Traditional food processing, Transition of food habits

Theme 8: 325

Dietary Approaches for Achieving Nutritional Security among Farm families

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Food security is an important prerequisite for improving the nutrition of vulnerable groups such as preschool children, adolescent girls and women. Farm women play vital role in providing nutrition to their family. But their own nutrition is often impaired under the social and biological stress. Thus challenges were to increase diversified food production for nutrition security of farm families in Gwalior district of Madhya Pradesh. For achieving this objective, different dietary approaches were adopted for round the year availability of nutritious food for farm families. For increase production and consumption of micronutrient rich foods, nutrition garden was established in the backyard of their houses. It increased availability and consumption of a nutritionally adequate micronutrient rich diet made up of a variety of available foods from 40 kg to 92 kg per unit. These farm women also learned the techniques for preserving and processing of extra produce of their garden. Locally available nutritious food sources like drumstick leaves powder were also incorporated in their daily diet. Promotion was given for production and consumption of pearl millet inform of a variety of foods. After skill development training, millet recipe competition was also organized among farm women for encouraging millet consumption among their family members. Nutritional education along with hygiene and sanitation was also given to them during training programmes. Thus these dietary approaches supported health and nutrition of the farm women with increase body mass index and improved hemoglobin levels from 9 to 11 gm/dl. Increasing diversity in food production and promoting sustainable production practices like millet production, nutrition garden, addition of locally available healthy foods in daily diet can improve nutrition levels of vulnerable group.

Keywords: Food, Nutrition, Diet, Diversity, Farm women

Theme 8: 326
Promotion of Entrepreneurship in Agriculture through Incubation of Start-ups

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Agriculture sector has great potential and need for entrepreneurship development to increase productivity, efficiency, value addition and ultimately raising income of farming community. Entrepreneurship development programs are crucial in the agricultural sector to boost economic growth, create employment, and improve the overall quality of life, particularly in rural areas. By fostering innovation and entrepreneurial skills, these programs help farmers diversify their income, access new markets, and adopt more sustainable practices. The Government has taken initiatives in establishing several incubation centres for promoting start-ups in agriculture sector to address key challenges like low productivity, inefficient supply chains, and lack of branding and access to market for farmers. They offer innovative solutions, including technology-driven approaches to increase yields, improve resource management, and connect farmers directly with consumers, reducing reliance on middlemen. The Centre for Agribusiness Incubation and Entrepreneurship (CAIE) is one of such initiative established at RVSKVV Gwalior (M.P.) with financial support from NABARD to promote agri-preneurship and start-ups in the field of agriculture. The CAIE is nurturing entrepreneurial ambitions by promoting agri-business ideas in the farm of agri-startups since last four years. The centre is operational on strategies to get impactful results by promoting complete incubation cycle, backward-forward linkages, technical & skill development, branding, marketing support for establishing agri-businesses to get food, finance and nutritional security. At present, we have more than 350 registered members from across the country including 80 FPOs who are in process of establishing their entrepreneurial ventures in the field of agriculture and allied areas. The centre is succeeded in nurturing around 40 DPIIT registered start-ups in last four years.

Keywords: Entrepreneurship, Start-ups, Incubation process

Theme 8: 327
From Microbes to Markets: Biocontrol and Tea Processing for Smarter Food Systems

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Post-harvest processing and value addition are key strategies to minimize food wastage, enhance shelf life, and improve both safety and nutritional quality of food. The study highlights the role of practical, sustainable post-harvest practices in ensuring food security, with a special focus on the application of biocontrol agents for safe storage and tea processing as a model of value addition. Drawing from hands-on training at Assam Agricultural University, Jorhat, in the preparation of biocontrol agents and tea processing technology, this work presents two practical approaches. Biocontrol agents such as *Pseudomonas fluorescens* and *Trichoderma harzianum* were used to prepare a biopesticide effective against various fungal and soil borne bacterial pathogens and evaluated for their potential in managing post-harvest diseases. These beneficial microbes inhibit the growth of spoilage-causing

pathogens through mechanisms like antibiosis, competition, and induced systemic resistance. Their application helps reduce losses while ensuring food safety without the risks associated with chemical preservatives. In parallel, tea processing and manufacturing, conducted at the same university, demonstrate how agricultural commodities can be transformed into high-value, shelf-stable products with enhanced nutritional profiles. Tea, rich in polyphenols and antioxidants, offers health benefits and holds significant commercial value in both domestic and global markets. Understanding its processing—from withering to drying—illustrates the potential of value addition in strengthening the agri-food chain. The study emphasizes on how integrating such practices can significantly reduce post-harvest losses, improve food safety, and contribute to nutritional security. By combining traditional knowledge with modern techniques, post-harvest technologies can empower farmers, reduce waste, and deliver safer, more nutritious food to consumers. These insights advocate for greater adoption of low-cost, sustainable technologies to support national and global food security goals.

