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SOUVENIR & ABSTRACTS

2nd International Conclave

कृषि मंत्रणा 2026

On

Transforming Indian Agriculture for Viksit Bharat@2047: Empowering Startups, Enhancing Skill Development & fostering Agripreneurship for Youth

Venue: JIBB AUDITORIUM, SHUATS PRAYAGRAJ, 211007

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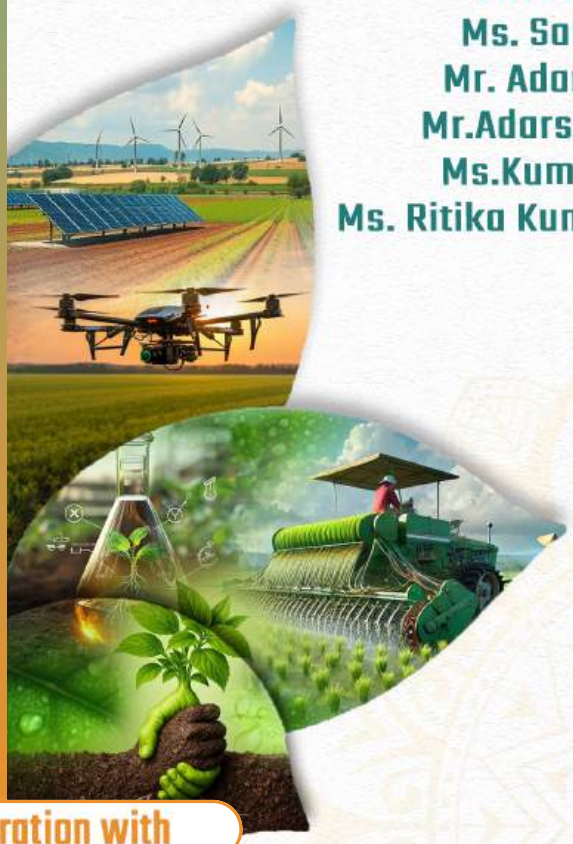

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Department of Agriculture & Farmers Welfare
राष्ट्रीय जैविक एवं प्राकृतिक खेती केंद्र
National Centre for Organic and Natural Farming

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2nd International Conclave: KRISHI MANTRANA 2026

Transforming Indian Agriculture for Viksit Bharat @2047: Empowering Startups, Enhancing Skill Development & Fostering Agripreneurship for Youth

February 12-14, 2026

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Citations:
Chaurasia, A., Barker, N., Masih, A., Rai, A., Mishra, A., Alexander, K., Singh, N., Srivastava, A.K., Yadav, P., Singh, S., Tiwari, A., Dwivedi, A., Srishti, K. and Singh, R. K. 2026. "Souvenir and Abstract Book" 2nd International Conclave: KRISHI MANTRANA 2026 "Transforming Indian Agriculture for Viksit Bharat @2047: Empowering Startups, Enhancing Skill Development & Fostering Agripreneurship for Youth" February 12-14, 2026 at JIBB Auditorium, SHUATS, Prayagraj, U.P

Note*:* Opinions in this publication are those of the authors and not necessarily of the organizers.

Published by:
Agri Express, Noida, Uttar Pradesh
DOI: https://doie.org/10.10346/AE.2026934028

Venue:
JIBB Auditorium, SHUATS, Prayagraj, U.P.

PREFACE

It affords me great privilege to present the Souvenir and Abstract Book of the 2nd International Conclave – KRISHI MANTRANA 2026, themed *"Transforming Indian Agriculture for Viksit Bharat @2047: Empowering Startups, Enhancing Skill Development & Fostering Agripreneurship for Youth"*, organized by the Department of Agricultural Economics, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, during 12th–14th February 2026. This conclave marks an important milestone as we assemble to deliberate, envision, and strategize the future of Indian agriculture in alignment with the national vision of a developed India by 2047.

The theme of Krishi Mantrana 2026 is not merely a reflection of our aspirations, but a collective call to action for all stakeholders in the agricultural sector to innovate, collaborate, and drive transformative change. The conclave brings together a diverse group of participants, including scientists, academicians, researchers, policymakers, entrepreneurs, progressive farmers, and students, providing a vibrant platform for sharing knowledge, experiences, and ideas to address the emerging challenges of agriculture and allied sectors.

The Souvenir and Abstract Book stands as a testament to the intellectual contributions and scholarly efforts presented during the conclave. It comprises abstracts and scholarly submissions covering a wide range of multidisciplinary themes such as agricultural economics, agribusiness, Agri-technology, sustainability, entrepreneurship, and rural development. The contributions reflect the depth and diversity of research, innovation, and practical insights that collectively enrich the discourse on strengthening India's agricultural ecosystem.

As readers engage with the contents of this volume, we hope it serves as a valuable academic resource and a source of inspiration for researchers, students, and policymakers alike. The knowledge shared herein is expected to foster continued inquiry, innovation, and collaboration, contributing towards the development of a resilient, sustainable, and inclusive agricultural sector.

We extend our heartfelt gratitude to all distinguished dignitaries, authors, reviewers, contributors, and participants for their invaluable support and dedication. May this conclave and its scholarly contributions serve as a beacon of knowledge, innovation, and cooperation, guiding India towards a prosperous agricultural future and the realization of Viksit Bharat @2047.

Organizing Secretary

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दिनांक : 11-02-2026

शुभकामना संदेश

कृषि के क्षेत्र में विचार, नवाचार और सहयोग को एक मंच पर लाने वाले "कृषि मंत्रणा–2026: अंतरराष्ट्रीय सम्मेलन" के सफल आयोजन हेतु मैं आयोजक समिति, शिक्षाविदों, वैज्ञानिकों, नीति-निर्माताओं तथा सभी सहभागियों को हार्दिक बधाई देता हूँ। यह सम्मेलन किसानों की आय बढ़ाने, आधुनिक कृषि तकनीकों के प्रसार, कृषि-उद्यमिता के विकास तथा सतत और आत्मनिर्भर कृषि की दिशा में महत्वपूर्ण भूमिका निभाएगा। आज आवश्यकता है कि हम परंपरागत ज्ञान को आधुनिक विज्ञान, डिजिटल तकनीक, स्टार्ट-अप संस्कृति और बाजार से जोड़ें, ताकि कृषि को अधिक लाभकारी, टिकाऊ और युवा-आकर्षक बनाया जा सके। मुझे विश्वास है कि कृषि अर्थशास्त्र विभाग, (शुआट्स) इस अंतरराष्ट्रीय मंच पर होने वाले विचार-विमर्श, अनुभवों का आदान-प्रदान और नीति-संवाद से प्रदेश और देश की कृषि को नई दिशा मिलेगी। यह सम्मेलन किसानों, युवाओं और उद्यमियों को नवाचार अपनाने और कृषि-मूल्य श्रृंखला को सशक्त करने के लिए प्रेरित करेगा।

मैं कामना करता हूँ कि कृषि मंत्रणा–2026 अपने उद्देश्यों में पूर्णतः सफल हो तथा "विकसित भारत" के संकल्प को साकार करने में उल्लेखनीय योगदान दे।

सभी प्रतिभागियों को शुभकामनाएँ।

(बलदेव सिंह औलख)

भाकृ अनुप
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Deputy Director General (Fisheries Science & Agricultural Education)

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MESSAGE

I extend my warm congratulations to the Department of Agricultural Economics, NAI, SHUATS, Prayagraj, for organizing KRISHI MANTRANA 2026: International Conclave during 12–14 February 2026. This timely and prestigious academic initiative provides an important platform for bringing together scholars, researchers, policymakers, entrepreneurs, and young professionals to deliberate on contemporary challenges and innovative strategies for transforming Indian agriculture.

The Conclave's focus on sustainability, resilience, technological advancement, and entrepreneurship is highly relevant in the context of evolving agri-food systems and national priorities. Such scholarly engagements play a pivotal role in strengthening agricultural education, promoting evidence-based policymaking, fostering youth-led innovations, and advancing agribusiness and allied sectors.

I am confident that the deliberations and outcomes of this conclave will generate valuable insights and actionable recommendations, contributing meaningfully to the vision of Viksit Bharat @2047. I appreciate the dedicated efforts of the organizing team and wish the conclave great success, marked by impactful discussions and enduring academic contributions for the future of Indian agriculture.

With best wishes,

(J.K. Jena)

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Dated 11.02.2026

MESSAGE

I am delighted to extend my warm greetings and best wishes to all the distinguished participants of the two-day International Conclave on "Entrepreneurial Development in Agribusiness and Sustainability of Agri-Tech in Self-Reliant Agriculture."

I congratulate the organizers for convening this important event, which reflects a strong commitment to advancing knowledge, promoting innovation, and supporting sustainable practices in the agricultural sector. The coming together of thought leaders, experts, researchers, and entrepreneurs provides an excellent platform for exchanging ideas, fostering collaborations, and exploring pathways for strengthening agribusiness and agri-tech ecosystems.

The theme of the conclave is both timely and relevant, as entrepreneurship and technological innovation are key drivers in achieving sustainable and self-reliant agriculture. Such initiatives play a vital role in encouraging practical solutions, promoting value addition, and creating new opportunities for farmers, youth, and agri-entrepreneurs.

I am confident that the deliberations and outcomes of this conclave will contribute significantly to shaping innovative approaches and strengthening the agricultural sector.

I convey my best wishes for the success of the conclave and for meaningful and productive discussions.

(Rajbir Singh)

प्रो. संजय कुमार सिंह
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MESSAGE

Indian Agriculture is the backbone of the country's economy, supporting a large portion of the population and contributing significantly to employment and GDP. It is diverse, ranging from subsistence farming to commercial agriculture, and depends heavily on monsoons, soil types, and regional climate. Major crops include rice, wheat, pulses, millets, sugarcane, cotton, and oilseeds, with horticulture, dairy, and fisheries also playing vital roles. In recent years, the sector has seen growth through technological advancements, irrigation projects, government schemes, and a focus on sustainability, though challenges like climate change, small landholdings, and farmers' income remain important concerns.

I extend my heartiest congratulations to the Department of Agricultural Economics, NAI, SHUATS, Prayagraj, for organizing KRISHI MANTRANA 2026: International Conclave scheduled from 12–14 February 2026. This prestigious platform will bring together policymakers, scientists, entrepreneurs, academicians, and progressive farmers to deliberate on emerging challenges and opportunities in Indian agriculture, agribusiness, and sustainable development. Such initiatives are vital for strengthening innovation-driven farming systems and achieving the vision of a resilient and self-reliant agricultural sector. I appreciate the dedicated efforts of the Organizing Team in creating a meaningful forum for knowledge exchange, collaborations, and youth engagement in agri-entrepreneurship. I am confident that the conclave will generate valuable outcomes and strategic pathways for the advancement of Indian Agriculture, including the horticulture Sector.

I convey my best wishes for the grand success of KRISHI MANTRANA 2026.

03/01/2026

(Sanjay Kumar Singh)

E-mail : ddghort.icar@gov.in Phone : (Off.) 91-11-25842068

ISARC
IRRI South Asia Regional Centre

MESSAGE

I am pleased to convey my heartfelt congratulations to the Department of Agricultural Economics, SHUATS, Prayagraj, for successfully organizing KRISHI MANTRANA 2026: International Conclave. This esteemed initiative reflects a strong commitment to advancing agricultural innovation, entrepreneurship, and sustainable development in the country.

In the context of rapidly changing micro-level climate dynamics, Indian agriculture increasingly demands innovative extension approaches, youth-driven agribusiness ventures, and technology-enabled solutions to enhance farmers' incomes and strengthen food and nutritional security. Platforms such as this conclave play a vital role in bringing together researchers, policymakers, academicians, entrepreneurs, and other stakeholders to exchange knowledge and develop actionable strategies for inclusive agricultural growth.

I am confident that KRISHI MANTRANA 2026 will foster meaningful deliberations, promote productive collaborations, and contribute significantly to building a resilient and future-ready agricultural ecosystem aligned with the vision of Viksit Bharat @2047.

On behalf of ISARC, I extend my best wishes for the grand success of this International Conclave and sincerely appreciate the organizing team for their commendable efforts.

With best wishes,

Sudhanshu Singh
Director,
IRRI South Asia Regional Centre (ISARC),
NSRTC Campus, G.T. Road, Collectry Farm,
P.O. Industrial Estate, Varanasi-221006 Uttar Pradesh, India

Uttar Pradesh Council of Agricultural Research
Rajkiya Udhyan, Cariappa Road, Alambagh, Lucknow-226005 (UP), India

Message

I am delighted to extend my heartfelt congratulations to the Department of Agricultural Economics at NAI, SHUATS, Prayagraj, for organizing KRISHI MANTRANA 2026: International Conclave, scheduled to be held from 12–14 February 2026. This notable academic and policy-oriented event provides a vital and timely platform for policymakers, scientists, academicians, entrepreneurs, development practitioners, progressive farmers, and students to engage in meaningful dialogue on emerging challenges, transformative innovations, and future prospects of Indian agriculture, agribusiness, and sustainable development.

In the present era, when agriculture is facing multifaceted challenges such as climate variability, natural resource degradation, market volatility, and the need for inclusive growth, such international conclaves play a crucial role in shaping informed strategies and evidence-based policies. The focus of KRISHI MANTRANA 2026 on innovation, sustainability, value chains, and agri-entrepreneurship aligns well with national priorities, including doubling farmers' income, promoting start-ups in agriculture, strengthening horticulture, and building climate-resilient farming systems.

I firmly believe that the deliberations, technical sessions, and interactions during this conclave will encourage interdisciplinary collaboration, foster innovation-driven agricultural systems, and contribute significantly toward achieving the national vision of a resilient, self-reliant, and future-ready agricultural sector. The emphasis on youth engagement and agri-entrepreneurship is particularly commendable, as it will inspire young minds to contribute creatively and professionally to the agricultural transformation of the country.

I sincerely appreciate and commend the dedicated efforts of the organizing committee for conceptualizing and executing such a meaningful forum that promotes knowledge exchange, institutional collaboration, and global perspectives. I am confident that KRISHI MANTRANA 2026 will generate valuable insights, practical recommendations, and strategic directions for the holistic and sustainable growth of Indian agriculture, including horticulture and allied sectors.

I convey my best wishes to the organizers and participants for the grand success of this international conclave and for fruitful deliberations.

With best wishes,

Prof. Permendra Singh
DDG Education, UPCAR

Sam Higginbottom University of Agriculture, Technology And Sciences
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MESSAGE

I am delighted to extend my sincere congratulations to the Department of Agricultural Economics, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, for organizing **KRISHI MANTRANA – 2nd International Conclave on Transforming Indian Agriculture for Viksit Bharat @2047.** This timely and forward-looking initiative highlights the critical role of innovation, startup ecosystems, skill development, and youth-led agripreneurship in shaping a resilient, self-reliant, and sustainable agricultural sector in India. I deeply appreciate the dedicated efforts of the organizing committee in bringing together policymakers, academicians, researchers, entrepreneurs, and industry experts from across the globe to deliberate on emerging challenges and transformative opportunities in agriculture and agribusiness. This conclave reaffirms SHUATS, Prayagraj's commitment to advancing agricultural research, innovation, and capacity building, while fostering an enabling environment for startups and skill-oriented education. Such initiatives are instrumental in nurturing future-ready agri-leaders and contributing meaningfully to national development goals. I extend my best wishes for the grand success of **KRISHI MANTRANA – 2nd International Conclave** and look forward to the insightful deliberations and impactful outcomes that will significantly contribute to transforming Indian agriculture in alignment with the vision of **Viksit Bharat @2047.**

With blessing and best wishes,

Rev. Prof. (Dr.) Rajendra B. Lal,

Vice Chancellor, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, U.P.

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MESSAGE

It is a great pleasure to extend my heartfelt congratulations to the Department of Agricultural Economics, SHUATS, Prayagraj, for successfully organizing **KRISHI MANTRANA 2026: International Conclave.** This esteemed forum highlights a strong commitment to advancing agricultural innovation, entrepreneurship, and sustainable development in India. In an era marked by rapid change, Indian agriculture demands progressive extension approaches, youth-driven agribusiness initiatives, and technology-enabled solutions to improve farmers livelihoods and strengthen food security. Platforms such as this conclave are instrumental in bringing together researchers, policymakers, academicians, entrepreneurs, and other stakeholders to facilitate knowledge sharing and to formulate practical strategies for inclusive agricultural development. I am confident that KRISHI MANTRANA 2026 will encourage meaningful deliberations, promote collaborations, and make a valuable contribution toward building a resilient and forward-looking agricultural ecosystem in alignment with the vision of **Viksit Bharat @2047** and SHUATS will lead the way

With best wishes,

Prof. (Dr.) ir. Jonathan A. Lal

Pro Vice-Chancellor (Academic Affairs), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P.

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MESSAGE

It gives me great pleasure to congratulate the entire organizing team of **KRISHI MANTRANA – 2nd International Conclave on Transforming Indian Agriculture for Viksit Bharat @2047**. This conclave represents a significant step toward empowering startups, strengthening skill development, and fostering youth-led agripreneurship for a sustainable and self-reliant agricultural future. In the present era of rapid transformation, agribusiness and agri-tech play a vital role in ensuring food security, rural livelihoods, and economic growth. This platform brings together policymakers, academicians, researchers, industry experts, and students to deliberate on innovative, technology-driven solutions for Indian agriculture. I am confident that the discussions and deliberations will generate meaningful insights and actionable outcomes aligned with national development goals. I extend my sincere appreciation to all participants, speakers, and collaborators for their valuable contributions and wish the conclave every success in shaping a resilient and progressive agricultural ecosystem.

Warm regards,

Prof. (Dr.) Ashish S. Noel

Head of Department

Department of Agricultural Economics, NAI, SHUATS

https://doie.org/10.10346/AE.2026934028

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LEAD PAPERS

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SYNERGIZING LEADERSHIP AND DIGITAL TECHNOLOGIES TO STRENGTHEN ENVIRONMENTAL PERFORMANCE IN SUSTAINABLE DAIRY SUPPLY CHAINS

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Assistant Professor
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ABSTRACT

Rising environmental pressures on the dairy industry have increased the importance of adopting sustainable supply chain management (SSCM) practices, particularly within developing economies such as India. This study explores the impact of SSCM practices on environmental performance (EP) in organized dairy processing firms located in the Uttar Pradesh. It further examines the mediating influence of strategic management and leadership (SML) in enhancing the effectiveness of sustainability-oriented supply chain initiatives, thereby providing an integrated view of managerial, technological, and operational factors influencing environmental outcomes. The research follows a quantitative approach and applies Partial Least Squares Structural Equation Modelling (PLS-SEM) to test the proposed relationships. Data were collected through structured questionnaires administered to managers and executives employed in organized dairy processing units across the Uttar Pradesh. The analysis focused on sustainable manufacturing practices, supplier sustainability practices, sustainable warehousing operations, sustainable information management systems, strategic management and leadership, and environmental performance. The measurement model's reliability and validity were established using Cronbach's alpha, Composite Reliability, Average Variance Extracted, and indicator loadings, while the structural model was evaluated through path analysis and explained variance. The results demonstrate that sustainable manufacturing activities, environmentally responsible warehousing practices, and sustainable information management systems significantly enhance environmental performance in the dairy supply chain. Among these, sustainable information management systems exert the strongest influence, reflecting the growing role of digitalization and information transparency in environmental improvement. In contrast, supplier-related sustainability practices do not directly affect environmental performance; however, their influence becomes significant when supported by effective strategic management and leadership. These findings underline the necessity for dairy firms to strengthen leadership commitment and invest in digital capabilities to advance environmental sustainability and meet evolving national and international sustainability requirements.

Keywords: Sustainable Supply Chain Management, Environmental Performance, Dairy Sector, Strategic Management and Leadership, SIMS, Digital Transformation.

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Introduction

India, the world's largest producer of milk, plays a vital role in ensuring food security, enhancing nutritional outcomes, and supporting rural livelihoods through its expansive dairy sector. Despite its economic and social significance, the industry is increasingly criticized for its environmental impacts, particularly with respect to energy use, greenhouse gas emissions, water consumption, and packaging waste. In response, the adoption of sustainable supply chain management (SCM) practices has emerged as a strategic necessity for improving environmental performance while sustaining competitiveness and operational efficiency. This study examines the combined effects of four key sustainable SCM dimensions—Sustainable Supplier Management Practices (SSMP), Sustainable Information Management Systems (SIMS), Sustainable Warehousing Management (SWM), and Sustainable Supply Chain Manufacturing Practices (SSCM) on environmental performance, while also exploring the mediating role of Strategic Management and Leadership (SML). These practices collectively reflect the integration of environmental considerations across supplier relations, digital information systems, warehousing operations, and manufacturing processes. SSMP focuses on supplier collaboration and environmental compliance, SIMS enables real-time monitoring and informed decision-making through digital technologies, SWM promotes energy-efficient storage and waste reduction, and SSCM emphasizes cleaner production, resource efficiency, and circular economy principles. However, the effectiveness of these practices largely depends on leadership commitment and strategic alignment, which translate sustainability objectives into actionable outcomes. The study is theoretically anchored in the Resource-Based View (RBV) and the Natural Resource-Based View (NRBV), which argue that firm-specific capabilities, including sustainable supply chain practices and leadership competencies, can generate both competitive advantage and environmental value. These internal perspectives are complemented by Institutional Theory, which explains how regulatory frameworks, industry norms, and stakeholder pressures encourage organizations to adopt sustainability-oriented practices, and by Stakeholder Theory, which highlights the leadership role in addressing diverse environmental expectations. In the Indian dairy context, institutional pressures from regulatory bodies and increasing stakeholder awareness further reinforce the need for sustainable transformation. Despite growing interest in sustainability within Indian agribusiness, empirical research examining the integrated impact of sustainable SCM practices and the mediating role of strategic leadership in the dairy sector remains limited. Addressing this gap, the present study aims to assess the collective influence of SSMP, SIMS, SWM, and SSCM on environmental performance, analyse the mediating role of SML in driving sustainability across the dairy value chain, and empirically validate these relationships within the Indian dairy industry under rising regulatory and market-driven sustainability pressures.

2. Literature Review

Sustainable supply chain practices have increasingly become critical to achieving improved environmental performance in firms across sectors, driven by global sustainability agendas and rising ecological concerns. Sustainable Supplier Management Practices (SSMP) represent a core dimension of sustainable supply chain management, encompassing green procurement, supplier evaluation with environmental criteria, collaboration, and eco-innovation initiatives aimed at reducing carbon footprints and waste generation. Empirical studies in manufacturing and agribusiness have shown that integrating environmental criteria into supplier selection and collaborative engagements with suppliers can significantly improve environmental outcomes, including reduced emissions and better compliance with environmental standards (Zhang et

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al., 2021; Kamble et al., 2022). Case evidence from dairy supply chains further suggests that supplier transparency and green innovation partnerships are associated with enhanced environmental sustainability (Yu et al., 2023; Bai et al., 2023). Nonetheless, barriers such as cost constraints and limited supplier awareness persist, particularly in emerging economies, underscoring the need for leadership and strategic interventions to overcome such challenges (Patel et al., 2021; Gupta & Verma, 2025). Sustainable Warehousing Management (SWM) practices, including energy-efficient designs, renewable energy use, waste segregation, green packaging, and automation, have also been highlighted in the literature as pivotal in reducing resource consumption and emissions within logistics operations. Warehousing upgrades such as sensor-based lighting and energy-efficient HVAC systems are shown to substantially cut energy use and carbon emissions, thereby improving environmental performance (Meena et al., 2022; Rao et al., 2023). These findings align with the broader argument that SWM is foundational to achieving sustainable supply chain outcomes in logistics-intensive sectors, and supports global sustainability goals such as SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). However, implementation challenges related to cost, skills shortages, and regulatory gaps are frequently cited impediments (Deshmukh et al., 2024; Patel & Jain, 2025). The advent of Sustainable Information Management Systems (SIMS) has further transformed sustainability discourse by integrating digital technologies, real-time analytics, cloud computing, AI, and blockchain to improve environmental monitoring, reporting, and decision-making across supply chains. Research demonstrates that accurate and timely information flows enabled by SIMS enhance resource efficiency and emissions tracking, support compliance reporting, and improve environmental accountability (Liu & Wang, 2022; Meena et al., 2023). Contemporary studies emphasize that digital technologies exert significant influence on sustainability outcomes by facilitating data-driven decisions and predictive analytics for optimizing sustainability metrics (Winkelmann, 2024; Singh & Iqbal, 2022). Advances in supply chain digitalization — including digital twins, IoT, and automation — have also been shown to enhance lean and resilient supply chain performance, with implications for environmental performance in perishable goods supply chains such as dairy (Kumar, 2024). Despite such advancements, challenges persist in terms of high investment costs and digital literacy gaps, especially among small and medium enterprises (Rao & Banerjee, 2024; Gupta et al., 2023). Sustainable Supply Chain Manufacturing (SSCM) practices target the environmental impacts of production through cleaner technologies, resource-efficient processes, waste minimization, and circular production models. Literature spanning multiple industries confirms that these practices reduce ecological footprints, improve energy efficiency, and enhance environmental compliance (Liu et al., 2022; Zhou et al., 2021). Moreover, SSCM has been linked with strategic advantages such as cost savings, enhanced brand reputation, and greater operational resilience (Zhang, 2024; Rahman et al., 2025). In the dairy sector, for example, integrating circular practices and eco-design approaches contributes to reduced waste and improved environmental outcomes, supporting global sustainability benchmarks. However, adoption barriers such as technological gaps and stakeholder resistance remain significant challenges that require targeted interventions (Rao & Mishra, 2021; Gupta et al., 2023). Across these sustainable practices, Strategic Management and Leadership (SML) is increasingly recognized as a key determinant of successful sustainability implementation. Rather than serving merely as a contextual or moderating variable, recent literature positions SML as a critical mechanism that institutionalizes sustainability, embeds environmental objectives into corporate strategies, and fosters accountability and cross-functional collaboration (Atieh et al., 2025; Mbamalu et al., 2023). Strategic leaders provide vision, allocate resources, and integrate sustainability metrics into performance systems, enabling supplier, warehousing, digital, and manufacturing practices to deliver measurable environmental results. Digital leadership in particular has been highlighted

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as a dynamic capability that supports the integration of digital technologies with sustainability objectives, thereby improving environmental outcomes through enhanced innovation and agility (Atieh et al., 2025). Furthermore, stakeholder and institutional theories underscore the influence of external pressures such as regulatory requirements, industry norms, and stakeholder expectations in driving firms to adopt and align sustainable supply chain practices with broader social and environmental imperatives. In the dairy industry context, these forces are reflected in initiatives to modernize cold chains, improve quality monitoring, and integrate AI and digital platforms to manage production and logistics more sustainably (Sinha & Mishra, 2023; MS Abedini et al., 2025). Collectively, the literature emphasizes that while individual sustainable supply chain practices contribute to environmental performance, their effectiveness is substantially amplified when guided by strategic leadership and embedded within a comprehensive sustainability governance framework.

Drawing upon the findings from the critical literature review, Figure 1 presents the theoretical model guiding the study."

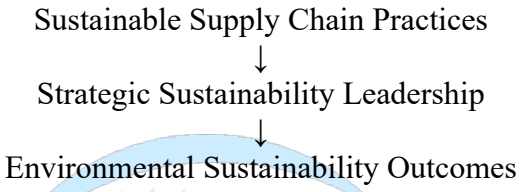

Figure 1: The Proposed Model

The figure 1 illustrates a simplified conceptual model in which environmentally oriented supply chain practices serve as the primary drivers of environmental sustainability outcomes. These practices include green supplier engagement, sustainable warehousing, sustainable manufacturing, and the use of digital environmental management systems, all of which aim to reduce emissions, minimize waste, and improve resource efficiency across the supply chain. The model shows that these practices have a direct influence on environmental sustainability outcomes. At the same time, the model highlights the mediating role of strategic sustainability leadership, which connects supply chain initiatives with environmental results by providing vision, strategic alignment, and managerial commitment. Strategic sustainability leadership ensures that sustainability goals are embedded in organizational strategy and effectively implemented in daily operations. Overall, the model emphasizes that while sustainable supply chain practices independently contribute to improved environmental outcomes, their impact is stronger and more consistent when guided and supported by effective leadership.

3. Research Methodology

This study adopts a quantitative research design to examine the relationship between sustainable supply chain management practices and environmental performance in the Indian dairy sector. Data were collected using a structured questionnaire administered to organized dairy processing units operating in the Uttar Pradesh. The Uttar Pradesh was selected due to its strategic importance as a major production, consumption, and distribution hub for dairy products, its high concentration of organized cooperative and private dairy firms, advanced logistics and information infrastructure, and strong regulatory oversight. Its proximity to milk surplus states such as Haryana, Rajasthan further strengthens its relevance as a focal point of the national dairy supply chain. 48 eligible dairy units were identified, of which 32 units were purposively selected considering operational scale, geographic presence within defined area,

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and engagement in sustainability or quality-certified practices. A judgmental sampling technique was employed to target respondents with direct involvement in sustainability-related decisions. Five employees across different discipline were surveyed from each unit, yielding a target sample of 160 respondents. Data collection was carried out from July 2025 to August 2025 using Google Forms, WhatsApp, email, and in-person follow-ups to ensure high response quality. Of the 160 questionnaires distributed, 109 valid responses were obtained, exceeding the minimum sample size requirements for structural equation modelling. All constructs were measured using a five-point Likert scale and were adapted from well-established and validated scales in prior studies. Descriptive analysis was performed using SPSS 24 to profile respondents, while Partial Least Squares Structural Equation Modelling (PLS-SEM) using Smart PLS was employed to assess the measurement and structural models.

4. Results

The results of this study, based on primary data collected from 109 valid responses obtained from 32 organized dairy processing units in Uttar Pradesh, provide strong empirical support for the proposed model. The measurement model assessment confirms that all constructs demonstrate acceptable reliability and validity, indicating that the questionnaire items consistently and accurately capture sustainable supply chain practices, strategic management and leadership, and environmental performance. Structural model analysis using PLS-SEM reveals that Sustainable Supply Chain Manufacturing Practices, Sustainable Warehousing Management Practices, and Sustainable Information Management Systems have a significant positive impact on Environmental Performance, highlighting the critical role of green manufacturing, efficient warehousing operations, and digital systems in reducing emissions, optimizing resource use, and improving environmental compliance in the dairy sector. In contrast, Sustainable Supplier Management Practices do not show a significant direct effect on environmental performance, suggesting that supplier-oriented sustainability initiatives require strategic guidance to yield tangible environmental benefits. Importantly, Strategic Management and Leadership exhibit a strong and significant direct influence on environmental performance and also acts as a partial mediator between supplier management practices, manufacturing practices, information management systems, and environmental performance. This indicates that leadership commitment and strategic alignment are essential for translating sustainability initiatives into measurable environmental outcomes. Sustainable Warehousing Management Practices, however, affect environmental performance directly, reflecting their operational and process-driven nature. The model explains a high proportion of variance in environmental performance, demonstrating strong explanatory power despite the modest sample size, which exceeds the minimum requirements for structural equation modelling. Overall, the findings suggest that in Uttar Pradesh's dairy industry, sustainable supply chain practices significantly enhance environmental performance, particularly when reinforced by effective strategic management and leadership, with digital information systems emerging as the most influential driver of environmental sustainability.

5. Conclusion and Recommendations

This study examined the relationship between sustainable supply chain management practices and environmental performance in the organized dairy sector of Uttar Pradesh, with particular emphasis on the mediating role of strategic management and leadership. Using primary data from 109 respondents across 32 dairy processing units and applying PLS-SEM, the findings provide clear evidence that sustainability-oriented practices significantly contribute to improved environmental outcomes. The results indicate that sustainable supply chain

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manufacturing practices, sustainable warehousing management practices, and sustainable information management systems have a strong and positive impact on environmental performance, highlighting the importance of clean production processes, efficient logistics operations, and digital technologies in reducing emissions, minimizing waste, and improving resource efficiency. Sustainable supplier management practices, however, do not exert a direct influence on environmental performance; instead, their impact is realized through strategic management and leadership. The strong direct and mediating effects of strategic management and leadership underscore its critical role in translating sustainability initiatives into measurable environmental outcomes. Overall, the study confirms that environmental performance in the dairy supply chain is best achieved through a combined approach that integrates operational sustainability, digital enablement, and strong leadership commitment. Based on these findings, several practical recommendations emerge for dairy firms and policymakers. Dairy companies should prioritize investments in sustainable manufacturing technologies, energy-efficient warehousing, and digital information management systems to achieve immediate and measurable environmental improvements. In particular, strengthening digital capabilities for real-time monitoring, reporting, and decision-making can significantly enhance environmental performance. Firms should also focus on developing strategic leadership capabilities by embedding sustainability into corporate strategy, performance evaluation systems, and managerial decision-making processes. Supplier sustainability initiatives should be supported through leadership-driven policies, supplier training programs, and long-term collaborative partnerships to ensure their effective implementation. From a policy perspective, government agencies and industry bodies can support sustainability adoption by providing incentives for green technologies, promoting digital transformation, and offering leadership development programs focused on sustainability. Collectively, these measures can help the dairy sector in Uttar Pradesh move toward environmentally responsible, competitive, and resilient supply chains aligned with national and global sustainability goals.

6. Practical Implications

The findings of this study offer several important practical implications for managers, policymakers, and other stakeholders in the Indian dairy sector, particularly in Uttar Pradesh. First, dairy firms should place greater emphasis on integrating sustainable manufacturing practices, such as clean production technologies, energy-efficient equipment, and waste reduction initiatives, as these practices have a direct and significant impact on environmental performance. Investments in environmentally responsible warehousing, including energy saving infrastructure, optimized cold-chain operations, and effective waste management systems, can further contribute to measurable reductions in emissions and resource consumption. Second, the strong influence of sustainable information management systems highlights the need for dairy companies to accelerate digital transformation. Managers should adopt digital tools for real-time environmental monitoring, data analytics, and sustainability reporting to improve transparency, compliance, and data-driven decision-making. Even for medium-sized dairy units, phased implementation of digital systems can yield substantial environmental benefits by enhancing operational efficiency and resource optimization. Third, the results underline the critical role of strategic management and leadership in achieving environmental sustainability. Senior management should actively embed sustainability objectives into organizational strategies, performance appraisal systems, and daily operational decisions. Leadership-driven initiatives such as employee training, cross-functional coordination, and sustainability-focused governance structures can significantly strengthen the effectiveness of supply chain sustainability practices. Finally, supplier-related sustainability efforts should be supported through leadership-led collaboration, capacity-building programs,

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and long-term partnerships with milk suppliers and logistics providers. Policymakers and industry associations can reinforce these efforts by offering financial incentives, technical support, and regulatory guidance for green technologies and digital adoption. Collectively, these practical implications suggest that a coordinated approach combining operational improvements, digital enablement, and strong leadership commitment is essential for enhancing environmental performance and building resilient and sustainable dairy supply chains.

7. Limitations and Scope for Future Research

While this study provides valuable insights into the relationship between sustainable supply chain management practices, strategic management and leadership, and environmental performance in the dairy sector, it is subject to certain limitations that should be acknowledged. First, the study is limited geographically to organized dairy processing units in Uttar Pradesh, which may restrict the generalizability of the findings to other regions of India or to unorganized and small-scale dairy units. Second, the study relies on cross-sectional data collected at a single point in time; therefore, it does not capture changes in sustainability practices or environmental performance over time. Longitudinal data could provide deeper insights into causal relationships and the long-term effects of sustainability initiatives. Third, the use of self-reported questionnaire data may introduce response bias, as perceptions of sustainability practices and environmental performance may differ from actual performance outcomes. Additionally, the sample size, although adequate for PLS-SEM, remains relatively modest, which may limit the robustness of subgroup or comparative analyses.

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RENDERING FARMER-CENTRIC EXTENSION SERVICE IN INDIA: ISSUES AND THE WAY FORWARD

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Introduction

India is an agrarian country with 160 million ha arable land, second largest in the world, predominantly (86%) performed by small and marginal farmers, operating land holding with less than 2.00 ha area (Agricultural Census, 2015-16). More than 1.3 billion population of the country expects their food to be supplied from agriculture and allied sectors and agriculture is practiced by about 43% of the population. Hence, it becomes extremely important to cater to the employment and food demands of such huge population. Hence, to make the relevant and reliable information to reach these farmers has become increasingly important (Claire *et al*, 2010). To cater to the information, input and technological needs of farmers of the country, a wide extension network is built, comprising of Ministry of Agriculture and Farmers Welfare and its line departments, extension functionaries of private agricultural industry and that of tertiary sector, especially non-governmental organizations (NGOs) and farmers' organizations. All these players are involved in influencing the farmers towards adoption of innovations developed by the technology development system. However, the impact of efforts of these organizations, in enhancing livelihood of the farming community is not felt at a tangible proposition (Babu *et al*., 2013). The share of agricultural research and education in India, is mere 0.37 % of the agriculture GVA, which is less compared to that of other developing countries. (Babu *et al*, 2012). The country's public extension system, second largest in the world, which was responsible for 'green revolution', is now at a stage from where, it has to explain about relevancy, effectiveness and efficiency of its efforts and hence, continuously evolves, in order to address the contemporary issues faced by the farmers (Joshi *et al*., 2005; Pal, 2008; Raabe, 2008; Sontakki *et al.*, 2010; Glendenning *et al*., 2010; Desai *et al.*, 2011).
Both public and private extension system in the country, planned and implemented many reforms, not only to serve the diverse needs of the farmers but also to be successful in bringing desirable impacts and thereafter to sustain the impacts. However, a strong mechanism to monitor, evaluate and document such developments is lacking, and hence, country-wide replication of the successfully experimented reforms does not happen. Moreover, these reforms are experimented at selected small pockets with external financial support. So, when the

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financial support ends, the reforms get struck, without being up scaled (Adhiguru *et al*, 2009; Aker, 2011; Birner and Anderson, 2007; Swanson and Rajajlahti, 2010; World Bank,2012).

Diverse Information Needs of a Farmer of 21st Century and Their Major Source of Information

The changing needs of farmers at a market-driven agricultural scenario, may be enlisted such as, technological options which may bring profitability within available limited resources; what are the option for diversifying the farming?; market demand for agriculture commodities; quality standards for agriculture produce to get maximum possible price in the market; time, place and method of buying agriculture inputs and selling produce; decision making towards resource-use planning and marketing; retrieving relevant and reliable agricultural information; feasible off-farm income generation activities (Rasheed and Van den ban, 2000). Hence, the information needs of the farmers of 21st Century is much diverse and mostly market-driven (Table 1). The information needs of them start from pre-planting stage and does not end just after the harvest. They need to think about post-production measures such as grading, packing and storing, moreover about marketing. Thus, the public extension officials with capacity inadequacies need to partner and network with various service providers to deliver farmer-centric holistic extension service.

Table 1. Information needs of Farmers for an Agricultural Cycle (DFI, 2017)

Pre-planting Stage	❖ Which crops to grow for which target market? ❖ How much land to allocate to each crop?
Seeding Stage	❖ Whether to purchase seed or use own seed? ❖ Which seed to purchase, where to purchase?
Preparing and Planting Stage	❖ How to prepare the land for the specific crop / produce? ❖ How to sow the seed (example: seed rate, sowing time, depth at which seed should be sown; to use seeds vs. seedlings) ?
Growing Stage	❖ How much quantity of water, fertilizers, manure, herbicides,micro-nutrients and pesticides to be applied? ❖ Which fertiliser, manure, herbicides, micro-nutrients to apply? ❖ Diagnosing pest attack (if any) and which pesticide to apply? ❖ How to apply various inputs, and judicious use of inputs? ❖ From where to purchase inputs?
Harvesting, Post-production, Packing and Storage Stage	❖ How to harvest the produce? ❖ How to pack the produce? ❖ Where to store the produce? ❖ How to cure the crop and options available for value addition?
Marketing Stage	❖ Whether to sell/ consume? ❖ Where, when and at what price to sell?