Keywords: Nutritional security, Biopesticide, Biocontrol agents, Tea processing

Theme 8: 328

Impact of Integrated Kitchen Gardening on Behaviour Household Food Security and Women's Empowerment in Tripura, India

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Integrated kitchen gardening initiatives, which combine capacity-building programme with nutritional education, have emerged as a promising strategy to improve dietary practices, particularly in low-income settings. This study assesses the sustained impacts of an integrated kitchen garden initiative implemented between 2021 and 2024 in the Khowai district of Tripura, under the supervision of Krishi Vigyan Kendra, Khowai. An ex-post facto research design was adopted, utilizing three rounds of survey data from 150 intervention households and 136 control households. The programme emphasized seasonal vegetable and fruit cultivation, mushroom production and processing and value addition of the produce. Findings reveal that, three years post-intervention, participating households experienced an average increase in vegetables and fruit production of 6062.5kgs/ha per year, representing a 38% rise over baseline levels ($p < 0.01$). Analysis of vegetable categories indicates that the most notable differences in daily per capita consumption were observed for leafy vegetables (65.6 grams in the intervention group vs. 38.4 grams in the control group, $p < 0.01$) and roots and tubers (86.9 grams in the intervention group vs. 63.7 grams in the control group, $p < 0.01$). This sustained increase in production reflects the program's long-term impact. Moreover, the availability of micronutrients such as iron, zinc, folate, and pro-vitamin A remained high, positively influencing women's health. The intervention significantly improved women's nutrition knowledge, food preparation practices, and gardening skills, which contributed to the retention of positive outcomes. Women's empowerment and participation in local markets also increased, highlighting the program's broader social benefits. Additionally, intervention households demonstrated significantly improved food security and income levels compared to control households. Importantly, women who participated in the program showed greater positive shifts in social and behavioural indicators than those in the control group, underscoring the potential of integrated kitchen gardening as a sustainable tool for household nutrition and empowerment.

Keywords: Integrated kitchen gardening, Household food security, Women's empowerment, Nutrition knowledge

Theme 8: 329

Nutri-gardens: A Sustainable Tool for Capacity Building of Rural Farm Women Towards Achieving Household Food Security

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Nutri-gardens is an innovative project initiated in India under the supervision of ICAR with the prime objective of providing relief for the masses on daily vegetable needs and creating a safe and sustainable environment with healthy people. It is now well conceived that by simply adding greens to the available food grains, the diet of the average Indian can be substantially upgraded. Homestead production of fruits and vegetables provides the poor with direct access to important nutrients that may not be readily available or within their economic rich. This study aimed to establish nutri-gardens in the selected villages of Faridabad district: Chirsi, Tajupur, Bhopani, Badarpur Said, and Nachuli by KVK, Faridabad. A total of 100 packets of improved varieties of vegetables during the summer season and 100 packets during the winter season were distributed during 2022-2023 among enthusiastic farm women volunteers. Results indicated that assuming an average saving price of Rs. 40 per kg for purchasing vegetables during the summer season and Rs. 20 per kg during the winter season, around Rs. 4614 was saved by each family on vegetable expenditure. Due to increased vegetable production, food variety and dietary diversity scores increased from 19.46 to 26.53 and from 5.90 to 8.70 in their daily diets. Per person, the availability of vegetables increased from 28.63 g to 286.21g with increased production of vegetables at the household level. Increased per-person availability of vegetables had contributed 35 to 59 per cent of the recommended dietary allowances of calcium, iron, vitamin C, and β-carotene. Efforts should be made through government agencies to provide seeds of biofortified varieties of fruits and vegetables to the farmers and the biofortified varieties of cereals & legumes & oilseed grains to achieve Max. nutrients with their eating habits.

Keywords: Dietary diversity, Food security, Nutri-garden, Vegetable intake

Theme 8: 330

Unlocking the Potential of Biostimulants as the Cornerstone of Food Security

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As we navigate through the complexities of 21st century, biostimulants are gaining significant attention as a crucial component in addressing the escalating global challenge of food security. Biostimulants represent a valuable emerging tool in the pursuit of modern agriculture. This innovative agricultural input, encompasses a diverse range of substances and beneficial microorganisms which work by stimulating the natural processes within plants and the rhizosphere. Unlike traditional fertilizers and pesticides that directly supply nutrients and control pests respectively, biostimulants act as a catalyst by enhancing plant growth, boosting nutrient uptake, strengthening resilience against adverse conditions and biotic stresses like diseases and ultimately improving the defense system, quality and yield of crops. Ultimately it promotes soil health, biodiversity and environmental preservation. Due to its multifaceted role, it has the ability to reduce the cost of cultivation. Population acceleration and climate change presents increasing challenges to agricultural productivity. Profound understanding of the effective utilization of biostimulants, offers a sustainable and environmentally conscious pathway towards a more food secure future.

Keywords: Biostimulants, Food security, Resilience, Sustainability

Theme 8: 331

From Academia to Agri-entrepreneurship: A Case Study of Organic Farming and Value Addition in Punjab

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Processing plays a crucial role in enhancing profitability for farmers by adding value to the raw produce. Through processing, agricultural produce such as wheat, barley, sugarcane, pulses and oilseeds are transformed into higher-value products like flour, dalia, jaggery, oils and other derivatives, which command better prices in the market. It not only increases the net revenue for farmers but also reduces dependency on raw produce sales, which are often subject to volatile market prices. Additionally, the transition to organic farming in India has been gaining momentum as a response to the increasing health concerns associated with the consumption of chemically treated crops. This case study explores the entrepreneurial journey of Smt. Harpreet Kaur, who transitioned from academician to an organic farming entrepreneur, successfully established an organic farm and processing enterprise in Sangrur, Punjab. Using a case study research method, data were collected through personal visits to Harpreet's farms and her processing complex, along with observations of routine activities, working pattern, and enterprise records. Harpreet Kaur, driven by a desire for family wellness, self-achievement and community impact, made the strategic decision to shift from teaching profession to organic farming, starting with a small-scale vegetable cultivation for domestic use in 2015. After conducting market research and receiving technical training from Krishi Vigyan Kendra (KVK) Sangrur, Punjab Agricultural University (PAU), Ludhiana and Punjab Agro, she expanded her operations and registered her organic farm with Punjab Agro in 2018. Her venture, Maan Kudra ti Kheti Farm, focused on organic farming and value-added processing of produce and dairy, benefiting local farmers and farm women through quality products, fair pricing and job creation. The study outlined the keychallenges, such as Harpreet's initial lack of experience, setting up of proper infrastructure, and navigating bureaucratic processes. With technical support in areas like crop production, and market linkages, Harpreet successfully grew her processing business. Her commitment to organic practices and innovative products, including mustard oil, organic wheat flour, organic pulses, pickles, spices, jaggery and dairy productspositioned her brand strongly in the market. This research highlighted the significance of processing as a viable opportunity for rural entrepreneurship.

Keywords: Processing, Agri-entrepreneur, Agri-enterprises, Organic farming

Theme 8: 332

Exploring Benefits of Plant Based Nutrition in our Life

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Plant-based nutrition plays a crucial role in enhancing both individual health and global nutrition security. Plant-based diets, rich in Fiber, vitamins, and minerals, are linked to reduced risks of chronic diseases like heart disease, type 2 diabetes, and certain cancers. Furthermore, they are more environmentally sustainable than meat-heavy diets, contributing to planetary health. For nutrition security, diverse plant-based foods can help ensure access to essential nutrients, particularly in regions facing food insecurity, while also promoting more sustainable agricultural practices. A variety of plant-based foods provides essential nutrients like protein, calcium, iron, and vitamins. Plant-

based diets are high in fiber, which supports a healthy gut microbiome and may have anti-inflammatory effects. Precision nutrition, tailoring diets to individual characteristics, holds promise for more effective disease management and prevention, but research is still in its early stages. Diverse plant-based diets can help ensure access to a range of nutrients, addressing micronutrient deficiencies that can occur in some plant-based diets if not well-planned. Plant-based diets are generally more resource-efficient and have a lower environmental impact compared to diets heavy in animal products. Exploring and incorporating underutilized plant species can diversify food sources and enhance nutrition security in specific regions. Plant-based diets can be a key part of solutions to address food insecurity and improve nutritional outcomes, especially in regions where access to animal products is limited.