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Table 2. Major Source of Information for Farmers (NSO, 2021)

Source of Technical Advice	July – December 2018		January- June 2019	
	% of Households Accessed Technical Advice	% of Households Adopted the Accessed Technical Advice	% of Households Accessed Technical Advice	% of Households Adopted the Accessed Technical Advice
Progressive Farmers	22.8	92.1	20.3	91.0
Input Dealers	19.9	93.3	19.1	92.4
Government Extension Agent/ATMA	3.1	83.4	1.5	86.2
Krishi Vigyan Kendra (KVK)	1.3	80.4	0.5	72.0
Agricultural University/College	0.3	79.9	0.2	73.8
Private Commercial Agents	1.2	74.6	0.9	85.7
Veterinary Department	6.6	89.5	6.8	90.6
Cooperatives/Dairy Cooperatives	2.7	89.5	1.8	90.1
Farmer Producer Organizations (FPOs)	0.5	79.0	0.3	87.6
Private Processors	2.1	86.5	2.3	90.2
AC&ABC*	0.5	70.9	0.3	90.5
NGOs	0.6	70.3	0.2	68.5
Kisan Call Centres (KCC)	1.5	69.5	0.7	72.0
Print Media	5.3	67.6	4.1	65.4
Radio/Television/other Electronic Media	13.2	65.4	8.2	61.7
Smartphone App-based Information	1.2	75.5	0.8	62.8
Any agent	48.7	89.8	42.2	89.5

*AC&ABC-Agriclinics & Agribusiness Centres

The data given in Table 2 clearly indicates that progressive farmers and input dealers, followed by Radio/ Television/ Other Electronic Media were the major sources of agricultural information for the farmers. Hence, these sources are to be mainstreamed by public extension system, so that adequate adoption of modern technologies by the agriculturists can be ensured. Use of progressive farmers in the information chain of agriculture has been widely experimented around the world including India (elaborately explained in Table 7), such models need to be institutionalized in major extension programmes. Government of India (GoI) initiated Diploma in Agricultural Extension Services for Input Dealers (DAESI) programme, especially for input dealers, so that they may extend right kind of information and input services. Radio, Television/ Other Electronic Media and Print media are effectively and regularly utilized by both public and private extension system in the country. Fascinatingly, it

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could also be understood from Table 2 that adoption of accessed technologies by the farmers were more towards information sources such as ATMA, KVK, Agricultural Universities/colleges, Cooperatives and private processors, though the percentage of farmers accessed these sources was less. Hence, strenuous efforts should be made to enhance the reach of these sources to the farmers. In fact, ATMA of the mainstream extension and KVK and Agricultural Universities/ Colleges of the frontline extension are the major players of extension system in the country and their efforts has to not only motivate but also attract and involve the progressive farmers, input dealers and media, towards providing farmer-centric extension through pluralistic style of extension.

Investment and return to investment in Extension and its Significance

India needs a strong extension mechanism, which can deliver access to information sought by the majority small holders of the country (NSSO, 2006). Moreover, reduction in poverty and hunger level of these farmers rely on successful delivery of agricultural information. These facts necessitate adequate investment to build a strong extension mechanism in the country, which can deliver diverse needs of the farmers apart from mere implementing central and state sector development and welfare schemes and programmes. There are studies which reveal that the reduction in poverty level of resource poor farmers is proportionate to the investment in agriculture research and development. There are also studies which unearthed the fact that favourable economic returns from investment in agricultural extension (Evenson, 2001; Benin *et al*., 2011; Birthal *et al*., 2015). The extension intensity (expenditure/ hectare of agricultural land) of the country is 0.18% of GDPA (2017-18), which is too less compared to that of research intensity (0.40%). On the contrary, the average rate of return from investment to extension was 75%, compared to that 71.8% for research (Gulati *et al*, 2018; Singh *et al*, 2020). The recommended extension intensity for a developing country is 0.22, such limit was not at all attained in India at any given point of time, implying the need for adequate investment in agricultural extension. The fact of inadequate investment in public extension may be due to the perception that such investment may not result in increase in farm productivity and increase in investment from private industry. As per 2018 estimates of Niti Ayogh, there will be increase in demand for food grains, milk, meat, vegetables, and fruits to the tune of 21, 42, 70, 33, and 54% respectively, compared to that of 2011-12. Interestingly, such increased demands have to be met through reduced cultivable lands, reduced resources like water, without polluting further the environment, causing less climate risks. At this juncture, agricultural extension plays a critical role and the farmers who efficiently uses the farm information will be more progressive. Hence, the extension approach should be farmer-centric (Sajesh and Suresh, 2016; Birthal *et al*., 2015).

Status of Public Extension Manpower in India

The state-wise manpower available in public-sector extension system in India and operational holdings available in the corresponding states are given Table 3. According to this data, it could be understood very well that the ratio of operational holdings: extension official is wider in states like Andhra Pradesh, Karnataka, Uttar Pradesh, Madhya Pradesh, Kerala, Gujarat, Rajasthan Odisha and West Bengal. This may be due to either larger nature of the states or due

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to fragmentation of operational holdings. Similarly, this ratio is narrower in smaller states located in North-eastern Hill Region. The average of this ratio was 1,162:1, which is much wider than the one recommended for irrigated regions (1,000:1); rain-fed regions (750:1) and hilly regions (400:1). Such data necessitates to employ adequate manpower in the public sector extension system or to have partnership among the various extension systems in the country, so that effective extension services can be extended to the farmers.

Table 3 Status of Public Manpower in Agricultural Extension

State	Operational Holdings (A)	Public Extension Manpower in Position (B)	Operational Holding: Extension Official Ratio
Andhra Pradesh	1,31,75,100	4,167	3,162:1
Arunachal Pradesh	1,09,298	1,145	95:1
Assam	27,20,223	2,779	979:1
Bihar	1,61,91,391	10,231	1,583:1
Chhattisgarh	37,46,480	4,313	869:1
Goa	78,020	95	821:1
Gujarat	48,85,610	3,501	1,395:1
Haryana	16,17,311	3,018	536:1
Himachal Pradesh	9,60,765	1,084	886:1
Jammu & Kashmir	14,49,397	5,812	249:1
Jharkhand	27,08,928	4,129	656:1
Karnataka	78,32,189	3,226	2,428:1
Kerala	68,30,789	3,933	1,737:1
Madhya Pradesh	88,72,377	10,775	823:1
Maharashtra	1,36,98,965	15,770	869:1
Manipur	1,50,620	629	239:1
Meghalaya	2,09,561	402	521:1
Mizoram	91,880	538	171:1
Nagaland	1,78,411	1,053	169:1
Odisha	4,667,466	3,794	1,230:1
Punjab	10,52,554	1,398	753:1
Rajasthan	68,88,436	5,495	1,254:1
Sikkim	74,928	357	210:1
Tamil Nadu	81,18,224	8,320	976:1
Tripura	5,78,479	2,913	199:1
Uttar Pradesh	2,33,25,456	12,976	1,798:1
Uttarakhand	9,12,650	1,031	885:1
West Bengal	712,3,347	6,164	1,156:1
All India	**13,83,48,461**	**1,19,048**	**1,162**:1

Note: Source of information - http://agcensus.dacnet.nic.in/stateholdingsizeclass.aspx

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**Figures given include dedicated manpower deployed for extension purposes under support to State extension programs for Extension reforms, 2010 (ATMA Scheme) and all other manpower posted by the State Government (excluding ministerial and office support staff).*

Agricultural Extension Service Providers in India (Gulati *et al*, 2018 and Singh *et al*, 2020) Table 4 explains the common and major extension service providers in the country along with their specific roles and responsibilities:

Table 4. Agricultural Extension Service Providers in India

Sector	Service Providers	Schemes/roles/responsibilities
Public	State level line departments	Implement the schemes (Central Sector) and programmes of Ministry of Agriculture and Farmers Welfare (MoA & FW) and their own (State Sector) programmes
	MoA & FW	Planning and implementing central sector schemes like NMAET (National Mission on Agricultural Extension and Technology), MIDH (Mission on Integrated Development of Horticulture), NMSA (National Mission on Sustainable Agriculture), RKVY (*Rashtriya Kristin Vikas Yojana*), NFSM (National Food Security Mission), NMOOP (National Mission on Oilseeds and Oil Palm), NHM (National Horticulture Mission), SHC (Soil Health Card), SMSP (Sub-Mission on Seed and Planting Material), SMAM (Sub-Mission on Agricultural Machinery) etc.,
	ICAR-Agriculture Technology Management Agency (ATARI) and *Krishi Vigyan Kendras* (KVKs)	Technology-assessment and refinement, Technology demonstrations (FLDs), capacity building programmes for farmers, farm women, youth and entrepreneurs.
	State Agricultural Universities/ Agricultural Universities (SAU/AUs)	Extension programmes are planned and implemented through Directorates of Extension Education (DEE), KVKs, Agricultural Technology Information Centres (ATICs), Farmers Training Centres (FTC) etc.
	Commodity Boards (eg: Rubber Board, Tea Board, Spices Board etc.,)	Planning and implementation of Central sector schemes
	Marketing Boards (eg: Maharashtra State Agriculture Marketing Board; Karnataka State Mango Development and Marketing Corporation Limited)	Advisory services on marketing information like price, cost of marketing etc., to help the farmers in decision making to sell the produce.
	Information and Communication Technologies (ICT)-led Extension models	Farmers portals; m-Kisan (SMS) and mobile app such as Kisan Suvidha, Pusa Krishi, Agricultural market); Kisan Call Centres (KCC) (Telephone-based advisory); Kisan TV channel (TV programs on agriculture and allied sector); Community Radio Stations (Need-

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		based radio programmes for a particular locality)
Private	Agri-clinics and Agribusiness Centres (AC&ABCs)	Agribusiness services on various aspects of agriculture and allied sectors
	Diploma in Agricultural Extension Services for Input Dealers (DAESI) holders	Advisory services on inputs and related areas More than 2.8 lakh input dealers of the country were trained through this programme from whom around 20% of the farmers get agro-advisory.
	Private company initiatives	These companies undertake direct extension initiatives to promote their own products. Tata Kisan Kendras (empowering farmers with knowledge); DCM Sriram (distribution of inputs) established Hariyali Kisan Bazaar; Agrocell Service Centres; Mahindra Shubhlabh centres; ITC e-Choupal; Contract farming by PepsiCo and Heritage Foods.
Tertiary Sector	Non-governmental organizations (NGOs)	3 million registered NGOs are actively involved in development of rural areas render agricultural extension services, as joint partners; as innovators; as networkers; as advisors and as providers of empowerment; sometimes serve through partnerships with public and private sector extension
	Farmers' Organizations	These groups facilitate farmers to reduce their cost of production and get remunerative price for their commodities through linkages with multi-agencies. Growers association (MAHA Grapes, MAHA Mango); Users associations (water users), Farmers Interest Groups (FIGs); Farmers Associations and societies (IFFCO, KRIBHCO); Farmers clubs (NABARD Farmers Clubs); Producer companies; Farmers cooperatives.

Information given in the above table clearly indicates that a large number of extension service providers are available around Indian agriculture. Situation-specific, customized, especially pluralistic use of these players, may address the diverse needs of the farmers and render farmer-centric extension.

Major Extension Approaches and their Impact

Indian public extension system though experimented many approaches to remain pragmatic and responsive to the farmers' demand, the country witnessed major three major extension approaches namely, green revolution approach, Training and Visit (T&V) approach and Agriculture Technology Management Agency (ATMA) approach (Table 5). The green revolution approach, though was successful in achieving self-sufficiency in food grain production, was criticized for its top-down approach, wherein the farmers passively adopted the advocated technologies. The T&V system approach was successful in building a strong

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organizational structure around the line departments, so that effectiveness in technology dissemination could be practiced. However, this approach was criticized for its lack of goal-orientation and hence resulted in low operational efficiency. Both these two approaches were terminated after World Bank ceased to fund. The much debated ATMA system approach, which has many advantages to handle the contemporary challenges emerge from the market-dominated agricultural scenario, through pluralistic mode, is criticized for being implemented just as an another scheme by the officials of the line departments. The implying message is that there is a need for adopting a flexible, situation and commodity-specific, pluralistic extension models, which can address the market-driven needs of the farmers.

Table 5. Major Extension Approaches in India and their Impact

S. No.	Type of extension system	Period	Approach and impact	Role of farmers	Constraints
1	Green revolution extension approach	1960s and 1970s	Field demonstration of high yielding varieties; effective input supply, market and policy support; The goal of achieving the self-sufficiency in food grain production through adoption of high yielding varieties was achieved. However, the approach was mere a top-down approach.	Passive adoption of advocated technologies.	As World Bank terminated to fund, sustainability of such efforts was compromised; Intensity of advocacy necessitated recruitment of more number of quality staff.
2	Training and Visit (T&V) System	1974 to early 1990s	World Bank funded approach; Strong organizational structure and resulted in successful but top-down approach of extension.	Passive adoption of advocated technologies.	The goals of the extension functionary was to distribute inputs and subsidy, which resulted in lack of goal-orientation and lower operational efficiency of the approach.
3	Agriculture Technology Management (ATMA) Agency	1998 onwards	Bottom up approach; Farmers and farmers organisations are involved in the planning of block level development programmes.	Farmers and farmers' organizations are supposed to actively participate in planning	Recruitment of dedicated staff; ATMA-KVK linkage, funding support, research - extension linkage,

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				and implementation of the need-based and situation-specific programmes.	percentage of budget allotted for knowledge component, involvement of farmers in making policy decisions; participation of agripruneurs in extending farm services etc. are embedded through holistic planning. However, in reality, this approach is considered as yet another scheme by the extension staff of the line departments.

Styles of Agricultural Extension in India and Their Impact

An overview of information given in Table 6 informs that all the extension styles, which are adopted around the agricultural landscape of the country, which have both advantages and demerits of their own. Hence, it may be reiterated that no style is best suited to all situations and there should be a combination of location-specific two or three styles and their positive benefits and such pluralistic combination alone can advocate best farmer-centric extension strategies.

Table 6. Style of Various Extension Approaches and their Impact on Empowering Farmers (Singh *et al*, 2020)

Extension Style	**Extension Service Provider**	**Roles/ Responsibilities**	**Approach and Impact**
General agricultural extension	Government and the government-owned development departments of the states	Implementing Central and State sector schemes and Programmes	Top down approach; Wider extension network; linear model of information flow, below par efficiency.
Commodity-based extension	Commodity board (Tea Board, Coffee Board, Spices Board, Tobacco Board, Coconut	Input supply; marketing support; assured price support	Adoption rate towards technology is high; Less farmer; extension worker ratio; limited number of farmers are the

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	Development Board etc.)		beneficiaries; market price fluctuation decides the fate of the commodity.
Participatory extension	Farmer groups (or) associations	Management/ maintenance of common properties of the communities	Highly successful in results than other approaches; participation of farmers is high; However, this approach needs greater coordination among the local communities and institutions.
Farming System Extension	Different service providers such as development departments/NGOs /farmers associations/private firms	a) Researcher designed and researcher implemented trails b) Researcher designed and farmer implemented trails c) Farmer designed and farmer implemented traits d) Farmer designed and researcher implemented trails e) Technology dissemination	Follows system/holistic approach; takes care of productivity, profitability, stability, sustainability; It suits the farmer needs, strong farmer-researcher-extension worker linkage exits. However, the success depends on effective collaboration.
Cost-sharing Extension	Government and government-owned developmental departments; share the cost of implementation of the programmes and schemes	Schemes of agriculture development made affordable and sustainable to the central and local level.	Reduces the financial burden of the central government; this approach ignores the case of small and marginal farmers who may have enormous burden to share their cost
Educational Institutional Extension	State Agricultural Universities (SAUs) and public research organisations	Researcher-farmer linkage models; research institute-village organization partnership model; SAU-farmer clubs association model etc.	Field problems are addressed; working relationship between researcher, extension personnel and farmers; Sometimes ended as highly academic programmes;

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			competition/conflict between extension agency and education institutions happens.
Public extension	Government and government-owned developmental departments of the States	Government planned and implemented programmes and schemes	Beneficial in areas, where no private efforts are explored; facilitates faster communication; criticised for lack of relevancy; inadequate operational budget and low manpower
Private extension	Extension personnel from private agency/organizations; clients are expected pay the service fee; they act as supplementary or alternative to public extension service.	Private services operated by many agencies.	It reduces the economic burden of the government; increases accountability of extension agents; increases competency of the extension system; provide relevant and highly effective agro-advisory services on high value crops and enterprises. However, it restricts free flow of information; reluctant attitude of rich farmers who paid the fee, to disseminate information to the poor farmers stop the technology dissemination; this system discourages the dissemination of eco-friendly and sustainable agriculture practices.
Civil society-based extension	Non-governmental (or) voluntary organizations	They work on various schemes/programmes implemented by the governments	More focused towards development work; mobilizes poor in a better way; closer to the community; deliver services in a cost effective way. However, their efforts depend on financial support; many NGOs are not managed efficiently.

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Farmer-Field School based extension	Farmers groups	Field-based problems are identified and solved including 1PM practices.	Promote natural resources management technologies; ensure healthy crop management; encourages lifelong learning through self-experience; facilitate research-extension-farmer linkage; empower farmers own decisions; adoption rate is, however, very low and slow; time consuming; less participation of other media.
Farmers' Organization based extension	Producer organizations associations; cooperatives; producer companies	Participate in the schemes/programmes implemented by the government.	Organised around a commodity, an activity, a group of farmers, or a company. Need to depend on the Government for financial support and networking facilitation.
Extension through public-private partnership	Ministries; departments; municipalities; state-owned enterprises within local/international private partners.	Risk sharing relationship between the public and private sectors, developed to bring about a desired public policy outcome.	Brings in efficiency; flexibility; and competency along within accountability; long-term perspective and social interest.
Pluralistic extension	Mix of public, private non-governmental organizations in association with farmers organizations, consultants and many more through the platform of ATMA (Agriculture Technology Management Agency)	The schemes and programmes implemented by the Government agencies	Pluralistic extension that promotes the participation of multiple stakeholders who extend extension services; However, the approach is considered an another scheme run through the government agencies, as perceived by the officials of the line departments.

Evolution of Farmer-to-Farmer extension and its Significance

Farmer to farmer extension is one of the effective methods of technology dissemination, wherein the progressive and innovative farmers share their knowledge with the fellow farmers. This model is very effective, as one among the farmers is sharing the knowledge, who can

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deliver to the localized information needs of the fellow farmers. In fact, this style is much needed in order to render farmer-centric extension. Here, the important aspect to be noticed is to orient these farmers, by explaining them their roles and responsibilities in disseminating farm information. Farmer schools and farmers field schools (FFS) are organized, where the progressive or innovative farmers transform themselves as teachers to disseminate need-based farm information and facilitate meaningful and pragmatic discussion among the fellow farmers for solving the field level problems encountered by the farmers. Table 7 provides an overview of farmer-to-farmer extension approaches practiced globally and their impact, emphasizing the need for drawing lessons from such approaches and institutionalizing them in various development programmes by satisfying the financial implications.

Table 7. An Overview of Farmer-to-Farmer Extension Experiences around the World

Approach	Country/Region	Purpose	Impact	Reported by
Lead farmer (LF)	Malawi	To accelerate technology dissemination	Lead farmer assisted extension staff in community meetings and farm demonstrations; served as an important bridge between farmers and extension staff.	Khalia *et al*.,2015; Ragasa, 2019.
Farmer Field School (FFS)	Asia	To discuss the field problems to arrive at solutions at the community level	FFS was facilitated by extension workers through skilled farmers. Served as a primary source of learning through non-formal education method.	Van den berg and Jiggins, 2007
Farmer to Farmer Journalism	India	Self-help journalism used to communicate success stories	Encouraged farmers to write articles, edit and publish through local agriculture journal	Kaur and Kaur, 2018
Farmer Friend approach	India	To serve as a vital link between farmer and extension system	Farmer Friend facilitated dissemination of information to farmers and farm women directly	Kaur and Kaur, 2018; Pauline, Anitha and Karthikeyan, 2015

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			through one to one interaction individually or in groups.	
Farmer Extension worker	Kenya	To make the volunteering farmers to work as extension workers to complement the efforts of public and private extension service providers.	Successful in facilitating farmer learning through farm demonstrations, field days; providing market information; resulted in improving the income of small holders and their standard of living.	DFID, ---------
Model Farmer	Ghana	To motivate the fellow farmers to adopt modern practices of agriculture.	The model encouraged the farmers to have commitment and motivation towards farm business; gave information to the farmers about financial resources for the production season; enhanced their willingness to reinvest the profits and access to farm land for future expansion	Kwapong *et al.*, 2020
Farmer Field Schools (FFS)	Benin	To integrate the knowledge sharing networking in cowpea farming	Served as a vital source for new skills and information, integrating a number of existing knowledge sharing networks of rural men and women.	Nathaniels, 2005
Farmer to Farmer extension approach	Indonesia	To motivate the generation of young farmers	The approach helped in motivating the young generation of farmers in terms of their	Anwarudin and Haryanto, 2018.

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			willingness to learn, work and self- development towards experience in agriculture.	
Progressive farmers	Indonesia	To promote progressive farmers as self-help extension workers	The progressive farmers were effective in providing technical assistance; disseminating need-based innovations; providing training to partner farmers; becoming informal leaders and maintaining local wisdom.	Haryanto *et al*., 2021
Independent extension officer	Indonesia	To facilitate coffee growers attain good security in association with civil servant extension officers	The role of independent extension officers dominatingly influenced the food security of coffee growers	Warnaen *et al*., 2022
Lead farmer	Nigeria	To deploy cost effectiveness; broader reach and sustainability.	The approach was cost and time effective. The approach was effective in complementing the efforts of extension workers.	Oyelami *et al*., 2018
Farmer to Farmer extension	Nepal	To enhance the diffusion of sustainable soil management technologies	The success of this approach led to inclusion of farmer to farmer model in Nepal Government in Agricultural Extension Policy (2007).	ICIMOD, 2007.
Farmer extension facilitators	Uganda	To disseminate technologies and value addition	Resulted in increased uptake of technologies; increased food production and	Ssemakula and Mutimba, 2011

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			more information flow.	
Lead Farmers	Kenya, Malawi, Cameroon	To facilitate effective technology dissemination.	It was found that linking lead farmers to extension organizations, farmers associations and private companies may help in making extension systems more effective and farmer to farmer approach more sustainable.	Simpson *et al*., 2015
Farmer trainer	India	To strengthen the information flow and enhance agricultural production	May reduce the extension cost and workload of the extension functionaries; however, needs community and government support for sustainability and scalability.	Meena *et al*., 2016

Farmer-to-farmer extension models help the extension organizations to reach the unreached at a lower cost. Since the trainer farmers are from the local community, they use the same language and know the culture of the fellow farmers and hence effective in technology dissemination. These farmers provide accurate feedback to the extension agencies and the issue of sustainability after the project funding ends, may be effectively managed (Meena *et al*, 2016). However, such approaches need continuous coaching and technical backstopping of the trainer farmers. There is a possibility of conflict between trainer farmers and extension personnel, if they substitute the role of extension personnel and the sustainability of such models may be in jeopardy sometimes, when the extension agencies refuse to finance such attempts (Meena *et al*, 2016). The criteria such as having adequate farming experience, capacity to be a role model, higher literacy level, being one among the local community, ability to communicate to the level of the fellow farmers, trustworthiness, acceptability from the local farmers, easy to access, and innovative in ideas may be considered for selecting the farmer trainers (Simpson *et al*, 2015). However, there are other factors such as closeness of the beneficiaries to the facilitators, multiple community role played by the facilitators and their dedication of time in facilitation of fellow farmers towards technology, which affect the effectiveness of farmer-to-farmer approach (Ssemakula and Mutimbe, 2011). The farmers' trainers need to be hardworking, achievers, with helping tendency, carrying respect in

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community, innovative, literate, effective in communicating, local resident, able to spend time, honest, with leadership skills and should own a plot (Khalia *et al*., 2015).

These farmers are supposed to play multiple roles such as training fellow farmers; providing technical advice; establishing demonstration plots, monitoring activities of the farmers; disseminating messages; mobilizing communities for the meeting; identifying problems and call for assistance; conducting meetings, reporting on progress of activities; representing organisations in the community and testing technologies with field staff (Khalia *et al*., 2015). It was reported that acquiring new knowledge; helping others; facilitating income generating activities; gaining social status or respect or esteem; ending poverty; and social networking were the motivating factors for becoming a lead farmer in farmer-to-farmer extension approach (Khalia *et al*., 2015). In similar approaches, there were certain difficulties felt by the facilitators such as difficulty in mobilizing farmers, insufficient honorarium, inability to travel long distances, and lack of time to spend towards facilitation, which are needed to be addressed, so that these models can be effective (Pauline, Anitha and Karthikeyan, 2015). Further, limited budget for activities; lack of interest from the fellow farmers and their high expectations; resistance from the extension staff; reaching female farmers; lack of cooperation from village head; less time left with for performing own farming; and depleting own resources; were the challenges faced by the lead farmers (Khalia *et al*., 2015). However, the potential solutions would be providing adequate incentives for the lead farmers; and mediating support from the community and other farmers, extension and local leaders (Ragasa, 2019).

Evolution of ICT-based Extension and the Resultant Farmer-centric Extension

Information and Communication Technologies (ICTs) are playing vital role in providing customized information services to needy farmers. In that way, ICTs are crucial in facilitating farmer-centric extension. It is interesting to know that 45% of the world's ICT projects are being implemented in India. However, most of the ICT projects in India, are implemented in developed states of South and North India (Saravanan, 2012). It was reported that adoption of farm innovations informed through ICTs is to the tune of 85% as against 11% of adoption of farm innovations informed through traditional extension methods. There were studies which revealed that as a result of ICT-based information dissemination projects, there was increase in yield and income of the beneficiaries (Gandhi *et al*, 2008; Krishnareddy and Ankaiah, 2005; and Gandhi *et al*, 2009).

The ICT projects implemented for agricultural development in India are facing the challenges such as pilot projects syndrome; unsustainable investments; unwillingness of the users to pay; small scale of operation; lack of permanency; mere information will not serve technology adoption; difficulty in content localization; one-way flow of information; lack of systemic evaluation and lack of coordination. However, ICTs bring efficiency in the extension system, which may be achieved through adopting a national level e-agricultural policy, deploying ICTs in public extension approaches, capacity building of all stakeholders towards ICTs applications in agriculture, so that e-literacy at all levels can be enhanced; strengthening infrastructure of ATMA and KVK, so that ICTs can be effectively handled at these platforms efficiently for agricultural extension; customizing the content used in ICTs to the local needs; establishing

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strong research and extension linkages through ICT applications; forging convergence among various ICT approached used for agricultural extension and planning and implementing ICT projects for agricultural development (DFI, 2017). The following ICT initiatives (Table 8) were taken in Indian agriculture to serve farmers through need-based customized information (Saravanan, 2012):

Table 8. ICT-based Initiatives in India to Provide Farmer-centric Extension

ICT initiative	Approach
a-AQUA	Providing solutions to the queries of the farmers in 5 languages.
Kisan Kerala	Integrated multimodal agriculture information system and citizen centric e-governance projects for Kerala. It includes online advisory services; television programmes; online video channel and mobile-based information services.
TNAU Agritech portal	Dynamic in nature; Disseminates information about agricultural technologies; schemes; services; market information and daily events and their updates and providing link to real time data.
AGRISNET	Established and governed by the Ministry of Agriculture and Farmers Welfare; Provides information about government, Scheme/Programme/Subsidy details etc.,
DACNET	e-Governance project of Department of Agriculture and Cooperation, being executed by National Informatics Centre (NIC). e-Governance is established through integration of government functions (G2G), integrating Agri-Business Partners (B2B), connecting farmers (C2C), empowering employees, enhancing government publicity and value and offering financial services.
e-Krishi	It is an agriculture portal which is an unified network for farmers agri-business sectors and agree experts to facilitate digital Indian agriculture.
ASHA	Providing relevant and need-based agriculture information for the farmers of Assam.
India Development Gateway (InDG) portal (*Vikaspedia*)	Provides e-knowledge using ICT-based applications for empowerment of rural poor. Provides universally accessible digital information in Indian languages; Created and shared collaboratively by various developmental stakeholders.
Rice Knowledge Management Portal (RKMP)	Comprehensive information portal on rice; Online soil health and fertiliser recommendation system; e-learning platforms; video and audio clippings; information available on 7 languages.

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Agropedia	It was an online repository for information related to agriculture in India. This national portal designed as an "Agriculture Wikipedia" hosts wide range of agricultural information on a variety of crops with an aim to empower farmers within crop information.
Agmarknet	It is a Government of India portal for agricultural marketing, wide-area information network connecting agricultural markets, State Marketing Boards/ Directorates and providing linkage to the websites of the important National and International organizations.
ITC e- Choupal	Innovative trading and e-commerce initiative in agriculture. Reached 4 million farmers by 6000 e-Choupals spread over 4000 villages of rural India.
EID Parry-India agriline	EID Parry created kiosks and internet connected computer access and established a web portal, which provided information related to farming techniques, farm business information, weather information etc., to increase their livelihood of the farmers.
Indian commodities.com	User-free market information is provided on cotton, sugar, oilseeds, pulses, spices, rice, meat, tea, coffee etc.
Mahindra Kisan Units	Web portal established by the Mahindra and Mahindra limited for the farmers to access the information which is updated on a daily basis
IFFCO Agri-portal	Web portal established by IFFCO provides information for farmers in local language.
Agriwatch portal	Web portal established for agri-commodities; Research reports covering more than 40 commodities and 400 markets across the country
i-Kisan	Portal established by Nagarjuna Chemicals and Fertilizers Limited (NCFL) to harness the power of information technology to address the key problem areas of agriculture value chain.
Village Knowledge Centres (VKCs) of MS Swami nathan Research Foundation	Along with Village Resource Centres (VRCS), VKCs implements location-specific content generation and dissemination along with agriculture support services
Village Resource Centres (VRCs) of ISRO	VRCs connected to knowledge experts centres like SAUs and Skill Developmental Institutes (SDI) to provide information on agriculture, horticulture, fisheries, livestock, water resources, healthcare, women empowerment, computer literacy etc.,
Common Service Centres (CSCs)	Provides web-based services including agricultural information
Kisan Call Centres (KCC)	Information about agriculture and allied sector are provided through dedicated landline telephone calls.
IFFCO Kisan Sanchar limited	Voice messages are provided in local language

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Fisher Friend	Mobile-based advisory service for the fishermen in the costal Tamil Nadu
Reuters Market Light (RML)	Information about agriculture and allied sectors are provided through dedicated landline telephone calls.
Mobile Advisory Services of KVKs of ICAR	Operational since 2010; mobile advisory services on agriculture and allied sectors are provided through mobile phones
e-Sagu	Agro-advisory provided as a response to photographs sent by the farmers on field-related problems.
Digital Green	Production and dissemination of farmer participatory videos as reference material for performing agriculture.

An overview of the above-mentioned ICT initiatives inform that these initiatives were taken by public, private and NGO sectors, by and large, tried to either provide general information about agricultural technologies, weather and market information or need-based customized and local information. In all these initiatives, the farmers played the role of information seeker, and receiver and as creator of information in very few initiatives only. The role of farmers as information disseminator is not ensured in all these projects, which is very pertinent in augmenting farmer-centric extension. Moreover, majority of these projects are experiments implemented on a limited scale without trying for replication. Hence, there is a need for systematic evaluation of these projects and wherever possible, they need to be replicated in similar agro-ecological regions to facilitate farmer-centric extension approach. Moreover, such projects are to be embedded with programmes/ schemes of extension system to bring enhanced and desired results.

Challenges of Extension System in India

On the whole, the extension service providers in the country may be classified in to three major categories such as public sector, private sector and the tertiary (third) sector. Each and every sector has its own advantages and demerits, as far as extension services rendered by them are concerned. Table 9. depicts the challenges faced by extension system in the country:

Table9: Challenges faced by Extension System in India

General challenges faced by the farmers	Lele *et al*, 2010	Limited land and water availability; degradation of natural resources; climate change; changes in demand and consumption pattern; moving towards high-value agriculture; increasing population pressure and liberalization of trade.

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	Sulaiman and Vandone, 2003	Lack of access to information about production technologies, post-harvest processing, remunerative market prices and business development.
Challenges faced by the public sector extension system	Raabe, 2008	Linear information content; concentrate only on production aspects, information flow is not need-based
	NSSO, 2005	Lack of quality of information disseminated.
	Raabe, 2008	Static and in-flexible nature of organisation, where a top-down hierarchical approach continuous
	Sulaiman 2003b; Sulaiman, Hall and Suresh, 2005	Access for farmers to extension services in low; Staff do implement state/central schemes, which do not suit the local needs and conditions.
	Sulaiman, Hall and Suresh, 2005; Swanson, 2006	Insufficient funds for operational costs, training and capacity development.
	Working group on Agricultural Extension, 2007	Of the required 1.3 to 1.5 million extension personnel, there are only about 1.0 lakh on the job; Line departments suffer from duplication and lack of convergence.
	Sulaiman, Hall and Suresh, 2005	At the state level, various line departments are working in isolation with weak linkages and rare partnerships.
	Reddy *et al*., 2006	Research–extension link is criticized for not absorbing or using feedback from farmers and extension staff. Scientists have limited exposure to field realities.
Challenges faced by private sector	Swanson, 2008	Private sector can provide services related to proprietary goods only, unlike public sector who can provide extension services related to public goods.
	Sulaiman and Van den Ban, 2003	Private sector tends to focus on areas, where sufficient resources are there and few commercial crops and areas where profits can be assured
	Papnai *et al*., 2013	Private sector could serve the needs of medium-size and commercial farmers, while the public sector could work in remote areas.

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Challenges faced by third Sector	Swanson 2009; Sulaiman and Holt, 2002	Farmer- Based organisations (FBOs) and Self-Help Groups (SHGs) could play an important role in articulating the needs of the farmers by operating side by side within either NGOs or the public sector, but challenges exists in both the sectors. Public sector capacity to build the FPOs and SHGs is limited, while NGOs which are not numerous rely on donor funds and would need the technical skills to facilitate the groups.
	Sulaiman and Holt, 2002	Third sector is prone to elite capture through which the gender and the caste equality may be affected. In such cases, building the capacity of all the members through inclusive approach will be a challenge.
	Gulati *et al,* 2018	The third sector extension players work closely with the farmers and rural people and they do satisfy the felt needs of the farmers, especially small holders. However, they lack capacity to work on a larger platform or region.

A review of Table 9 clearly states that there are challenges, which are faced by all the three sectors and these challenges are unique to particular sector and thereby implies that, if these sectors are effectively made to converge for providing farmer-centric extension service, there may be a possibility of overcoming the challenges faced by individual sector due to cumulative efforts. However, concerted efforts are needed to bring these sectors together, so that, much needed convergence may be brought-in. All the three sectors are working in isolation and rarely they do converge through meaningful partnerships and collaboration. Further, a large number of private and tertiary sector players do render extension services but quality standards of their efforts need to be authenticated (Gulati *et al*, 2018).

SWOT Analysis of Extension System in India

An analysis of strengths, weaknesses, opportunities and threats (SWOT) of Indian extension system states that there is an urgent need for addressing the weaknesses and threats and harnessing the strengths and opportunities, so that a strong extension system can be built (Table 10).

Table 10. SWOT Analysis of Extension System in India

Strengths	Weakness	Opportunities	Threats
❖ Second largest extension system in	❖ Top down; Being commodity-specific and supply-driven;	❖ The system is in a transition mode. Decentralization,	❖ Information flow is supply-driven

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the world (Brewer, 2000) ❖ Financed by State large budget. Practice different approaches (Swanson and Mathur, 2003)	lack of farming system approach; No accountability; weak linkages with research system; little focus on empowerment of farmers (Singh *et al*., 2006) ❖ Multiplicity of efforts; narrow focus; lack of farmers' participation in planning; lack of market-driven approach; lack of transparency and accountability; inadequate technical capacity; lack of capacity for assessment and refinement; no emphasis on training; lack of PPP; weak communication capacity (Swanson and Mathur, 2003) ❖ High staff vacancy rates, low social status, lack of operational funds (Birner and Anderson, 2007)	pluralism, cost-sharing, cost-recovery, stakeholders participation is some of the aspects of transition (Swanson, 2006) ❖ Reforms are oriented towards demand-driven, broad-based and holistic agricultural extension system (Planning Commission, 2005)	(Raabe, 2008) ❖ Extension personnel and farmers are passive actors; scientists have limited field exposure (Ready *et al*, 2006 ❖ Private sector concentrate only proprietary goods (Meena *et al*., 2015) ❖ Lack of capacity building of farmers-based organisation (FPOs) (Bharati *et al*., 2014).

Convergence for Farmer-centric Extension and Agricultural Technology Management Agency (ATMA)

India, with diversified agro-ecological situations, support cultivation of various crops and harbour varied components of allied sectors. Though, a number of extension service providers work towards better outputs and outcomes from such crops and sectors, there is a lack of effective and meaningful convergence among these players, resulting in redundancy and wastage of scare resources. Hence, to provide much needed efficiency in approving operation

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of pluralistic extension players, convergence of efforts is needed. In this context, the policy makers need to bring a policy product that should clearly define the roles of extension service providers, modalities of sharing the resources and aspects of convergence (Mukherjee and Maity, 2015).

The inadequacies co-exist with public extension system of the country such as, lack of adequate operational funds; narrow focus towards extension goals and linearity in technology dissemination; lack of capacity building of ill-qualified staff and non-adoption of meaningful partnerships in extension efforts resulted in a situation, wherein the extension mechanism of private industry and tertiary sector components such as NGOs and FPOs ought to either supplement at places wherein the public extension presence is not felt and complement at places wherein the public extension efforts are inadequate. Though the private industry extension efforts are successful, they do not cater to the needs of small and marginal farmers, rather they do concentrate on the needs of commercial farmers, with their customized business models. The tertiary sector too, though is successful in addressing the needs of small holder farmers, they do operate in selected pockets of areas through intensive social engineering efforts, and replicability and scalability of such efforts does not happen. These facts necessities, the public extension system, who has a large network of functionaries throughout the country, to converge their efforts with private extension services and that of tertiary sector. Such pluralistic approach will address the diversified needs of the majority small holder farmers of the country, in a holistic manner (Glendenning *et al*., 2010; Raabe, 2008; Sulaiman and Holt, 2002)

The much-debated Agricultural Technology Management Agency (ATMA) was established to lay a platform wherein convergence of pluralistic extension services from public, private, tertiary extension systems will happen and the small holder farmers and their organization will participate actively to plan strategies for developing their own agricultural scenario. However, to establish successful convergence, there is a need for allowing structural and financial flexibility in implementation of planned schemes with agricultural innovations get disseminated to reach the unreached; facilitating strong research-extension-farmer-market linkage to happen; building the capacity at all levels of technology development, dissemination and utilization; encouraging public-private (both private industry and tertiary sector components)-panchayat-farmer participation; bringing-in efficiency towards planning and implementation of development programmes through ICT applications; figuring-out long term financial sustainability; and inculcating learning and refinement through effective monitoring and evaluation methods (Babu *et al*, 2013).

The extension efforts of public, private and tertiary sectors are though effective at times, not efficient due to the lack of meaningful convergence. The main reason is that the extension officials of the public extension system are not trained to have partnership with other sectors at a broad-based extension platform and hence they do not understand the need and benefits of such convergence. Such constraint may be overcome through effective capacity building of the officials of development departments; bringing-out policy products towards pragmatic convergence among extension service providers; and allocating sufficient budget for convergence activities (Kareem and Phand, 2018).

In order to encourage effective convergence among all the sectors of Indian extension system, cross learning among them need to be encouraged, as far as their successful experiences are

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concerned. Moreover, the role of public, private and tertiary sector needs delineation, so that the duplication and wastage of resources can be avoided. Further, the extension service providers of private and tertiary sectors need to be certified by independent third party certification agencies. Another point of concern for the extension service providers in general and that of tertiary sector in specific, is, financial sustainability of extension projects, which needs to be addressed by giving adequate attention, so that the efforts of public extension system can be supplemented or complemented efficiently. Diplomatically approve the innovation network of extension service providers, so that success stories of efforts of all sectors can be documented digitally and shared for cross-implementation (Gulati *et al*, 2018). At a platform, wherein private and tertiary sector players effectively deliver pluralistic extension services, the public extension system must engage in monitoring and evaluation of such efforts, imposing quality standards. The public system may also concentrate on policy issues pertaining to mechanism for input distribution, credit, marketing and price to support resource-poor farmers. The efficiency of extension programmes depends on the effectiveness of planning at four levels such as policy, programme, projects and strategies by the multiple extension players. In such scenario, the private extension players have the potential to bring-in technical and allocative efficiency, so that cost minimization and profit maximization through optimal use of resources may be achieved (Mukherjee and Maity, 2015).

The Agricultural Technology Management Agency (ATMA) was an innovation introduced in 1998 under the Innovations in Technology Dissemination (ITD) component of the World Bank-funded National Agriculture Technology Project (NATP). The main purpose was to establish a platform wherein much awaited convergence of public, private and tertiary extension systems may happen, with active participation of farmers and their organizations through appropriate empowerment in planning and implementation of agricultural development programmes (Babu *et al*., 2013; Ferroni and Zhou, 2011)

The private extension system of the country is quite vibrant and innovative in its approach, so that their extension models, though limited and profit-oriented are accepted by the farmers, especially the young and educated lots. Unlike public extension system, the staff of private extension system are trained and have broader and holistic vision in their approaches, which are mostly market-driven. With increasing literacy levels and commercialization of agriculture in the country, there is a likely chance of more and more young and educated farmers may be attracted towards the private extension approaches. Hence, the public extension system must seriously think about partnership and convergence models, with private industry entities as their active partners (Mahendra Dev., 2012; Mukherjee *et al*., 2012).