Keywords: Plant based nutrition, Nutrition security, Plant based diet

Theme 8: 333

Nutritional Fortification and Sensory Impact of Sausages Enriched with Indigenous Fruits and Herbs from Northeast India

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Sausages are a popular meat product in many regions and offer substantial potential for nutritional enhancement through the incorporation of functional ingredients. The present study explores the enrichment of pork sausages using indigenous fruits and herbs such as *Haematocarpus validus* (blood fruit), *Salvia officinalis* (sage), and *Houttuynia cordata* (chameleon plant), which are native to Northeast India, a region well known for its biodiversity and rich repository of traditional medicinal plants. Blood fruit being rich in anthocyanin content (200mg/100gm), beta carotene (14mg/100gm), total flavonoids (57.4 mg QE/100gm) and fiber (10.29%), its incorporation into sausages led to a significant improvement in the nutritional profile, particularly by enhancing levels of polyphenols, flavonoids, vitamins, minerals, and dietary fiber. Similarly, sage and chameleon herbs, known for their therapeutic properties, are rich in flavonoids (29.6 mg and 64.2 mg QE/100 g, respectively) and essential oils (2.5% in sage and 3.6% in chameleon). These herbs contributed not only to nutritional improvement but also imparted antimicrobial benefits. The inclusion of sage and chameleon showed functional attributes resulting in significantly increased in the fiber content of the sausages to 7.56% and 2.31%, respectively, compared to 1.57% in plain pork sausage. A series of sensory evaluations assessed the impact on flavor, aroma, texture, and overall acceptability. The results indicated positive consumer perception, particularly in taste and aroma, with respondents expressing interest in the health benefits associated with these natural additives. Furthermore, the antimicrobial properties of the herbs contributed to an extended shelf life of the sausages, reducing the need for artificial preservatives. This innovation highlights the potential for commercial development of functional meat products that combine health, nutrition, and the sustainable utilization of Northeast India's indigenous plant resources.

Keywords: Functional sausage, Bloodfruit, Sage, Chameleon

Theme 8: 334

Impact of Paramparagat Krishi Vikas Yojana in Promoting Sustainable Agriculture

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The increasing environmental challenges in Indian agriculture, driven by excessive chemical use, have underscored the need for sustainable farming practices. Organic farming offers an eco-friendly alternative, but it accounts for only 2% of India's net sown area. To promote its adoption, the Government of India launched the Paramparagat Krishi Vikas Yojana (PKVY) in 2015–16, providing financial support, training, and market access. This study evaluates the impact of PKVY on farmers in the Narmadapuram district of Madhya Pradesh, which has the highest number of PKVY clusters. Primary data was collected by using a structured interview schedule from 100 farmers—50 PKVY beneficiaries from Pahanbarri village and 50 non-beneficiaries from a neighboring village. Socio-economic, psychological and communication-related characteristics will be studied in relation to farmers' knowledge and adoption levels of organic farming. Findings suggest that PKVY beneficiaries possess higher levels of knowledge and a more favorable attitude toward organic farming compared to non-beneficiaries. The study also identifies key barriers such as certification delays, limited market access and financial risks during the transition phase. The study will offer practical recommendations to enhance the adoption of organic farming and strengthen sustainable agricultural development.

Keywords: Organic farming, Eco-friendly, Financial support and PKVY beneficiaries

Theme 8: 335

Post-Harvest Innovations and Therapeutic Potential of Black Cardamom from Northeastern India

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The rare spices from Northeastern states of India are highly recognised, and they have played a major role in making the country the leader in the world of spices. This region, known for exotic spices, including black cardamom, are key players in the international spice market. Black cardamom, recognized as the "Black Gold" of the eastern Himalayas, undergoes a transformative curing process enhancing its value and aroma. Its therapeutic properties, attributed to essential oils rich in 1,8-cineole, have been extensively studied in pharmacological contexts. Traditional post-harvest curing methods like the bhatti systems face challenges such as smoke exposure and temperature control, impacting product quality. Innovative curing systems have been developed in response, including the enhanced bhatti by ICAR, gasifier-based systems, mechanical trolley systems with indirect heating utilising fuel and electricity, portable curing chambers, solar dryers, etc. Modern dryers have not become widely accepted among farmers despite these developments; this could be because of the expensive installation costs and the indirect heating method that affects flavour development. Maintaining quality standards requires an understanding of how post-harvest processing and geographic location affect the chemical makeup of black cardamom. Black cardamom has a wide range of medical uses in Chinese, Unani, and Ayurvedic medicine. Phytochemical research reveals these applications, as well as advantages like antioxidant, immunomodulatory, and anticancer characteristics. In order to address the increasing demand for high-quality black cardamom spice, further research must prioritize efficient, cost-effective curing systems to meet global demand.

Keywords: Black cardamom, Curing system, Therapeutic properties, Pharmacological properties, Post-harvest


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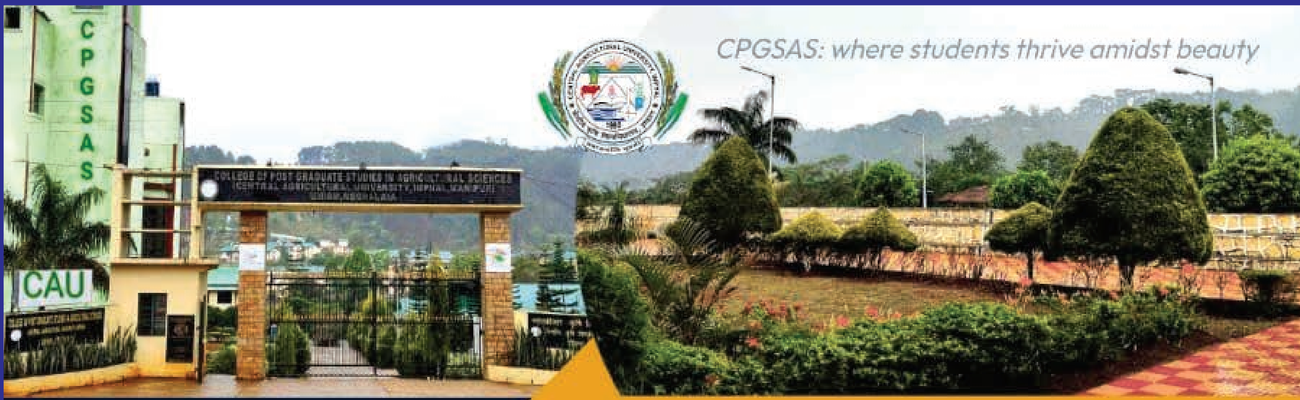


"Empowering Agri-Excellence: Cultivating Leaders for Northeaste Indias Prosperity"

College of Post Graduate Studies In Agricultural Sciences, Central Agricultural University(I), Umaim

About Us

CPGSAS excels in fostering excellence across 10 specialized disciplines within agricultural sciences. Dedicated to cultivate proficient postgraduates nationwide, empowering them to spearhead agricultural advancement and bolster farming communities. With unwavering dedication, our scholars are adept at pioneering advanced research, adeptly operating cutting-edge research instruments, and gaining invaluable hands-on experience in hill and mountain agricultural ecosytem.

Programmes offered

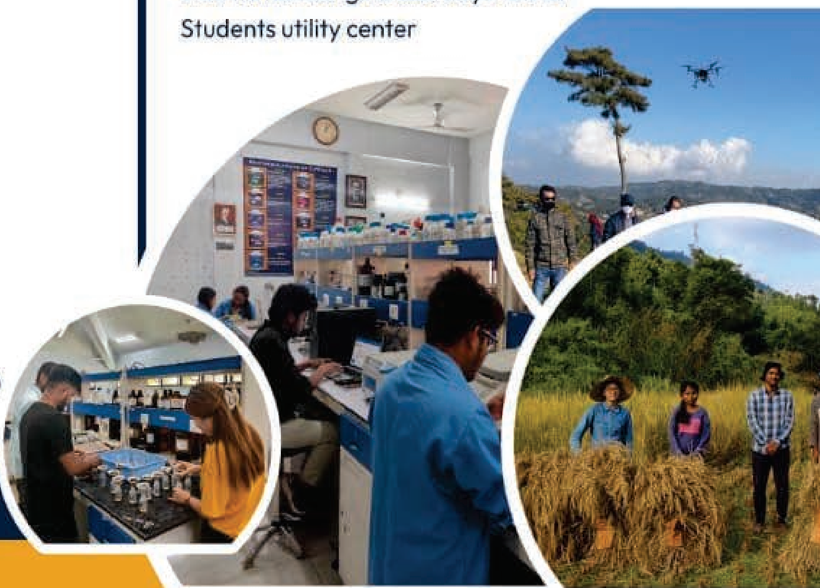
Agronomy (PG & PhD)
Agril. Economics (PG & PhD)
Agril. Extension(PG & PhD)
Entomology (PG & PhD)
Genetics & Plant Breeding (PG & PhD)
Nematology (PG)
Plant Pathology (PG & PhD)
Pl. Mol. Biology & Biotech(PG & PhD)
Soil Science & Agril Chimestry (PG & PhD)
MBA (Agri-Business Management)