The trained agripruneurs of Agri-clinics and Agri-business Centres (ACABC) scheme operated by National Institute for Agricultural Extension Management (MANAGE), Hyderabad through the network of identified nodal training institutes (NTIs) all over the country, and with the back-ended financial assistance from National Bank for Agriculture and Rural Development (NABARD) assures promise in extending agribusiness services in rural areas. Similarly, the innovative single window system of rendering holistic services to the farming community, namely, Agriculture Technology Information Centre (ATIC) is well known for its successful structure and function under National Agricultural Research and Education System (NARES).

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Inclusion of these innovations to render farm services through the ATMA platform may add value to the proposed convergence (Shekara., 2001; Gulati *et al*., 2018).

Thus, the ATMA platform should be utilized to bring meaningful partnership among all agriculture and agribusiness service providers and effective convergence of their extension efforts. The strategies include making the farmers-based organizations to participate in the frontline activities along the side of public extension agencies, mainly, to bridge the information and technology gaps. Encourage private industry to extend services to the needy farmers and augment situation-specific public-private partnership, which may avoid duplication of efforts and effective utilization both the services; importantly, harness in a planned manner the advantages of public (strong backward linkage), private (aggressive forward linkage) and tertiary (strong in building social capital) extension systems through mission mode approach ((Mukherjee *et al*., 2015)

Rendering Farmer-Centric Extension through Farmers Producers Organizations (FPOs)

The majority small and marginal farmers of the country face typical problem as they have limited access to agricultural inputs apart from their lack of interest towards adoption of modern agricultural practices. Such challenges may be overcome, if these farmers are mobilized as farmers' organizations, so that scale of economy can be brought-in for input supply and output marketing. (Birner and Anderson 2007; Rao *et al*, 2011; Reardon *et al*, 2011 b). Self-Help Groups help technology dissemination, adoption and marketing. These groups are constituted by like-minded farmers who support each other to get benefits from the schemes of Government organizations and technologies and services of private organizations (Munshi, 2004).

The farmers' organizations such as farmer producer companies (FPCs), cooperatives, self-help groups (SHGs), common interest groups (CIGs) and joint liability groups (JLGs) are facilitated in such a way that they can render multi-faceted services needed by the group members such as input supply, procurement, grading, packing, storing, value addition, marketing and export of agricultural commodities, apart from arranging for credit and insurance. There is a need for facilitating these organizations towards networking and automation of their services, so that their organizational capacity and operational efficiency can be enhanced, which will positively impact agriculture and rural development (DFI, 2017).

The performance of FPOs can be enhanced by inculcating effective FPO management and governance system through adequate capacity building, facilitating market linkages; financial support, infrastructure development and ensuring assured and remunerative market price (Ranjit Kumar *et al*, 2022). Table 11 depicts general challenges faced by FPOs in the country and appropriate strategies suggested to overcome such challenges:

Table 11. Challenges and Strategies for FPOs in India

Reported by	Challenges faced by the FPOs	Respective strategies suggested
Ranjit Kumar *et al*, 2022	❖ Lack of understanding of business process; lack of managerial capability and	❖ Link the FPOs to KVKs/ Agricultural Universities/ research institutes for technical

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	regulatory compliances by FPOs ❖ Poor capital formation and financial support.	backstopping towards business process and empanel auditors to facilitate FPOs towards regulatory compliances. ❖ Minimum assured seed funding support as grant may be provided. Similarly, special provision for working capital finance may be included.
Venkattakumar and Narayanaswamy, 2022	❖ Lack of business partnership from input companies. ❖ Collateral security-based bank finance products. ❖ Lack of experiencing in operating business process and marketing. ❖ Ideology and socio-economic clashes among the shareholders.	❖ Suitable policy products from state governments to encourage private companies to this effect. ❖ Policy measures supporting FPOs to be given preferential treatment. ❖ Promote regional FPO brands and hire regional-level business consultants. ❖ Engage NGOs for adequate and appropriate social engineering of shareholders.

Strategies for Rendering Farmer-Centric Extension in Indian Agriculture

The 'Committee on Doubling Farmers Income' envisages empowerment of farmers through effective extension and knowledge dissemination. To this effect, the focused areas of extension system that need strengthening are, delivering of real-time market information; integrating farmers within agri-value system platform; promoting use of warehouses; connecting within retail and primary wholesale markets; promotion of contract farming; scaling up of Farmer Procedures Organizations (FPOs); farm mechanization; primary processing; pest management; primary processing; promoting small scale agri-business through improving entrepreneurial skills; introduction of new on-farm, off-farm and non-farm income generating activates; providing psychological counselling to farmers to manage distress; developing managerial competencies of farmers and extension personnel and effective means of ICT by farmers.

Rendering farmer-centric extension needs adequate understanding of issues and challenges in Indian extension system and addressing them with contemporary strategies. The following are the strategies suggested by Committee for Doubling Farmers Income (2017) for rendering farmer-centric extension in India:

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- Convergence of public, private and tertiary extension services;
- Formulating situation-specific partnerships among private extension services;
- Rejuvenating ATMA;
- Building the capacity of extension functionaries;
- Orienting extension services towards agri-business;
- Down-streaming the institutional linkages among MANAGE, regional-level EEIs and stakeholder-level SAMETIs through governance and financial obligations;
- Manpower strengthening in agricultural extension system;
- Enhancing remuneration for farmer friends and making 50% women farmer friends;
- Promoting ICT-based extension services;
- Developing women-centric schemes and
- Revisiting agricultural extension curriculum towards agri- business orientation (DFI, 2017).

Similarly, Table 12 suggests initiatives to be taken towards effective and farmer-centric public extension in the country:

Table 12. Initiatives to be taken for Effective Public Extension in India (Singh *et al*., 2020)

Initiative to be taken	What should be the approach?
Research in Extension Education	Need for coordinated research in the areas of extension methods, and techniques, research methodologies and psychometric analysis, management and behavioural principles.
Promote Farmer-to-Farmer learning and Technology Transfer	Farm schools operated by farmer-achiever should be established in large members. Farm schools and farmers field schools are effective tools in farmer-led extension. These structures can shift the orientation from production to market-led extension.
Promote Research-Extension-Farmer-Market Linkage	Need to be addressed through participatory technology development mode through a coordination committee, linking all four components of this Continuum.
Collegiate Participation of Farmers	Apply principles of participation by farmers, ITK, and farmer perspective to extension. Treat farmers as partners and take decisions on agreements/consensus.
Adopt ICT enabled Technology Dissemination	Use interactive multimedia; build the capacity of content developers in media; Effective use of mass media and ICT could be one of the possible means for bridging knowledge deficiency among farmers at a faster rate.

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Develop Cases as a Tool for Technology Dissemination	Develop success stories to explain how extension made differences in people lives and convince farmers towards adoption of disseminated technologies.
Make Agriculture as a Profitable Venture	Evolve concrete strategies to make Indian agriculture competitive and enhance its efficiency. Right decision towards farm enterprise will enable to exploit the complete potential of farm.
Scale-up Group Mobilization	Promote access of groups towards microfinance.
Promote micro-enterprises	Promote micro-enterprises through skill upgradation and inculcating entrepreneurial spirit and dynamism. Provide intensive training and hand-holding.

The following are the strategies suggested for reinventing agricultural extension system in India, in order to render farmer-centric extension services (Suresh *et al*, 2022):

- Promote farmer-led extension by mobilizing small and marginal farmers (more than 80% to total) as self-help groups (SHGs), farmer-interest groups (FIGs), joint liability groups (JLGs), farmer producer organizations (FPOs) (producer companies, producer cooperatives).
- Public extension system should own the responsibility of preparing, validating and communicating content in agriculture.
- Public extension system must ensure involvement of all stakeholders of a particular commodity for effective convergence of efforts and resources across the agriculture supply and value chain.
- Public extension system must tap the corporate social responsibility (CSR) funding avenues of private system and involve private extension system through meaningful partnerships.
- Public extension system must inculcate effective linkage among research-extension-farmer continuum, so that the research system will develop need-based technologies and the extension system will render demand-driven strategies.
- Public extension system should experiment, evaluate, adapt and upscale innovative extension models, which are customized towards specific commodity and regional requirements. Again the public extension system should do away with top-down linear communication style of extension, which no longer suits the market-driven agricultural scenario.
- Identify potentials areas and commodities for entrepreneurship development and build the capacity of farmers concerned, so that technology-based entrepreneurship can be promoted.
- The public extension system must leverage the application of Information Technology (IT)/ Information and Communication Technologies (ICT) advancements such as block-chain technology, artificial intelligence (AI), cloud computing, geographical information systems (GIS) towards enhancing farm productivity, providing weather and pest forecasting, market intelligence and building the capacity of farmers. To this effect,

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the extension personnel of public sector must be trained in terms of markets, finance and insurance, emerging technologies, policies, standards, input delivery and natural resource management and encouraged and facilitated through appropriate policy measures.

- Adopt customized extension strategies for promoting high-value agriculture, which has its niche in both domestic and international markets. Similarly, strengthen the extension strategies for allied sectors of agriculture by addressing the challenges faced by these sectors, especially horticulture, dairy, fisheries and animal husbandry.
- Role of women in agriculture has been tremendous and their contribution increases day by day towards feminization of Indian agriculture. Hence, the functionaries of extension system must be sensitized and trained to mainstreaming women in agriculture and engendering agricultural operations, so that gender-specific extension strategies can be formulated and implemented.

Policy Recommendations for Farmer-centric Extension

- Public extension system in India has to partner with multiple extension service providers in order to satisfy the diverse needs of the farmers in the market-driven agricultural scenario, as 'convergence', is the major strategy for rending farmer-centric extension.
- Mainstream the extension services of progressive farmers and input dealers, being the major sources of agricultural information, through meaningful partnerships towards implementation of farmer-centric programmes of public extension system.
- As, the investment in public extension is inadequate, involve private and tertiary sector service providers, so that effectiveness and efficiency in implementing the farmer-centric programmes.
- Given wider extension worker: operational holdings ratio and available scope and opportunities for inclusion of services of ACABC agripreneurs; DAESI input dealers, NGOs and FPOs, the public sector extension should plan location-specific and farmer-centric convergence.
- Among all the extension styles and approaches, pluralistic extension through ATMA platform provides scope for effective convergence of available service providers. Hence, strengthen the ATMA platform and augment pragmatic farmer-centric convergence efforts.
- Global experiences of farmer-to-farmer extension approach provides scope for effectively institutionalizing such models, while implementing farmer-centric programmes.
- Effectively leverage ICTs to render customized content and need-based services. Also, effectively network the ICT initiatives of public, private and tertiary sectors for achieving 'digital convergence'.
- Institutionalize the involvement of FPOs in planning and implementation of farmer-centric extension programmes. To this effect, solve the issues faced by the FPOs on priority-basis.

Strategic Model suggested for Farmer-centric Extension

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In order to deliver farmer-centric extension, there is a need for strong partnership among public, private and tertiary sector extension service providers, with adequate and appropriate involvement of need-based ICT applications. Such partnership and convergence must satisfy the farmers, the much needed inputs, credit and insurance, market linkage, value addition options and policy support (Fig 1).

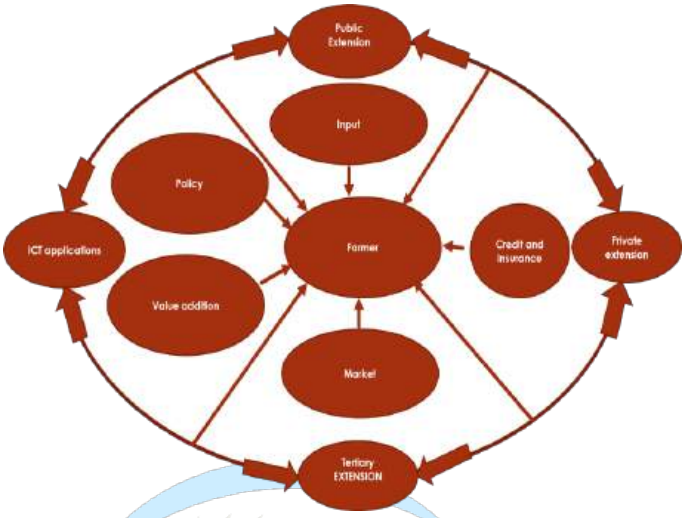

Fig. 1. Strategic Model suggested for Farmer-centric Extension in India

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AGRICULTURAL MARKETING, E-COMMERCE & DIGITAL MARKET LINKAGES (FPO-LED COMMERCE, DIRECT-TO-CONSUMER AGRI BRANDS)

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Introduction:

Agricultural marketing includes all the activities like assembling, packaging, processing, storage, transport, sales, promotion etc. for moving the farm products aiming to satisfy farmers, intermediaries, and buyers by creating value (time, place, form utility). It connects producers with consumers through complex channels, facing challenges like bulkiness, quality variation, and irregular supply, scattered production, intermediaries. However, the advent of digital technologies and e-commerce platforms has revolutionized this sector by facilitating new market linkages that bypass traditional intermediaries. This article explores how Digital Market linkages; e-Commerce, FPO-led commerce and direct-to-consumer (D2C) agri-brands—are reshaping the landscape of agricultural marketing.

E-Commerce focuses on the transactional process of buying and selling products or services online, acting as the digital storefront (e.g., Amazon, Shopify). In contrast, digital marketing involves promoting brands and driving traffic to these platforms using channels like social media, SEO, and email. Both of them have a close relationship; e-commerce builds the store and digital marketing acts the catalyst for growth and sales. FPOs are also pivotal in digitizing the agricultural value chain, providing crucial access to technology and financial support. Currently India has more than 10,000 FPOs under different legal structures (Ranjt Kumar, et al.2022). They are transforming Indian agriculture by enabling smallholder farmers to aggregate produce, facilitate better bargaining power, pooled resources, reduce input costs, enhance market access, connect rural producers to wider markets and improve income. Another innovative marketing strategy is the D2C brands in India. India's D2C ecosystem is expanding at a compound annual growth rate (CAGR) of nearly 25%, projected to reach USD 267 billion by 2030. (Mohamad Aham Naqvi, *et al*., 2025). The D2C agri-brands are emerging as an alternative to the traditional agricultural marketing system. These brands focus on building a direct relationship with consumers, offering fresh, organic, or specialty products through their own digital platforms or e-commerce channels.

Traditional marketing challenges:

The conventional agricultural marketing system, especially in developing countries, is marked by mainly the following challenges:

Multiple intermediaries: Farmers often rely on a chain of intermediaries such as commission agents, wholesalers, and traders, reducing the price farmers receive.

Price volatility*:* Due to limited access to market information and global price trends, farmers are often unable to sell at competitive prices

Quality control and standardization: Lack of infrastructure and standardized processes results in inconsistent quality and branding of agricultural products.

Geographical barriers: Farmers in rural areas often face logistical hurdles to reach large urban markets or export channels.

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DIGITAL MARKETING IN AGRICULTURE:

To reach a wider range of audiences Digital Marketing plays a crucial role. Platforms like social media, blogs, email campaigns, e-commerce etc. are acting as efficient marketing channels. In India digital platforms are transforming Indian agricultural marketing by enabling direct-to-consumer sales, enhancing price transparency, and reducing dependency on intermediaries. Key platforms like e-NAM, Agri Bazaar, and e-Choupal connect farmers to wider markets, offer real-time data, and improve income, although challenges like digital literacy and logistics persist.

Key Roles of Digital Platforms in Agricultural Marketing:

Global reach: Digital Marketing allows exploring new markets and reaching global market.

Direct Marketing & Better Prices**:** Platforms enable farmers to bypass middlemen, directly accessing consumers or bulk buyers, which lead to better price discovery and higher profits.

Information & Decision Making*:* Digital tools provide real-time market intelligence, weather forecasts, and demand forecasting, helping farmers make informed decisions.

Access to Inputs & Finance*:* Platforms facilitate the purchase of quality seeds and fertilizers, and offer easier access to credit and insurance.

Supply Chain Efficiency*:* Digital adoption reduces post-harvest losses through better logistics and traceability.

Consumer satisfaction: Through Digital marketing the consumers can make comparison among products or services by different suppliers.

Digital Marketing initiatives and Platforms:

e-NAM: A pan-India electronic trading portal was introduced named as National Agriculture Market (e-NAM) 14 April, 2016 for creating a unified national market for agricultural commodities by interconnecting the existing Agricultural Produce Market Committee (APMC) mandis. The major crops like are paddy, wheat, cotton, etc. are traded on e-NAM platform by the farmers of various states. To facilitate farmers to use e-NAM, the e-NAM portal has been made available in English and other 11 Indian languages.

National mission on Agricultural Extension and Technology: this scheme is a judicious mixture of physical outreach and interactive methods of information dissemination, use of ITC, capacity building etc.

Agri Market App: Developed by IT department of Ministry of Agriculture. With the Agri Market Mobile App, Farmers can Access information about crop prices within 50 km.

Governance efforts: under the e-governance programme software developed to provide nutrient recommendations using the soil test crop response model.

AGMARKNET: it's a portal on agricultural marketing with information network connecting to agricultural markets.

E-commerce Website: by developing an e-commerce website

Social Media marketing: Through LinkedIn, Instagram, WhatsApp, Facebook etc.

Agri Bazaar**:** Connects farmers with buyers, providing logistical support.

e-Choupal**:** ITC's initiative for direct sourcing.

Other Agri-tech startups**:** Jumbotail and AgUnity also play a role in connecting farmers to markets.

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E-COMMERCE:
E-commerce or electronic commerce is the buying and selling of goods and services or funds or data, over an electronic network, mainly the internet.

Types of e-Commerce Models: On the basis of the parties that are involved in the transactions electronic commerce can be classified into four main categories as follows.
Business to Business*(B2B***) :** In this transaction is made between the companies without involving the final consumer. Here, the online transactions only involve the manufacturers, wholesalers, retailers *etc.*
Business to Consumer *(B2C):* In this category the company sells their goods and/or services directly to the consumer. The consumer can browse the company's websites and look at product description and analyse the reviews. The interested consumer place their order after which the company ships the goods directly to them. Some of the examples are Amazon, Flipkart, Jabong *etc.*
Consumer to Consumers *(C2C)* **:** In this, the consumers are in direct contact with each other. Without the involvement of any company. This provides facility to anyone to sell their personal goods and assets directly to an interested customer. The commonly traded goods includes cars, bikes, electronics *etc.* This type of model is followed by OLX, Quikr *etc.*.
Consumer to Business *(C2B)* : The reverse of B2C is the consumer to business model. Here, the consumer provides a good or service to the company. Say for example an company purchases a software from an IT freelancer.
Advantages of e-Commerce:

The geographical barrier can be overcome by proving a common virtual platform for the sellers and buyers**.**
The transaction cost can be minimized along with the elimination of many fixed costs for maintaining brick and mortar shops which may result in higher profit margin.
The time, energy and profit for both buyer and seller can be saved.
Consumers feedback is also easily available.
There is the provision of 24 hours services for the all seven days of the week, which makes it more convenience for the consumers.

Type	*Description*
Established e-commerce platforms expanding into the grocery segment	Major e-commerce platforms are expanding their online offerings to include grocery products. Amazon has launched its online grocery delivery service, Amazon Fresh, in select regions of the US, UK and Germany. Alibaba, Flipkart and Mercado Libre, also sell groceries online. Amazon acquired Whole Foods, which operates 400+ retail stores in the US, While Alibaba plans to open 100 Hema-branded supermarkets in China. Some e-commerce platforms have added bricks and mortar stores to complement their online assets. The store act as a network of mini distribution centers or collection hubs for fresh produce, to shorten customer lead times.
Offline grocery stores opening online channels	Some of the offline grocery stores have made investments to develop logistics networks suitable for e-commerce. Many supermarkets have launched their own delivery services, such as Waitrose's partnership with Ocado in the UK, Smaller retailers have formed partnerships with specialist delivery companies, including Happy Fresh in the US and Instacart in Southeast Asia. Offline grocery retailers also use their store footprints to offer click-and-collect services

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Pure-play agri e-commerce businesses	The internet has enabled the emergence of online-only services that connect farmers to consumers. This includes enterprises such as Farmstead, Good Eggs, Grub Market and Imperfect Produce in the US. In the UK, sales between producers and buyers via the likes of Abel and Cole, Farmdrop and Riverford have also grown Agricultural producers can also sell produce to third-party merchants who, in turn, sell through e-commerce platforms to end users. This is common in China where major e-commerce companies, such as JD, Pinduoduo and Tmall, benefit from the highly advanced logistics infrastructure in the country to reach consumers with fresh produce. Pinduoduo uses an innovative purchase model whereby users invite their contacts to form a shopping team to get a lower price for their purchase.

Both the parties can have personal communication without the involvement of any intermediary.

E-commerce in Agriculture:

Agriculture sector was one of the challenging sectors for e-commerce due to its high level of fragmentation in the supply chain, large volume dealing, and typical nature of the product, involvement of middlemen, logistical challenges, consumer's preference for the in-person purchase of groceries and fresh produce like fruits and vegetables. However, these problems are taken care of by e-commerce solutions. Online bulk orders of fresh produce are common among businesses, such as hotels and restaurants in the develop markets. Online grocery orders have started to gain popularity among the consumers. In the US, for example, online grocery sales doubled between 2014 and 2018, and now account for around 7 per cent of the total grocery market. (M.Patel *et. al*.,2022)

Growth in Agri e-commerce in developed markets is largely driven by the emergence of, agri e-commerce players under three broad categories:

Agri e-Commerce Market Entry Strategies in Developed Markets

M.Patel *et.al*.(2022)

Requirements for Agri e-commerce:

The sustainability and scalability of an Agri e-commerce service depends on:

Mobile-internet penetration in the market for accessing online services.

Appropriate logistic like road facility, facility for physical distribution of the goods.

Digital payment methods for accelerating the transaction process.

Producers' knowledge about the formal value chain which includes access to mobile devices, understanding notifications etc.

Consumer's readiness in adoption of agri e-commerce services.

Urbanization can be the catalyst for shifting consumers towards e-commerce services.

The demand for e-commerce services is greatly depended on the amount of disposable income of the consumer.

Benefits of Agri E-Commerce :

The post-harvest wastage can be minimized through e-commerce services by improving the market efficiency. Farmers selling fruit and vegetables through Frubana in Colombia record post-harvest losses of 3 per cent, compared with the average of 58 per cent for farmers that sell through traditional channels (Patel, M. et al, 2022).

Transparency in transaction offers fair prices to the produces.

Eliminates intermediaries and thus improves the efficiency.

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The digital history of the business transaction can be a tool for demonstrating credit worthiness of the farmers. This can broaden the scope for availing credit facilities from the financial institutions.
The buyer can trace the origin of specific supplies and thus can encourage the farmers to go for quality production.

FPO-LED COMMERCE:
FPO-led commerce involves farmer's collectives acting as business entities to manage the entire value chain, from procurement to marketing, thereby eliminating the intermediaries. The rise of e-commerce and digital platforms is helping FPOs directly connect with buyers, bypassing traditional, fragmented supply chains. The Indian government has launched a, scheme to form 10,000 new FPOs to strengthen the agricultural sector. Promoting agencies like NABARD, SFAC, NAFED, and NCDC provide technical, financial, and managerial support. As of August 2023, SFAC registered 2773 FPOs, with the highest number in Uttar Pradesh, followed by Madhya Pradesh and Bihar. SFAC, with 901 FPOs has controlled 8.92 lakh farmers as registered members (SFAC, 2022). Key benefits of this approach include
Better Bargaining Power: by pooling resources and produce, FPOs can negotiate better prices for farmers.
Streamlined Logistics: FPOs can invest in logistics infrastructure, reducing transportation costs and improving the efficiency of moving goods from farms to markets.
Branding and marketing: FPOs can create collective brands for their produce, ensuring consistency and quality, which are increasingly valued by consumers.
Through the Government effort for marketing of FPOs products, Open Network for Digital Commerce (ONDC) has been created. More than 7000 farmers' collectives across various states are able to sell unique agricultural products through ONDC (Financial Express, May 20th 2024).

Examples of Successful FPO Initiatives:
Kandamal AEX Spices Association for Marketing (Kasam) in Odisha successfully exports organic turmeric.
Chetna Organic works with over 25,000 farmers in multiple states to improve, livelihoods.
Various, women-led FPOs in Jharkhand, Bihar, and Odisha are, enhancing local, agricultural commerce.

Successful FPO-led Digital Marketing Initiatives:
India's Amul Dairy: Although not a traditional FPO, Amul exemplifies the power of cooperative marketing. With over 3 million farmers as members, Amul has leveraged its brand and collective bargaining power to dominate both domestic and international dairy markets. Amul's digital marketing centres on high involvement of social media like Facebook, Twitter and Instagram by leveraging its iconic 'Amul Girl".
Digital FPO Initiatives: in states like Madhya Pradesh, Odisha, and Andhra Pradesh, FPOs have adopted mobile apps to connect farmers with buyers directly, facilitating online sales of grains, vegetables, and fruits. MP Farm Gate App and e-NAM, ITCMAARS, Book my Crop, BigHatt etc., Kishan rath, e-Rythu, Kisan Suvidha etc. are the platforms used by the FPOs of those states.

DIRECT TO CONSUMER:
Direct-to-consumer (DTC or D2C) is a business model where brands sell products directly to their end customers online typically through their own e-commerce website or app, or sometimes through their own stores, giving them full control over customer experience, data,

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branding, and margins, bypassing traditional middlemen like wholesalers, distributors, and retailers, allowing for greater control, lower costs, and direct customer relationships. This approach, also called dis intermediation, builds brand loyalty and allows for quick adaptation using real-time customer feedback, though it requires significant investment in marketing and logistics. These brands manage the entire customer journey, including production, marketing, branding and fulfilment. D2C Agri-brands are emerging as an alternative to the traditional agricultural marketing system. These brands focus on building a direct relationship with consumers, offering fresh, organic, or specialty products through their own digital platforms or e-commerce channels.

The rise of D2C Agri-Brands:
Fresh produce and organic Farming: Brands like Farmers Fresh Zone and Organic India have capitalized on growing consumer demand for fresh, organic, and sustainably grown produce. These D2C brands use e-commerce to reach consumers who prioritize transparency, quality, and sustainability.
Subscription –based Models: Many D2C Agri-brands operate on subscription models, delivering fresh produce regularly to consumers, ensuring consistent sales and fostering customer loyalty. Key players of such models in India are Country Delight, Two Brothers Organic Farms, Spudnik Farm, Deep Rooted
Customization and Branding: D2C Agri-brands are adept at building their own narratives around sustainability, transparency, and local farming. Through social media, content marketing, and influencer partnerships, these brands create a connection with the end consumer.

How it works:
Eliminates intermediaries**:** Products go straight from the manufacturer to the buyer, cutting out layers in the supply chain.
Uses online channels**:** Common platforms include brand-owned e-commerce sites, social commerce, and mobile apps.
*Manages the whole process***:** Brands handle inventory, marketing, sales, packaging, and shipping themselves.
Data-Driven**:** Collects valuable first-party data for personalization and innovation.
Personalization**:** Builds direct relationships for tailored experiences.

Key benefits for D2C brands:
Direct customer data: Real-time feedback improves products and marketing.
Brand control: Full control over the customer experience and brand story.
Agility: Faster response to market trends and customer needs.
Customers satisfaction: Better prices, unique products, personalized service, faster adaptation.
Higher margins: By eliminating intermediaries, D2C brands can retain a larger share of the value chain, leading to higher profit margins
Niche Market Creation: D2C brands can cater to niche segments like organic produce, gluten-free grains, or ethnic foods, capitalizing on the growing demand for specialized agricultural products.

Examples of DTC brands:
Indian D2C Brands
Beauty & Personal Care: Mamaearth, SUGAR Cosmetics, Plum, mCaffeine, Minimalist, Bombay Shaving Company.
Electronics: boAt, Noise (audio, wearables).

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Food & Beverage: Licious (meat/seafood), Paperboat (snacks), Bira 91 (beer).
Home Goods: Wakefit, SleepyCat, Pepperfry (furniture).
Fashion & Apparel: Bewakoof, Bombay Shirt Company, Zivame, The Souled Store.
Eyewear*:* Lenskart.
Global D2C Brands:
Apparel/Accessories: Everlane (sustainable fashion), Allbirds (shoes), *Warby Parker (eyewear)*.Subscription/Services: Dollar Shave Club (razors), 23andMe (genetic testing).
Home Goods: Away (luggage).
Wellness: Blume (wellness lattes).
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CHALLENGES:

While the digital platforms into agricultural marketing present significant benefits and opportunities, it also brings challenges that need to be addressed for long-term success.

Low internet penetration in rural areas, Poor internet connectivity, inadequate warehousing, and lack of cold chain infrastructure remain significant obstacles
Lack of Digital literacy is a major problem. A significant portion of rural farmers may not have the digital literacy required to use e-commerce platforms or mobile apps effectively.
The logistical complexity of handling perishable goods.
The digital agricultural market is often subject to different regulations in various countries, creating challenges for cross-border commerce and standardization.
Initial expenses need for e-commerce portal is very high. The cost includes setting up cost of hardware and software, training cost of employee, maintenance etc.
Risk of failure
The lack of offline personal touch makes it difficult to trade some services or products like interior designing, jewelry etc.
Credit card theft, identity theft *etc.* are some common security threats.
Sometimes the shipping or delivery of the products creates dissatisfaction among the customers.
Lack of knowledge and understanding about business model by the FPOs.
Limited access to capital of FPOs.
lack of professional management and inadequate infrastructure facilities in the FPOs
High customer acquisition costs in D2C model i.e., increased reliance on digital ads, especially social media, can be expensive.
P Some D2C brands struggle to achieve sustainable profits.
D2C demands appropriate logistics i.e., significant investment in fulfilment and customer service.

CONCLUSION:

Future growth of Digital Marketing relies on improving digital literacy, expanding the infrastructure and supporting the required logistic. Digital platforms and mobile payment systems provide farmers with easier access to financial services like loans, insurance, and payments. By streamlining logistics and reducing intermediaries, digital tools can reduce supply chain inefficiencies, improving product delivery and quality. E-commerce platforms allow farmers to diversify their customer base, reduce dependency on local markets, and help them engage in export markets.
Despite challenges, FPOs are considered a critical element in transforming Indian agriculture into a sustainable and profitable enterprise. FPOs can be linked with KVKs or Agricultural Universities and auditors should be empanelled for regulatory compliance (Ranjit Kumar et.

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al., 2022). The government approach like creation of Open Network for Digital Commerce (ONDC) can facilitate the growth of the FPOs. The collaboration between FPOs and D2C agri-brands, can create an ecosystem where farmers have direct access to consumers and the benefits of collective action. There is a need of support from the Governments and private players to invest in rural internet connectivity, mobile infrastructure, and digital literacy programs to ensure the broader success of e-commerce in agriculture. There is a scope of leveraging digital technologies to unlock the full potential of Indian agriculture.

From the benefits and challenges, it can be concluded that, transformation of Indian agriculture is still indeterminate. But as the adoption of the changing environment is the core for the sustainability of any venture, transformation towards the modernization is the only way to sustain, though this adoption may be a slower process.

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LIVESTOCK, DAIRY AND POULTRY STARTUPS AS ENGINES OF RURAL EMPLOYMENT: PATHWAYS FOR VIKSIT BHARAT @2047

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Introduction

As India advances towards the centenary of its independence, the national vision of Viksit Bharat @2047 envisages a developed, inclusive, and resilient economy with agriculture and allied sectors as foundational pillars. Within this national framework, the vision of Viksit Uttar Pradesh @2047 assumes special significance given that Uttar Pradesh is India's largest agrarian state with a substantial dependence on livesock-based livelihoods. Agriculture and allied sectors contribute approximately 18 per cent to India's Gross Value Added (GVA) and provides livelihoods to nearly 55 per cent of the population. In Uttar Pradesh these sectors account for nearly 25 per cent to the State Gross Value Added (SGVA) and support livelihoods for over 65 per cent of the rural population.

Despite rapid structural transformation in industry and services, agriculture continues to serve as the primary source of income for a large proportion of rural households and acts as a critical stabilizer during economic and climatic shocks. Recognizing this centrality, national policy frameworks emphasize a paradigm shift from input-intensive and production-centric agriculture towards a technology-enabled, market-oriented, climate-resilient, and youth-driven agricultural system.

The long-term vision for Indian agriculture is no longer confined to food sufficiency alone. It extends to enhancing farmers' income, promoting value addition, improving global competitiveness, ensuring environmental sustainability, and building resilience against climate risks. In this evolving policy landscape, agriculture is increasingly being repositioned as an enterprise-driven sector, capable of generating dignified employment for youth, fostering innovation through startups, and contributing meaningfully to national economic growth. Livestock, dairy, and poultry startups represent a powerful pathway to achieve these objectives.

Scenario of Livestock, Dairy, and Poultry sector in India

India's livestock and poultry sectors are critical to the agricultural framework, providing essential support to smallholder farmers and large-scale commercial enterprises while significantly contributing to rural employment, income generation, food and nutritional security. Accelerating livestock production is essential not only for maintaining agricultural growth but also for reducing rural poverty, especially in regions dominated by small landholdings. Livestock contributes nearly half of the income for smallholders, who can produce more cost-effectively due to the ample labour resources at their disposal. India ranks first globally in milk production and is among the top producers of meat and eggs, underscoring the importance of these sectors. From 2014–15 to 2022–23, the livestock sector achieved a notable CAGR of 7.38% at constant prices, with its contribution to the total GVA of agriculture and allied sectors rising from 24.32 to 30.38% (DAHD,2025). According to the 20th Livestock Census, the country's total livestock population stood at 535.78 million, marking a 4.6% increase from the 2012 census. Approximately, 20.5 million people depend upon livestock for their livelihood. The contribution of livestock to small farm household is 16 percent as contrast to an average of 14 percent for all rural households. Livestock generates livelihood to two third of rural community. It also contributes to reduction of unemployment i.e. nearly 8.8 percent of the population in India. Uttar Pradesh contributes approximately 7% to the state's Gross State

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Value Added (GSVA) from livestock, higher than the national average of ~5.2%. It remains India's largest milk-producing state, contributing around 16–16.2% of national milk output (~388 lakh tonnes in 2023-24). The state has a milch animal population of over 5.31 crore, which is about 19% of India's in-milk livestock population. Poultry and meat production in UP is significant as well. Recent livestock production figures show UP's poultry/meat output at ~361 thousand tonnes, reflecting an upward trend.

The sector's contribution to rural employment is multifaceted: direct engagements in production and care of animals, as well as indirect jobs in feed supply, health services, logistics, and product marketing. Moreover, the large repository of indigenous breeds presents opportunities for breed-based enterprises and genetic improvement startups that can further enhance productivity and rural incomes. The state of Uttar Pradesh, with its large agrarian population and evolving rural enterprise landscape, exemplifies the potential of livestock-based startups to drive inclusive growth and resilience in rural livelihoods.

Startup Ecosystem in Livestock, Dairy and Poultry

Livestock, dairy, and poultry startups generate both direct and indirect employment, offering year-round livelihood opportunities in rural areas. Unlike seasonal crop agriculture, livestock enterprises ensure continuous engagement through activities such as feeding, milking, breeding, health management, and product processing. Even small-scale household units create stable employment for family labour and hired workers, thereby acting as a critical buffer against seasonal and climatic income fluctuations (Sahoo,2022).Beyond direct on-farm employment, livestock startups stimulate extensive indirect employment across value chains, including feed manufacturing, veterinary and breeding services, milk and egg collection, cold-chain logistics, processing, packaging, and marketing. The emergence of digital platforms and service-based business models has lowered entry barriers for first-generation entrepreneurs and enabled smallholders to access quality inputs, advisory services, and organized markets (Chandra, 2018). This structural diversification has significantly expanded employment opportunities beyond primary production into allied services and downstream activities.

Dairy Technology Startups: Innovations and Impacts: Dairy technology startups are emerging as powerful agents of change in rural India by addressing long-standing inefficiencies in milk production, procurement, and marketing. The studies highlights that innovations such as digital milk collection systems, quality testing devices, mobile-based advisory platforms, and cold-chain logistics have significantly improved transparency and reduced transaction costs in the dairy value chain (DAHD,2023). For instance, startups such as Stellapps have deployed integrated platforms for milk procurement, quality testing, and cold-chain monitoring, enabling small dairy farmers to receive transparent, quality-based payments while reducing spoilage losses. Similarly, Milk Mantra has combined farmer aggregation with branded dairy marketing, creating backward linkages that generate employment for rural youth in milk collection, quality testing, and logistics (Saxena & Jha, 2020).

By enabling real-time payment, quality-linked pricing, and direct market access, dairy tech startups enhance farmers' incomes while creating local employment for youth as collection agents, technicians, and logistics providers. These ventures also strengthen producer institutions like Farmer Producer Organizations (FPOs) and dairy cooperatives, thereby contributing to inclusive rural development and livelihood diversification (Singh & Shukla, 2017).Technological innovations such as **IoT-enabled sensors**, automated milking systems, herd management software, and data analytics tools support precision dairy farming by improving animal health monitoring, reproductive efficiency, and feed optimization. Cold-chain and logistics startups further reduce post-harvest losses and ensure consistent quality of milk and dairy products.

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Breed Improvement Startups and Genetic Innovation Ventures: Breed improvement and genetic innovation startups are increasingly addressing productivity gaps in India's livestock sector through scientific breeding solutions and reproductive technologies. Ventures focusing on artificial insemination services, sex-sorted semen, embryo transfer technologies, and performance recording systems are improving herd genetics and reducing mortality and inter-calving periods.

Such startups generate skilled employment for veterinarians, para-vets, and trained rural youth, while also enhancing milk yield and disease resistance at the farm level. By combining biotechnology with digital recordkeeping and advisory services, genetic innovation ventures contribute to sustainable livestock development and long-term income stability for small and marginal farmers.India's rich pool of indigenous breeds also offers significant opportunities for breed-based enterprises that combine conservation with commercialization. Startups promoting indigenous cattle, buffalo, sheep, goat, and poultry breeds—known for their resilience, adaptability, and lower input requirements—can generate localized employment while preserving genetic diversity.Ventures such as BovSmart and Ingene offer data-driven herd management and genetic advisory services, helping farmers make informed breeding decisions. In the Indian context, startups providing doorstep artificial insemination and sex-sorted semen services have significantly improved calving efficiency and milk yield while reducing the economic burden of unproductive male calves.

Feed and Nutrition Innovation Startups : Feed innovation ventures play a critical role in improving livestock productivity by addressing one of the largest cost components in animal husbandry—feed and fodder. Feed-based startups are developing balanced compound feeds, mineral mixtures, silage units, and region-specific fodder solutions that improve feed efficiency and reduce production costs.Innovations such as nutrient-dense feed formulations, use of agricultural by-products, hydroponic fodder systems, and climate-resilient fodder crops are gaining prominence. Precision feeding solutions supported by digital tools enable optimized ration formulation based on animal age, breed, and production stage.Startups such as **Sikko Industries** and **Growel Feeds** have introduced scientifically formulated mineral mixtures, bypass proteins, and specialty feeds tailored to different production stages. Other ventures focusing on **silage-making units, hydroponic fodder production, and utilization of crop residues** have helped farmers overcome seasonal fodder shortages and stabilize milk output. These ventures not only enhance livestock productivity but also create employment in feed manufacturing, fodder cultivation, storage, transport, and advisory services. These enterprises strengthen backward linkages in the livestock value chain and improve the sustainability of dairy and poultry startups.

Poultry Startups and Emerging Employment Opportunities: Poultry startups represent one of the fastest-growing segments within agripreneurship, owing to low entry barriers, quick returns, and rising demand for eggs and poultry meat. The studies note significant entrepreneurial potential in areas such as hatchery services, broiler and layer integration models, feed production, veterinary health services, and value-added poultry products (Prabakaran, 2014; DAHD, 2023).

These startups generate substantial employment across production, processing, transportation, and retailing, particularly for rural youth and women. Moreover, technology-driven poultry ventures using automated housing, climate control, and digital health monitoring systems are improving productivity while creating new categories of skilled and semi-skilled jobs in rural and peri-urban areas.Companies such as Suguna Foods and Venky's have popularized contract farming and integrator models, enabling small poultry farmers to access inputs, technical support, and assured markets while generating large-scale employment in feed mills,

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hatcheries, processing plants, and distribution networks. In addition, emerging startups in desi poultry, antibiotic-free meat, and value-added egg products are creating niche employment opportunities, particularly for women and rural youth.

Challenges Constraining Livestock and Dairy Startups:

Limited Access to Finance and Credit Constraints: Access to timely and affordable finance remains one of the most binding constraints for livestock and dairy startups, particularly those operating in capital-intensive segments such as dairy processing, cold chains, feed manufacturing, and breeding services. Studies indicate that formal financial institutions often perceive livestock enterprises as high-risk due to biological uncertainties, disease outbreaks, and price volatility, resulting in stringent collateral requirements and high interest rates (Birthal et al., 2019; NABARD, 2022). Venture capital and angel investments are also skewed towards crop-based agri-tech startups, leaving livestock ventures underfinanced, especially at early stages (GOI, 2020).

Infrastructural Bottlenecks and High Transaction Costs: Inadequate rural infrastructure significantly constrains the operational efficiency and scalability of livestock and dairy startups. Poor cold-chain infrastructure, unreliable electricity supply, weak rural roads, and limited access to modern milk testing and processing facilities lead to high post-harvest losses and increased transaction costs (Planning Commission, 2018). Empirical studies show that lack of cold storage and refrigerated transport alone can account for 8–10 per cent losses in milk and dairy products, undermining startup profitability (NDDB, 2021). Digital startups further face challenges due to inconsistent internet connectivity and low digital readiness in rural areas.

Regulatory Complexity and Policy Fragmentation: Livestock and dairy startups operate in a complex regulatory environment involving multiple agencies related to food safety, animal health, environmental standards, and interstate trade. Studies highlight those overlapping regulations under FSSAI, state animal husbandry departments, pollution control boards, and municipal authorities increase compliance costs and procedural delays (World Bank, 2020). Lack of uniformity in state-level regulations—particularly for milk procurement, animal movement, and poultry operations—creates uncertainty and discourages private investment in the sector (GOI, 2021).

Input Supply Constraints and Quality Variability: Irregular availability and inconsistent quality of critical inputs such as feed, fodder, veterinary medicines, and improved germplasm pose major challenges to livestock startups. Research shows that feed and fodder account for nearly 60–65 per cent of the cost of milk production, and shortages or price spikes directly affect startup margins (Birthal & Negi, 2012). Breed improvement and genetic startups also face limitations due to inadequate performance recording systems and uneven access to quality semen and breeding infrastructure, particularly in eastern and northern states (ICAR, 2020).

Human Capital and Skill Gaps: Shortage of skilled manpower is another key constraint affecting livestock and dairy startups. Studies point to a mismatch between the skills imparted by conventional veterinary and dairy education and the requirements of modern, technology-driven enterprises (ASCI, 2019). Startups often struggle to recruit trained professionals in dairy engineering, quality assurance, data analytics, and livestock management. At the farm level,

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low awareness and risk aversion among smallholders slow the adoption of new technologies, reducing the effectiveness of startup-led innovations (Rao et al., 2018).

Market Volatility and Informal Sector Dominance: Livestock startups face significant market-related challenges arising from price volatility, dominance of informal markets, and weak consumer awareness of value-added products. Studies suggest that over 50 per cent of milk in India is still marketed through informal channels, limiting market access for organized startups (NDDB, 2020). In poultry, high input price volatility—particularly feed ingredients such as maize and soybean—exposes startups to income instability (FAO, 2019). Competition from established cooperatives and large integrators further constrains entry and growth of new enterprises.

Disease Risks and Climate Vulnerability: Frequent disease outbreaks and increasing climate variability pose systemic risks to livestock startups. Evidence shows that outbreaks of diseases such as lumpy skin disease, avian influenza, and foot-and-mouth disease can cause substantial economic losses and disrupt supply chains (OIE, 2022). Climate-induced heat stress has also been found to reduce milk yield and poultry productivity, increasing production risks for startups operating without adequate insurance or risk-mitigation mechanisms (Thornton et al., 2021).

The literature clearly indicates that while livestock and dairy startups hold significant promise for employment generation and rural transformation, their growth is constrained by interlinked financial, infrastructural, regulatory, and market challenges. Addressing these constraints requires coordinated policy action, targeted financial instruments, infrastructure investment, skill development, and stronger Centre–State convergence to unlock the sector's full entrepreneurial potential.

Institutional Support, Skill Development, and Startup Ecosystem

Role of National and State Institutions in Livestock Entrepreneurship: Institutional support constitutes the foundation of a resilient and scalable livestock startup ecosystem in India. At the national level, institutions such as the Indian Council of Agricultural Research (ICAR), Department of Animal Husbandry and Dairying (DAHD), National Dairy Development Board (NDDB), and National Bank for Agriculture and Rural Development (NABARD) play a critical role in technology generation, enterprise promotion, and financial facilitation (DAHD, 2023; ICAR, 2022). ICAR institutes and State Agricultural and Veterinary Universities generate region-specific technologies related to breed improvement, feed and fodder management, animal health, and dairy processing, which serve as essential innovation inputs for startups. NDDB has strengthened dairy entrepreneurship through cooperative development, milk procurement infrastructure, quality assurance systems, and producer-oriented institutional models, while NABARD supports livestock startups through refinance, credit-linked subsidy schemes, and promotion of Farmer Producer Organizations (NABARD, 2021).

Incubation, Innovation, and Startup Promotion Mechanisms: The expansion of agri-incubation and innovation support mechanisms has significantly enhanced startup formation in the livestock and dairy sector. Programmes such as the RKVY–RAFTAAR Agri-Business Incubation (R-ABI) initiative, Startup India, and the Atal Innovation Mission provide structured support in the form of seed funding, mentoring, technology commercialization, and market linkage development (MoA&FW, 2022). Several ICAR institutes and agricultural universities host agri-business incubators with a focus on dairy technology, digital livestock

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advisory services, feed innovation, and animal health diagnostics. These incubation platforms play a vital role in bridging the gap between research outputs and market-ready enterprises, thereby reducing entry barriers for rural youth and first-generation entrepreneurs (Chandra, 2018).

Skill Development and Capacity Building for Livestock Startups: Skill development remains central to transforming livestock activities from subsistence-oriented practices to enterprise-driven ventures. National initiatives under the National Skill Development Corporation (NSDC), Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY), and DAHD-supported training programmes focus on dairy farm management, artificial insemination services, feed formulation, poultry production, and entrepreneurship development (NSDC, 2020; DAHD, 2023). Krishi Vigyan Kendras (KVKs) and veterinary extension systems contribute through hands-on training, frontline demonstrations, and exposure visits to successful enterprises. For startups, complementary training in business planning, financial literacy, digital marketing, and regulatory compliance is increasingly recognized as essential, highlighting the need for integrated technical and entrepreneurial capacity-building frameworks (Pandey et al., 2017).

Financial Institutions and Market Linkages: Access to institutional finance is a decisive factor influencing the growth and sustainability of livestock startups. Credit support through commercial banks, cooperative banks, and regional rural banks—backed by schemes such as the Animal Husbandry Infrastructure Development Fund (AHIDF) and Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE)—has expanded investment opportunities for dairy and poultry entrepreneurs (DAHD, 2022). In addition, Farmer Producer Organizations (FPOs), dairy cooperatives, and private aggregators play a crucial role in ensuring assured market access, reducing transaction costs, and improving price realization for producers. Increasing integration of livestock startups with organized retail chains, food processing industries, and digital marketplaces is strengthening value-chain participation and enhancing income stability (Singh & Shukla, 2017).

Digital Platforms and Knowledge Networks: Digitalization has emerged as a transformative force in the livestock startup ecosystem by improving access to real-time information, advisory services, and markets. Mobile-based livestock advisory applications, tele-veterinary services, digital milk procurement platforms, and data-driven herd management systems are redefining extension delivery mechanisms (Chandra, 2018). Knowledge networks linking startups with research institutions, incubators, financial agencies, and market actors foster collaborative innovation and enable scaling of successful business models. Such ecosystem-based approaches are critical for addressing production, health, and market-related challenges faced by emerging livestock enterprises.

Institutional Ecosystem in Uttar Pradesh: Uttar Pradesh possesses a strong institutional base for promoting livestock-based startups, with multiple agricultural and veterinary universities, ICAR institutes, an extensive network of Krishi Vigyan Kendras, and a large cooperative and private dairy sector presence. State-level initiatives under the Uttar Pradesh Startup Policy, Mukhyamantri Kamdhenu Yojana, and dairy infrastructure development programmes complement national schemes such as AHIDF, RKVY–RAFTAAR, and Startup India (Government of Uttar Pradesh, 2022; DAHD, 2023). However, enhanced convergence among research institutions, skill development agencies, incubators, and financial institutions remains essential. With district-specific incubation support, targeted skilling of

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rural youth and women, and stronger market linkages, Uttar Pradesh has the potential to emerge as a leading hub for livestock, dairy, and poultry startups, contributing significantly to rural employment generation and the vision of Viksit Uttar Pradesh @2047.

Way Forward: Roadmap for Promoting Livestock-Based Startups

The future trajectory of livestock, dairy, and poultry startups in India must be guided by a convergence-driven, innovation-led, and employment-centric approach. First, a district-specific startup strategy is required, wherein livestock resources, market access, and skill availability are mapped to identify high-potential enterprise clusters such as dairy technology hubs, breed-based enterprises, poultry production zones, and feed innovation clusters. Such spatial targeting will enhance resource use efficiency and improve startup survival rates. Second, technology adoption must be accelerated through stronger linkages between research institutions, incubators, and startups. Translational research in areas such as precision dairy farming, genomics-assisted breeding, climate-resilient feed formulations, and digital animal health services should be prioritized. Public–private partnerships can facilitate large-scale piloting and commercialization of these innovations, particularly for smallholder-oriented solutions. Third, integrated skill development frameworks need to be institutionalized, combining technical livestock training with entrepreneurship, financial literacy, and digital skills. Special emphasis should be placed on youth and women, supported through modular training, certification, and post-training handholding. Strengthening Krishi Vigyan Kendras, veterinary universities, and Agri-incubators as nodal skill hubs will be critical for creating a steady pipeline of capable livestock entrepreneurs.

Fourth, financial inclusion and risk mitigation mechanisms must be expanded to address the capital-intensive nature of livestock enterprises. Enhanced access to credit under schemes such as AHIDF, interest subvention, credit guarantees, and livestock insurance will reduce entry barriers for startups. In parallel, promoting Farmer Producer Organizations, cooperatives, and startup–FPO partnerships can improve scale, market access, and income stability.

Finally, policy convergence and governance coordination between central ministries, state governments, and startup ecosystems is essential. Alignment of national initiatives such as Startup India, RKVY–RAFTAAR, and AHIDF with state-level livestock, dairy, and entrepreneurship policies can minimize duplication and maximize impact. A unified monitoring framework focusing on employment generation, value addition, and startup sustainability would further strengthen outcomes.

Conclusion

Livestock, dairy, and poultry startups represent a transformative pathway for rural employment generation, income diversification, and inclusive economic growth in India. As agriculture transitions from subsistence to enterprise orientation, livestock-based entrepreneurship offers unique advantages—year-round employment, low land dependence, strong value-chain linkages, and high participation of women and smallholders. Innovations in dairy technology, breed improvement, and feed and nutrition are reshaping traditional production systems into efficient, market-responsive enterprises.

For Uttar Pradesh, with its vast livestock resources, youthful population, and expanding dairy infrastructure, the potential for livestock-based startups is particularly significant. By strengthening institutional support, fostering innovation-led entrepreneurship, enhancing skills, and ensuring effective Centre–State–startup convergence, the state can position itself as a national leader in livestock and dairy entrepreneurship. Strategic investments and policy coherence in this sector will not only generate sustainable rural employment but also contribute meaningfully to food security, nutritional well-being, and the broader vision of Viksit Uttar Pradesh @2047 and Viksit Bharat @2047.

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https://doie.org/10.10346/AE.2026934028

ABSTRACT

https://doie.org/10.10346/AE.2026934028

AGRI-BIOTECHNOLOGY & BIO-INNOVATION FOR NEXT-GENERATION ENTREPRENEURS: OPPORTUNITIES IN BIOFERTILIZERS, BIOPESTICIDES, AND MOLECULAR BREEDING

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ABSTRACT

Agri-biotechnology is increasingly being recognized as a key area for sustainable agricultural development as well as entrepreneurial growth. The rising challenges of declining soil fertility, climate variability, pest resistance, and over-dependence on chemical inputs have created a strong demand for innovative and eco-friendly agricultural solutions. The present study focuses on understanding the potential of agri-biotechnology and bio-innovation as an opportunity for next-generation entrepreneurs, particularly in the areas of biofertilizers, biopesticides, and molecular breeding. The study is based on an analytical review of existing research literature, government reports, and selected case studies related to agri-biotech enterprises. Emphasis has been given to examining how biological inputs such as biofertilizers and biopesticides contribute to improved soil health, crop productivity, and environmental sustainability. In addition, modern molecular breeding techniques have been discussed for their role in developing high-yielding and stress- tolerant crop varieties within a shorter time frame. The analysis indicates that bio-innovations not only reduce the negative environmental impact of conventional agriculture but also offer promising business opportunities for young entrepreneurs. Growing awareness about organic and residue-free food, policy support for bio-inputs, and advancements in biotechnology have encouraged the emergence of agri-biotech start-ups in India. However, challenges such as limited technical knowledge, regulatory procedures, and initial investment requirements continue to affect large-scale adoption. The study concludes that agri-biotechnology can play a vital role in shaping future-ready agripreneurs by integrating scientific innovation with market-oriented agribusiness models. Strengthening research support, skill development, and commercialization pathways will be crucial for the long-term success of bio-based enterprises in agriculture. Agri-biotechnology is increasingly being recognized as a key area for sustainable agricultural development as well as entrepreneurial growth. The rising challenges of declining soil fertility, climate variability, pest resistance, and over-dependence on chemical inputs.

Keywords: Agri-Biotechnology, Bio-Innovation, Biofertilizers, Biopesticides, Molecular Breeding

https://doie.org/10.10346/AE.2026934028

MARKETING ANALYSIS OF PEACH AND PLUM IN MANDI DISTRICT OF HIMACHAL PRADESH

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ABSTRACT

Peach and plum are among the most important temperate fruit crops cultivated in the hilly regions of Himachal Pradesh, contributing significantly to farm income and rural livelihoods. The Mandi district, characterized by favourable agro-climatic conditions, has emerged as a notable area for the production of these fruits. Despite increasing production, farmers often face marketing challenges such as price fluctuations, inadequate market infrastructure, high transportation costs, and the dominance of intermediaries, which adversely affect their returns. In this context, the present study aims to analyse the marketing system, costs, margins, and efficiency of peach and plum marketing in the Mandi district of Himachal Pradesh. The specific objectives include examining the existing marketing channels, estimating marketing costs and margins, and identifying major constraints faced by fruit growers. The study is based on both primary and secondary data. Primary data were collected from selected peach and plum growers, commission agents, and traders using a structured questionnaire through a multistage sampling technique. Secondary data were obtained from government reports, published literature, and records of market committees. Analytical tools such as tabular analysis, percentage analysis, price spread, and marketing efficiency measures were employed for analysis. The findings reveal that multiple intermediaries increase the price spread, thereby reducing the producer's share in the consumer's rupee. High transportation costs and lack of organized marketing facilities were identified as major constraints. The study concludes that improving market infrastructure, promoting direct marketing, and strengthening farmer cooperatives can enhance marketing efficiency and farmers' income. The results provide useful insights for policymakers and planners to formulate strategies for improving fruit marketing systems in hilly regions.

Keywords: Peach, Plum, Marketing Analysis, Price Spread, Marketing Efficiency, Himachal Pradesh

https://doie.org/10.10346/AE.2026934028

STUDY ON POST HARVEST LOSSES AND MARKETING OF GREEN CHILLI IN PRAYAGRAJ DISTRICT UTTARPRADESH

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ABSTRACT

Post-harvest losses in horticultural crops like green chilli represent a critical challenge to food security, farmer incomes, and supply chains in India, where up to 20-30% of produce is lost due to inefficient handling, transportation, and marketing. In Prayagraj district, Uttar Pradesh—a key chilli-producing region—these losses exacerbate economic vulnerabilities for smallholder farmers amid fluctuating market dynamics. This study addresses the gap in localized data on post-harvest losses and marketing inefficiencies to inform sustainable interventions. The primary aim was to quantify post-harvest losses in green chilli, analyze marketing channels, assess price variability, and identify constraints faced by farmers and intermediaries. A multi-stage stratified random sampling technique was employed in Prayagraj district, covering 200 farmers and 50 market intermediaries across five major blocks. Data were collected via structured questionnaires, focus group discussions, and field observations during the 2024 kharif season. Quantitative analysis included descriptive statistics, Garrett ranking, and regression models using SPSS software. Post-harvest losses averaged 18.5%, primarily from mechanical damage (42%) and decay (35%). Marketing through intermediaries dominated (72%), yielding low farmer margins (28%). Price fluctuations correlated strongly with supply glut (R^2=0.67), while poor infrastructure amplified losses. Findings underscore the need for improved grading, cold storage, and direct farmer-market linkages. Policy recommendations include subsidies for packhouses and market intelligence apps to reduce losses by 10-15% and boost incomes, supporting Uttar Pradesh's horticultural goals.

Keywords: post-harvest losses, green chilli, marketing channels, Prayagraj district, Uttar Pradesh, farmer incomes

https://doie.org/10.10346/AE.2026934028

AGROFORESTRY AS A PATHWAY TO ACHIEVE FOOD SECURITY

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ABSTRACT

Food security can be realized when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that satisfies their dietary requirements for an active and healthy life. Food insecurity in India is a major concern, with 195 million people being malnourished and 43 percent of children being chronically malnourished. The continued problems of high population growth rate, climate change, water scarcity, and biodiversity loss further worsen food availability and accessibility. Agroforestry, which involves the integration of trees, crops, and livestock on the same land, provides a comprehensive strategy for addressing food security problems. Through the diversification of agricultural products, yield stabilization, direct food production such as fruits and vegetables, and increased income from agriculture, agroforestry provides resilience for households and communities. Technologies such as home gardens, alley cropping, mixed cropping, and Silvi pasture can help in this endeavour by increasing food, fertility, and ecological balance. Support and investment in agroforestry are needed to ensure the promotion of sustainable agriculture practices, providing a stable and eco-friendly means to achieve food security.

Keywords: Agroforestry, Food security, Sustainable agriculture, Homegarden , Soil

https://doie.org/10.10346/AE.2026934028

DIGITAL AGRICULTURE & AI-DRIVEN SOLUTIONS FOR YOUTH-LED STARTUPS

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ABSTRACT

Digital Agriculture is emerging as a transformative force in the agricultural sector by integrating advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT), drones, and data analytics. These innovations are creating new opportunities for youth-led startups to address long-standing challenges like low productivity, climate variability, resource inefficiency, and market access. AI-driven solutions enable predictive analytics for crop yield forecasting, pest and disease detection, and optimized input usage, helping farmers make data-driven decisions. IoT-based smart farming systems use sensors to monitor soil moisture, temperature, nutrient status, and weather conditions in real time, thereby improving irrigation efficiency and reducing input costs. Drone technology supports precision agriculture through aerial surveillance, crop health assessment, spraying, and mapping, enhancing farm management and reducing labour dependency. Youth-led agritech startups are playing a crucial role in bridging the gap between traditional farming practices and modern digital solutions. With their technological skills, innovative mindset, and entrepreneurial approach, young innovators are developing scalable, affordable, and farmer-friendly platforms. These startups not only improve farm productivity and sustainability but also generate employment opportunities and promote rural entrepreneurship. Digital agriculture, supported by AI-driven technologies, has the potential to make farming more resilient, profitable, and environmentally sustainable. Encouraging youth participation in agritech startups through policy support, funding, incubation, and skill development can significantly accelerate the digital transformation of agriculture and contribute to food security and economic growth.

Keywords: Digital Agriculture, Artificial Intelligence, IoT, Drones, Smart Farming, Youth-Led Startups, Agritech, Precision Agriculture

https://doie.org/10.10346/AE.2026934028

FEASIBILITY STUDY OF PRODUCTION OF BIOCHAR FROM AGRICULTURE WASTE

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ABSTRACT

This study explores the potential of rice straw-derived biochar as a sustainable solution for environmental remediation agricultural sustainability. Biochar, a carbon-rich material, was produced from rice straw through pyrolysis and characterized for its physicochemical properties. The results showed that the biochar produced at 500°C exhibited high carbon content, surface area, and adsorption capacity. The biochar was found to be effective in removing pollutants from water and improving soil fertility. The study highlights the potential of rice straw-derived biochar as a sustainable and eco-friendly solution for environmental remediation and agricultural sustainability. The findings of this study can be used to develop cost-effective and environmentally friendly technologies for waste management and sustainable agriculture. This study investigates the potential of rice straw-derived biochar as a sustainable solution for environmental remediation and agricultural sustainability. The biochar was produced through pyrolysis and characterized for its physicochemical properties. The results showed that the biochar produced at 500°°C exhibited high carbon content, surface area, and adsorption capacity. The biochar was found to be effective in removing pollutants from water and improving soil fertility. The study highlights the potential of rice straw-derived biochar as a sustainable and eco-friendly solution for environmental remediation and agricultural sustainability.

Keyword: - Environmental Remediation, Agricultural Sustainability.

https://doie.org/10.10346/AE.2026934028

ROLE OF AGRIBUSINESS ENTREPRENEURSHIP IN RURAL EMPLOYMENT GENERATION

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ABSTRACT

Agribusiness entrepreneurship has emerged as a powerful tool for promoting rural development and generating employment in India. Agriculture alone is no longer sufficient to provide sustainable income to the growing rural population because of small landholdings, low productivity, and seasonal employment. Agribusiness entrepreneurship includes activities such as food processing, input supply, Agri-logistics, marketing, storage, and Agri-services, which create additional income opportunities beyond that of farming. By encouraging rural youth and farmers to adopt agribusiness ventures, dependency on traditional farming can be reduced. Government initiatives, access to credit, skill development programs, and agribusiness incubation centres play significant roles in promoting entrepreneurship. Agribusiness enterprises generate local employment, reduce rural–urban migration, and improve farmers' incomes. Therefore, promoting agribusiness entrepreneurship is essential for achieving inclusive growth, strengthening the rural economy, and ensuring sustainable agricultural development.

Keywords: - Agribusiness Entrepreneurship, Rural Development, Employment Generation, Farmers' Income, Sustainable Agriculture.

https://doie.org/10.10346/AE.2026934028

SUSTAINABLE AGRIBUSINESS PRACTICES FOR LONG-TERM ECONOMIC GROWTH

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ABSTRACT

Sustainability had become a critical focus in agribusiness management due to rising environmental challenges, resource scarcity, and the demand for inclusive economic development. The agribusiness sector had played a significant role in ensuring food security, generating employment, and supporting rural livelihoods, particularly in developing economies such as India. This study had examined the importance of sustainable agribusiness practices in achieving long-term economic growth while maintaining environmental and social balance. Sustainable practices such as efficient utilization of land, water, and energy resources, climate-smart agriculture, organic and natural farming, integrated pest management, and sustainable supply chain management had contributed to reducing environmental degradation and improving soil health and productivity. From a managerial perspective, sustainability had enhanced cost efficiency, minimized production risks, improved market access, and strengthened the competitiveness of agribusiness enterprises. Furthermore, sustainable agribusiness practices had supported rural development by increasing farmers' income, creating employment opportunities, and strengthening institutional frameworks such as Farmer Producer Organizations. Government initiatives, technological innovations, and increasing consumer preference for environmentally friendly products had further promoted the adoption of sustainability in agribusiness operations. However, constraints such as limited awareness, high initial investment requirements, and restricted access to finance had posed challenges to widespread adoption. The study had concluded that integrating sustainability into agribusiness strategies had been essential for balancing economic growth, environmental protection, and social welfare, thereby ensuring the long-term viability and resilience of the agribusiness sector.

Keywords: - Sustainable agribusiness, economic growth, rural development, environmental protection, agribusiness management.

https://doie.org/10.10346/AE.2026934028

INNOVATIONS IN SEED, CROP PROTECTION & PRECISION INPUT DELIVERY SYSTEMS
(STARTUPS IN PRECISION INPUT MANAGEMENT, NANO-FERTILIZERS, BIOLOGICALS)

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ABSTRACT

Agriculture worldwide grapples with resource scarcity, climate variability, and pressure to boost yields sustainably, where traditional inputs like chemical fertilizers and pesticides often lead to soil degradation and resistance issues. Innovations in seeds, crop protection, and precision input delivery—driven by startups specializing in precision management, nano-fertilizers, and biologicals—offer targeted solutions to optimize resource use and minimize environmental impact. This study explores these advancements in India, a key agrarian economy, evaluating startup-led technologies for enhanced efficiency, farmer adoption, and scalability in regions like Uttar Pradesh. The research aims to assess their role in transforming input delivery, quantify performance gains, and propose integration strategies for mainstream agriculture. Employing a mixed-methods design, the analysis draws from 2024-2025 field trials across 15 startup incubators in northern India, involving 300 smallholder farmers and 12 ventures like those developing nano-urea and AI-driven biological sprayers. Data collection included sensor-monitored plot experiments measuring yield and input savings, farmer surveys on usability, and case studies of platforms using drones for precision foliar applications. Statistical tools like ANOVA evaluated efficacy, while SWOT analysis framed market readiness. Results indicate nano-fertilizers reduced usage by 40-50% while lifting yields 25%, biologicals curbed pest damage 35% without residues, and precision systems via IoT/drones cut delivery waste by 30%. Startups reported 60% farmer retention, with cost savings enabling 20% profit hikes. Challenges like high upfront costs persisted but eased via subsidies. These breakthroughs signal a shift to resilient farming, urging policies for startup funding, regulatory fast-tracking of biologicals, and extension services. Scaling could cut India's Agri-input imports by 15%, fostering sustainability and food security.

Keywords: women agripreneurs, skill development, startup ecosystems, gender incubation, leadership training, agricultural entrepreneurship

https://doie.org/10.10346/AE.2026934028

AGRI-TOURISM, RURAL TOURISM & COMMUNITY-BASED ENTERPRISES
(FARM TOURISM, EXPERIENTIAL RURAL ENTREPRENEURSHIP)

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ABSTRACT

Agriculture in rural India supports over 60% of the population yet faces economic stagnation, prompting Agri-tourism and community-based enterprises as revitalization strategies. Farm tourism integrates experiential activities like homestays, crop harvesting, and cultural immersion, while rural entrepreneurship leverages local resources for sustainable income. This study investigates their growth in Uttar Pradesh, where declining farm incomes meet rising urban demand for authentic rural experiences, aiming to evaluate economic impacts, community empowerment, and scalable models for replication nationwide. A mixed-methods framework analysed 2024-2025 data from 20 farm tourism sites across Lucknow and surrounding districts, engaging 200 households and 500 visitors. Farmer surveys tracked revenue diversification, visitor feedback assessed satisfaction via Net Promoter Scores, and enterprise audits measured job creation. Qualitative insights from focus groups captured cultural preservation benefits, with econometric modelling (difference-in-differences) quantifying income uplifts against non-tourism controls. Findings reveal Agri-tourism boosted household incomes by 45%, generating 2.5 jobs per farm through activities like organic farming demos and village crafts. Visitor spending averaged ₹3,200 per trip, with 85% repeat intent due to immersive experiences. Community enterprises in honey processing and millet cuisine thrived, reducing migration by 30% among youth. Challenges included seasonal fluctuations and skill gaps in hospitality, addressed via cooperatives. These models demonstrate Agri-tourism's potential to blend conservation with commerce, recommending policy incentives like tax breaks, digital marketing platforms, and training hubs. Widespread adoption could add ₹50,000 crore to rural GDP annually, preserving heritage while fostering inclusive growth.

Keywords: Agri-tourism, rural tourism, farm stays, experiential entrepreneurship, community enterprises, rural development

https://doie.org/10.10346/AE.2026934028

MARKET ANALYSIS OF AMLA PRODUCTS IN PRATAPGARH DISTRICT OF UTTAR PRADESH WITH REFERS TO SMALL SCALE PRODUCERS

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ABSTRACT

Amla (Indian gooseberry, *Phyllanthus emblica*), a nutrient-rich superfruit, holds immense potential for economic upliftment in rural India, particularly in Uttar Pradesh, a leading producer. However, small-scale producers in Pratapgarh district face challenges such as limited market access, price volatility, and inadequate value addition, hindering their profitability and sustainability. This study addresses the gap in localized market intelligence for amla products, aiming to empower smallholders amid rising demand for natural health foods. The primary aim was to analyse the market dynamics of amla products (fresh fruit, powder, juice, and pickles) in Pratapgarh district, focusing on small-scale producers. Specific objectives included assessing supply chains, pricing structures, consumer preferences, and marketing constraints. A mixed-methods approach was employed in Pratapgarh district, Uttar Pradesh. Primary data were collected from 150 small-scale producers and 100 consumers via stratified random sampling, using structured questionnaires and focus group discussions. Secondary data from government reports and market surveys supplemented the analysis. Descriptive statistics, SWOT analysis, and regression modelling evaluated market trends. Results revealed a fragmented market with 65% of producers relying on local mandis, facing 30-40% price fluctuations. High demand for processed products existed, yet value addition was minimal (under 20%). Consumer preferences favoured organic amla powder, with small producers capturing only 25% market share due to competition from larger firms. Findings underscore the need for farmer cooperatives, processing units, and digital marketing to enhance small-scale producers' competitiveness. Policy recommendations include subsidies for value addition and market linkages, fostering inclusive growth and rural livelihoods.

Keywords: - Amla products, market analysis, small-scale producers, Pratapgarh, Uttar Pradesh, value chain

https://doie.org/10.10346/AE.2026934028

ZERO-WASTE POST-HARVEST APPROACH FOR FRUIT PEEL UTILIZATION IN INNOVATIVE FOOD PRODUCT DEVLOPMENT

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ABSTRACT

Fruit peel waste is generated during post-harvest handling and processing, and it is often wasted despite its high nutritional and functional value. Fruit peels include a high concentration of dietary fibre, phenolic compounds, flavonoids, antioxidants, and other bioactive components that may have health advantages. The disposal of such nutrient-dense byproducts not only pollutes the environment, but also results in a huge loss of precious resources. In recent years, zero-waste post-harvest initiatives have received attention as long-term solutions to reduce food waste and improve resource efficiency in the food system. A zero-waste post-harvest approach stresses the efficient use and value of fruit peels through appropriate processing procedures such as drying, fermentation, and enzyme-assisted treatments. These strategies improve the bioavailability of nutrients, boost functional qualities, and facilitate their inclusion into novel food items. Fruit peel powders and extracts have been successfully investigated for use in baked goods, snacks, drinks, and functional meals, adding health-promoting qualities and improving nutritional quality. Moreover, using fruit peels in food compositions lessens reliance on artificial ingredients while promoting the creation of value-added goods. All things considered, using fruit peels in zero-waste post-harvest methods presents a viable route toward sustainable food production. This strategy supports consumer health and environmental sustainability by addressing the rising issue of food waste management and encouraging the creation of novel, nutrient-rich food items.

Keywords: - Fruit peel waste; post-harvest handling; Zero-waste approach; Sustainable food production; Value-added food products; Functional food ingredients.

https://doie.org/10.10346/AE.2026934028

DIGITAL AGRICULTURE AND AI-DRIVEN SOLUTIONS FOR YOUTH-LED STARTUPS

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ABSTRACT

Digital agriculture and artificial intelligence (AI)–driven solutions have emerged as powerful instruments for transforming the agricultural sector, particularly by creating new opportunities for youth-led startups. Traditional agricultural practices often face challenges such as low productivity, inefficient resource use, climate variability, and limited access to timely information. In this context, the integration of digital technologies and AI offers innovative solutions to enhance decision-making, efficiency, and sustainability in agriculture. The primary objective of this study was to examine the role of digital agriculture and AI-driven solutions in promoting youth-led agripreneurial startups. The study aimed to analyze how technologies such as artificial intelligence, Internet of Things (IoT), data analytics, drones, and smart farming tools contribute to innovation, productivity improvement, and business development in Agriculture. The study adopted a descriptive and analytical research approach based on secondary data collected from research journals, government reports, startup case studies, and policy documents related to digital agriculture and Agri-startups. In addition, selected examples of youth-led agricultural startups were reviewed to assess the practical application of AI-based technologies and digital platforms. The key findings revealed that AI-driven solutions significantly improved farm management, resource optimization, yield forecasting, and market access.Youth-led startups were found to play a crucial role in developing scalable digital tools that reduced production risks and enhanced farmers' income. However, challenges such as high initial investment, limited digital literacy, and infrastructure gaps were also identified. The study concluded that digital agriculture and AI-driven solutions have strong potential to empower youth entrepreneurs and modernize the agricultural sector. Supportive policies, skill development programs, and access to funding are essential to accelerate the growth of youth-led Agri-startups and ensure sustainable agricultural development.

Keywords: - Digital Agriculture, Artificial Intelligence, Youth-Led Startups, Aggrotech Innovation, Smart Farming, Entrepreneurship

https://doie.org/10.10346/AE.2026934028

CROP INSURANCE AND RISK MANAGEMENT

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ABSTRACT

Agriculture remains highly vulnerable to climatic uncertainties, pests, and market fluctuations, leading to substantial income losses for smallholder farmers, particularly in developing economies. Despite the proliferation of crop insurance schemes, low penetration rates and inadequate risk coverage persist, exacerbating rural poverty and food insecurity. This study addresses the gap in understanding the efficacy of crop insurance as a risk management tool in enhancing farmer resilience. The primary objective is to evaluate the impact of crop insurance adoption on risk mitigation and farm income stability among smallholder farmers. Employing a mixed-methods approach, the research was conducted in the drought-prone Bundelkhand region of Uttar Pradesh, India. A stratified random sample of 450 farmers (225 insured and 225 uninsured) was surveyed using structured questionnaires, supplemented by focus group discussions and secondary data from government records (2018–2024). Econometric analysis, including propensity score matching and regression discontinuity design, was applied to assess causal impacts. Key findings reveal that insured farmers experienced a 32% reduction in income volatility and a 28% increase in adaptive investments compared to uninsured counterparts. However, scheme awareness (only 41%) and delayed claim settlements hindered full potential. In conclusion, strengthening crop insurance through digital outreach, streamlined claims, and subsidized premiums can bolster risk management. Policymakers should prioritize these reforms to foster sustainable agriculture and rural livelihoods.

Keywords: - crop insurance, risk management, smallholder farmers, income stability, agricultural resilience, propensity score matching

https://doie.org/10.10346/AE.2026934028

YOUTH LEADERSHIP IN START-UP AND ENTREPRENEURSHIP

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ABSTRACT

This study examined the role of youth leadership in startups and entrepreneurship, with the primary objective of understanding how young leaders influenced innovation, organizational performance, and entrepreneurial growth. The research addressed the problem of limited empirical evidence on leadership capabilities of youth founders and the challenges they faced within startup ecosystems. A mixed-method research approach was adopted for the study. Quantitative data were collected through a structured questionnaire administered to 220 startup founders aged 18–30 years across selected urban startup hubs in India, while qualitative data were gathered through semi-structured interviews with 20 young entrepreneurs and ecosystem experts. Descriptive statistics and regression analysis were used to analyse quantitative data, and thematic analysis was applied to qualitative responses. The results revealed that youth leadership significantly contributed to innovation, adaptability, and growth orientation in startups. Digital skills, risk-taking ability, and transformational leadership behaviours showed a positive association with team motivation and business performance. However, constraints such as limited access to finance, inadequate mentorship, and regulatory complexities emerged as major challenges. The study concluded that youth leadership was a critical driver of entrepreneurial success, and strengthening institutional support, leadership training, and mentorship frameworks could enhance the sustainability of youth-led startups. The findings provided valuable insights for policymakers, educators, and startup support institutions aiming to promote youth entrepreneurship and leadership development.

Keywords: - Youth leadership, Startups, Entrepreneurship, Innovation, Business Performance.

https://doie.org/10.10346/AE.2026934028

STUDY ON SMART GREENHOUSE THE FUTURE AGRIBUSINESS DEVELOPMENT IN BAREILLY DISTRICT OF UTTAR PRADESH

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ABSTRACT

IoT-driven smart farming revolutionizes agriculture by integrating sensors for real-time monitoring of soil moisture, temperature, humidity, and irrigation, addressing resource inefficiencies in rural India where 58% of the population depends on farming. Youth-led startups deploy affordable IoT networks—such as sensor-based platforms like those from Cropin and DeHaat—to automate precision irrigation, reducing water usage by 30-50% and boosting yields by 20-25%, thereby creating jobs in device installation, data analytics, and field maintenance for over 18,000 agritech roles nationwide. These ventures enable smallholders to access mobile apps for remote farm control, minimizing manual labour and enabling scalable entrepreneurship amid labour shortages. Empirical data from pilot projects show monthly income gains of ₹5,000-10,000 per household via optimized inputs, with government support like Budget 2026's agri-AI push amplifying adoption through subsidies and training. Challenges including high initial costs and digital literacy gaps persist, yet integrating IoT with drones and AI fosters inclusive growth, recommending public-private partnerships to train 1 million rural youth by 2027 for sustainable livelihoods.

Keywords: - IoT smart farming, precision agriculture, youth startups, rural employment, sensor networks, agritech India.

https://doie.org/10.10346/AE.2026934028

STUDY ON CONSUMER BUYING BEHAVIOUR OF VERMICOMPOST TOWARDS ON WHEAT IN CHITRAKOOT DISTRICT OF UTTAR PRADESH

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ABSTRACT

Eco-labelling serves as a critical market signal for natural, organic, and regenerative agriculture products, enabling consumers to identify ventures committed to environmental sustainability. This study analyses the multifaceted impacts of eco-labels, drawing on empirical evidence from certification schemes like USDA Organic and EU Ecolabel, which demonstrate a 20-30% premium price uplift for labelled products while boosting consumer trust and purchase intent. For producers, particularly small-scale regenerative enterprises, eco-labels facilitate access to premium markets and export channels, fostering innovations such as soil carbon sequestration verification. However, high certification costs—often exceeding $1,000 annually—and inconsistent standards across regions hinder adoption, exacerbating inequities for enterprises in developing markets like India. The research employs a mixed-methods approach, including case studies of ventures like Indigo Ag and econometric analysis of sales data pre- and post-labelling. Findings reveal that harmonized global standards could amplify environmental gains, such as biodiversity enhancement, by 15-25%, while policy interventions addressing cost barriers are essential for scaling regenerative impacts. This underscores eco-labelling's potential as a catalyst for sustainable agriculture transitions amid rising climate pressures.

Keywords: - Eco-labelling, organic certification, regenerative agriculture, sustainable ventures, consumer behaviour.

https://doie.org/10.10346/AE.2026934028

STUDY ON MARKETING OF BOILER CHICKEN IN PATNA DISTRICT OF BIHAR

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ABSTRACT

Livestock, dairy, and poultry sectors form the backbone of rural economies in India, engaging over 50% of the rural workforce and contributing significantly to livelihood security. This paper examines the transformative role of startups in these domains—focusing on dairy technology (e.g., AI-driven precision platforms like Nitara and Dairytech.ai), breed improvement initiatives for indigenous cows, and feed innovation ventures— in generating sustainable employment opportunities. Drawing from recent trends, startups address key challenges such as labur shortages, low productivity, and feed deficits by deploying robotic milking systems, genetic conservation programs, and sustainable fodder solutions, thereby creating jobs in tech deployment, extension services, processing, and market linkages. Empirical insights reveal that backyard poultry units boost monthly incomes by ₹3,000–7,000 for 8,500 rural households, while dairy cooperatives support 35,000 farmers through enhanced milk yields (from 8 to 12 litters per animal via breed upgrades), employing 800 technical personnel. Government schemes like the National Livestock Mission further amplify impacts by fostering entrepreneurship in small ruminants, poultry, and fodder, with backyard poultry trainings yielding 86–267% employment gains for rural women. However, barriers like high input costs and adoption hurdles persist, necessitating policy support for scaling. Findings underscore that integrating startups with skill development can double rural incomes, aligning with India's $5 trillion economy goals by 2025, and recommend public-private partnerships for inclusive growth.

Keywords: - Rural employment, dairy tech startups, breed improvement, feed innovations, poultry entrepreneurship, livestock value chain.

https://doie.org/10.10346/AE.2026934028

RURAL ENTREPRENEURSHIP AND ITS IMPORTANCE

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ABSTRACT

Rural entrepreneurship has emerged as a vital instrument for accelerating rural development and addressing persistent socio-economic challenges such as poverty, unemployment, low-income levels, and regional imbalances. Despite the abundance of natural resources and human capital in rural areas, the lack of entrepreneurial initiatives, infrastructure, financial access, and skill development continues to limit economic growth. This study emphasizes the importance of rural entrepreneurship in transforming rural economies by promoting self-employment, enhancing income generation, and reducing excessive migration from rural to urban areas. The primary objective of this research is to examine the significance of rural entrepreneurship in fostering economic development and improving the standard of living in rural regions. The study also aims to analyse the factors influencing rural entrepreneurial activities, identify major constraints faced by rural entrepreneurs, and assess the role of institutional and policy support in promoting rural enterprises. The research adopts a descriptive and analytical approach. The study is based on both primary and secondary data. Primary data were collected through structured questionnaires and personal interviews with selected rural entrepreneurs from the study area, while secondary data were obtained from government reports, research articles, and published literature. Simple statistical tools such as percentages, averages, and tabular analysis were used for data interpretation. The findings indicate that rural entrepreneurship plays a significant role in employment generation, income diversification, utilization of local resources, and reduction of rural poverty. However, issues such as inadequate finance, poor infrastructure, limited market access, and lack of entrepreneurial training remain major challenges. The study concludes that strengthening rural entrepreneurship through targeted policies, skill development programs, financial inclusion, and infrastructural support can contribute substantially to inclusive growth, sustainable rural development, and balanced regional development.