Students placement

Government sector (Assitant professor/ Scientist/ Agricultural development officer/ Civil services)- 60%
Private sector (Agro base MNCs) - 25 %
Higher studies (PhD & Post Doc.) - 15 %

Facilities

Experienced faculties
State of the art Research facilities
Experimental cum demonstaration field
Smart classrooms
Well furnished girls and boys hostel
Students utility center



MORE INFORMATION :

+91-6033247110
https://www.cpgs.ac.in/index.php
College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umroi Road, Umiam, Ri Bhoi, Meghalaya 793103

SCHOLARSHIP ARE AVAILABLE TO ALL THE STUDENTS

Courses offered:

- B. Sc. Horticulture (Hons.)
- B. Sc Forestry (Hons.)
- M.Sc Horticulture (Vegetable Science)
- M.Sc Horticulture (Fruit Science)
- M.Sc Horticulture (Floriculture & Landscape Architecture)
- M.Sc Forestry
- Ph. D Horticulture (Vegetable Science)
- Ph. D Horticulture (Fruit Science)

College of Horticulture and Forestry
Central Agricultural University
Pasighat-791102, Arunachal Pradesh

COLLEGE OF VETERINARY SCIENCES AND ANIMAL HUSBANDRY (CENTRAL AGRICULTURAL UNIVERSITY)

SELESIH, AIZAWL, MIZORAM: 796015

UG course (BVSc& AH)

Eligibility:

- Pass with a minimum of 50% in Physics, Chemistry, Biology/Biotechnology & English
- 47.5% for SC/ST/PWD/In-service categories
- Minimum age of 17 years and maximum 25 years

15 PG courses (MVSc)

Courses offered: The PG program facilitates both theoretical and practical applications in Veterinary Anatomy, Veterinary Physiology, Animal Nutrition, Livestock Production & Management, Animal Husbandry Extension, Animal Genetics & Breeding, Veterinary Microbiology, Veterinary Pathology, Veterinary Parasitology, Livestock Products Technology, Veterinary Biochemistry, Veterinary Medicine, Veterinary Public Health & Epidemiology, Animal Reproduction, Gynecology & Obstetrics and Veterinary Surgery & Radiology.

11 PhD courses

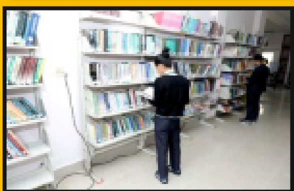
PhD program imparts best training to conduct advanced research bystrengthening Biochemical, Physiological, Nutritional, Medical, Anatomical aspects of Veterinary Science.

Courses offered: Veterinary Anatomy, Veterinary Biochemistry, Veterinary Medicine, Animal Nutrition, Veterinary Microbiology, Veterinary Pathology, Veterinary Surgery & Radiology, Livestock Production and Management, Animal Reproduction Gynecology & Obstetrics, Veterinary Public Health & Epidemiology and Veterinary Parasitology.

COLLEGE OF COMMUNITY SCIENCE

CENTRAL AGRICULTURAL UNIVERSITY (IMPHAL)
SANGSANGGRE, TURA, MEGHALAYA- 794005






The College of Community Science (erstwhile Home Science) came into exist as a constituent college of CAU, Imphal issued the first ordinance in 1997 and started on September 2004. The College is situated in Sangsanggre at a distance of about 3 km from Tura town, West Garo Hills, Meghalaya. The College is bestowed upon by the breathtaking sceneries. Community Science is a multi-disciplinary subject preparing graduates to address critical challenges with the intersection of science and society especially in the North-Eastern States.

Courses Offered	Intake Capacity			Duration
	State Nominee	Open Category	ICAR Nom-inee	
B.Sc. (Hons.) Community Science	32	18	10	4 years
B.Sc. (Hons.) Food Nutrition and Dietetics	8	11	3	4 years

Courses Offered	Intake Capacity		Duration
	CAU Entrance Exam	ICAR Nominee	
M.Sc. Community Science (Extension Education & Communication Management	2	1	2 years
M.Sc. Community Science (Food & Nutrition)	2	1	2 years

Departments

- Basic Science & Humanities
- Extension Edu. & Comm. Management
- Family Resource Management
- Food Science & Nutrition
- Human Dev. & Family Studies
- Textile & Apparel Designing

Facilities

- Smart Classroom, Well Equipped Labs, Library, IT & Internet Facility
- Gym, Play Ground, Multi-Purpose Indoor Hall
- Hostel, Guest House, Medical Unit
- Canteen