Keywords: - Rural entrepreneurship, Rural development, Employment generation, Poverty alleviation, Inclusive growth

https://doie.org/10.10346/AE.2026934028

WOMEN-LED AGRIPRENEURSHIP AND DIGITAL PLATFORMS BUILDING INCLUSIVE RURAL STARTUP ECOSYSTEMS

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ABSTRACT

Women-led agripreneurship has emerged as a significant driver of inclusive rural development, particularly with the increasing integration of digital platforms in agricultural value chains. Despite women's substantial involvement in agriculture, their participation in agribusiness entrepreneurship remains constrained by limited access to markets, finance, technology, and institutional support. This study addressed the need to understand how digital platforms can enable women agripreneurs to overcome these barriers and contribute to the development of inclusive rural startup ecosystems. The primary objective of the study was to examine the role of digital platforms in promoting women-led agripreneurship and strengthening rural entrepreneurial ecosystems. Specifically, the research aimed to analyze the opportunities created by digital tools for market access, business scalability, and capacity building among women agripreneurs. The study adopted a descriptive and analytical research design based on secondary data collected from government reports, policy documents, research journals, and published case studies related to women entrepreneurship, agribusiness, and digital agriculture. The analysis focused on digital interventions such as e-commerce platforms, mobile-based advisory services, digital payment systems, and online training initiatives. The findings indicated that digital platforms significantly enhanced market linkages, reduced information asymmetry, and improved income opportunities for women agripreneurs. They also facilitated greater participation of women in agribusiness startups and strengthened local value chains. However, challenges related to digital literacy, infrastructure gaps, and access to finance persisted. The study concluded that promoting women-led agripreneurship through targeted digital policies, skill development programs, and institutional support could foster inclusive and sustainable rural startup ecosystems.

Keywords: - Women Agripreneurship, Digital Platforms, Rural Startups, Inclusive Development, Agribusiness, Entrepreneurship

https://doie.org/10.10346/AE.2026934028

EVOLUTION of AGRIBUSINESS

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ABSTRACT

The business of agribusiness is much more than just farming. It includes all the activities connected with food and fibre production, starting from supplying seeds, fertilizers, and machines to farmers, and ending with processing, transporting, and selling food to consumers. Agriculture has evolved into agribusiness and has become a vast and complex system that reaches far beyond the farm to include all those who are involved in bringing food and fibre to consumers. Agribusiness system has undergone a rapid transformation as new industries have evolved and traditional farming operations have grown larger and more specialized. The transformation did not happen overnight, but came slowly as a response to variety of forces. Knowing something about how this system operates today and how it is likely to change in the future. Over time, agriculture has changed from small, self-sufficient farms to a large and organized system. Today, many people and industries work together to make sure food reaches our homes in good quality and quantity. Farmers now depend on input industries, technology, and services, while consumers depend on agribusiness for safe and processed food. A new agriculture product made their way into the export market and were sold to buyers in other countries. Farmers found it increasingly profitable to concentrate on production and began to purchase inputs they formerly made themselves. This trend enabled others to build business that focused on meeting the need for inputs used in production agriculture such as seed , fencing , and machinery and so on. In simple words, agribusiness connects farmers, industries, markets, and consumers into one system. It helps in improving production, creating jobs, increasing income, and supporting the country's economy. Therefore, agribusiness plays a very important role in modern agriculture and in meeting the needs of society.

Keywords: - Transformation, export market, fencing, machinery, technology, economy

https://doie.org/10.10346/AE.2026934028

FIELD SURVEY-BASED ASSESSMENT OF PLANT-PARASITIC NEMATODE DISTRIBUTION IN SELECTED VILLAGES OF PRAYAGRAJ, U.P.

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ABSTRACT

Plant-parasitic nematodes are among the most destructive worms that causes significant damage to agricultural and horticultural crops worldwide, including tomato. It leads to symptoms such as root galls, lesions, stunted growth, chlorosis, wilting, and yield reduction. The present study aims to assess the distribution and occurrence of plant-parasitic nematodes through field surveys conducted in 20 selected villages of Prayagraj district, Uttar Pradesh. Field surveys were carried out during the harvest season to collect root samples from many vegetable crops. Standard nematological techniques were employed for the extraction and identification of nematodes. The intensity of infestation was assessed based on gall index and population density. This survey aims to provide spatial variation in the distribution of plant-parasitic nematodes across the surveyed villages, influenced by factors such as cropping pattern, soil type, and agricultural practices. Higher nematode populations were observed in intensively cultivated fields of villages namely, Iradatganj, Jasra, Bahadurpur and Phulpur with susceptible host crops. The study highlights the widespread presence of plant-parasitic nematodes (*Meloidogyne* spp.), *Steinernema*, *Helicotylenchus*, *Tylenchorhynchus* and *Tylencholaimus* in the study area and emphasizes their potential threat to sustainable crop production. This field-based assessment provides information on the distribution status of plant-parasitic nematodes in Prayagraj district, which can be useful for developing location-specific management strategies and for future research on nematode–crop interactions.

Keywords: - Plant-parasitic nematodes; Nematode distribution; Field survey; Soil sampling.

https://doie.org/10.10346/AE.2026934028

SURVEY OF PLANT PARASITIC NEMATODES IN OKRA FIELDS OF SELECTED AREAS IN PRAYAGRAJ DISTRICT

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ABSTRACT

Okra is an important vegetable crop, but its production is seriously affected by plant parasitic nematodes. To understand the present situation of this problem, a field survey was carried out in okra-growing areas of Prayagraj district, Uttar Pradesh. The survey was conducted in four major blocks, namely Bahadurpur, Phulpur, Chaka and Jasra. Okra fields were visited, and the root and soil samples were collected. Root galling was recorded using a standard galling scale, and nematode population was estimated from soil samples. The survey results showed that *Meloidogyne incognita* was present in all the surveyed blocks. Along with this, other plant parasitic nematodes such as *Pratylenchus spp., Rotylenchus spp., Tylenchus spp., Helicotylenchus spp.* and *Heterodera spp.* were also recorded in the region. Higher galling intensity and nematode population were observed in the Chaka and Bahadurpur blocks, while relatively lower infestation was found in the Phulpur block. The study indicates that plant parasitic nematodes are a common problem in okra cultivation in the region and emphasises the need for integrated nematode management practices.

Keyword: - Parasitic, Galling, Integrated

https://doie.org/10.10346/AE.2026934028

BIOLOGICAL CONTROL OF RICE ROOT -KNOT NEMATODE (*MELOIDOGYNE GRAMINICOLA)*

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ABSTRACT

The rice root knot- nematode *Meloidogyne graminicola* is a serious pest. This nematode can cause significant loss, in India, with yield reduction ranging from approximately 16%-80%, depending on soil type and infection severity. Infected plants show stunted growth, yellowing and characteristic knots on the root tips. According to various study it has been concluded that bacterial and fungal biocontrol agents like *Trichoderma harziaum*, *Pseudomonas fluorescence* and *Bacillus subtilis* are very effective for the management of rice root-knot nematode, when applied specially as seed treatment (10g/kg) and soil treatment (20g/m2 or 2.5kg/hectare) in nurseries. Dipping seedlings in suspension of *P. chlamydosporium* at planting is highly effective, especially when combined with or followed by one or two soil application (15-30 days after planting).

Keywords: Biological control; Rice root-knot nematode; Meloidogyne graminicola; Biocontrol agents; Sustainable pest management.

https://doie.org/10.10346/AE.2026934028

TRANSFORMING INDIAN AGRICULTURE FOR VIKSIT BHARAT 2047: IMPOWERING STARTUP, ENHANCING SKILL DEVELOPMENT AND FOSTERING AGRIPRENEURSHIP FOR YOUTH

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ABSTRACT

The realization of Viksit Bharat 2047 is intrinsically linked to the comprehensive transformation of Indian agriculture into a knowledge-intensive, innovation-driven, and globally competitive sector. This study conceptualizes agricultural transformation as a multi-dimensional process encompassing technological modernization, institutional restructuring, and human capital advancement, with a specific emphasis on startup empowerment, skill development, and youth-centric agripreneurship. The analytical framework integrates endogenous growth theory, innovation systems approach, and value-chain economics to examine the role of agritech startups as catalysts for technology diffusion and entrepreneurial dynamism. Advanced digital and biophysical technologies—including artificial intelligence, machine learning, geospatial analytics, Internet of Things (IoT), blockchain-enabled traceability, and climate-smart agricultural systems—are evaluated for their potential to enhance total factor productivity, reduce transaction costs, and mitigate climate-induced production risks. Concurrently, the study underscores the importance of competency-based skill development architectures in agribusiness management, agri-logistics, post-harvest engineering, and financial technology to facilitate the transition of rural youth from agrarian labor to entrepreneurial agents. Institutional mechanisms such as innovation clusters, agri-incubation centers, blended finance models, and public–private–academic partnerships are identified as critical enablers for entrepreneurial ecosystem development and market integration. The synthesis of technological innovation, skilled human capital, and enabling policy regimes is posited to generate positive externalities in terms of inclusive rural growth, employment elasticity, and sustainable intensification. The findings contribute to policy discourse by proposing a scalable and replicable agripreneurship-led development paradigm capable of strengthening food system resilience and accelerating India's progression toward a high-income, knowledge-based agrarian economy under the Viksit Bharat 2047 vision.

Keywords: Transforming, Viksit Bharat, Startup, Skill Development, Agripreneurship, Youth

https://doie.org/10.10346/AE.2026934028

SUSTAINABLE AGRICULTURE IN VIKSIT BHARAT 2047

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ABSTRACT

Sustainable agriculture forms the cornerstone of India's Viksit Bharat 2047 vision, transforming the sector from a food security focus to a resilient, tech-driven engine of inclusive growth. By integrating climate-smart practices, precision farming, and regenerative techniques, it addresses challenges like soil degradation, water scarcity, and smallholder vulnerabilities while boosting productivity to record levels, such as 353.96 million tonnes in 2024–25. Realizing Viksit Bharat requires policy reforms like agri-tech incentives, institutional convergence, and capacity building to scale adoption, positioning agriculture as a self-reliant pillar for a developed India by 2047.

Keywords*: *Sustainable agriculture, Vikisit bharat 2047, Soil degradation, Water scarcity, Biodiversity loss, Smallholder empowerment, Environmental health, Precision farming.

https://doie.org/10.10346/AE.2026934028

VALUE ADDITION AND FOOD PROCESSING ENTERPRISES AS A PATHWAY FOR RURAL EMPLOYMENT AND AGRIPRENEURSHIP

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ABSTRACT

Value addition and food processing enterprises have emerged as a vital pathway for promoting rural employment, enhancing farm income, and strengthening agripreneurship in India. As agriculture transitions from primary production to market-oriented agribusiness under the vision of *Viksit Bharat @2047*, the integration of value addition and processing activities offers significant opportunities for rural youth and aspiring entrepreneurs. These enterprises not only reduce post-harvest losses but also create demand-driven market linkages, improve product quality, and enhance profitability across the agricultural value chain. This paper examines the role of value addition and food processing enterprises in fostering rural employment and agripreneurship. It highlights how activities such as grading, sorting, packaging, branding, cold storage, primary processing, and product diversification can generate sustainable livelihood opportunities in rural areas. Special emphasis is placed on youth participation in food processing startups, including small-scale agro-processing units, ready-to-eat products, organic food brands, and digital marketing-based agri-food businesses. The study is based on secondary data collected from government reports, industry publications, research articles, and case studies of successful food processing enterprises in India. It identifies key opportunities such as market expansion, income diversification, women's participation, and rural industrialization, while also addressing challenges including inadequate infrastructure, limited access to finance, lack of technical skills, and regulatory barriers. The paper concludes that strengthening value addition and food processing enterprises through skill development, technology adoption, policy support, and market access can significantly contribute to rural employment generation and youth-led agripreneurship, thereby promoting inclusive and sustainable agricultural growth in India.

Keywords: Value Addition, Food Processing, Rural Employment, Agripreneurship, Agri-Startups, Supply Chain.

https://doie.org/10.10346/AE.2026934028

FARMER-PRODUCER ORGANISATIONS (FPOS) AS A CATALYST FOR YOUTH-LED AGRIBUSINESS AND RURAL ECONOMIC TRANSFORMATION IN INDIA

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ABSTRACT

Farmer Producer Organizations (FPOs) have emerged as a transformative institutional model for strengthening agribusiness, enhancing farmer income, and promoting youth leadership in rural India. In the context of *Viksit Bharat @2047*, FPOs play a crucial role in shifting agriculture from a subsistence-oriented activity to a market-driven and entrepreneurship-led sector. This study examines the role of FPOs as a catalyst for youth-led agribusiness development and rural economic transformation in India. The paper focuses on how FPOs facilitate collective action by aggregating small and marginal farmers, enabling economies of scale in input procurement, production, value addition, and marketing. Special emphasis is given to the involvement of rural youth in FPO management, governance, and startup-oriented agribusiness activities such as primary processing, branding, digital marketing, and supply chain integration. By acting as job creators rather than job seekers, youth-led FPOs contribute significantly to employment generation, skill development, and inclusive growth. The study is based on secondary data collected from government reports, policy documents, research publications, and case studies of successful FPOs across India. The analysis highlights the opportunities offered by FPOs in improving market access, reducing transaction costs, enhancing bargaining power, and promoting sustainable agribusiness practices. It also identifies key challenges such as limited managerial skills, access to finance, infrastructure constraints, and market linkages. The paper concludes that strengthening FPOs through capacity building, digital integration, policy support, and youth-focused entrepreneurship programs can significantly accelerate rural economic transformation. FPOs, when effectively led by skilled youth, have the potential to become powerful engines of agribusiness growth, contributing meaningfully to a resilient and self-reliant agricultural economy by 2047.

Keywords: Farmer-Producer Organisations, Youth Leadership, Agribusiness, Rural Development, Viksit Bharat @2047.

https://doie.org/10.10346/AE.2026934028

FACTORS INFLUENCING AGRI-ENTREPRENEURIAL INTENTION AMONG YOUTH

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ABSTRACT

In India, increasing youth unemployment and declining participation of young people in traditional farming had emerged as major challenges to the sustainability and growth of the agricultural sector, highlighting the need to promote agri-entrepreneurship as a viable career option. The present study examined the factors influencing agri-entrepreneurial intention among rural youth in India, with particular emphasis on socio-economic, educational, psychological, and institutional determinants. The study aimed to assess the influence of variables such as education level, entrepreneurship training, access to credit, family background, risk perception, exposure to successful agri-entrepreneurs, and government support on entrepreneurial intention. A descriptive and analytical research design was adopted, and the study was conducted in a selected district of India. Primary data were collected from a sample of rural youth, including agriculture graduates and non-graduates, using a structured questionnaire, while secondary data were gathered from government reports, policy documents, and relevant literature. The data were analysed using percentage analysis, mean score ranking, and correlation analysis. The findings revealed that higher educational attainment, participation in agri-entrepreneurship training programs, access to institutional finance, and awareness of government schemes significantly enhanced agri-entrepreneurial intention among youth. In contrast, constraints such as income uncertainty, lack of land ownership, inadequate market access, and high perceived risk negatively influenced entrepreneurial motivation. The study concluded that strengthening skill-oriented agricultural education, improving financial and mentoring support, and implementing youth-focused agri-entrepreneurship development policies were essential for fostering entrepreneurial intention and promoting sustainable agricultural development in India.

Keywords: Agri-entrepreneurial intention, Rural youth, Agri-entr epreneurship, Entrepreneurship development, Indian agriculture, Youth employment

https://doie.org/10.10346/AE.2026934028

STUDY ON SUPPLY CHAIN EFFICIENCY OF GARLIC IN RATLAM DISTRICT OF MADHYA PRADESH

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ABSTRACT

Garlic (Allium sativum) is a vital horticultural crop in India, contributing significantly to agricultural economies and food security. In Ratlam District, Madhya Pradesh—a key garlic-producing region—supply chain inefficiencies, including post-harvest losses, fragmented marketing channels, and inadequate infrastructure, undermine farmer incomes and market competitiveness. This study addresses these challenges by evaluating supply chain efficiency to identify bottlenecks and enhancement strategies. The primary aim was to assess the supply chain efficiency of garlic in Ratlam District, examining procurement, processing, transportation, and distribution stages, while identifying factors affecting overall performance and proposing optimisation measures. A mixed-methods approach was employed in Ratlam District, involving a stratified random sample of 200 stakeholders (farmers, traders, processors, and retailers). Primary data were collected via structured questionnaires, focus group discussions, and key informant interviews. Efficiency was analysed using Data Envelopment Analysis (DEA), Garrett Ranking Technique, and regression models, supplemented by secondary data from government reports. Results revealed an average supply chain efficiency score of 68%, with major inefficiencies in transportation (42% losses) and storage (post-harvest losses at 22%). Small-scale farmers faced higher barriers due to limited access to cold chains and market information, while intermediaries captured 35% of the value chain margins. Enhancing supply chain efficiency requires investments in cold storage, digital marketplaces, and farmer cooperatives. These findings offer actionable insights for policymakers, promoting sustainable garlic production and rural livelihoods in Madhya Pradesh.

Keywords: garlic supply chain, efficiency, Ratlam District, Data Envelopment Analysis, post-harvest losses, agricultural marketing

https://doie.org/10.10346/AE.2026934028

ROLE OF AGRIBUSINESS ENTREPRENEURSHIP IN RURAL EMPLOYMENT GENERATION

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ABSTRACT

Agribusiness entrepreneurship has emerged as a powerful tool for promoting rural development and generating employment in India. Agriculture alone is no longer sufficient to provide sustainable income to the growing rural population because of small landholdings, low productivity, and seasonal employment. Agribusiness entrepreneurship includes activities such as food processing, input supply, agri-logistics, marketing, storage, and agri-services, which create additional income opportunities beyond that of farming. By encouraging rural youth and farmers to adopt agribusiness ventures, dependency on traditional farming can be reduced. Government initiatives, access to credit, skill development programs, and agribusiness incubation centers play significant roles in promoting entrepreneurship. Agribusiness enterprises generate local employment, reduce rural–urban migration, and improve farmers' incomes. Therefore, promoting agribusiness entrepreneurship is essential for achieving inclusive growth, strengthening the rural economy, and ensuring sustainable agricultural development.

Keywords: Agribusiness Entrepreneurship, Rural Development, Employment Generation, Farmers' Income, Sustainable Agriculture

https://doie.org/10.10346/AE.2026934028

FEASIBILITY STUDY OF VALUE-ADDED PRODUCTS (BIOFUEL)FROM AGRICULTURAL WASTE

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ABSTRACT

The increasing demand for energy and environmental concerns associated with fossil fuels have led to a growing interest in biofuels as a sustainable alternative. Agricultural waste, a abundant and renewable resource, can be converted into biofuels, providing a valuable opportunity for waste management and energy production. This paper explores the potential of agricultural waste as a feedstock for biofuel production, highlighting recent advancements in conversion technologies and processes. Biofuels such as ethanol, biodiesel, and biogas can be produced from agricultural waste through biochemical and thermochemical processes. The production of biofuels from agricultural waste not only reduces greenhouse gas emissions but also generates income opportunities for farmers and contributes to energy security. This abstract discusses the benefits, challenges, and future prospects of biofuel production from agricultural waste, emphasizing its potential to contribute to a more sustainable energy mix.

Keywords: Agricultural waste, biofuel, sustainability, energy, bioconversion

https://doie.org/10.10346/AE.2026934028

MARKET PRICE VOLATILITY AND ITS IMPACT ON FARMERS' INCOME STABILITY

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ABSTRACT

Market price volatility is a persistent challenge in the agricultural sector, significantly affecting farmers' income stability and economic security. Fluctuations in agricultural commodity prices arise due to factors such as seasonal variations in production, changes in demand and supply, climatic uncertainties, inadequate storage facilities, and inefficiencies in agricultural marketing systems. For small and marginal farmers, high price volatility increases income uncertainty, reduces profitability, and discourages long-term investment in farming activities. Unpredictable price movements often compel farmers to sell their produce immediately after harvest, leading to distress sales and lower price realization. Market price volatility also impacts agribusiness firms by increasing procurement risks and supply chain instability. Institutional mechanisms such as Minimum Support Price (MSP), crop insurance, contract farming, and Farmer Producer Organizations (FPOs) play a crucial role in mitigating price risks and stabilizing farmers' income. The abstract emphasizes the need for improved market intelligence, price forecasting, efficient storage and logistics infrastructure, and policy interventions to reduce the adverse effects of price volatility. Strengthening market integration and promoting collective marketing can enhance income stability and ensure sustainable agricultural development.

Keywords: Market Price Volatility, Farmers' Income, Price Risk, Agricultural Markets, Income Stability, Agribusiness

https://doie.org/10.10346/AE.2026934028

ACCORDING TO MILANKOVITCH CYCLES EFFECT OF AGRICULTURE ON PLANT AND HUMAN LIFE ON EARTH. (LONG-TERM EFFECT)

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ABSTARCT

The Milankovitch cycles—eccentricity, obliquity, and precession—function as the primary astronomical pacers of Earth's climate, exerting a profound but often overlooked influence on the long-term viability of the biosphere, agricultural productivity, and human health. Research indicates that these orbital oscillations dictate the distribution of solar forcing, which directly modulates plant phenology and photosynthetic efficiency; notably, periods of high eccentricity are linked to "dilution effects" that alter the nutrient-to-biomass ratio in staple crops, threatening global food security. Beyond agriculture, these cycles have acted as evolutionary catalysts for human physiology, with long-term shifts in UV exposure and seasonal duration driving adaptations in vitamin D synthesis, circadian regulation, and endocrine health. Historically, the transitions between these cycles served as macro-stressors, where abrupt shifts in arable land and freshwater availability triggered nutritional deficiencies and altered the habitats of disease vectors. By integrating paleoclimatic ice core data with archaeological records, it becomes clear that the "drought-famine-starvation" nexus and the spread of pathogens are inextricably linked to these astronomical rhythms. Consequently, incorporating Milankovitch-driven forcing into modern climate adaptation strategies is essential for building agricultural resilience and mitigating systemic health crises, as the current anthropogenic acceleration of climate change threatens to decouple human stability from the predictable orbital pacing that has governed the Quaternary period.

Keywords: Milankovitch Cycles, Paleoclimatology, Agricultural Resilience, Plant Phenology, Human Evolutionary Health.

https://doie.org/10.10346/AE.2026934028

A STUDY ON BRAND PROMOTION OF ORGANIC FERTILISER IN SHAHJAHANPUR DISTRICT OF UTTAR PRADESH

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ABSTRACT

The present study, entitled "A Study on Brand Promotion of Organic Fertilizer in Shahjahanpur District of Uttar Pradesh" has been undertaken to examine the effectiveness of brand promotion strategies and their influence on farmers' awareness, and adoption of organic fertilizers. With growing concerns fertilizers, organic fertilizers have emerged as a viable alternative for sustainable agriculture regarding soil health degradation and excessive dependence on chemical development. However, despite their agronomic and economic benefits, the adoption of organic fertilizers remains limited due to inadequate awareness, weak brand visibility, and ineffective promotional efforts. The study focuses on Shahjahanpur district of Uttar Pradesh. Primary data will be collected from selected farmers and market functionaries through personal interviews using a structured schedule, while secondary data will be obtained from government records, journals, reports, and relevant publications. A multistage sampling technique will be adopted for selecting the district, block, villages, and respondents. Analytical tools such as Likert scale analysis, weighted average scores, chi-square test, and Garrett ranking technique will be employed to assess farmers' perceptions, identify influential promotional tools, and analyze problems faced in the purchase and adoption of organic fertilizers. The study aims to evaluate the market potential of organic fertilizers, understand the role of branding and promotional activities, and identify constraints affecting farmer acceptance. The findings of this research are expected to provide valuable insights for agribusiness firms, marketers, and policymakers. Ultimately, the study seeks to promote wider adoption of organic fertilizers, strengthen sustainable farming practices, and contribute to the long-term agricultural and economic development of the Shahjahanpur district.

Keywords: Organic Fertilizer, Compost, Manure, Soil Fertility, Sustainable Agriculture

https://doie.org/10.10346/AE.2026934028

FPOS, COOPERATIVES & YOUTH LEADERSHIP FOR COLLECTIVE AGRIBUSINESS

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ABSTRACT

Smallholder farmers in developing economies face chronic challenges, including fragmented landholdings, limited market access, and low bargaining power. Farmer-Producer Organisations (FPOs) and cooperatives have emerged as crucial collective institutions designed to address these constraints, yet their sustainability often hinges on effective governance and the integration of young leadership to modernise agribusiness practices. This study aims to investigate the role of FPOs and cooperatives in facilitating value chain integration, with a specific focus on the impact of youth leadership on organisational governance, technological adoption, and commercial success. Adopting a mixed-methods approach, the research utilises data from case studies of successful youth-led FPOs in India, comprising interviews with board members and surveys of member farmers. Data analysis focuses on governance structures, value-addition activities, and market linkage efficacy. Preliminary results indicate that FPOs with active youth leadership demonstrate higher rates of digital tool adoption, proactive market diversification, and better compliance with governance norms. Youth-led collectives are more proficient at linking smallholders to modern agricultural value chains, resulting in increased income and reduced transaction costs. The study highlights that fostering youth leadership is essential for strengthening the governance and entrepreneurial capacity of FPOs. It implies that policy initiatives should focus on providing tailored training, financial support, and mentorship to young leaders to ensure the long-term sustainability of collective agribusiness, transforming them from aid-dependent entities into professional producer enterprises.

Keywords: Farmer-Producer Organisations (FPOs), Cooperative Governance, Youth Leadership, Value Chain Integration, Agribusiness, Smallholder Farmers.

https://doie.org/10.10346/AE.2026934028

ROLE OF SOIL ORGANIC CARBON IN IMPROVING SOIL FERTILITY AND SUSTAINABILITY

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ABSTRACT

Soil Organic Carbon (SOC) serves as a fundamental component of the terrestrial ecosystem, acting as a primary indicator of soil health and a critical regulator of global carbon cycles. Despite its importance, intensive conventional farming practices and land degradation have led to a significant depletion of SOC stocks, threatening global food security and environmental stability. This research aims to investigate the role of SOC in enhancing soil physical, chemical, and biological fertility while specifically quantifying the correlation between SOC sequestration rates and crop yield stability. Utilizing a comparative longitudinal approach across diverse agro-ecological zones, the study analyzed soil samples from plots treated with no-till farming, cover cropping, and organic amendments using the dry combustion method and phospholipid fatty acid (PLFA) analysis. Key findings indicate that a 1% increase in SOC leads to a measurable improvement in water-holding capacity and a significant reduction in nutrient leaching, with high-carbon soils exhibiting 15–20% greater resilience during moisture stress. These results underscore that SOC is not merely a nutrient reservoir but a cornerstone of sustainable agriculture, demonstrating a strong synergistic relationship between carbon levels and microbial diversity. Ultimately, the study implies that policies must prioritize carbon-farming incentives and regenerative techniques to restore soil vitality, providing a framework for integrating soil carbon management into national climate adaptation and food security strategies.

Keywords: Soil Organic Carbon (SOC), Soil Fertility, Sustainable Agriculture, Carbon Sequestration, Soil Health, Regenerative Farming

https://doie.org/10.10346/AE.2026934028

YOUTH LEADERSHIP IN FPOS FOR COLLECTIVE AGRIBUSINESS: A STRATEGY FOR SUSTAINABLE RURAL TRANSFORMATION

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ABSTRACT

As India aims for the "Viksit Bharat 2047" vision, the agricultural sector faces a critical challenge in retaining youth interest and professionalizing rural enterprises. Farmer Producer Organizations (FPOs) and cooperatives are central to this transformation, yet many struggle with traditional governance models that lack technological agility. There is an urgent need to address the gap between aging farm management and the modern requirements of global supply chains. This study aims to evaluate how youth leadership in FPOs enhances collective agribusiness outcomes. It focuses on assessing the impact of young leaders on producer enterprise governance, digital market linkages, and value chain integration. The research utilizes a mixed-methods approach, combining qualitative case studies of youth-led FPOs with quantitative data analysis from rural startup ecosystems. The study area includes diverse agricultural clusters, utilizing digital survey tools and semi-structured interviews with FPO board members to measure operational efficiency and technology adoption. The study expects to find that FPOs with active youth leadership exhibit a significantly higher rate of digital integration, particularly in e-commerce and direct-to-consumer (D2C) branding. Youth-led governance is anticipated to correlate with improved transparency in financial management and greater success in establishing quality protocols required for export competitiveness. Integrating youth into the leadership of collective agribusinesses is vital for fostering a circular Agri-economy. Policy interventions should prioritize gender-focused incubation and specialized skill development to empower young agripreneurs. This shift is essential for transitioning Indian agriculture from a traditional livelihood to a globally competitive, innovation-driven sector.

Keywords: FPOs, Youth Leadership, Collective Agribusiness, Value Chain Integration, Agripreneurship, Governance.

https://doie.org/10.10346/AE.2026934028

STUDY ON IMPACT OF MICROFINANCE IN ENHANCING OF WOMEN'S PARTICIPATION FOR AGRI-PRODUCTS IN PURBA BARDHAMAN DISTRICT OF WEST BENGAL

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ABSTRACT

This abstract examined the impact of microfinance on enhancing women's participation in the production and marketing of agri-products within the Purba Burdwan district of West Bengal. Known as the "Rice Bowl of Bengal," the district offered significant opportunities for value-added agricultural activities; however, rural women traditionally faced barriers to credit access and market entry. Through a combination of primary field surveys and secondary data, this research evaluated how access to micro-credit, primarily channeled through self-help groups (SHGs), enabled women to transition from subsistence labor to active agri-entrepreneurship. The findings indicated a significant positive correlation between micro-credit availability and women's involvement in post-harvest processing, organic vegetable cultivation, and seed production. The study highlighted that beyond financial capital, microfinance facilitated capacity building and leadership skills, leading to greater decision-making power within households and local *haats* (markets). However, challenges such as digital illiteracy and limited branding support persisted. The research concluded that integrated policy interventions focusing on digital financial services and direct market linkages were essential to sustain these gains. By strengthening the microfinance framework, the district could foster a more inclusive agricultural economy that leveraged women untapped entrepreneurial potential.

Keywords: Microfinance, women empowerment, Purba burdwan, Agri-products, self-help groups (SHGs), rural entrepreneurship, credit access, West bengal.

https://doie.org/10.10346/AE.2026934028

VALUE ADDITION OF PADDY STRAW THROUGH SUSTAINABLE MUSHROOM CULTIVATION: A CIRCULAR BIO-ECONOMY APPROACH FOR RURAL LIVELIHOOD IN NORTH 24 PARGANAS DISTRICT OF WEST BENGAL

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ABSTRACT

This study explored the economic and environmental potential of value addition to paddy straw through the sustainable cultivation of mushrooms, particularly in rice-intensive regions. Traditionally treated as agricultural waste and often disposed of through open-field burning—a major contributor to air pollution—paddy straw served as an ideal, lignin-rich substrate for varieties such as Oyster (*Pleurotus* spp.) and Straw (*Volvariella volvacea*) mushrooms. By utilizing the bioconversion capabilities of fungi, this research demonstrated how a low-value byproduct could be transformed into a high-protein food source, creating a secondary income stream for farmers. The analysis highlighted that this circular economy model not only reduced the carbon footprint of rice farming but also generated nutrient-dense spent mushroom substrate (SMS), which could be recycled back into fields as organic fertilizer. The findings suggested that with minimal capital investment and technical training, mushroom farming offered a viable solution for waste management and rural entrepreneurship. The study concluded that scaling this practice through institutional support could significantly enhance farm-level profitability while promoting ecological resilience.

Keywords: Paddy Straw, Value Addition, Sustainable Mushroom Cultivation, Waste Management, Circular Economy, Oyster Mushroom, Rural Livelihoods, Bio-utilisation.

https://doie.org/10.10346/AE.2026934028

A STUDY ON VALUE CHAIN ANALYSIS OF GOBINDOBHOG RICE IN BURDWAN DISTRICT OF WEST BENGAL

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ABSTRACT

This study analyzed the value chain of Gobindobhog rice in Purba Bardhaman, West Bengal, a region globally recognized for this GI-tagged aromatic variety. By mapping the flow from smallholder farmers through intermediaries and millers to final consumers, the research identified critical gaps in value distribution and market efficiency. The findings indicated that while the Geographical Indication (GI) status had catalyzed international demand, primary producers often faced low profit margins due to high input costs, information asymmetry, and limited direct market access. The analysis highlighted that value addition was concentrated at the milling and export stages, leaving farmers vulnerable to price volatility. The study concluded that the integration of Farmer Producer Organizations (FPOs), adoption of standardized processing technologies, and localized branding strategies were essential to optimize the value chain. Strengthening these linkages was expected to ensure a more equitable distribution of wealth, transforming traditional cultivation into a competitive, export-oriented agribusiness model.

Keywords: Gobindobhog Rice, Value Chain Analysis, Purba Bardhaman, GI Tag, Aromatic Rice, Farmer Producer Organizations (FPOs), West Bengal, Export Potential.

https://doie.org/10.10346/AE.2026934028

RENEWABLE ENERGY SOLUTIONS & CIRCULAR ECONOMY IN AGRICULTURE

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ABSTRACT

Agriculture confronts escalating climate vulnerabilities, resource scarcity, and waste from linear models, necessitating renewable energy integration (e.g., solar irrigation, biogas) with circular economy practices for sustainability. This study addresses the entrepreneurial gap in scaling these solutions for smallholder farmers in rural India, where emissions and costs undermine resilience. The primary aim is to assess entrepreneurship's role in deploying renewable-circular hybrids, identifying viable models, impacts, and adoption barriers. A mixed-methods approach surveyed 250 farmers in Prayagraj, Uttar Pradesh (2024-2025), alongside 15 agribusiness case studies, using life-cycle assessments, cost-benefit analyses, and Stata econometrics. Key findings reveal 35% energy cost reductions via solar-biogas systems, 28% waste valorization (e.g., crop residues to biofertilizers), and 40% faster scaling with incentives—though financing gaps affect 60% of smallholders. These outcomes highlight entrepreneurship as a catalyst for low-emission agri-systems, with implications for policy subsidies, incubators, and SDG 7/12 advancement, potentially cutting sector emissions 20-30% through scalable models.

Keywords: Renewable Energy, Circular Economy, Entrepreneurship, Sustainable Farming, Smallholder Farmers

https://doie.org/10.10346/AE.2026934028

SUPPLY CHAIN MANAGEMENT PRACTICES FOR REDUCING POST-HARVEST LOSSES IN POTATO IN UTTAR PRADESH

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ABSTRACT

Post-harvest losses (PHL) in potato supply chains pose a significant challenge in India, where the crop accounts for over 50 million tonnes of annual production but suffers considerable losses due to inadequate storage, transportation, and handling practices. This inefficiency leads to substantial income loss for farmers in key regions such as Uttar Pradesh, the largest potato-producing state, and also affects food availability for consumers. The main objective of this study is to assess supply chain management practices that minimize PHL in potatoes, with special emphasis on cold chain use, improved packaging, and better coordination among stakeholders from the farm gate to the market. A mixed-methods approach was employed in selected potato-growing areas of Uttar Pradesh, covering 250 potato farmers, 50 cold storage operators, and 30 traders through stratified random sampling. Data were collected using a structured interview schedule, focus group discussions, and field observations, and were analyzed using descriptive statistics, logistic regression, and cost-benefit analysis. The results indicate that ventilated packaging, refrigerated transport, and farmer producer organizations substantially reduce PHL, while the adoption of cold storage helps in preserving the marketable quality of potatoes and stabilizing prices. The study suggests that targeted support for cold storage infrastructure and capacity building of farmer groups can play an important role in reducing losses and improving farmer incomes.

Keywords: potato supply chain, post-harvest losses, cold chain management, value chain optimization, digital traceability

https://doie.org/10.10346/AE.2026934028

REGIONAL DIFFERENCE IN CLIMATE CHANGE IMPACTS ON GLOBAL AGRICULTURE

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ABSTRACT

Climate change poses uneven threats to agricultural productivity worldwide, with arid and semi-arid regions facing the greatest declines due to rising temperatures (e.g., +1.8°C), reduced precipitation (e.g., -12%), and yield losses up to 22%, while floodplains and irrigated zones exhibit yield gains (+10%) supported by adaptive infrastructure. In tropical and low-latitude areas like Africa, South Asia, and the Middle East, precipitation shortages and heat stress exacerbate vulnerabilities, leading to output drops of 16% without CO2 fertilisation effects, contrasting with mid-to-high latitude benefits in North America and Europe from CO2 mitigation and milder warming. Central and Eastern Europe shows southeast gradients of increasing drought intensity, with the Pannonian lowlands most affected, though minimum tillage adaptations could boost yields by 6-10% on sandy soils. Köppen-based analyses confirm dry climates suffer most severely across maize, wheat, and rice, underscoring the need for region-specific policies like technology investments and agro-ecological zoning to enhance resilience. This mixed-methods study employs time-series data and multivariate modelling to advocate geographically tailored strategies for sustainable food security.

Keywords: Arid & semi-arid region, Köppen-based analyses, agro-ecological zoning, tropical and low-latitude areas, dry climates & Pannonian lowlands.

https://doie.org/10.10346/AE.2026934028

MPACT OF DIGITAL MARKET LINKAGES ON PRICE REALIZATION AND INCOME OF SMALLHOLDER FARMERS

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ABSTRACT

Agricultural marketing systems in developing economies are often characterized by inefficiencies, information asymmetry, and the dominance of intermediaries, which limit price realization and income growth for smallholder farmers. The rapid expansion of digital market linkages and e-commerce platforms has emerged as a transformative approach to address these challenges by improving market access, transparency, and competitiveness. This study examines the impact of digital market linkages on price realization and income levels of smallholder farmers within the broader framework of agricultural marketing and e-commerce. The primary objective of the research is to analyze how participation in digital marketing platforms influences farm-gate prices and overall farm income. Additionally, the study seeks to assess the extent of adoption of digital market linkages and identify key constraints faced by smallholder farmers in utilizing these platforms effectively. A descriptive and analytical research design was employed for the study. Primary data were collected from a selected sample of smallholder farmers using structured questionnaires in the chosen study area, while secondary data were sourced from government reports, digital platform records, and relevant literature. Analytical tools such as percentage analysis, mean comparison, and ranking techniques were used to evaluate the impact of digital market participation. The findings reveal that farmers using digital market linkages experienced improved price realization, reduced dependence on intermediaries, and enhanced income stability compared to non-users. However, limited digital literacy, inadequate infrastructure, and trust-related issues remain significant barriers. The study concludes that strengthening digital infrastructure, promoting farmer training, and supportive policy measures are essential to maximise the benefits of digital agricultural marketing systems.

Keywords: Digital market linkages, Price realization, Smallholder farmers, Agricultural marketing, E-commerce, Farmers' income

https://doie.org/10.10346/AE.2026934028

REGENERATIVE ECONOMICS: THE ROLE OF CARBON CREDITS IN INCENTIVIZING ORGANIC FARMING

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ABSTRACT

As global agriculture faces the dual challenges of climate change and soil degradation, regenerative organic farming has emerged as a critical solution for restoring ecosystem health. However, the high cost of transition and lower initial yields often deter small-scale farmers from adopting these sustainable practices. This study addresses the economic gap by exploring how carbon credit markets can provide the necessary financial incentives to make organic transition viable. The primary objective of this research is to evaluate the efficacy of carbon credit frameworks in incentivizing farmers to switch from conventional to organic regenerative systems. It specifically aims to identify the barriers to market entry for youth-led agri-enterprises. A mixed-methods approach was employed, involving a comparative analysis of three carbon-sequestration projects across diverse ecological zones. Data were collected through structured surveys from a sample of 150 certified organic farmers and qualitative interviews with key stakeholders in the "waste-to-wealth" startup ecosystem. Preliminary results indicate that while carbon credits can increase annual farm income by 15–22%, significant hurdles remain regarding high verification costs and the lack of digital monitoring tools. Furthermore, the study finds that collective bargaining through Farmer Producer Organizations (FPOs) significantly reduces transaction costs for individual farmers. The study concludes that carbon credits are a potent tool for regenerative economics, provided that policy frameworks simplify the certification process for smallholders. These findings suggest that integrating AI-driven soil-carbon monitoring can catalyse the scaling of organic farming, offering a roadmap for sustainable, inclusive rural entrepreneurship.

Keywords: Regenerative Agriculture, Carbon Credits, Organic Farming, Agri-Fintech, Sustainable Entrepreneurship, Climate Finance

https://doie.org/10.10346/AE.2026934028

VALUE ADDITION THROUGH BIOFUEL FROM SUGARCANE BY-PRODUCTS

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ABSTRACT

Lakhimpur Kheri district in Uttar Pradesh ranks among India's top sugarcane producers, yielding over 10 million tonnes annually, yet byproducts like molasses and bagasse suffer underutilization, leading to economic losses exceeding ₹500 crore yearly for farmers and mills while missing national renewable energy targets under the 20% ethanol blending program by 2025. This study pursued a comprehensive economic analysis of value addition strategies through biofuel production—specifically ethanol distillation from molasses and bio-CNG/electricity generation from bagasse—to address critical challenges including volatile sugar prices, high conversion costs (₹45-50/litre for ethanol), inadequate infrastructure, limited market linkages, and low farmer share (merely 15-20% of byproduct value). Adopting a descriptive-cum-ex post facto research design, primary data was collected via pre-tested schedules from 120 purposively selected small and marginal sugarcane farmers (60 each from irrigated and rainfed areas) and 10 sugar mills/processors during the 2024-25 crushing season, augmented by secondary sources from Uttar Pradesh Sugarcane Department, NITI Aayog reports, and RBI agricultural statistics; analytical tools encompassed cost-benefit ratios (BCR), net present value (NPV), internal rate of return (IRR), payback period, sensitivity analysis, and break-even computations using SPSS 25.0 and Excel modeling. Major findings revealed ethanol units achieving BCR of 1.45, IRR 28%, NPV ₹1.85 crore/ha, and 35% superior net returns over conventional animal feed/power uses; bagasse cogeneration excelled with BCR 1.62, IRR 32%, and 40% waste reduction, significantly enhanced by government subsidies (₹6.5/litre) and priority procurement. Value addition increased farmer incomes by 32%, generated 150 rural jobs per MW capacity, and improved energy security. The research concludes that biofuel integration via biorefineries offers transformative potential for sustainable agribusiness; policy recommendations advocate subsidised loans, FPO-led processing hubs, technology incubation, and carbon credit linkages to replicate across UP's 12 lakh ha sugarcane belt, advancing circular economy principles and Atma Nirbhar Bharat goals in agriculture.

Keywords: Biofuel, Sugarcane, Molasses, Bagasse, Value Addition

https://doie.org/10.10346/AE.2026934028

MARKETING ANALYSIS OF PEACH AND PLUM IN MANDI DISTRICT OF HIMACHAL PRADESH

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ABSTRACT

Peach and plum are among the most important temperate fruit crops cultivated in the hilly regions of Himachal Pradesh, contributing significantly to farm income and rural livelihoods. The Mandi district, characterized by favorable agro-climatic conditions, has emerged as a notable area for the production of these fruits. Despite increasing production, farmers often face marketing challenges such as price fluctuations, inadequate market infrastructure, high transportation costs, and the dominance of intermediaries, which adversely affect their returns. In this context, the present study aims to analyse the marketing system, costs, margins, and efficiency of peach and plum marketing in the Mandi district of Himachal Pradesh. The specific objectives include examining the existing marketing channels, estimating marketing costs and margins, and identifying major constraints faced by fruit growers. The study is based on both primary and secondary data. Primary data were collected from selected peach and plum growers, commission agents, and traders using a structured questionnaire through a multistage sampling technique. Secondary data were obtained from government reports, published literature, and records of market committees. Analytical tools such as tabular analysis, percentage analysis, price spread, and marketing efficiency measures were employed for analysis. The findings reveal that multiple intermediaries increase the price spread, thereby reducing the producer's share in the consumer's rupee. High transportation costs and lack of organized marketing facilities were identified as major constraints. The study concludes that improving market infrastructure, promoting direct marketing, and strengthening farmer cooperatives can enhance marketing efficiency and farmers' income. The results provide useful insights for policymakers and planners to formulate strategies for improving fruit marketing systems in hilly regions.

Keywords: Peach, Plum, Marketing Analysis, Price Spread, Marketing Efficiency, Himachal Pradesh

https://doie.org/10.10346/AE.2026934028

MARKETING OF ORGANIC AGRICULTURAL PRODUCTS IN INDIA

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ABSTRACT

The marketing of organic agricultural products in India presents significant opportunities as well as challenges, driven by increasing consumer awareness regarding health, environmental sustainability, and food safety. With the rising demand for chemical-free and naturally grown food products, organic agriculture has emerged as a promising segment within the Indian agribusiness sector. This study highlights the key marketing aspects of organic agricultural products, focusing on consumer preferences, pricing, certification, and distribution channels. One of the major challenges faced by organic product marketing is the high cost of production and certification, which often results in premium pricing and limits affordability for a larger population. Limited awareness among rural consumers and inadequate supply chain infrastructure further constrain market expansion. However, opportunities exist in urban and semi-urban markets where health-conscious consumers are willing to pay a premium for quality and authenticity. Strengthening branding strategies, ensuring transparent certification systems, and improving distribution through organized retail, farmers' markets, and e-commerce platforms can enhance market reach. The adoption of digital marketing tools and direct marketing approaches such as farmer–consumer linkages can play a crucial role in promoting organic products. Overall, effective marketing strategies and supportive government policies are essential for the sustainable growth of organic agriculture in India.

Keywords: Organic Agricultural Products, Marketing, Consumer Awareness, Certification, Distribution Channel, India.

https://doie.org/10.10346/AE.2026934028

ZERO-WASTE POST-HARVEST APPROACH FOR FRUIT PEEL UTILISATION IN INNOVATIVE FOOD PRODUCT DEVELOPMENT

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ABSTRACT

Fruit peel waste is generated during post-harvest handling and processing, and it is often wasted despite its high nutritional and functional value. Fruit peels include a high concentration of dietary fiber, phenolic compounds, flavonoids, antioxidants, and other bioactive components that may have health advantages. The disposal of such nutrient-dense byproducts not only pollutes the environment, but also results in a huge loss of precious resources. In recent years, zero-waste post-harvest initiatives have received attention as long-term solutions to reduce food waste and improve resource efficiency in the food system. A zero-waste post-harvest approach stresses the efficient use and value of fruit peels through appropriate processing procedures such as drying, fermentation, and enzyme-assisted treatments. These strategies improve the bioavailability of nutrients, boost functional qualities, and facilitate their inclusion into novel food items. Fruit peel powders and extracts have been successfully investigated for use in baked goods, snacks, drinks, and functional meals, adding health-promoting qualities and improving nutritional quality. Moreover, using fruit peels in food compositions lessens reliance on artificial ingredients while promoting the creation of value-added goods. All things considered, using fruit peels in zero-waste post-harvest methods presents a viable route toward sustainable food production. This strategy supports consumer health and environmental sustainability by addressing the rising issue of food waste management and encouraging the creation of novel, nutrient-rich food items.

Keywords: Fruit peel waste; post-harvest handling; Zero-waste approach; Sustainable food production; Value-added food products; Functional food ingredients.

https://doie.org/10.10346/AE.2026934028

VALUE ADDITION, FOOD PROCESSING AND SUPPLY CHAIN ENTREPRENEURSHIP

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ABSTRACT

Value addition, food processing, and supply chain entrepreneurship have gained increasing importance in the agricultural sector due to rising demand for processed food, income instability in primary agriculture, and significant post-harvest losses. Traditional agricultural systems often suffer from inadequate processing facilities, inefficient supply chains, and limited market access, which reduce farmers' income and employment opportunities. In this context, entrepreneurship in value addition and food processing has emerged as a critical pathway for strengthening agribusiness and promoting rural economic development. The primary objective of this study was to examine the role of value addition, food processing, and supply chain entrepreneurship in enhancing agricultural profitability, reducing post-harvest losses, and generating employment opportunities. The study also aimed to analyze the contribution of entrepreneurial ventures in improving market efficiency and integrating farmers with modern value chains. The study adopted a descriptive and analytical research approach based on secondary data collected from government reports, research journals, policy documents, and published case studies related to food processing units and agribusiness enterprises. In addition, selected examples of small and medium food processing enterprises were reviewed to understand operational and supply chain practices. The findings revealed that value addition and food processing entrepreneurship significantly increased farmers' income through better price realization and diversification of agricultural products. Efficient supply chain management, including cold storage, transportation, and packaging, was found to reduce post-harvest losses and improve product quality. The study also highlighted the role of food processing enterprises in generating rural employment and encouraging youth participation in agribusiness. However, challenges such as inadequate infrastructure, limited access to finance, and skill gaps were identified as major constraints. The study concluded that promoting entrepreneurship in value addition, food processing, and supply chain development is essential for sustainable agricultural growth. Strengthened policy support, infrastructure development, and capacity-building initiatives can enhance the effectiveness of agribusiness entrepreneurship.

Keywords: Value Addition, Food Processing, Supply Chain Management, Agribusiness Entrepreneurship, Rural Employment, Post-Harvest Losses

https://doie.org/10.10346/AE.2026934028

AGRIPRENEURSHIP: TRANSFORMING TRADITIONAL FARMING INTO SUSTAINABLE AGRIBUSINESS

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ABSTRACT

Agripreneurship has emerged as a crucial strategy for transforming traditional subsistence farming into a sustainable and market-oriented agribusiness system. In the context of increasing population pressure, climate variability, limited farm incomes, and unemployment in rural areas, traditional farming practices often fail to ensure economic viability and long-term sustainability. This study highlights the growing importance of agripreneurship in enhancing productivity, value addition, innovation, and rural livelihoods while promoting sustainable agricultural development. The main objective of this research is to examine the role of agripreneurship in converting conventional farming into a profitable and sustainable agribusiness model. Specifically, the study aims to analyse the entrepreneurial characteristics of farmers, identify opportunities and constraints in agripreneurial activities, and assess the impact of agripreneurship on income generation and employment creation. The study adopts a descriptive and analytical research design. Primary data were collected through structured questionnaires and personal interviews with selected farmers and agripreneurs in the study area, while secondary data were obtained from reports, journals, and government publications. Basic statistical tools such as percentages, averages, and comparative analysis were used to interpret the data. The findings reveal that agripreneurship significantly improves farm income, encourages diversification, promotes efficient resource utilization, and enhances market linkages. However, challenges such as lack of finance, inadequate training, and limited access to technology remain major constraints. The study concludes that promoting agripreneurship through policy support, skill development programs, credit facilities, and technological interventions can play a vital role in achieving sustainable agriculture, rural development, and inclusive economic growth.

Keywords: ***Agripreneurship, Sustainable agriculture, Agribusiness, Rural development, Value addition, Farm entrepreneurship***

https://doie.org/10.10346/AE.2026934028

ORGANIC FERTILIZER

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ABSTRACT

The present study "Consumer Buying Behaviour towards Organic Fertilizer in Jaunpur" was undertaken in Jaunpur district of Uttar Pradesh to understand the purchase patterns and preferences of farmers for organic fertilizers amid rising concerns over chemical overuse and soil degradation. A descriptive research design was applied using a structured questionnaire on a sample of 300 farmers from three major blocks (Jaunpur, Machhlishahr, and Kerakat), selected through multi-stage random sampling; data were collected from personal interviews and analyzed with descriptive statistics, chi-square tests, and Garrett ranking technique. The study focused on factors like price, availability, perceived efficacy, and awareness influenced by extension services.Results indicated that 58% of farmers purchased organic fertilizers primarily from local dealers (65%), prioritizing soil health benefits and government subsidies, with vermicompost being the most preferred (rank 1, Garrett score 72.5). However, high cost (rank 1 constraint) and delayed effects deterred adoption among 42% of smallholders; younger, educated farmers showed higher preference (χ^2=12.4, $p<0.05$). Top three problems included inadequate supply (rank 1), lack of knowledge (rank 2), and low profitability (rank 3).These findings highlighted the need for improved supply chains and training to boost organic fertilizer uptake, contributing to sustainable farming in Uttar Pradesh by addressing managerial, financial, and marketing barriers for farmers.

Keywords: organic fertilizer, buying behaviour, Jaunpur farmers, adoption constraints, sustainable agriculture

https://doie.org/10.10346/AE.2026934028

EMPOWERING WOMEN AGRIPRENEURS IN INDIA: INCLUSIVE SKILL ECOSYSTEMS FOR SUSTAINABLE STARTUPS UNDER VIKSIT BHARAT@2047

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ABSTRACT

Women agripreneurs played a pivotal role in transforming India's agricultural sector; however, they faced persistent systemic barriers such as limited access to finance, skill training, and markets, which constrained their contribution to the Viksit Bharat@2047 vision. Although agriculture employed over 80 percent of rural women, entrepreneurial outcomes remained low, highlighting the need for inclusive skill ecosystems to promote sustainable startups and inclusive growth. This study assessed the effectiveness of gender-focused incubation programs and skill development initiatives in empowering women agripreneurs, identified gaps in existing ecosystems, and proposed scalable models aligned with national agripreneurship goals for 2047. A mixed-methods approach was adopted in the Varanasi region of Uttar Pradesh, where 150 women agripreneurs associated with Farmer Producer Organizations (FPOs) and startups were surveyed using purposive sampling, along with 20 key informant interviews conducted with scheme implementers. Quantitative data were analysed using SPSS through regression modelling, while qualitative data were thematically coded using NVivo in alignment with KRISHI MANTRANA 2026 themes of inclusive skill development. The findings indicated that targeted training improved startup survival rates by 35 percent, although only 22 percent of respondents accessed formal credit due to collateral constraints. Digital platforms and FPO linkages doubled market access, and organic agribusiness ventures recorded 28 percent higher profitability. Strengthening hybrid incubation hubs integrating finance, digital skills, and policy support significantly enhanced women-led startups and rural employment. The study recommended prioritizing gender-responsive budgeting in schemes such as MKSP to realize the goals of Viksit Bharat@2047.

Keywords: Women agripreneurs, skill ecosystems, sustainable startups, Viksit Bharat@2047, inclusive incubation, rural entrepreneurship

https://doie.org/10.10346/AE.2026934028

YOUTH-LED FPO GOVERNANCE FOR VALUE CHAIN SUCCESS

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ABSTRACT

In India, Farmer Producer Organizations (FPOs) play a pivotal role in enhancing agricultural value chains, yet governance challenges often hinder their sustainability and impact. Youth-led governance emerges as a promising solution, leveraging the demographic dividend of rural youth to drive innovation, market linkages, and profitability. This study addresses the gap in understanding how youth involvement in FPO governance, integrated with real government schemes, optimizes value chain success. The primary aim is to evaluate the effectiveness of youth-led FPO governance models in achieving value chain success. Specific objectives include assessing governance structures, scheme integration, and their impact on productivity, income, and market access. A mixed-methods approach was employed in Uttar Pradesh, India, focusing on 12 youth-led FPOs under the Formation and Promotion of 10,000 FPOs Scheme and PM Kisan Samman Nidhi. A sample of 240 farmer members and 36 youth leaders was surveyed using structured questionnaires, supplemented by focus group discussions and value chain analysis tools like SWOT and Porter's Five Forces. Youth-led FPOs demonstrated 35% higher value chain efficiency, with 28% increased farmer incomes and stronger market linkages via e-NAM integration. Effective scheme convergence amplified technology adoption, reducing post-harvest losses by 22%. Youth-led governance proves optimal for FPO success, offering scalable models for policy. Recommendations include incentivizing youth training under ATMA schemes to foster resilient agri-value chains, informing national FPO policies for inclusive growth.

Keywords: Youth-led governance, Farmer Producer Organizations, value chain success, FPO schemes, agricultural innovation, rural youth empowerment

https://doie.org/10.10346/AE.2026934028

STUDY ON VALUE CHAIN AND MARKETING OF MAKHANA IN DARBHANGA DISTRICT

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ABSTRACT

The present study was conducted to analyse the value chain and marketing system of makhana in Darbhanga district of Bihar, with special emphasis on the socio-economic profile of makhana farmers and processors, marketing efficiency, and constraints affecting the sector. Makhana is an important aquatic crop of the region, contributing significantly to rural livelihoods; however, inefficiencies in production, processing, and marketing limit farmers' income. The study aimed to assess the socio-economic characteristics of makhana producers and processors, evaluate the marketing efficiency of different marketing channels through price spread, marketing margins, and farmers' share in the consumer's rupee, identify major constraints across the value chain, and suggest strategies for improving value chain performance and enhancing farmers' income. The study was based on both primary and secondary data. Primary data were collected from selected farmers, traders, and processors through personal interviews using a pre-tested schedule, while secondary data were obtained from published reports and official records. Analytical tools such as tabular analysis, price spread analysis, and marketing efficiency measures were employed. The results revealed that most makhana farmers belonged to small and marginal categories with limited access to institutional credit and modern processing facilities. Marketing efficiency varied across channels, with longer channels showing higher price spread and lower farmers' share in the consumer's rupee. Major constraints identified included high labour cost, lack of improved processing technology, inadequate storage facilities, price fluctuation, and dominance of intermediaries. The study concluded that strengthening producer organizations, promoting value addition, improving market infrastructure, and ensuring better price realization through efficient marketing channels could significantly enhance farmers' income and overall value chain efficiency.

Keywords: Makhana, Value Chain, Marketing Efficiency, Price Spread, Darbhanga District

https://doie.org/10.10346/AE.2026934028

POST-HARVEST LOSS REDUCTION OF OKRA THROUGH IMPROVED MARKETING CHANNEL INTEGRATION AND STORAGE INNOVATIONS

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ABSTRACT

Post-harvest losses (PHL) in okra (Abelmoschus esculentus) pose a significant challenge in regions like India, where 30-40% of production is wasted due to fragmented marketing channels and suboptimal storage, undermining farmer incomes and food security; this study investigates integrated solutions to mitigate these issues. The main objectives were to assess the impact of enhanced marketing channel integration—such as farmer-producer organizations and direct retailer linkages—paired with storage innovations like modified atmosphere packaging and zero-energy cool chambers on PHL reduction. Employing a quasi-experimental approach in Varanasi district, Uttar Pradesh, involving 200 farmers in intervention and control groups, data were gathered through pre- and post-harvest surveys, quality assessments, and econometric analysis using SPSS and cost-benefit modeling. Key findings revealed a 25-35% PHL reduction, with innovations maintaining 92% pod quality for 7 days compared to 65% traditionally, alongside 18% higher farmer prices and 22% increased net returns (benefit-cost ratio of 1.8:1). These results highlight the transformative potential of combined strategies, offering practical, scalable recommendations for policymakers to strengthen horticultural value chains, enhance rural livelihoods, and promote sustainable agriculture.

Keywords: Marketing channels, Storage innovations, Farmer income, Food security

https://doie.org/10.10346/AE.2026934028

STUDY ON SUPPLY CHAIN AND MARKETING OF WHEAT IN PRAYGARAJ U.P.

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ABSTRACT

Wheat, as a staple crop in India, underpins food security and rural economies, yet its supply chain in regions like Prayagraj, Uttar Pradesh, faces inefficiencies such as post-harvest losses, fragmented marketing channels, and limited entrepreneurial interventions. This study addresses these challenges by examining the wheat supply chain and marketing dynamics, emphasizing entrepreneurial opportunities to enhance resilience and profitability in an agribusiness context. The primary aim is to analyse the wheat supply chain structure, evaluate marketing strategies, and explore entrepreneurial models for value addition, while identifying bottlenecks and proposing sustainable interventions. A mixed-methods approach was employed in Prayagraj district, involving a stratified random sample of 150 stakeholders (farmers, traders, processors, and entrepreneurs). Primary data were collected via structured questionnaires, personal interviews, and focus group discussions, supplemented by secondary sources like government reports. Descriptive statistics, Garrett ranking, and SWOT analysis were applied using SPSS and Excel. Results reveal a multi-layered supply chain dominated by intermediaries, with 28% post-harvest losses and low farmer margins (averaging 15-20%). Digital platforms and farmer producer organizations (FPOs) emerged as key entrepreneurial enablers, boosting market access by 35%. The findings underscore the potential of entrepreneurship-driven models, such as FPOs and e-marketing, to streamline supply chains and increase incomes. Policymakers should prioritize incentives for Agri-startups, fostering inclusive growth in Uttar Pradesh's wheat economy.

Keywords: Wheat supply chain, marketing strategies, Prayagraj, agribusiness entrepreneurship, post-harvest losses, farmer producer organizations

https://doie.org/10.10346/AE.2026934028

IMPACT OF DIGITAL TECHNOLOGY IN ENHANCING GREEN CHILLI AGRI-BUSINESS IN VARANASI DISTRICT OF UTTAR PRADESH

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ABSTRACT

Green chilli cultivation plays a significant role in vegetable-based agribusiness and rural entrepreneurship in the Varanasi district of Uttar Pradesh. Although the region has suitable climatic conditions and a strong market demand, green chilli growers often struggle with issues such as unstable prices, limited market connectivity, lack of timely technical information, and inefficient farm management practices. In this context, digital technologies have emerged as practical tools to support farmers and strengthen agribusiness entrepreneurship. The main objective of this study is to examine how digital technology contributes to the growth and efficiency of green chilli agribusiness and entrepreneurial activities in the study area. The research adopts a descriptive and analytical approach and was conducted in selected blocks of Varanasi district. Primary data were collected from green chilli farmers and agripreneurs using structured questionnaires and personal interviews, while secondary data were obtained from relevant reports and literature. Simple statistical tools such as percentages, averages, and correlation analysis were used for data interpretation. The study findings indicate that the use of digital tools—such as mobile-based advisory services, online input purchasing, digital payment systems, and e-marketing platforms—has positively influenced production planning, market access, and income levels. Farmers using digital technologies were better equipped to make informed decisions, reduce transaction costs, and manage market risks. The study concludes that digital technology has considerable potential to enhance green chilli agribusiness entrepreneurship. Strengthening digital infrastructure, improving digital literacy, and expanding extension support can further accelerate sustainable agribusiness development in the region.

Keywords: Digital technology, green chilli cultivation, Agribusiness entrepreneurship, Digital marketing, Farmer income, Varanasi district

https://doie.org/10.10346/AE.2026934028

PERFORMANCE ANALYSIS OF AGRIBUSINESS ENTERPRISES AND THEIR ROLE IN RURAL ECONOMIC DEVELOPMENT

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ABSTRACT

Agribusiness enterprises play a significant role in promoting agricultural commercialization, employment generation and rural economic development. In recent years, the growth of agribusiness enterprises has gained importance as an effective means of enhancing farmers' income and strengthening rural livelihoods. The present study aims to analyze the performance of selected agribusiness enterprises with respect to their production efficiency, cost structure, profitability and managerial practices. The study examines various factors influencing the performance and sustainability of agribusiness enterprises, including access to capital, adoption of improved technologies, input procurement systems, marketing strategies and institutional support. Emphasis is laid on evaluating the financial performance of agribusiness enterprises using indicators such as cost and returns, net income, benefit–cost ratio and break-even analysis. The role of entrepreneurship development, skill enhancement and value addition in improving enterprise performance is also analyzed. Further, the contribution of agribusiness enterprises to employment generation, income diversification and rural economic development is highlighted. The study concludes that efficient management practices, access to finance, market linkages and supportive policy measures are essential for improving the performance and long-term sustainability of agribusiness enterprises.

Keywords: Agribusiness Enterprises, Performance Analysis, Rural Development, Entrepreneurship, Farm Income

https://doie.org/10.10346/AE.2026934028

A STUDY ON POMEGRANATE MARKETPLACE DYNAMICS IN JEEVANA, RAJASTHAN WITH REFERENCE TO VEGROW COMPANY

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ABSTRACT

The present study was conducted to analyse the marketplace dynamics of pomegranate cultivation in the Jeevana region of Rajasthan with reference to VeGrow Company, a technology-enabled agribusiness platform. The primary objective of the study was to examine the effectiveness of digital procurement systems in enhancing value chain integration, farmer linkage, pricing efficiency, and overall market performance. The study addressed critical issues related to market inefficiencies, price volatility, and limited access to organized procurement channels faced by pomegranate growers. An analytical and descriptive research design was adopted, utilizing primary data collected during the MBA Agribusiness internship through direct farmer interactions, field observations, procurement and grading assessments, and structured discussions with VeGrow's field and operations teams. Secondary data were sourced from company records, market reports, and relevant agribusiness literature. The results indicated that VeGrow's digital marketplace significantly streamlined procurement operations, reduced intermediary involvement, and improved transparency in price discovery. Standardized grading, demand-led aggregation, and coordinated logistics enhanced supply chain efficiency and farmer price realization. However, challenges such as quality inconsistency, logistical constraints, and limited awareness of premium market standards among farmers were observed. The study concluded that VeGrow's marketplace-driven model played a vital role in strengthening the pomegranate value chain in the Jeevana region. The findings highlighted the importance of technology-enabled agribusiness platforms in improving market access, farmer income, and supply chain sustainability.

Keywords: Pomegranate, VeGrow, Digital Marketplace, Value Chain Integration, Pricing Efficiency

https://doie.org/10.10346/AE.2026934028

A STUDY ON MARKETING OF POTATO VARIETY SURYA T7 IN ALIGARH

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ABSTRACT

The present study entitled "A Study on Marketing of Potato Variety Surya T7 in Aligarh District of Uttar Pradesh" was undertaken to examine the marketing channels, marketing cost, margins, price spread, and problems faced by potato growers in the study area. The study also aimed to analyse the production practices and farmers' preferences regarding the potato variety Surya T7. A multistage stratified random sampling technique was adopted for the selection of blocks, villages, and respondents. Primary data were collected through personal interviews using a pre-tested structured questionnaire. The data pertained to the agricultural year 2025–26. Secondary data were collected from sources such as the District Agriculture Office, mandi records, government publications, and related reports. The results of the study revealed that potato growers faced various production, financial, and marketing problems. Major production problems included high cost of quality seed, pest and disease incidence, and lack of technical knowledge. The important financial problems were inadequate and untimely availability of credit and high interest rates. Marketing problems mainly consisted of price fluctuation, lack of storage facilities, high transportation cost, and involvement of middlemen. The study suggests that farmers should be provided with quality seed at reasonable prices, timely institutional credit at lower interest rates, training on improved production practices, and better storage and marketing infrastructure. Strengthening regulated markets and promoting farmer producer organizations (FPOs) would help farmers to obtain better prices for their produce.

Keywords: Potato, Surya T7, Marketing, Price Spread, Storage, Aligarh District

https://doie.org/10.10346/AE.2026934028

FROM FARMING TO AGRI BUSINESS: TRANSFORMING INDIAN AGRICULTURE THROUGH YOUTH ENTERPRENEURSHIP AND INNOVATION

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ABSTRACT

This study investigated the structural transition from traditional farming to agribusiness in India, focusing on the role of youth entrepreneurship and technological innovation in reshaping agricultural production, marketing, and value chains. The research sought to analyze how entrepreneurial initiatives and digital innovations influenced agricultural productivity, income diversification, and sustainability, while also examining the institutional and socio-economic constraints limiting youth participation in agribusiness. A mixed-method research design was employed, drawing on secondary data from government publications, peer-reviewed studies, policy reports, and documented case studies of agri-entrepreneurship ventures. A conceptual framework integrating innovation systems, value chain development, and digital agriculture was utilized to assess the transformation of subsistence-based farming into market-oriented agribusiness. The findings demonstrated that youth-driven agribusiness models significantly improved resource efficiency, reduced post-harvest losses, and enhanced rural employment through the adoption of precision agriculture, digital platforms, and organized supply chains. However, persistent challenges such as limited access to institutional finance, inadequate entrepreneurial training, fragmented markets, and infrastructural gaps constrained the scalability of these initiatives despite supportive policy interventions. The study concluded that youth entrepreneurship and innovation were pivotal to agricultural modernization in India, and that strengthening skill development, financial inclusion, digital infrastructure, and market integration was essential for achieving sustainable agribusiness development, rural prosperity, and long-term food security.

Keywords: Agribusiness, Youth Entrepreneurship, Agricultural Innovation, Digital Agriculture, Rural Transformation

https://doie.org/10.10346/AE.2026934028

ECONOMIC ANALYSIS OF MANGO MARKETING IN CHAPRA DISTRICT OF BIHAR

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ABSTRACT

The present study entitled "Economic Analysis of Mango Marketing in Chapra District of Bihar" was undertaken to investigate the marketing efficiency, price spread, and constraints faced by mango growers in the region. A multistage stratified purposive cum random sampling technique was employed for the selection of blocks, villages, and 120 respondents. Primary data were collected through personal interviews using a pre-tested schedule for the agricultural year 2024-25. The study examined various marketing channels, including direct sales to consumers and sales through wholesalers and pre-harvest contractors. The investigation revealed that the majority of farmers faced significant management and technical challenges, most notably a lack of scientific knowledge regarding post-harvest handling and a shortage of quality pesticides. Financial constraints, such as high interest rates from informal credit sources and a lack of timely institutional credit, were also prevalent. Marketing problems were identified as the most critical bottleneck, with growers citing the highly perishable nature of mangoes, the absence of cold storage facilities, and fluctuating market prices as major hurdles. Based on these findings, it is suggested that the establishment of local processing units, improved storage infrastructure in mandis, and the provision of low-interest institutional loans are essential to enhance the economic returns for mango cultivators in the district.

Keywords: Mango, Marketing Margin, Chapra, Price Spread, Post-harvest Constraints

https://doie.org/10.10346/AE.2026934028

STUDY ON VALUE CHAIN OF MUSTARD IN SULTANPUR DISTRICT OF UTTAR PRADESH

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ABSTRACT

The present study entitled **"**Study on Value Chain of Mustard in Sultanpur District of Uttar Pradesh" was undertaken to analyse the structure and functioning of the mustard value chain and to examine the role of different stakeholders involved from production to consumption. The study aimed to identify various marketing channels, cost and margin distribution, value addition at different stages, and constraints faced by participants in the value chain. The research was based on both primary and secondary data. Primary data were collected through a field survey using structured questionnaires from mustard farmers, traders, wholesalers, processors, and retailers in the selected areas of Sultanpur district. Secondary data were collected from government publications, research reports, journals, and official records. A descriptive research design was adopted, and suitable statistical tools were used for data analysis. The findings of the study revealed that the mustard value chain involved multiple intermediaries, which increased marketing costs and reduced the producer's share in the consumer's price. Farmers faced several constraints such as price fluctuations, lack of storage facilities, inadequate market information, and limited bargaining power. The study also indicated that value addition through processing significantly increased profitability but required higher investment and better technical support. The study concluded that strengthening market infrastructure, promoting farmer producer organizations, improving access to market information, and encouraging direct marketing channels could enhance the efficiency of the mustard value chain and improve farmers' income. The findings of the study would be useful for policymakers, researchers, and stakeholders in formulating strategies for sustainable development of the mustard sector.

Keywords: Mustard, Value Chain, Marketing Channels, Value Addition, Uttar Pradesh

https://doie.org/10.10346/AE.2026934028

STRUCTURAL AND POLICY DIMENSIONS OF INDIAN AGRICULTURE IN THE CONTEXT OF VIKSIT BHARAT 2047

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ABSTRACT

The paper is aiming to identify reforms for sustainable growth, technological integration, and enhanced farmer welfare to achieve a developed nation status with a USD 30-40 trillion economy, focusing on food security, climate resilience, and tripling agrarian incomes. The objective is to address challenges like low productivity, fragmented landholdings, and climate vulnerabilities while aligning with goals of nutritional security for 1.4 billion people, net-zero emissions by 2070, and sectoral tripling in size. Materials and methods involve synthesizing secondary data from key sources including NITI Aayog's roadmap on frontier technology-led transformation, TNAU's blueprint for agricultural research and extension, ICRIER's policy brief on a new deal for agriculture, World Bank reports on accelerated reforms, and the Economic Survey 2026, employing qualitative thematic analysis and quantitative projections on yields (e.g., 450-500 Mt food grains), resource efficiency (water use 70-90%, nitrogen 60%), R&D investments (1% of agri-GDP), and employment shifts (agriculture from 45% to ~12% of GDP). Results reveal structural issues such as 86% smallholders with 0.74 Ha average holdings, post-harvest losses of 15-20% (Rs. 1.5 trillion annually), groundwater depletion, and yield gaps, alongside policy gaps in siloed data, limited mechanization, and fertilizer inefficiencies; opportunities include frontier technologies like AI, IoT, drones, CRISPR, and blockchain for 21% productivity boosts, diversification to horticulture (42.2 Mha), agroforestry (35 Mha), conservation agriculture, and Digital Agriculture Mission 2.0 with PPPs for innovation, carbon credits, and skilling to boost irrigation efficiency above 60% and labor participation to 65%. In conclusion, Viksit Bharat 2047 requires holistic agricultural transformation through tech-driven structural reforms, inclusive policies, and sustainable practices to foster resilient systems, ensure inclusive rural growth, position India as a global agri-powerhouse, and align with SDGs.

Keywords: Viksit Bharat 2047, Indian Agriculture, Frontier Technologies, Climate-Resilient Farming, Policy Reforms, etc.

https://doie.org/10.10346/AE.2026934028

AGRICULTURAL SUBSIDIES AND THEIR IMPACT ON FARM PRODUCTIVITY AND SUSTAINABILITY

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ABSTRACT

This study examined the role of agricultural subsidies in influencing farm productivity and long-term sustainability within the agricultural sector. The primary objective of the research was to analyze how different forms of subsidies—such as input subsidies, price support mechanisms, and direct income support—affected farmers' production decisions, resource utilization, and environmental practices. The study employed a descriptive and analytical research design, using secondary data collected from government reports, agricultural statistics, and existing empirical studies. Comparative analysis was conducted to assess productivity trends before and after the implementation of major subsidy programs, while sustainability outcomes were evaluated in terms of soil health, water usage, and adoption of environmentally friendly practices. The results indicated that agricultural subsidies had a positive impact on farm productivity by reducing input costs, improving access to modern technology, and stabilizing farm incomes. However, the findings also revealed that excessive or poorly targeted subsidies sometimes encouraged overuse of chemical fertilizers, water, and other natural resources, thereby posing risks to environmental sustainability. The study highlighted that well-designed and targeted subsidy policies promoted sustainable farming practices, enhanced resource efficiency, and supported small and marginal farmers. Overall, the research concluded that agricultural subsidies played a significant role in improving farm productivity, but their long-term contribution to sustainability depended largely on policy design, effective implementation, and alignment with environmental objectives.

Keywords: Agricultural subsidies, farm productivity, sustainable agriculture, resource efficiency, agricultural policy

https://doie.org/10.10346/AE.2026934028

AGRI-STARTUPS AS CATALYSTS FOR DOUBLING FARMERS' INCOME IN INDIA

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ABSTRACT

The present study examined the role of agri-startups as catalysts in achieving the objective of doubling farmers' income in India, in the context of rising input costs, low profitability, and market inefficiencies faced by the agricultural sector. The study adopted a descriptive and analytical approach, based on secondary data collected from government reports, policy documents, startup case studies, and published research. It analysed how agri-startups supported under the Startup India initiative contributed to income enhancement through technological innovation, cost reduction, and improved market access. The findings indicated that agri-startups facilitated higher productivity and resource-use efficiency through precision farming, digital advisory services, and data-driven decision-making, while market-linked startups improved price realization by enabling direct farmer–market linkages and reducing intermediary margins. Additionally, startups engaged in post-harvest management and value addition significantly reduced post-harvest losses, thereby increasing net farm income. The study also highlighted the role of agri-startups in promoting diversification into high-value crops and allied activities, creating multiple income streams for farmers. The study concluded that despite challenges related to scalability, financing, and digital adoption, agri-startups represented a viable and sustainable pathway for enhancing farm income and strengthening the economic resilience of Indian agriculture.

Keywords: Agri-Startups, Doubling Farmers' Income, Startup India, Agricultural Innovation, Market Efficiency, Farm Income, Market Linkages.

https://doie.org/10.10346/AE.2026934028

AGRI-BIOTECHNOLOGY & BIO-INNOVATION FOR NEXT-GENERATION ENTREPRENEURS: OPPORTUNITIES IN BIOFERTILIZERS, BIOPESTICIDES, AND MOLECULAR BREEDING

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ABSTRACT

Agri-biotechnology is increasingly being recognized as a key area for sustainable agricultural development as well as entrepreneurial growth. The rising challenges of declining soil fertility, climate variability, pest resistance, and over-dependence on chemical inputs have created a strong demand for innovative and eco-friendly agricultural solutions. The present study focuses on understanding the potential of agri-biotechnology and bio-innovation as an opportunity for next-generation entrepreneurs, particularly in the areas of biofertilizers, biopesticides, and molecular breeding. The study is based on an analytical review of existing research literature, government reports, and selected case studies related to agri-biotech enterprises. Emphasis has been given to examining how biological inputs such as biofertilizers and biopesticides contribute to improved soil health, crop productivity, and environmental sustainability. The analysis indicates that bio-innovations not only reduce the negative environmental impact of conventional agriculture but also offer promising business opportunities for young entrepreneurs. Growing awareness about organic and residue-free food, policy support for bio inputs, and advancements in biotechnology have encouraged the emergence of agri-biotech start-ups in India. However, challenges such as limited technical knowledge, regulatory procedures, and initial investment requirements continue to affect large-scale adoption. The study concludes that agri-biotechnology can play a vital role in shaping future-ready agripreneurs by integrating scientific innovation with market-oriented agribusiness models. Strengthening research support, skill development, and commercialization pathways will be crucial for the long-term success of bio-based enterprises in agriculture. Agri-biotechnology is increasingly being recognized as a key area for sustainable agricultural development as well as entrepreneurial growth. The rising challenges of declining soil fertility, climate variability, pest resistance, and over-dependence on chemical inputs

Keywords: Agri-Biotechnology, Bio-Innovation, Biofertilizers, Biopesticides, Molecular Breeding

https://doie.org/10.10346/AE.2026934028

HARNESSING THE SUPER-TREE POTENTIAL OF PONGAMIA PINNATA (KARANJ) FOR BIO- ENERGY, GLOBAL AGRICULTURE AND SUSTAINABILITY

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ABSTRACT

The present study was undertaken to examine the potential of the *Pongamia pinnata* (Karanj) tree as a multifunctional resource for renewable energy generation and circular economy-based agricultural systems. The study addressed critical challenges faced by contemporary agriculture, including increasing production costs, dependence on fossil fuels, degradation of marginal lands, and the underutilization of biological resources for value creation. A "Super-Tree" and "Total-Use" framework was conceptualized, focusing on the integrated utilization of all components of the Karanj tree to support sustainable farming, bio-energy production, and rural livelihoods. The methodology involved secondary data analysis derived from peer-reviewed scientific literature, and documented case studies related to bio-energy applications and agroforestry systems. The findings indicated that Karanj yielded a non-edible oil, making it particularly suitable for bio-diesel production and Sustainable Aviation Fuel (SAF) without competing with food crops, thereby supporting food security objectives. The oil also demonstrated significant relevance for pharmaceutical and traditional medicine industries, enhancing its commercial viability. The residual seed cake was found to be an effective bio-fertilizer and bio-stimulant, contributing to soil fertility improvement, nutrient recycling, and sustainable crop production, thereby reinforcing circular agricultural practices. Additionally, the tree contributed ecological benefits such as carbon sequestration, atmospheric oxygen generation, biodiversity support, fodder availability, and rehabilitation of degraded lands. The study emphasized that the systematic and integrated utilization of Karanj resources could serve as a foundation for decentralized bio-energy systems and agri-based waste-to-wealth start-ups. It was concluded that Karanj represented a scalable and climate-resilient model capable of linking renewable energy solutions with sustainable agriculture, rural entrepreneurship, and environmental restoration, aligning strongly with global clean energy transitions and long-term sustainability goals.

Keywords: Pongamia pinnata, Circular Economy, Bio-energy, Tree Improvement, Sustainable Agriculture

https://doie.org/10.10346/AE.2026934028

AGROFORESTRY PRACTICES FOR FOOD SECURITY, CLIMATE RESILIENCE AND ENHANCED FARMERS' INCOME

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ABSTRACT

Agroforestry has emerged as a sustainable land-use system that integrates trees with crops and/or livestock to address the growing challenges of food insecurity, climate change, and declining farm incomes. The primary objective of this paper was to examine the role of agroforestry practices in enhancing food security, strengthening climate resilience, and improving farmers' income within the framework of smart farming ventures. The study addressed the research question of how agroforestry systems contribute to ecological sustainability and socioeconomic benefits under changing climatic conditions. A qualitative and quantitative synthesis approach was adopted, drawing upon secondary data from peer-reviewed research articles, policy reports, and case studies related to agroforestry systems across different agro-ecological regions. The analysis focused on productivity outcomes, climate adaptation benefits, and income diversification opportunities. The results indicated that agroforestry practices significantly improved soil fertility, microclimate regulation, and crop productivity, leading to enhanced food availability and stability. Additionally, diversified outputs such as timber, fruits, and non-timber forest products contributed to increased and more stable farm incomes. The integration of agroforestry with smart farming approaches further strengthened climate resilience by optimizing resource use and reducing vulnerability to climate risks. The study concluded that agroforestry is a viable climate-smart farming venture with strong potential to support sustainable food systems, improve rural livelihoods, and contribute to long-term agricultural resilience.