ACADEMIC ACHIEVEMENTS

- ICAR-JRF Examination: 1st Rank in 2009, 2010, 2019 / 2nd Rank in 2011, /3rd Rank in 2014 / 12th 2023
- Placements In Various State /Central Governments Services: Scientist (ARS ICAR, BIS) Academics, Active Services, Health Sector, Handloom & Handicraft, SMS in KVKs, Education Dept. JRDO, Circle Officer, Technical Officer (FSSAI)
- Entrepreneurs

ACHIEVEMENTS IN RESEARCH

- Ergonomics & Drudgery Reduction Cashew Nut Peeling Knife, Improved Kokcheng, Pupa Extractor
- Non-Conventional Fiber Technology Areca Nut Husk Fibers Apparel Article, Sanitary Napkins, Non-Woven Mulch Mat
- Food & Nutrition Technology
- Low GI Cheela Mix, Low GI Upma Mix,
- Nutri Dense Mix, etc.

EXTENSION ACTIVITIES

- Awareness Programs
- Training Programs For Rural Youths & Extension Professionals
- Capacity Building Programs

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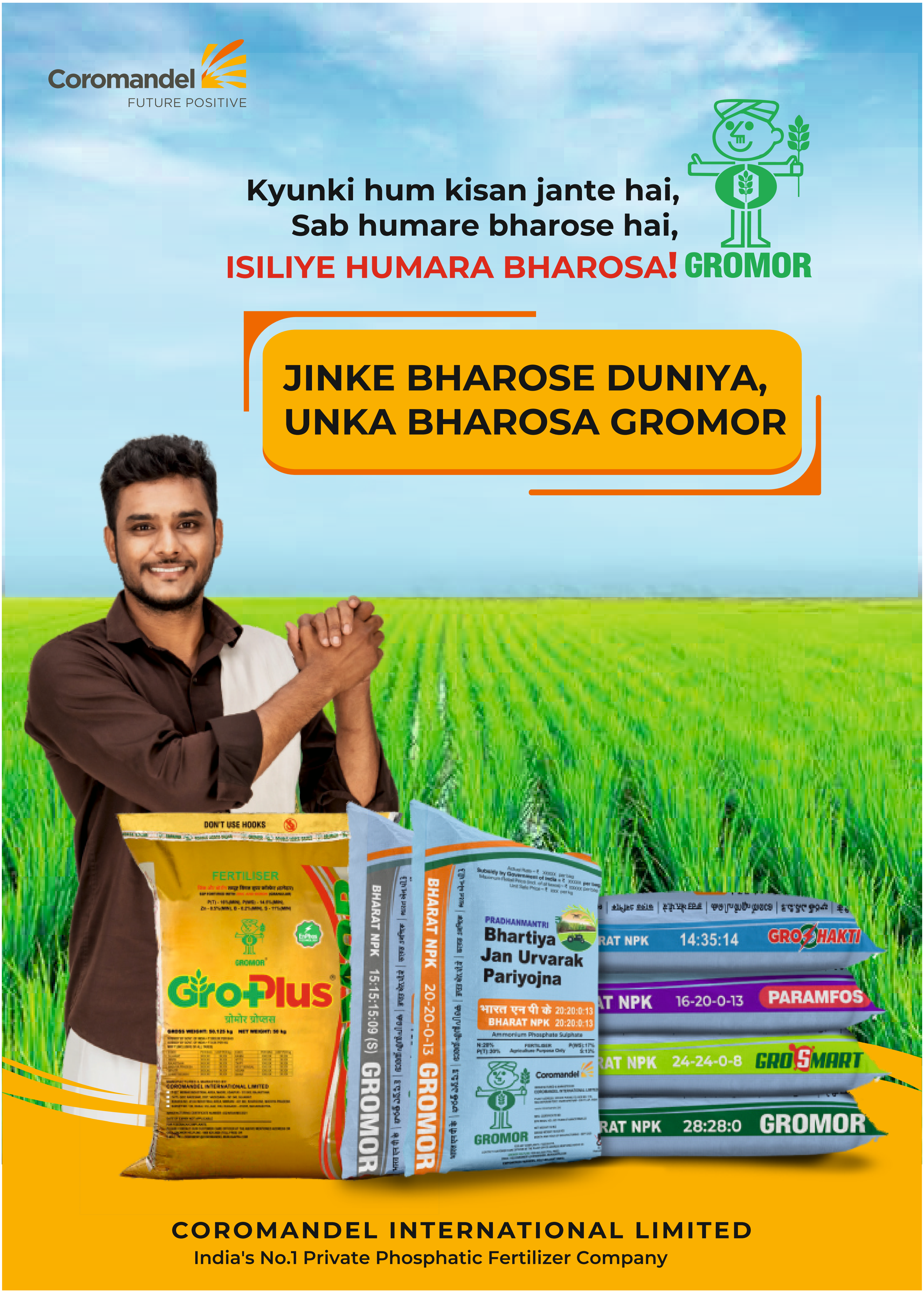