Keywords: Agroforestry, Food Security, Climate Resilience, Smart Farming, Farmers' Income

https://doie.org/10.10346/AE.2026934028

EMPOWERING THE NEXT-GEN AGRIPRENEUR

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ABSTRACT

This study investigated the critical misalignment between traditional agricultural education and the evolving requirements of the modern "Agripreneur." While the global agricultural landscape shifted toward high-tech, data-driven systems, youth participation remained constrained by a persistent "skills gap" and the perception of farming as a low-value manual labour sector. The research employed a mixed-methods approach, utilizing a systematic literature review alongside a comparative analysis of youth-led agribusiness incubators to identify specific barriers to entry. Findings indicated that while basic agricultural knowledge was prevalent, significant deficiencies existed in "Agripreneurial" competencies, specifically regarding financial literacy, supply chain optimization, and the application of Precision Agriculture (PA) technologies. The analysis revealed that traditional vocational training programs often failed to address the digital-Agri transition, leaving young workers ill-equipped to manage modern agribusiness ecosystems. Furthermore, the study determined that engagement strategies centred on peer-to-peer mentorship and digital integration were significantly more effective in attracting youth than top-down policy mandates. The research concluded that empowering the next generation of agripreneurs required a fundamental shift from subsistence-based training to a holistic ecosystem approach that integrated technological fluency with accessible credit and land tenure reform. Ultimately, the study demonstrated that rebranding agriculture as a sophisticated, tech-centric career path was essential for ensuring global food security and reducing rural youth unemployment. By bridging the identified skill gaps, stakeholders can transform the sector into a primary engine for economic innovation and sustainable development.

Keywords: - Agripreneurship, Youth Engagement, Skill Development, Precision Agriculture, Rural Development, Vocational Training.

https://doie.org/10.10346/AE.2026934028

WOMEN AND YOUTH-LED BEEKEEPING STARTUPS: A PATHWAY TO INCLUSIVE AGRIBUSINESS DEVELOPMENT

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ABSTRACT

Beekeeping has become an important agribusiness that helps rural communities, supports the environment, and fosters entrepreneurship. Women and young people engaged in beekeeping in India contribute to inclusive agribusiness development, particularly in rural areas where jobs are scarce. This study adopts a qualitative approach and policy analysis, using secondary data from government reports, scheme guidelines, and published research on the National Beekeeping and Honey Mission (NBHM) and various state apiculture projects. The findings show that beekeeping is an affordable and straightforward way to enter the agribusiness sector. It offers relatively quick financial returns and boosts agricultural productivity through improved pollination. Hive products like honey, beeswax, royal jelly, and pollen create additional revenue opportunities. Growing consumer interest in specific floral and wild honeys, such as acacia and litchi honey, has driven niche and health-focused markets. Entrepreneurs like Amit Godse, known as the "Beeman of Bengaluru and Pune," demonstrate how scientific methods, effective branding, and strong market connections can transform beekeeping into a scalable and sustainable business. Policy support from the NBHM has been crucial in increasing participation. With a ₹500 crore investment and subsidies between 50% and 90%, support for training and skill development has encouraged more involvement from rural entrepreneurs, women, youth, and self-help groups (SHGs). State-level initiatives further strengthen this ecosystem. In Uttar Pradesh, women-led beekeeping enterprises gain support from the "Madhu Sakhi" initiative. In Karnataka, substantial subsidies for equipment and infrastructure enhance access to modern tools, processing facilities, and markets. Haryana's honey price support programs help stabilize beekeeper incomes. Beekeeping startups provide an effective and inclusive path for agribusiness growth, especially with scientific guidance and supportive policies. By generating income, creating jobs, and offering environmental benefits, beekeeping stands out as a sustainable and scalable sector that supports India's goals of rural development, gender equality, and green growth.

Keywords: Beekeeping Women and youth entrepreneurship Inclusive agribusiness, National Beekeeping and Honey Mission Rural development

https://doie.org/10.10346/AE.2026934028

HARNESSING MICROALGAE: INNOVATION FOR FORTIFIED NUTRITIONAL SUPPLEMENT

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ABSTRACT

The deterioration of the ecological status of urban areas and the industrialization of the food industry requires the additional enrichment of the diet with biologically valuable food substances. Plant and animal-based nutritional supplements play a substantial role in addressing food challenges such as malnutrition and food uncertainty. Animal based protein, dairy and meet mainly have been the most consumed protein source. However, they are facing several inquiries as well as negative effect on human health. So, novel source like microalgal food supplement have been considered as a relevant alternative. Microalgae, particularly Spirulina and Chlorella, have emerged as sustainable, nutrient-rich resources for developing functional foods, dietary supplements, and therapeutic formulations. Microalgae are rich in bioactive compounds such as proteins, essential amino acids, β-carotene, chlorophyll, and Chlorella as growth Factor. These microalgae exhibit remarkable health-promoting properties, including antioxidant, anti-inflammatory, and immunomodulatory effects. Comparative evaluation reveals that Spirulina offers exceptional protein content and phycocyanin-linked antioxidant capacity, while Chlorella provides superior chlorophyll levels, detoxifying properties, and potent immune-enhancing effects. The integration of these microalgae into food systems addresses not only nutritional deficiencies but also offers preventive strategies against degenerative and lifestyle-related diseases.

Keywords: Microalgae, Spirulina, Chlorella, functional foods, nutraceuticals, bioactive compounds, immunomodulation, antioxidants

https://doie.org/10.10346/AE.2026934028

UNLOCKING THE POTENTIAL OF WOMEN AGRIPRENEURS: A STRATEGIC FRAMEWORK FOR INCLUSIVE SKILL DEVELOPMENT AND MARKET INTEGRATION

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ABSTRACT

Despite the increasing concentration of women in the Indian agrarian workforce, their involvement remained largely restricted to low-wage, labour-intensive tasks with negligible representation in the lucrative segments of the agribusiness value chain. This study investigated the systemic impediments that hindered rural women from advancing into high-potential entrepreneurial enterprises. The principal aim was to assess the efficacy of capacity-building programs in improving the commercial sustainability of startups led by women. Through a strategic evaluation of current incubation frameworks, it was identified that the scarcity of technical proficiency in post-harvest operations, coupled with inadequate financial literacy, served as the primary constraint to scaling operations. The research further explored the outcomes of focused interventions, particularly within the spheres of secondary agriculture and digital market access. It was noted that equipping women with modern processing infrastructure and direct trade channels led to a marked increase in profit margins compared to the conventional sale of raw commodities. The study underscored the efficacy of the 'Cluster Approach,' demonstrating that collectivization via Self-Help Groups (SHGs) and Farmer Producer Organizations (FPOs) empowered women to secure superior pricing and obtain institutional finance. The data indicated that a comprehensive ecosystem—anchored in technical upskilling, mentorship, and digital integration—was indispensable for cultivating sustainable livelihoods. It was concluded that reorienting policy priorities from simple 'welfare' measures to active 'enterprise generation' constituted the most viable strategy for ensuring long-term self-reliance among women in the agricultural domain.

Keywords: Women Entrepreneurship, Value Chain Integration, Economic Viability, Skill Development, FPOs, Digital Inclusion, Strategic Agribusiness.

https://doie.org/10.10346/AE.2026934028

AN ANALYSIS OF CONSTRAINTS HINDERING ENTREPRENEURIAL TRANSFORMATION IN THE CONTEXT OF VIKSIT BHARAT@2047.

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ABSTRACT

The objective of this paper is to critically analyse the key constraints hindering entrepreneurial transformation in India within the framework of *Viksit Bharat@2047*, the Government of India's ambitious vision to transform the nation into a developed, self-reliant economy by 2047, emphasizing pillars such as youth empowerment, inclusive growth, innovation, sustainability, and global competitiveness. Entrepreneurship and startups are positioned as central engines for job creation, technological advancement, economic scaling, and addressing societal challenges in sectors like manufacturing, agriculture, green energy, and digital inclusion to achieve a $30-trillion economy and broad-based prosperity. To achieve the vision it involved a mixed-methods approach, combining a comprehensive literature review of policy documents, government reports, academic studies, and industry analyses from 2020–2025; secondary data synthesis from sources like World Bank ease-of-doing-business rankings, and recent surveys on Indian entrepreneurship; and qualitative thematic analysis of identified constraints, categorized into regulatory, financial, infrastructural, skill-related, and socio-cultural dimensions. Persistent regulatory and bureaucratic hurdles, including complex compliance, licensing delays, and policy-implementation gaps that deter early-stage ventures and increase operational costs; chronic access-to-finance challenges, particularly for startups in Tier-2/3 cities and non-metro regions, with limited seed funding, investor concentration in metros, and collateral issues; inadequate infrastructure significant skill gaps and talent shortages due to misalignment between education systems and industry needs; and socio-cultural factors such as risk aversion, limited mentorship, and gender/regional disparities that restrict inclusive entrepreneurship. Ultimately, these constraints collectively slow India's entrepreneurial momentum and risk undermining the transformative potential required for Viksit Bharat@2047. Addressing them demands targeted reforms—such as single-window clearances, expanded funding mechanisms for underserved areas, skill-aligned education reforms, infrastructure upgrades, and inclusive policies—to foster a vibrant, scalable startup ecosystem. Overcoming these barriers will accelerate innovation-driven growth, empower youth and marginalized groups, and position India as a global leader in entrepreneurship by 2047.

Keywords: Viksit Bharat@2047, Entrepreneurial Constraints, Startup Ecosystem, Regulatory Hurdles etc.

https://doie.org/10.10346/AE.2026934028

REVOLUTIONIZING FINANCIAL MANAGEMENT: THE IMPACT OF ARTIFICIAL INTELLIGENCE ON DECISION-MAKING AND PERFORMANCE

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ABSTRACT

The integration of Artificial Intelligence (AI) is fundamentally transforming financial management by enhancing decision-making processes and driving superior organizational and institutional performance. This abstract explores how AI technologies—such as machine learning, deep learning, natural language processing, and predictive analytics—enable the processing of vast, complex datasets in real time, uncovering patterns and insights beyond traditional methods. AI significantly improves predictive accuracy in key areas, including market trend forecasting, investment portfolio optimization, credit risk assessment, and algorithmic trading. By minimizing human biases and emotional influences, these tools facilitate more objective, data-driven decisions, leading to reduced risks, lower default rates, enhanced fraud detection, and optimized resource allocation. In corporate finance, AI automates routine tasks, accelerates reporting cycles, refines cash and working-capital management, and supports strategic planning through scenario analysis and forward-looking insights. Empirical evidence indicates substantial performance gains, including cost reductions, efficiency improvements (e.g., up to 15 percentage points in efficiency ratios for adopting institutions), increased profitability, and better revenue generation via personalized services and innovative opportunities. However, challenges persist, such as algorithmic biases, model opacity, data quality issues, ethical concerns, and potential systemic risks like market herding or overreliance on uniform AI outputs. Overall, AI revolutionizes financial management by shifting from reactive to proactive, intelligent frameworks, promising sustained competitive advantages and resilience while necessitating robust governance, explainability, and regulatory oversight to mitigate adverse effects and ensure equitable benefits across stakeholders.

Keywords: Artificial Intelligence, Financial Management, Decision-Making, Predictive Analytics Etc.

https://doie.org/10.10346/AE.2026934028

IN RURAL DEVELOPMENT NEW TECHNIQUE AND GENERATE EMPLOYMENT IN RURAL AREAS

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ABSTRACT

India is an agricultural country, and agriculture is considered the backbone of the Indian economy because approximately two-thirds of the population depends directly or indirectly on it for their livelihood. It plays a vital role in ensuring food security, supporting industrial development, and sustaining the rural economy, thereby contributing significantly to the country's GDP. In recent years, the entire economy has been moving towards development, including advancements in farming practices. However, during this phase of development, farmers have been left behind. Although agricultural production has increased every year, the number of people and the area involved in farming have continuously declined. In 2005–2006, about 60–70% of the population was engaged in agriculture, but by 2015–2016 this figure had fallen to around 50–55%, and it is expected to decline further to about 46–50% by 2024–2025.If this trend continues, it will create serious problems and negatively affect the country's food sector and overall economy. Therefore, immediate steps must be taken to increase farmers' income and improve their standard of living so that they remain connected to agriculture. Farmers should be trained in value-addition activities such as processing agricultural produce after harvesting. In addition, they should be educated in marketing strategies and communication skills. If farmers acquire processing skills, they can generate employment for other farmers in their villages, thereby increasing their income. They can also productively utilize their time during the off-season after harvesting. The continuous decline in the farming population is a serious threat to India's food security and economy. To sustain agriculture, it is necessary to increase farmers' income through value addition, food processing, and skill development. Training farmers in processing, marketing, and communication can create rural employment and encourage them to remain connected with agriculture, ensuring sustainable economic growth.

Keywords: Agriculture, Indian Economy, Farmers' Income, Food Security, Rural Development, Value Addition, Food Processing, Employment Generation

https://doie.org/10.10346/AE.2026934028

FARM-TO-FORK ENTREPRENEURSHIP

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ABSTRACT

Farm-to-fork entrepreneurship is a transformative business model that bridges the traditional gap between agricultural producers and modern consumers. By streamlining the supply chain and eliminating unnecessary intermediaries, these ventures ensure that fresh, nutrient-rich produce reaches the table with unparalleled transparency. This entrepreneurial approach is deeply rooted in sustainability, actively reducing "food miles" and minimizing the carbon footprint associated with long-distance logistics. Beyond environmental stewardship, it serves as a powerful engine for local economic growth, offering farmers fairer returns and fostering resilient community bonds through direct-to-consumer channels like digital marketplaces and farmers' markets. In an era where diners increasingly value the provenance of their meals, farm-to-fork pioneers leverage technology—such as blockchain for traceability and IoT for cold chain integrity—to build lasting trust. Ultimately, this movement is more than just a logistical shift; it is a holistic philosophy that reimagines the food system as a transparent, ethical, and community-centric ecosystem.

Keywords: Farm-to-Fork, Value Chain Optimization, Traceability, Sustainability, Direct-to-Consumer, Agri-Tech Integration, Ethical Sourcing

https://doie.org/10.10346/AE.2026934028

SOLAR-POWERED COLD CHAINS: DECENTRALIZED POST-HARVEST SOLUTIONS TO EMPOWER WOMEN-LED AGRI-STARTUPS

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ABSTRACT

Post-harvest losses remain a critical challenge in developing agrarian economies, disproportionately affecting smallholder farmers and women entrepreneurs engaged in agri-based enterprises. Limited access to reliable cold storage infrastructure leads to significant quality deterioration, income losses, and reduced market participation. Solar-powered cold chains offer a sustainable and decentralized solution by leveraging renewable energy to provide affordable, off-grid cold storage in rural and peri-urban areas. This paper examines the role of solar-powered cold chain systems in strengthening post-harvest management while empowering women-led Agri-startups. By reducing spoilage, extending shelf life, and enabling value addition, these systems enhance market linkages, improve price realization, and support enterprise scalability. Furthermore, women-led startups adopting solar cold storage demonstrate improved economic resilience, increased employment generation, and enhanced decision-making power within local value chains. The study highlights the environmental benefits of reduced carbon emissions, the socio-economic impact on women's entrepreneurship, and the potential for integrating solar cold chains into inclusive agri-business models. Policy support, access to finance, and capacity-building initiatives are identified as key enablers for scaling solar-powered cold chain solutions to promote sustainable agriculture and gender-inclusive rural development.

Keywords: Solar cold chains, post-harvest losses, Women entrepreneurship, Decentralized storage, Renewable energy, Sustainable agri-business.

https://doie.org/10.10346/AE.2026934028

IMPLEMENTING CIRCULAR ECONOMY IN AGRICULTURE: AN ECONOMIC ANALYSIS OF RENEWABLE ENERGY AND WASTE-TO-WEALTH MODELS

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ABSTRACT

The agricultural sector in India has long struggled with rising input costs, primarily driven by a heavy dependency on fossil fuels and inefficient resource management. This paper analysed the economic potential of transitioning towards a 'Circular Economy' framework, specifically focusing on the integration of renewable energy solutions in farm operations. The primary objective was to evaluate how shifting from linear consumption to sustainable alternatives could reduce operational costs and create new revenue streams. The study examined the financial feasibility of two key interventions: the adoption of solar-powered irrigation systems and the conversion of crop residue into bio-energy sources like biogas and bio-briquettes. The research viewed crop residue not as an environmental burden to be burned, but as a critical raw material for energy generation. Through a comparative cost analysis, it was observed that while the upfront capital requirement for renewable infrastructure was significant, the operational expenditure (OPEX) dropped drastically over time. The data demonstrated that decentralized energy systems allowed farmers to utilize farm waste to power their own operations, effectively creating a closed-loop system. This transition significantly insulated growers from the volatility of global fuel prices and offered a viable solution to the persistent issue of stubble burning. The findings suggested that strong financial incentives were necessary to bridge the technology adoption gap. The paper concluded that the 'waste-to-wealth' approach was not merely an environmental compliance measure, but a financially robust business model that enhanced the overall profitability and resilience of the Indian agribusiness sector.

Keywords: Circular Economy, Renewable Energy, Waste-to-Wealth, Solar Irrigation, Farm Economics, Bio-energy, Cost-Benefit Analysis.

https://doie.org/10.10346/AE.2026934028

BIOMASS PRODUCTION AND CARBON SEQUESTRATION POTENTIAL OF DIFFERENT AGROFORESTRY SYSTEM IN INDIA

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ABSTRACT

Agroforestry systems (AFS) are a significant land use practice that involves the integration of trees with crops and/or livestock, thereby increasing biomass productivity and carbon sequestration. The objective of this study is to evaluate the biomass productivity and carbon sequestration potential of various agroforestry systems in different agro-climatic zones of India. The study is based on a critical review and compilation of secondary data collected from published research articles, institutional reports, and documented case studies on agroforestry systems, biomass productivity, and carbon sequestration in aboveground, belowground, and soil organic carbon pools. The findings indicate large variability in biomass productivity and carbon sequestration potential of agroforestry systems, mainly due to climatic factors, species composition, soil fertility, and management practices. Agroforestry systems in humid and sub-humid climates have relatively higher biomass productivity and carbon sequestration potential compared to arid and semi-arid climates. The results clearly indicate that agroforestry systems have a significant potential for climate change mitigation through enhanced carbon sequestration, in addition to improving agricultural productivity and ecological sustainability. The study highlights the potential of agroforestry systems as an effective strategy for fulfilling national climate change commitments and ensuring long-term environmental sustainability.

Keywords: Agroforestry, Agro-Climatic Zones, Biomass Production, Corbon Storage, Soil

https://doie.org/10.10346/AE.2026934028

PROMOTION OF ALECTO (BROFLANILIDE 20% SC) IN COLE CROPS THROUGH AGRICULTURAL MARKETING, E-COMMERCE AND DIGITAL MARKET LINKAGES IN VAISHALI DISTRICT OF BIHAR

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ABSTRACT

The present study entitled "Promotion of Alecto (Broflanilide 20% SC) in Cole Crops through Agricultural Marketing, E-Commerce and Digital Market Linkages in Vaishali District of Bihar" was undertaken to examine the effectiveness of modern, market-driven promotional strategies in enhancing farmer adoption and sales performance of advanced crop protection products. Vaishali district was selected due to its significant area under Cole crop cultivation and increasing exposure to digital agricultural services. The study was based on primary data collected through farmer training programmes, one-to one farmer meetings, field day meetings, and on-farm demonstrations conducted during the cropping season. Secondary data were sourced from company sales records, field reports, and digital advisory platforms. The integration of conventional extension methods with digital communication tools such as mobile-based advisories and FPO-led outreach resulted in improved farmer awareness and engagement. The findings indicated a positive impact of these promotional activities on farmer acceptance and market penetration of Alecto. Enhanced product visibility, effective pest control performance, and timely technical guidance contributed to an increase in product demand and repeat purchases in the study area. Sales performance showed noticeable improvement following structured demonstration and digital outreach activities. The study concludes that a hybrid agricultural marketing approach combining field-based extension with e-commerce and digital market linkages can significantly strengthen Agri-input adoption and sales growth. In the future, expanding FPO-led digital platforms, data-driven advisory services, and youth-led agribusiness initiatives can further enhance sustainable crop protection marketing and farmer profitability in regions like Vaishali, Bihar.

Keywords: Alecto, Agricultural Marketing, Digital Market Linkages, Cole Crops, Vaishali, Bihar, FPOs

https://doie.org/10.10346/AE.2026934028

BIOTECHNOLOGY POLICY AND THE RISE OF AGRI-BIOTECH ENTREPRENEURSHIP IN INDIAN UNIVERSITIES

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ABSTRACT

The National Biotechnology Development Strategies (NBDS 2007, 2015–2020, and 2021–2025) of India have enhanced Agri-biotechnology and bio-innovation as key drivers of sustainable agriculture and bio-based entrepreneurship in academia. This study examines how these three NBDS policies have framed Agri-biotechnology research priorities and entrepreneurial orientation within academic research institutes (ARIs) or universities. A qualitative policy analysis was conducted of all three NBDS documents (2007, 2015–2020, and 2021–2025) to examine their evolving focus on research capacity building, translational pathways, and mission-oriented innovation in ARIs. The analysis reveals that these policies have significantly enhanced Agri-biotechnology & bio-innovation by providing support to next-gen entrepreneurs within Indian ARIs. This leads to a consequential shift in institutions such as Indian Agricultural Research Institute (IARI), National Agri-Food Biotechnology Institute (NABI), where priority was given to biofertilizers, biopesticides, molecular breeding, marker-assisted selection, and pre-breeding platforms as sustainable alternatives to chemical-intensive agriculture. In various central universities and IITs these policy directions have also reshaped research agendas in Indian ARIs by promoting use-inspired discovery focusing on solving real-world societal and economic problems, interdisciplinary crop science, and climate-resilient innovation by using advanced biotechnological tools. This has further led to the creation of centres of excellence and provided support for shared research infrastructure, bio-incubators, and technology transfer mechanisms, which has embedded entrepreneurship within academic ecosystems. Collectively, the NBDS policies have transformed universities into innovation hubs that integrate research, translation, and enterprise development through initiatives like Biotechnology Industry Research Assistance Council (BIRAC), strengthening Agri-biotechnology's contribution to India's emerging bioeconomy.

Keywords: Agri-biotechnology; National Biotechnology Development Strategy (NBDS); Bio-innovation; Academic research institutes; Bio-entrepreneurship

https://doie.org/10.10346/AE.2026934028

GLOBAL AGRIBUSINESS SUPPLY CHAINS: POST-PANDEMIC CHALLENGES

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ABSTRACT

The present study entitled "Global Agribusiness Supply Chains: Post-pandemic Challenges" aims to analyse the structural, operational, and economic disruptions faced by global agribusiness supply chains after the COVID-19 pandemic. The study focuses on changes in input supply, logistics, price volatility, trade flows, and risk management practices across major agricultural commodities. A mixed-method research approach was adopted, combining secondary data from international trade databases, policy reports, and agribusiness firms with primary survey inputs from supply chain stakeholders including producers, traders, processors, and exporters. The findings indicate that post-pandemic agribusiness supply chains are facing persistent challenges such as logistics bottlenecks, increased transportation costs, input shortages, demand uncertainty, and regulatory shifts. Digitalization gaps, dependency on limited sourcing regions, and weak cold-chain infrastructure have further amplified supply risks. Financial stress and working capital constraints among small and medium agribusiness enterprises were also observed. The study suggests that strengthening supply chain resilience through diversification of sourcing, digital traceability systems, localized storage and processing infrastructure, and improved risk-sharing financial instruments is essential. Policy support for trade facilitation, infrastructure development, and technology adoption can significantly enhance post-pandemic supply chain stability and efficiency in the global agribusiness sector.

Keywords: Agribusiness, Supply Chain, Post-pandemic, Trade, Logistics, Resilience

https://doie.org/10.10346/AE.2026934028

WOMEN AGRIPRENEURS: INCLUSIVE SKILL DEVELOPMENT & STARTUP ECOSYSTEMS A GENDER-FOCUSED INCUBATION AND LEADERSHIP STUDY OF INDIAN WOMEN IN AGRICULTURE

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ABSTRACT

Women constitute 80% of India's economically active rural population, contributing nearly 70% of agricultural labour, yet own merely 12-13% of agricultural land. This paradox of "feminization of responsibility without power" reflects systemic barriers: limited land ownership, constrained institutional credit access, inadequate extension services, and sociocultural constraints that render women agripreneurs invisible within agricultural decision-making frameworks. While the Government of India has implemented landmark initiatives including the Mahila Kisan Sashaktikaran Pariyojana (MKSP), Mahila Lakhpati Scheme, and PM-KISAN, significant implementation gaps persist in addressing women agripreneurs' multifaceted vulnerabilities—particularly in skill development customization, digital literacy, market linkages, and entrepreneurial leadership opportunities. This research critically examines India's gender-focused incubation and skill-development landscape for women agripreneurs, analysing the effectiveness of government platforms, self-help group models, and emerging startup incubators in transitioning women from subsistence farming to viable agricultural enterprises. Through investigation of successful models—such as Deccan Development Society, SEWA initiatives, and Telangana's WE Hub the study identifies structural impediments and catalysts for transformative change, while examining policy implementation mechanisms at ground level. Findings reveal that sustainable empowerment requires integrated, multi-level interventions: (1) legislative reforms strengthening land ownership rights and formal farmer recognition; (2) gender-responsive, demand-driven skill development curricula addressing local contexts; (3) enhanced financial inclusion mechanisms transcending traditional collateral requirements; (4) women-centric incubation ecosystems with mentorship, market connections, and leadership development; and (5) strengthened implementation with accountability mechanisms addressing ground-level disparities. This study contributes evidence-based policy recommendations and underscores that recognizing women as entrepreneurs—not merely agricultural workers—is fundamental to agricultural transformation and achieving sustainable, inclusive growth in India's agrarian economy.

Keywords: Women Agripreneurs, Gender-Inclusive Agriculture, Skill Development, Startup Ecosystems, Incubation Models, Land Rights, Rural Entrepreneurship, Women Empowerment, Agricultural Policy, Leadership Development

https://doie.org/10.10346/AE.2026934028

NATURAL, ORGANIC AND REGENERATIVE AGRICULTURE ENTERPRISES

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ABSTRACT

Natural and organically oriented as well as regenerative agricultural ventures have become a key component of sustainable food systems with the rise of environmental, economic, and social problems associated with industrial agriculture. The objective of this paper is to bring forth the importance that these agricultural ventures have contributed to ecological balance, improving soil health, food security and sustainable livelihoods. The research is a secondary literature review of global academic and grey literature, policy reports and sustainability frameworks that are concerned with alternative modes of agriculture. The results suggest that where natural agriculture is based on low-input, chemical-free farming, and organic agriculture is grounded in certified eco-friendly production and consumer health, regenerative agriculture centres around soil restoration, biodiversity increase, and climate resilience. In combination, these enterprises reduce environmental degradation and enhance farm productivity and Agro-eco-system resilience. The study argue that the development of natural, organic and regenerative agricultural industries is necessary if we hope to achieve long-term farm sustainability, and aligning food systems around the world with sustainable development goals.

Keywords: natural agriculture; organic agriculture; regenerative agriculture; agro-ecosystem sustainability; low input farming; environmental sustainability.

https://doie.org/10.10346/AE.2026934028

POST-HARVEST MANAGEMENT & LOSS REDUCTION TECHNOLOGIES

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ABSTRACT

Post-harvest losses remain one of the most critical challenges in agriculture, particularly in developing countries where inadequate infrastructure, poor handling practices, and limited access to modern technologies lead to significant quantitative and qualitative losses. This study explores innovative post-harvest management and loss reduction technologies that can enhance value retention, improve farmer incomes, and strengthen food supply chains. The focus is on practical, scalable solutions such as scientific drying methods, low-cost storage systems, improved grading and sorting mechanisms, and digital monitoring tools for temperature and humidity control. The research highlights how the integration of modern technologies such as solar dryers, hermetic storage bags, cold chain micro-units, and AI-based sorting systems can drastically reduce spoilage in perishable commodities like fruits, vegetables, grains, and pulses. Emphasis is placed on decentralized, farmer-friendly models that can be adopted at the village or Farmer Producer Organization (FPO) level. The role of startups and Agri-entrepreneurs in providing post-harvest services like mobile packhouses, aggregation centres, and pay-per-use cold storage is also examined as a sustainable business opportunity. Furthermore, the abstract discusses the economic, environmental, and social benefits of reducing post-harvest losses, including improved food security, reduced pressure on natural resources, and increased market competitiveness. Policy support, access to credit, and skill development are identified as key enablers for large-scale adoption. Overall, strengthening post-harvest systems through technology, entrepreneurship, and institutional support can transform agricultural value chains from loss-prone to value-driven, ensuring better returns for farmers and more stable food availability for consumers.

Keywords: Post-harvest management, Value chain efficiency, Cold chain infrastructure, AI-based grading and sorting, Food security.

https://doie.org/10.10346/AE.2026934028

WOMEN IN AGRIBUSINESS: UNLOCKING RURAL POTENTIAL

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ABSTRACT

India is an agrarian economy with about 54.6 percent of total workforce engaged in agricultural and allied sector activities. For many years, their contribution remained unpaid and unrecognized, even though they were involved in almost every farming activity. Today, this situation is changing as rural women are moving beyond being just farm labours and becoming agribusiness entrepreneurs in areas such as dairy, poultry, fisheries, food processing, and Agri-input services. The workforce participation rate for rural females is significantly higher at 41.8 percent against urban women participation rate of 35.31 percent. The article highlights how women agripreneurs are contributing to rural economic growth by creating employment, increasing household income, and strengthening agricultural value chains. The study adopts a descriptive and analytical approach based on secondary data collected from official government sources, reports, and published literature to show the growing participation of women in agriculture and entrepreneurship, at the same time it shows the challenges faced by women agripreneurs related to access to resources, markets, infrastructure, and social barriers. The paper discusses key strategies to support women-led agribusiness, including better institutional support, digital access, skill development, and public–private partnerships. The All India Coordinated Research Project (AICRP) on Women in Agriculture (WIA) takes up the region-specific issues related to women in agriculture to address the livelihood security, household nutrition, drudgery reduction, occupational health hazards and capacity building of agrarian families. The transition of women from unpaid labourers and homemakers to agripreneurs has not only led to a shift in rural economy but also a strategic sustainable rural development indicating that empowering women in agribusinesses is far more than a matter of gender-equality and equity.

Keywords: Rural Development, Women Agripreneurs, Inclusive Growth, Economic Development, Agricultural Value-Chains.

https://doie.org/10.10346/AE.2026934028

ROLE OF DIGITAL PLATFORMS IN STRENGTHENING AGRI-PRENEURSHIP IN INDIAN AGRICULTURE

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ABSTRACT

The research investigates the role of digital platforms in promoting agri-preneurship in India by examining how digital tools support the growth and performance of agricultural start-ups. As Indian agriculture faces challenges such as market inefficiencies, rural unemployment, limited access to information, and climate-related risks, digital platforms offer new opportunities for sustainable economic growth and innovation. The study explores key digital components influencing agri-preneurial development, including access to online markets, digital financial services, technology adoption, and supportive institutional mechanisms. The study employs a mixed-methods approach, collecting quantitative data through surveys of agri-preneurs from different regions of India and qualitative data through interviews with digital service providers, startup founders, and agricultural stakeholders. The findings indicate that digital platforms such as e-commerce portals, mobile-based advisory services, digital payment systems, and precision agriculture technologies play a significant role in improving productivity and market connectivity for agri-startups. Access to digital finance and real-time market information was found to be crucial for business viability and expansion. Networking through digital platforms connects agri-preneurs with research institutions, extension services, and investors, enhancing knowledge generation and capacity building. Additionally, supportive digital policies and infrastructure development create a conducive environment for strengthening agri-preneurship and encouraging entrepreneurial innovation in Indian agriculture.

Keywords: Digital Platforms, Agri-preneurship, Agri-Startups, Indian Agriculture, Digital Innovation.

https://doie.org/10.10346/AE.2026934028

POST-HARVEST MANAGEMENT AND LOSS REDUCTION TECHNOLOGIES

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ABSTRACT

The world population is increasing rapidly, and to meet these growing needs, pesticides are widely used to protect crops. Pesticides pose a significant threat to the environment and to human health as they accumulate in the food chain. To address this concern, scientists have developed a botanical insecticide, a natural alternative derived from plants and plant extracts. Integrated Pest Management is a significant component of modern agriculture that tends to minimise the use of pesticides and replace them with eco-friendly bioinsecticides. Bioinsecticides work by targeting biological systems in insects, such as their nervous, respiratory, and endocrine systems, which are crucial for their survival. They are classified based on how they enter the insect's body: stomach poisons are ingested, contact poisons are absorbed through the skin, and fumigants are gases that can be inhaled. Plant-based bioinsecticides offer a sustainable and economically viable approach within the framework of bio innovation. Such innovation can contribute to sustainable agriculture while fostering green startups and rural bio enterprises.

Keywords: Pesticide, Botanical insecticide, Integrated Pest Management.

https://doie.org/10.10346/AE.2026934028

STUDY OF BRAND PROMOTION ACTIVITY OF HERBICIDE IN GORAKHPUR DISTRICT OF UTTAR PRADESH

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ABSTRACT

The present study examines the brand promotion strategies and field activity of herbicides in the Gorakhpur district of Uttar Pradesh, a prominent agricultural region of eastern India. Weed infestation is a major constraint to crop productivity, and the increasing adoption of herbicides reflects the growing role of agricultural technology, precision tools, and modern farm practices in weed management. The study aims to analyze the effectiveness of various marketing and promotional tools used by agrochemical companies and to evaluate the actual performance of herbicides under local farming conditions. Primary data were collected through structured questionnaires, personal interviews, and field-level observations, while secondary data were obtained from company publications, dealer records, and extension literature. The research evaluates the impact of promotional tools such as field demonstrations, dealer networks, mobile-based advisory services, point-of-sale materials, and technical support by company representatives on farmers' purchasing behaviour. Herbicide activity was assessed using parameters including weed control efficiency, crop safety, ease of application, compatibility with spraying equipment, and farmer satisfaction. The findings reveal that dealer influence combined with practical field demonstrations plays a decisive role in enhancing brand awareness and adoption. Farmers prefer herbicide brands that offer consistent weed control, quick action, and reliable technical guidance. However, the study also identifies gaps in farmers' knowledge related to proper dosage, timing of application, and safe handling practices, which can reduce herbicide effectiveness and increase risk. The study concludes that the integration of technology-driven promotional strategies, digital advisory tools, and farmer training programs can significantly improve both brand credibility and herbicide performance. Strengthening the link between agronomic efficiency and marketing communication will support sustainable weed management and improved agricultural productivity in Gorakhpur district.

Keywords: - Herbicide Activity, Brand Promotion, Agricultural Technology, Weed Management, Farmer Perception, Agrochemical Marketing

https://doie.org/10.10346/AE.2026934028

FROM CRISIS TO TRANSFORMATION: EVALUATING STRUCTURAL DISPARITIES AND PUBLIC INVESTMENT IN INDIAN AGRICULTURE (1991–2026)

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ABSTRACT

This study analyzes the structural evolution of the Indian agricultural sector from the 1991 liberalization to the Viksit Bharat 2026 framework. Using the FY26 Economic Survey data, the research identifies a persistent "productivity paradox": while India has emerged as a $4 trillion+ economy, the agricultural sector remains "overburdened," contributing ~18.2% to the GDP while sustaining 45.8% of the national workforce. The study highlights a significant growth divergence, where traditional crop farming (growing at 3.1–3.5%) is being outperformed by high-value allied sectors like livestock (7.1%) and fisheries (8.8%).The analysis focuses on the modern drivers of agrarian distress, specifically "green-flation" (rising input costs) and climate-induced volatility affecting the 52% of net sown area that remains rain-fed. It concludes that the historical model of subsidy-led growth has reached a point of diminishing returns. The study argues that public investment must pivot from input subsidies to Digital Public Infrastructure (AgriStack), climate-resilient water management, and post-harvest logistics to bridge the widening rural-urban income gap. The research recommends that for inclusive growth, policy must prioritize the scaling of Farmer Producer Organizations (FPOs) and the diversification of smallholder farms into high-value exports and processed food chains.

Keywords: Economic Liberalization, Structural Disparity, Climate-Smart Agriculture, Public Investment, Indian Agriculture

https://doie.org/10.10346/AE.2026934028

IMPACT OF E-COMMERCE AND DIGITAL MARKET LINKAGES ON INCOME AND MARKET ACCESS OF SMALL FARMERS IN INDIA

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ABSTRACT

The present study was undertaken to analyze the impact of e-commerce platforms and digital market linkages on income generation and market access of small and marginal farmers in India. The agricultural marketing system in the country had traditionally been dominated by intermediaries, which had resulted in limited price transparency and reduced bargaining power for farmers. In this context, digital platforms such as e-NAM, mobile-based agri-market applications, and direct-to-consumer channels had emerged as important tools for strengthening farmer-market connectivity. The main objective of the study was to assess the level of awareness, adoption, and perceived benefits of digital marketing platforms among farmers and to identify the major challenges in their effective utilization. The study followed a descriptive research design and was based on both primary and secondary data. Primary data were collected from 120 farmers through a structured questionnaire using random sampling techniques, while secondary data were obtained from government publications, research articles, and online databases. Analytical tools such as percentage analysis, mean scores, and ranking methods were used for interpretation of the data. The results indicated that farmers who adopted digital platforms experienced improved price realization, reduced dependency on middlemen, and better access to wider markets. The findings also revealed that digital marketing had contributed to faster transactions, increased market information availability, and enhanced income stability. However, major constraints identified included low digital literacy, poor internet connectivity in rural areas, lack of trust in online transactions, and limited institutional support. The study concluded that e-commerce and digital market linkages had significant potential to transform agricultural marketing and promote agripreneurship among rural youth, and that strengthening digital infrastructure, improving awareness programs, and providing training support could further enhance the adoption of digital platforms and contribute to sustainable income growth for farmers.

Keywords: Agricultural marketing, E-commerce, Digital platforms, Farmer income, Market access.

https://doie.org/10.10346/AE.2026934028

INTEGRATED FARMING SYSTEM: ECONOMIC BENEFIT AND IMPLICATIONS FOR FARMERS

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ABSTRACT

Integrated Farming System (IFS) aimed to enhance farm income and livelihood security of farmers by efficiently integrating different agricultural enterprises such as crops, livestock, fisheries, poultry, and agroforestry within a single farming system. The main purpose of this study was to examine the economic benefits of Integrated Farming Systems and understand how they contribute to improving farmers' income and sustainability. The study was based on a review of existing literature, reports, and secondary data related to integrated farming practices. The approach focused on analyzing documented economic outcomes such as cost reduction, income diversification, and efficient resource utilization achieved through IFS. The findings indicated that Integrated Farming Systems helped farmers increase overall farm productivity by utilizing farm resources optimally and reducing dependency on external inputs. Income stability was improved through diversification, which minimized risks arising from crop failure or market fluctuations. Additionally, recycling of farm waste within the system reduced production costs and enhanced profitability. The study concluded that Integrated Farming Systems played a significant role in improving the economic condition of farmers by ensuring regular income, better employment opportunities, and sustainable use of natural resources. Adoption of IFS was found to be particularly beneficial for small and marginal farmers, contributing to long-term farm sustainability and rural development.

Keywords: Integrated Farming System, Economic Benefits, Farm Income, Sustainable Agriculture, Farmers' Livelihood

https://doie.org/10.10346/AE.2026934028

ROLE OF FARMER PRODUCER ORGANIZATIONS IN STRENGTHENING THE COLLECTIVE AGRIBUSINESS SECTOR IN INDIA

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ABSTRACT

Farmer Producer Organizations (FPOs) are growing as a critical institutional mechanism for strengthening India's collective agribusiness sector by addressing long-standing challenges faced by small and marginal farmers. This paper examines the role of FPOs in enhancing collective action, improving market access, reducing transaction costs, and promoting value addition across agricultural supply chains. By aggregating farm produce and resources, FPOs enable farmers to achieve economies of scale, enhance bargaining power, and integrate more effectively with input suppliers, processors, and organized markets. The study analyses the contribution of FPOs to agribusiness development in India with a focus on their role in improving price realization, facilitating access to institutional credit, encouraging adoption of modern technologies, and promoting participation in value-oriented activities such as grading, processing, branding, and direct marketing. Continuous institutional support, capacity-building initiatives, and policy-driven interventions have further strengthened the operational efficiency and market orientation of FPOs. Government programs, including the 10,000 FPO Scheme, along with NABARD and SFAC initiatives, have played a significant role in enhancing managerial capabilities, financial access, and market integration of FPOs. The paper concludes that well-supported FPOs serve as effective instruments for inclusive growth, farmer empowerment, and sustainable agribusiness development in India, reinforcing their importance within the collective agribusiness ecosystem.