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Jan Urvarak
Pariyojna
BHARAT NPK 20:20:0:13
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14:35:14 GROSHAKTI
16-20-0-13 PARAMFOS
24-24-0-8 GROSMART
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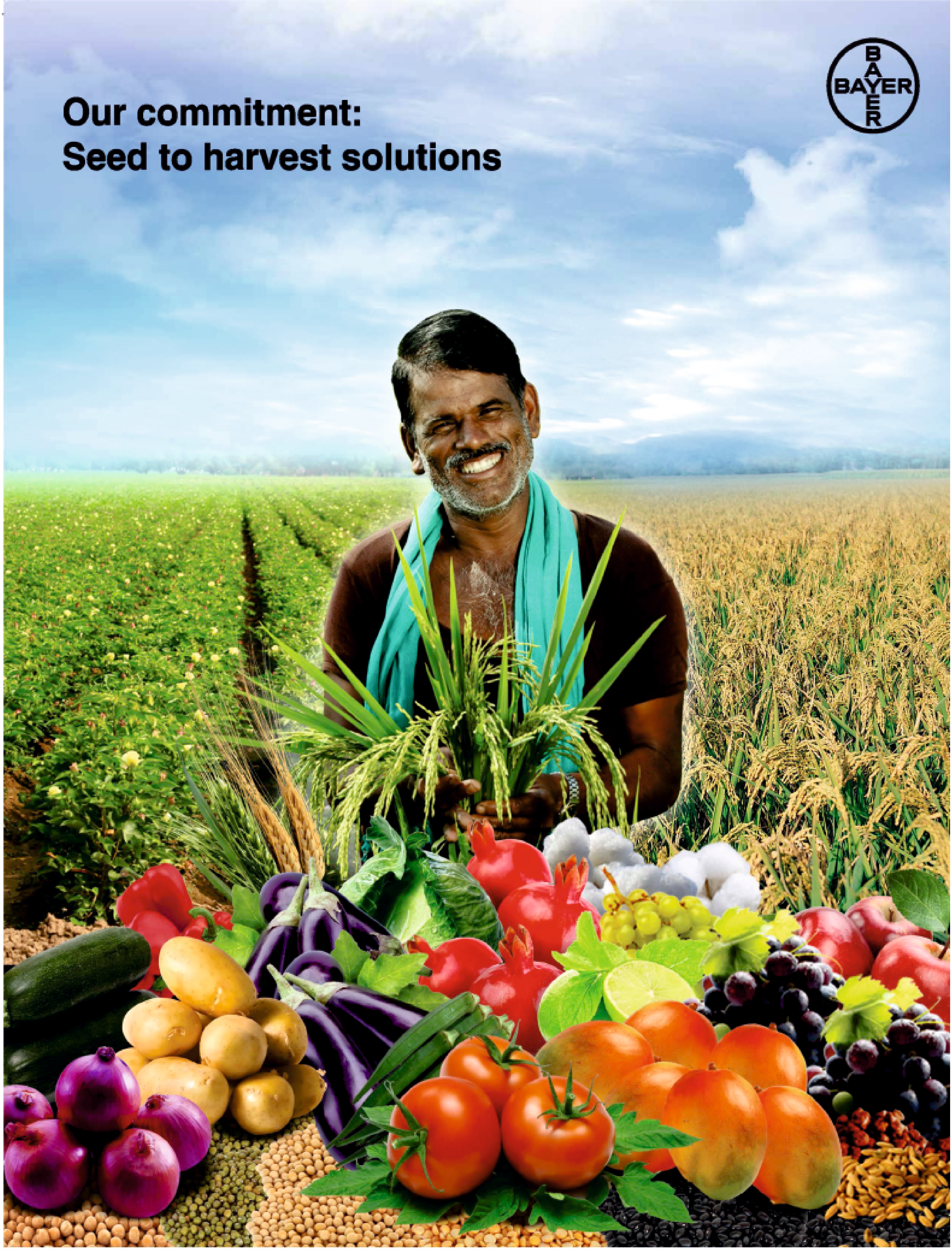
Our commitment:
Seed to harvest solutions
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