Keywords-Farmer Producer Organizations; Collective Agribusiness; Farmer empowerment; Agricultural Supply Chain; India

https://doie.org/10.10346/AE.2026934028

RECIRCULATORY AQUAULTURE SYSTEM AS A SUSTAINABLE APPROACH FOR EXOTIC FISH TILAPIA (*OREOCHROMIS NILOTICUS*) CULTURE IN WEST BENGAL

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ABSTRACT

The present study targeted to evaluate the performance of tilapia (*Oreochromis niloticus*) culture in a Recirculatory Aquaculture System (RAS) in private fish farms of Purulia district of West Bengal. The study emphasis on growth, survival, optimum water quality, and production efficiency. The experiment was conducted in 10 m^3 RAS tanks stocked at a density of 80 fish m^{-3} with an initial mean weight of 15.2 ± 1.8 g and reared for 150 days under controlled environmental conditions. A floating pelleted feed containing 32% crude protein was applied strictly following through the standard feeding protocols. Throughout the culture period, water quality parameters such as temperature (28.3 ± 1.6 °C), dissolved oxygen (5.3 ± 0.7 mg L^{-1}), pH (7.4 ± 0.3), total ammonia nitrogen (0.21 ± 0.05 mg L^{-1}), and nitrite (0.08 ± 0.02 mg L^{-1}) remained within optimal ranges for tilapia culture. The fish attained a final mean weight of 412.6 ± 28.4 g with an average daily weight gain of 2.65 g day^{-1}. Feed utilization was efficient, with a feed conversion ratio of 1.42, while survival rate was recorded at 91.5%. Total biomass production reached 30.2 kg m^{-3}. The findings demonstrate that RAS-based tilapia culture is technically viable and economically promising under climatic conditions of West Bengal state and hence one of the significant systems to reach and fulfil the increased demand of food fish species, offering a sustainable alternative to conventional aquaculture systems.

Keywords: Aquaculture, Fish farms, Fish growth, Food security, Physico chemical parameters

https://doie.org/10.10346/AE.2026934028

ROLE OF PROBIOTICS AND EFFECTIVE FEED CRUXES ON GROWTH RATE, FEED CONSUMPTION, SURVIVAL RATE, AND DISEASE PREVALENCE IN TILAPIA FISH (*OREOCHROMIS NILOTICUS*) IN CONFINED ENVIRONMENTS

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ABSTRACT

The present study assessed the effects of probiotics and other effective feed cruxes on growth performance, feed consumption, survival rate, and disease prevalence in cultured tilapia (*Oreochromis niloticus*) fish species in aquaculture practices. A 90-day feeding trial was experimented using four dietary treatments: a control diet without additives (T_1), a probiotic-supplemented diet containing *Lactobacillus sp.* (T_2), a synbiotic diet combining probiotics and prebiotics (T_3), and a probiotic diet supplemented with β-glucan as an immunostimulant (T_4) were fed to the fishes. The fish fed additive-supplemented diets unveiled improved growth rate and feed consumption rate compared to the control. Final mean weight increased to 185 ± 12 g in T_1 214 ± 15 g in T_2, 228 ± 18 g in T_3, and 221 ± 16 g in T_4 respectively. Precise growth rate improved from 1.92% day^{-1} in the control to 2.14–2.26% day^{-1} in treated groups, while feed conversion ratio decreased to 1.72 in T_1 and 1.31–1.44 in other treated groups. Survival rates were higher in supplemented groups (91.8–94.2%) compared to the control (86.5%). Disease prevalence was remarkably reduced from 22% in the control group to 14%, 9%, and 11% in T_2, T_3, and T_4, respectively, signifying boosted health status and disease resistance. Water quality parameters remained same within optimal ranges throughout the experiment period. The results proved that dietary supplementation of probiotics and other feed crux's, predominantly synbiotics, considerably increases growth performance, feed take efficiency, and disease resistance, highlighting their potential as sustainable substitutions to antibiotics in aquaculture.

Key words: Exotic fish, Experiment, Aquaculture, Synbiotic diet, Probiotics

https://doie.org/10.10346/AE.2026934028

SUPPLY CHAIN ANALYSIS OF PEA IN PRATAPGARH, UTTAR PRADESH

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ABSTRACT

The present study entitled "Supply Chain Analysis of Vegetable Pea in Pratapgarh District of Uttar Pradesh" examines the production, marketing, and distribution system of vegetable pea (Pisum sativum) in the study area. The main objective of the research is to analyze the structure and performance of the supply chain, identify major market intermediaries, and assess costs, margins, and price spread at different stages. Primary data were collected from pea growers, traders, wholesalers, and retailers through a structured questionnaire, while secondary data were obtained from published reports and government records. The results indicate that the supply chain involves multiple intermediaries, which increases marketing costs and reduces the producer's share in the consumer's price. Major problems faced by farmers include price fluctuation, lack of cold storage facilities, inadequate transportation, and weak market linkages. The study suggests that strengthening farmer organizations, improving market infrastructure, providing timely market information, and promoting direct marketing channels can enhance supply chain efficiency and farmers' income. The findings of the study will be useful for policymakers, researchers, and agribusiness stakeholders in improving vegetable marketing systems.

Keywords: Supply Chain Analysis, Vegetable Pea, Marketing Channels, Price Spread, Producer's Share

https://doie.org/10.10346/AE.2026934028

RABI & KHARIF CROPS; AGRICULTURE PRODUCTION IN PRODUCTION IN INDIA

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ABSTRACT

Indian agriculture is primarily based on two major cropping seasons, Kharif and Rabi, which together play a vital role in ensuring national food security. Kharif crops, sown during the monsoon season, include rice, maize, millets, cotton, and oilseeds, and largely depend on rainfall. Rabi crops, grown in the winter season, comprise wheat, pulses, mustard, and barley, relying mainly on irrigation and residual soil moisture. In recent years, India has recorded high and stable agricultural production, with significant contributions from both seasons. Improved irrigation facilities, modern farming practices, and supportive government policies have led to increased production of major cereals, pulses, and oilseeds, strengthening food availability and rural livelihoods in the country.

Keywords: Rabi crops, Kharif crops, Cropping seasons, Foodgrain production

https://doie.org/10.10346/AE.2026934028

TRANSFORMING INDIAN AGRICULTURE FOR VIKSIT BHARAT 2047: IMPOWERING STARTUP, ENHANCING SKILL DEVELOPMENT AND FOSTERING AGRIPRENEURSHIP FOR YOUTH

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ABSTRACT

The realization of Viksit Bharat 2047 is intrinsically linked to the comprehensive transformation of Indian agriculture into a knowledge-intensive, innovation-driven, and globally competitive sector. This study conceptualizes agricultural transformation as a multi-dimensional process encompassing technological modernization, institutional restructuring, and human capital advancement, with a specific emphasis on startup empowerment, skill development, and youth-centric agripreneurship. The analytical framework integrates endogenous growth theory, innovation systems approach, and value-chain economics to examine the role of agritech startups as catalysts for technology diffusion and entrepreneurial dynamism. Advanced digital and biophysical technologies—including artificial intelligence, machine learning, geospatial analytics, Internet of Things (IoT), blockchain-enabled traceability, and climate-smart agricultural systems—are evaluated for their potential to enhance total factor productivity, reduce transaction costs, and mitigate climate-induced production risks. Concurrently, the study underscores the importance of competency-based skill development architectures in agribusiness management, Agri-logistics, post-harvest engineering, and financial technology to facilitate the transition of rural youth from agrarian labour to entrepreneurial agents. Institutional mechanisms such as innovation clusters, Agri-incubation centres, blended finance models, and public–private–academic partnerships are identified as critical enablers for entrepreneurial ecosystem development and market integration. The synthesis of technological innovation, skilled human capital, and enabling policy regimes is posited to generate positive externalities in terms of inclusive rural growth, employment elasticity, and sustainable intensification. The findings contribute to policy discourse by proposing a scalable and replicable agripreneurship-led development paradigm capable of strengthening food system resilience and accelerating India's progression toward a high-income, knowledge-based agrarian economy under the Viksit Bharat 2047 vision.

Keywords**: Transforming, Viksit Bharat, Startup, Skill Development, Agripreneurship, Youth

https://doie.org/10.10346/AE.2026934028

SURVEY OF PLANT PARASITIC NEMATODES IN OKRA FIELDS OF SELECTED AREAS IN PRAYAGRAJ DISTRICT

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ABSTRACT

Okra is an important vegetable crop, but its production is seriously affected by plant parasitic nematodes. To understand the present situation of this problem, a field survey was carried out in okra-growing areas of Prayagraj district, Uttar Pradesh. The survey was conducted in four major blocks, namely Bahadurpur, Phulpur, Chaka and Jasra. Okra fields were visited, and the root and soil samples were collected. Root galling was recorded using a standard galling scale, and nematode population was estimated from soil samples. The survey results showed that *Meloidogyne incognita* was present in all the surveyed blocks. Along with this, other plant parasitic nematodes such as Pratylenchus spp., Rotylenchus spp, Tylenchus spp, Helicotylenchus spp. and Hetero1dera spp. were also recorded in the region. Higher galling intensity and nematode population were observed in the Chaka and Bahadurpur blocks, while relatively lower infestation was found in the Phulpur block. The study indicates that plant parasitic nematodes are a common problem in okra cultivation in the region and emphasises the need for integrated nematode management practices.

Keywords: Plant parasitism, Roadside vegetation, Okra (Abelmoschus esculentus), Parasitic weeds, Agricultural fields, Host–parasite interaction, Crop productivity.

https://doie.org/10.10346/AE.2026934028

BIOLOGICAL CONTROL OF RICE ROOT-KNOT NEMATODE (MELOIDOGYNE GRAMINICOLA)

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ABSTRACT

The rice root knot- nematode Meloidogyne graminicola is a serious pest. This nematode can cause significant loss, in India, with yield reduction ranging from approximately 16%-80%, depending on soil type and infection severity. Infected plants show stunted growth, yellowing and characteristic knots on the root tips. According to various study it has been concluded that bacterial and fungal biocontrol agents like Trichoderma harziaum, Pseudomonas fluorescence and Bacillus subtilis are very effective for the management of rice root-knot nematode, when applied specially as seed treatment (10g/kg) and soil treatment (20g/m2 or 2.5kg/hectare) in nurseries. Dipping seedlings in suspension of P. chlamydosporium at planting is highly effective, especially when combined with or followed by one or two soil application (15-30 days after planting).

Keywords: Biological nematicides, Meloidogyne graminicola, Rhizosphere microorganisms, Integrated nematode management, Sustainable rice production.

https://doie.org/10.10346/AE.2026934028

VERMICOMPOST - AN ORGANIC GOLD (EARTHWORM FARM ENTREPRENEURSHIP)

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ABSTRACT

Vermicompost is nutrient- rich organic fertilizer produced by the breakdown of organic waste through earthworms. Vermicomposting is the process of using earthworms to convert organic waste materials into nutrient-rich Vermicompost. Vermicompost is a valuable resource that supports soil health, sustainable agriculture and environmental conservation. Its importance lies in its ability to provide plants with essential nutrients, improve soil structure, and reduce the ecological footprints of organic disposal. Vermicomposting is a low-investment, high - return opportunity, especially suitable for rural areas. Vermicomposting production is an advantageous solution that changes waste into "black-gold" (nutrient - rich fertilizer). By focusing on proper training, quality assurance and direct marketing it serves as a sustainable, eco-friendly livelihood, enhancing soil health while providing significant economic empowerment especially for women and Rural youth.

Keywords: Vermicompost, Earthworm farming, Agripreneurship, Organic fertilizer, Sustainable agriculture.

https://doie.org/10.10346/AE.2026934028

FIELD SURVEY-BASED ASSESSMENT OF PLANT-PARASITIC NEMATODE DISTRIBUTION IN SELECTED VILLAGES OF PRAYAGRAJ, U.P.

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ABSTRACT

Plant-parasitic nematodes are among the most destructive worms that causes significant damage to agricultural and horticultural crops worldwide, including tomato. It leads to symptoms such as root galls, lesions, stunted growth, chlorosis, wilting, and yield reduction. The present study aims to assess the distribution and occurrence of plant-parasitic nematodes through field surveys conducted in 20 selected villages of Prayagraj district, Uttar Pradesh. Field surveys were carried out during the harvest season to collect root samples from many vegetable crops. Standard nematological techniques were employed for the extraction and identification of nematodes. The intensity of infestation was assessed based on gall index and population density. This survey aims to provide spatial variation in the distribution of plant-parasitic nematodes across the surveyed villages, influenced by factors such as cropping pattern, soil type, and agricultural practices. Higher nematode populations were observed in intensively cultivated fields of villages namely, Iradatganj, Jasra, Bahadurpur and Phulpur with susceptible host crops. The study highlights the widespread presence of plant-parasitic nematodes (*Meloidogyne* spp.), *Steinernema*, *Helicotylenchus*, *Tylenchorhynchus* and *Tylencholaimus* in the study area and emphasizes their potential threat to sustainable crop production.This field-based assessment provides information on the distribution status of plant-parasitic nematodes in Prayagraj district, which can be useful for developing location-specific management strategies and for future research on nematode–crop interactions.

Keywords: Plant parasitic nematodes, Field survey, Distribution pattern, Crop fields, Soil sampling, sHost crops, Population density.

https://doie.org/10.10346/AE.2026934028

ROLE OF UNDERUTILIZED FRUITS FOR MAINTAINING HUMAN HEALTH

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ABSTRACT

Underutilized fruit species are scattered around the country. These fruits have their own specialty and uniqueness. Many of these fruit species have not been fully exploited and no proper documentation of the status and distribution of them are done in the country so these are called underutilized fruits. Underutilized fruits are quite nutritious in terms of their vitamin C, carotenoid and antioxidant contents like flavonoids, phenolic acid, betacyanin's. They are naturally fat free and high in fibre. They may lower the blood sugar level and can strengthen your immune system. Being especially rich sources of minerals, these serve well as emergency or alternative fruits and are well adopted to the marginal or waste lands. Some of the underutilized fruit species are Aegle marmelos, Emblica officinalis, Artocarpus heterophyllies, Syzygium cuminii, Carissa carandas, Grewia subinaequalis, Garcinia indica, Feronia limonia, Annona spp., Amranthus spp. Tamarindus indica, Bassia latifolia, Artocarpus lakoocha, Punica granatum and Trapa natans var. bispinous, etc. Some of them have distinct flavour and are easy to cultivate under harsh conditions as compared to exotic fruits. The underutilized fruits are naturally disease tolerant and have medicinal properties. They are adopted in hot and hardy climatic conditions. These lesser-known plants are in common use especially in rural areas which have not been fully exploited and are commonly used by local people. These species, thus, need to be exploited at the national and international levels in order to improve the socio-economic and health status of the society.

Keywords: Underutilized, Unexploited, Antioxidant, Nutrition, Human health

https://doie.org/10.10346/AE.2026934028

STUDY ON POST-HARVEST AND MARKETING OF GERBERA FLOWER IN AZAMGARH DISTRICT UTTAR PRADESH

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ABSTRACT

Gerbera cultivation has become an important income-generating activity for farmers and rural entrepreneurs due to its high market demand and better profit potential compared to traditional crops. In Azamgarh district of Uttar Pradesh, many farmers have adopted gerbera cultivation under protected conditions. However, despite good production, farmers face several problems related to post-harvest handling and marketing, such as poor storage facilities, high transportation costs, involvement of middlemen, and post-harvest losses, which reduce their overall income. Therefore, understanding post-harvest and marketing practices is essential for promoting floriculture-based entrepreneurship. The main objectives of this study are to examine the existing post-harvest management practices followed by gerbera growers, to analyse the marketing channels and cost–margin structure, and to identify major constraints faced by farmers in marketing their produce. The study was conducted in Azamgarh district using primary data collected from selected gerbera growers and market intermediaries through personal interviews and structured questionnaires. Simple statistical tools, cost and return analysis, and marketing efficiency measures were used for data analysis. The results of the study indicate that lack of cold storage, improper packaging, and delayed transportation lead to significant post-harvest losses. Farmers selling flowers through traditional marketing channels receive a lower share of the consumer's price due to the dominance of middlemen. The study concludes that improved post-harvest infrastructure, training on scientific handling practices, and promotion of direct marketing channels can enhance farmers' income and strengthen gerbera-based entrepreneurship in the region.

Keywords: - Gerbera flower, post-harvest losses, marketing channels, Floriculture entrepreneurship, Farmer income.

https://doie.org/10.10346/AE.2026934028

FEASIBILITY STUDY OF PRODUCTION OF BIOCHAR FROM AGRICULTURE WASTE

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ABSTRACT

This study explores the potential of rice straw-derived biochar as a sustainable solution for environmental remediation agricultural sustainability. Biochar, a carbon-rich material, was produced from rice straw through pyrolysis and characterized for its physicochemical properties. The results showed that the biochar produced at 500°C exhibited high carbon content, surface area, and adsorption capacity. The biochar was found to be effective in removing pollutants from water and improving soil fertility. The study highlights the potential of rice straw-derived biochar as a sustainable and eco-friendly solution for environmental remediation and agricultural sustainability. The findings of this study can be used to develop cost-effective and environmentally friendly technologies for waste management and sustainable agriculture. This study investigates the potential of rice straw-derived biochar as a sustainable solution for environmental remediation and agricultural sustainability. The biochar was produced through pyrolysis and characterized for its physicochemical properties. The results showed that the biochar produced at 500°°C exhibited high carbon content, surface area, and adsorption capacity. The biochar was found to be effective in removing pollutants from water and improving soil fertility. The study highlights the potential of rice straw-derived biochar as a sustainable and eco-friendly solution for environmental remediation and agricultural sustainability.

Keyword: – Environmental Remediation, Agricultural Sustainability.

https://doie.org/10.10346/AE.2026934028

STUDY ON POST-HARVEST AND MARKETING OF GERBERA FLOWER IN AZAMGARH DISTRICT UTTAR PRADESH

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ABSTRACT

Post-Harvest Management & Loss Reduction Technologies for Mushrooms the present study investigated post-harvest management strategies for mushrooms, aiming to reduce losses through drying, grading, sorting, and storage innovations. Mushrooms face high perishability due to 85-90% moisture content and rapid enzymatic browning, limiting shelf life to 1-2 days. The research question addressed how integrated technologies like ultrasound-assisted drying, automated optical sorting, and modified atmosphere packaging (MAP) could extend viability while minimizing weight loss and spoilage. Button mushrooms (Agaricus bisporus) were harvested at the second flush (40-50 mm cap diameter), graded manually and by machine vision for size, colour, and defects. Samples underwent microwave-vacuum drying, non-thermal plasma decontamination, ultrasound-assisted immersion freezing, and MAP (5% O_2, 10% CO_2 at 4°C). Metrics included weight loss (gravimetric), texture (profile analysis), colour (ΔE colorimetry), microbial loads (plate counts), and ergothioneine (HPLC) over 14 days .Ultrasound (200-300 W) cut weight loss by 40-60%, maintained ΔE <5 and >80% chewiness; microwave drying removed 90% moisture in <2 hours with 85% antioxidant retention; sorting reduced defects 70%; MAP prolonged shelf life to 12-15 days (<1 log microbe rise). Overall losses dropped 75% synergistically. These multimodal innovations provide scalable, cost-effective solutions for growers, boosting market value, cutting waste, and supporting sustainable production in regions like Uttar Pradesh. Implications include policy for tech adoption and farmer training.

Keywords: - mushroom drying, post-harvest sorting, storage innovations, shelf-life extension, loss reduction.

https://doie.org/10.10346/AE.2026934028

INDUSTRIAL WASTE MANAGEMENT THROUGH CIRCULAR ECONOMY AND RENEWABLE ENERGY PATHWAYS FOR CLIMATE-RESILIENT AGRICULTURE IN INDIA

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ABSTRACT

India's agricultural sector, vital to its economy and food security, faces escalating challenges from industrial waste pollution and climate change. Conventional linear waste management practices exacerbate soil degradation, water contamination, and greenhouse gas emissions, undermining climate-resilient farming. This study addresses the integration of circular economy principles with renewable energy pathways to transform industrial waste into resources for sustainable agriculture. The primary aim is to evaluate circular economy models that repurpose agro-industrial waste via renewable energy technologies, enhancing waste valorisation and fostering climate-resilient agricultural practices in India. A mixed-methods approach was employed, focusing on case studies from Uttar Pradesh and Maharashtra as primary study areas. Data were collected from 150 industrial units and 500 farms through surveys, life-cycle assessments (LCA), and techno-economic modelling using tools like SimaPro and RET Screen. Anaerobic digestion, biomass gasification, and biofertilizer production were analysed for feasibility. Results reveal that circular pathways could divert 65% of organic industrial waste, generating 12.5 MW renewable energy and 2.3 million tons of biofertilizers annually, reducing emissions by 40% and boosting farm yields by 25% under climate stress scenarios. These findings underscore the potential for scalable, waste-to-wealth models to build climate-resilient agriculture. Policymakers should incentivize public-private partnerships and integrate these into national frameworks like the National Biofuel Policy for sustainable development.

Keywords: - circular economy, industrial waste, renewable energy, climate-resilient agriculture, waste valorisation, biofertilizers.

https://doie.org/10.10346/AE.2026934028

STUDY OF MARKETING AND POST-HARVEST LOSSES OF ONION IN DISTRICT GHAZIPUR OF UTTAR PRADESH.

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ABSTRACT

Onion is one of the most important commercial vegetable crops in India and plays a vital role in farmers' income as well as in ensuring food and nutritional security. Uttar Pradesh is a major onion-producing state, and Ghazipur district contributes significantly to its production. However, inefficiencies in marketing systems and substantial post-harvest losses continue to reduce farmers' returns and create price instability. Post-harvest losses occur at various stages such as harvesting, curing, storage, transportation, and marketing due to inadequate infrastructure, poor handling practices, and lack of market information. In this context, the present study examines the marketing structure and extent of post-harvest losses of onion in Ghazipur district of Uttar Pradesh. The main objectives of the study are to analyse the existing marketing channels of onion, estimate the magnitude of post-harvest losses at different stages, identify major constraints faced by farmers, and suggest measures to reduce losses and improve marketing efficiency. The study is based on primary data collected from onion growers, traders, and commission agents selected through a multistage sampling technique in Ghazipur district. Data were collected using a pre-tested structured interview schedule and analysed using descriptive statistics, percentage analysis, and simple tabular methods. The findings reveal that post-harvest losses are highest at the storage and transportation stages, mainly due to lack of scientific storage facilities and improper packaging. The marketing of onion is dominated by intermediaries, resulting in a lower producer's share in the consumer's price. The study concludes that improving storage infrastructure, promoting scientific post-harvest practices, strengthening market linkages, and providing timely market information can significantly reduce losses and enhance farmers' income. The results of the study have important implications for policymakers, extension agencies, and stakeholders involved in onion production and marketing.

Keywords: - Onion, Post-Harvest Losses, Marketing Channels, Income.

https://doie.org/10.10346/AE.2026934028

STUDY ON BRAND PROMOTION OF HYBRID PEARL MILLET AT AGRA DISTRICT IN UTTAR PRADESH

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ABSTRACT

Pearl millet (Pennisetum glaucum), a vital coarse cereal in semi-arid regions of India, supports food security and livelihoods for smallholder farmers in Uttar Pradesh. Despite its nutritional value and resilience to drought, pearl millet faces market challenges including low consumer awareness, poor branding, and competition from hybrid varieties and processed foods. This study addresses the gap in effective brand promotion strategies to enhance market visibility and farmer incomes in Agra district, a key production hub. the primary objective was to assess current brand promotion practices for pearl millet and identify strategies to improve market penetration and consumer preference among rural and urban stakeholders. A mixed-methods approach was employed in Agra district, Uttar Pradesh, targeting 200 respondents including 150 farmers, 30 Agri-retailers, and 20 consumers via stratified random sampling. Data collection involved structured questionnaires, focus group discussions, and key informant interviews, analysed using descriptive statistics, chi-square tests, and SWOT analysis with SPSS Software. Key findings revealed low brand recognition (only 32% awareness), ineffective digital and traditional marketing (e.g., limited packaging and labelling), and opportunities in value-added products like millet flour and snacks. Farmers reported 25% higher income potential through branded hybrids. the study concludes that targeted branding via social media, certifications, and public-private partnerships can boost pearl millet demand. Implications include policy recommendations for extension services and subsidies on branded seeds, fostering sustainable agribusiness growth in Uttar Pradesh.

Keywords: - pearl millet, brand promotion, Agra district, Uttar Pradesh, agribusiness marketing, farmer income.

https://doie.org/10.10346/AE.2026934028

IMPACT OF GOVERNMENT POLICY 'KCC' ON FARMER'S INCOME IN PRAYAGRAJ DISTRICT OF UTTAR PRADESH

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ABSTRACT

The Kisan Credit Card (KCC) scheme is a major government policy initiative aimed at improving farmers' access to timely and affordable institutional credit, thereby enhancing agricultural productivity and farm income. Despite its wide implementation, variations in awareness, utilization, and actual income impact persist across regions. The Prayagraj district of Uttar Pradesh, characterized by diverse farming systems and a predominance of small and marginal farmers, provides an important context to assess the effectiveness of the KCC scheme in improving farmers' income and reducing dependence on informal credit sources. The primary objective of this study is to examine the impact of the Kisan Credit Card scheme on farmers' income in Prayagraj district. Specifically, the study aims to analyse changes in farm income, input use, cropping intensity, and credit utilization patterns among KCC beneficiary farmers. The study adopts a descriptive and analytical research design. Primary data were collected through a structured interview schedule from a sample of KCC beneficiary and non-beneficiary farmers selected using a multistage random sampling technique across selected blocks of Prayagraj district. Secondary data were obtained from government reports, bank records, and published literature. Analytical tools such as tabular analysis, percentage analysis, mean comparison, and simple statistical tests were used to assess income differences and scheme impact. The findings indicate that KCC beneficiaries experienced a noticeable increase in farm income, improved access to institutional credit, timely purchase of inputs, and reduced reliance on moneylenders compared to non-beneficiaries. However, issues related to credit limits, awareness, and procedural delays were also observed. The study concludes that the KCC scheme has a positive impact on farmers' income in Prayagraj district, though its effectiveness can be further enhanced through improved awareness, simplified procedures, and periodic revision of credit limits. The findings hold significant policy relevance for strengthening credit delivery mechanisms in rural areas.

Keywords: - Kisan Credit Card, Farmers' Income, Institutional Credit, Government Policy.

https://doie.org/10.10346/AE.2026934028

A STUDY ON MARKETING OF HYBRID PADDY IN MIRZAPUR DISTRICT OF UTTAR PRADESH

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ABSTRACT

The present study was conducted to analyse the marketing system of hybrid paddy in Mirzapur district of Uttar Pradesh with the objective of examining marketing channels, cost and margins, price spread, and major constraints faced by farmers. The study aimed to identify key marketing problems affecting farmers' income and efficiency in the paddy value chain. A multistage sampling technique was adopted for the selection of blocks, villages, and respondents. Primary data were collected from hybrid paddy growers through personal interviews using a pre-tested structured schedule for the agricultural year 2023–24. Secondary data were obtained from published reports, government records, and related institutions. The results revealed that farmers primarily sold their produce through local traders and commission agents, resulting in higher marketing costs and reduced-price realization. Major problems identified included price fluctuation, lack of storage facilities, high transportation cost, delayed payments, and limited access to institutional credit. The study also found that intermediaries captured a significant share of the consumer's price, leading to a wider price spread. The findings highlight the need for strengthening market infrastructure, promoting direct marketing channels, improving access to credit, and providing timely market information to farmers. The study concludes that enhancing marketing efficiency and reducing intermediary dominance can significantly improve the income of hybrid paddy farmers and support sustainable agricultural development in the region.

Keywords: - Hybrid Paddy, Marketing Channels, Price Spread, Farmers' Constrain.

https://doie.org/10.10346/AE.2026934028

ENHANCING AGRICULTURAL SUSTAINABILITY THROUGH EFFECTIVE KNOWLEDGE SHARING AMONG AGRIBUSINESS STAKEHOLDERS

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ABSTRACT

Agribusiness and sustainable agriculture are increasingly dependent on effective knowledge sharing among key stakeholders, including farmers, researchers, policymakers, and businesses. The aim of this research is to identify and develop strategies that can enhance the flow of knowledge and foster collaboration in order to promote sustainability in agriculture. The research methodology involved a comprehensive review of existing literature on knowledge-sharing frameworks, alongside surveys and interviews with stakeholders from various sectors. These approaches helped uncover the current challenges in communication and collaboration, as well as potential solutions, such as the use of digital tools and the formation of partnerships. The findings suggest that digital platforms for collaboration, regular workshops and conferences, and the use of web-based and mobile technologies play a pivotal role in improving knowledge exchange. Open access to agricultural data was also identified as a significant enabler of innovation. Building strong partnerships between academia, government, and industry emerged as critical for promoting sustainable practices. However, there remains a gap in providing accessible, real-time data and technical support to small-scale farmers, highlighting the need for more inclusive knowledge-sharing models. In conclusion, fostering a culture of collaboration and knowledge sharing among agribusiness stakeholders is essential for advancing sustainability in agriculture. By improving communication, leveraging technology, and promoting inclusive practices, the sector can accelerate innovation and ensure more widespread adoption of sustainable agricultural practices, benefiting both the environment and the global economy.

Keywords: agribusiness, sustainable agriculture, knowledge sharing, collaboration.

https://doie.org/10.10346/AE.2026934028

POST-HARVEST MANAGEMENT & LOSS REDUCTION TECHNOLOGIES

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ABSTRACT

Post-harvest losses remain one of the most critical challenges in agriculture, particularly in developing countries where inadequate infrastructure, poor handling practices, and limited access to modern technologies lead to significant quantitative and qualitative losses. This study explores innovative post-harvest management and loss reduction technologies that can enhance value retention, improve farmer incomes, and strengthen food supply chains. The focus is on practical, scalable solutions such as scientific drying methods, low-cost storage systems, improved grading and sorting mechanisms, and digital monitoring tools for temperature and humidity control. The research highlights how the integration of modern technologies—such as solar dryers, hermetic storage bags, cold chain micro-units, and AI-based sorting systems—can drastically reduce spoilage in perishable commodities like fruits, vegetables, grains, and pulses. Emphasis is placed on decentralized, farmer-friendly models that can be adopted at the village or Farmer Producer Organization (FPO) level. The role of startups and Agri-entrepreneurs in providing post-harvest services—like mobile packhouses, aggregation centres, and pay-per-use cold storage—is also examined as a sustainable business opportunity. Furthermore, the abstract discusses the economic, environmental, and social benefits of reducing post-harvest losses, including improved food security, reduced pressure on natural resources, and increased market competitiveness. Policy support, access to credit, and skill development are identified as key enablers for large-scale adoption. Overall, strengthening post-harvest systems through technology, entrepreneurship, and institutional support can transform agricultural value chains from loss-prone to value-driven, ensuring better returns for farmers and more stable food availability for consumers.

Keywords: - Post-harvest management, Value chain efficiency, Cold chain infrastructure, AI-based grading and sorting, Food security.

https://doie.org/10.10346/AE.2026934028

WOMEN IN AGRIBUSINESS: UNLOCKING RURAL POTENTIAL

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ABSTRACT

India is an agrarian economy with about 54.6 percent of total workforce engaged in agricultural and allied sector activities. For many years, their contribution remained unpaid and unrecognized, even though they were involved in almost every farming activity. Today, this situation is changing as rural women are moving beyond being just farm labours and becoming agribusiness entrepreneurs in areas such as dairy, poultry, fisheries, food processing, and Agri-input services. The workforce participation rate for rural females is significantly higher at 41.8 percent against urban women participation rate of 35.31 percent. The article highlights how women agri-entrepreneurs are contributing to rural economic growth by creating employment, increasing household income, and strengthening agricultural value chains. The study adopts a descriptive and analytical approach based on secondary data collected from official government sources, reports, and published literature to show the growing participation of women in agriculture and entrepreneurship, at the same time it shows the challenges faced by women agri- entrepreneurs related to access to resources, markets, infrastructure, and social barriers. The paper discusses key strategies to support women-led agribusiness, including better institutional support, digital access, skill development, and public–private partnerships. The All India Coordinated Research Project (AICRP) on Women in Agriculture (WIA) takes up the region-specific issues related to women in agriculture to address the livelihood security, household nutrition, drudgery reduction, occupational health hazards and capacity building of agrarian families. The transition of women from unpaid labourers and homemakers to agripreneurs has not only led to a shift in rural economy but also a strategic sustainable rural development indicating that empowering women in agribusinesses is far more than a matter of gender-equality and equity.

Keywords: - Rural Development, Women Agripreneurs, Inclusive Growth, Economic Development, Agricultural Value-Chains.

https://doie.org/10.10346/AE.2026934028

NATURAL, ORGANIC & REGENERATIVE AGRICULTURE ENTERPRISES

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ABSTRACT

Background/Introduction: The accelerating degradation of agricultural ecosystems has prompted a global shift toward natural, organic, and regenerative agriculture. While these practices promise enhanced soil health, carbon sequestration, and biodiversity, the rapid proliferation of diverse certification schemes and eco-labels has created a complex landscape that challenges consumer trust and business differentiation. There is a pressing need to understand how these ventures balance ecological, social, and financial goals. Objectives: This research aims to analyse the business models, certification strategies, and market positioning of regenerative and organic agriculture enterprises, focusing on how eco - labelling influences consumer perception and market access. Methodology: A mixed-methods approach was employed, combining a systematic literature review (2000–2025) with a case study analysis of 15 pioneering regenerative enterprises in the North American market. Data was collected via semi-structured interviews with industry leaders and analysis of company sustainability reports, focusing on the adoption of Regenerative Organic Certified (ROC) and similar standards. Key Findings: Results indicate that while organic certification is a baseline, regenerative ventures gain a competitive advantage by adopting "outcomes-based" standards that emphasize soil health and biodiversity. Conclusion/Implications: The findings highlight that successful sustainable product ventures integrate "re-naturalization" practices with robust, verified, and transparent labelling. Policy implications suggest that governments should offer tailored financial incentives for certification to scale regenerative adoption, transforming it from a niche market to a standard for sustainable food systems.

Keywords: - Regenerative Agriculture, Organic Certification, Eco- labelling, Sustainable Entrepreneurship, Soil Health, Consumer Trust.

https://doie.org/10.10346/AE.2026934028

STUDY OF SUPPLY CHAIN OF FRUITS AND VEGETABLE IN PRAYAGRAJ DISTRICT OF UTTAR PRADESH.

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ABSTRACT

The supply chain of fruits and vegetables in India faces significant challenges, including high post-harvest losses, inefficient logistics, and inadequate cold storage infrastructure, leading to substantial economic losses and reduced market access for smallholder farmers. In Prayagraj District, Uttar Pradesh—a key agricultural hub with diverse horticultural production—these issues are exacerbated by fragmented marketing channels and seasonal perishability, underscoring the need for a comprehensive study to enhance supply chain resilience and sustainability. This research aims to analyse the structure, functioning, and bottlenecks of the fruits and vegetables supply chain in Prayagraj District, identify key actors and inefficiencies, and propose strategies for optimization to minimize losses and improve farmer incomes. A mixed-methods approach was employed in Prayagraj District, encompassing 250 respondents (farmers, intermediaries, wholesalers, and retailers) selected via multi-stage stratified random sampling. Primary data were collected through structured questionnaires, semi-structured interviews, and focus group discussions, supplemented by secondary data from government reports. Supply chain mapping, gap analysis, and statistical tools such as descriptive statistics and regression modelling were used for analysis. The study revealed a multi-layered supply chain dominated by intermediaries, with post-harvest losses averaging 25–30% due to poor transportation and storage. Small farmers received only 40–50% of the consumer price, while inefficiencies in grading and packaging contributed to quality degradation. The findings highlight the potential for interventions like farmer producer organizations, improved cold chains, and digital marketplaces to reduce losses by up to 15% and boost farmer incomes. Policymakers can leverage these insights to formulate targeted strategies promoting sustainable horticultural supply chains in similar agrarian regions.

Keywords: - fruits and vegetables, supply chain, Prayagraj District, post-harvest losses, Uttar Pradesh, farmer incomes.

https://doie.org/10.10346/AE.2026934028

STUDY ON POST HARVEST LOSSES AND MARKETING OF GREEN CHILLI IN PRAYAGRAJ DISTRICT UTTARPRADESH

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ABSTRACT

Post-harvest losses in horticultural crops like green chilli represent a critical challenge to food security, farmer incomes, and supply chains in India, where up to 20-30% of produce is lost due to inefficient handling, transportation, and marketing. In Prayagraj district, Uttar Pradesh—a key chilli-producing region—these losses exacerbate economic vulnerabilities for smallholder farmers amid fluctuating market dynamics. This study addresses the gap in localized data on post-harvest losses and marketing inefficiencies to inform sustainable interventions. The primary aim was to quantify post-harvest losses in green chilli, analyse marketing channels, assess price variability, and identify constraints faced by farmers and intermediaries. A multi-stage stratified random sampling technique was employed in Prayagraj district, covering 200 farmers and 50 market intermediaries across five major blocks. Data were collected via structured questionnaires, focus group discussions, and field observations during the 2024 kharif season. Quantitative analysis included descriptive statistics, Garrett ranking, and regression models using SPSS software. Post-harvest losses averaged 18.5%, primarily from mechanical damage (42%) and decay (35%). Marketing through intermediaries dominated (72%), yielding low farmer margins (28%). Price fluctuations correlated strongly with supply glut (R^2=0.67), while poor infrastructure amplified losses. Findings underscore the need for improved grading, cold storage, and direct farmer-market linkages. Policy recommendations include subsidies for packhouses and market intelligence apps to reduce losses by 10-15% and boost incomes, supporting Uttar Pradesh's horticultural goals.

Keywords: - post-harvest losses, green chilli, marketing channels, Prayagraj district, Uttar Pradesh, farmer incomes.

https://doie.org/10.10346/AE.2026934028

STUDY ON SUPPLY CHAIN MANAGEMENT OF VEGETABLES PEA IN PRAYAGRAJ DISTRICT OF THE UTTAR PRADESH

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ABSTRACT

Vegetable supply chains in India, particularly for perishable crops like peas, face significant challenges including post-harvest losses, inefficient logistics, and market volatility, contributing to food insecurity and farmer income instability. In Prayagraj district, Uttar Pradesh—a major pea-producing region—these issues are exacerbated by fragmented marketing channels and inadequate cold chain infrastructure, necessitating targeted research to enhance sustainability and efficiency. This study aims to analyse the pea supply chain structure, identify bottlenecks, assess economic viability for stakeholders, and propose strategies for optimization in Prayagraj district. A mixed-methods approach was employed in Prayagraj district, involving a multi-stage stratified random sampling of 200 stakeholders (farmers, wholesalers, retailers, and processors). Primary data were collected via structured questionnaires, focus group discussions, and key informant interviews. Secondary data from government reports supplemented the analysis, with tools including descriptive statistics, Garrett ranking, and supply chain mapping via SWOT analysis. Results reveal high post-harvest losses (18-22%) due to poor transportation and storage. Wholesalers dominate the chain (45% marketing share), yet farmers receive only 52% of consumer price. Cold storage utilization stands at a low 35%, with significant scope for cooperatives to reduce intermediaries. The findings underscore the need for integrated cold chains and digital marketplaces to minimize losses and boost farmer incomes. Policy recommendations include subsidies for storage infrastructure and farmer producer organizations, offering practical pathways for resilient pea supply chains in similar agrarian districts.

Keywords: - pea supply chain, Prayagraj district, post-harvest losses, Uttar Pradesh, cold chain, marketing efficiency.

https://doie.org/10.10346/AE.2026934028

FACTORS INFLUENCING CONSUMER BUYING BEHAVIOUR TOWARDS HYDROPONIC PRODUCE IN DEHRADUN DISTRICT

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ABSTRACT

The present study was conducted to identify the factors influencing consumer buying behaviour towards hydroponic produce in Dehradun district of Uttarakhand. Hydroponic produce is increasingly gaining attention due to its perceived quality, freshness, and pesticide-free nature; however, consumer adoption remains limited. The study aimed to examine the role of product attributes, price, awareness, availability, and socio-economic characteristics in influencing purchase decisions. Primary data were collected from selected consumers through a structured questionnaire using personal interview method. A simple random sampling technique was adopted for selecting respondents. Secondary data were collected from published reports, articles, and related sources. The findings revealed that health consciousness, quality, and freshness were the most important factors influencing consumer buying behaviour, followed by awareness about hydroponic production. High price and limited market availability were identified as major constraints affecting purchase frequency. The study concluded that improving consumer awareness, expanding market availability, and adopting suitable pricing strategies could enhance consumer acceptance of hydroponic produce in urban markets.

Keywords: - Consumer behaviour, Hydroponic produce, Awareness, Price, Dehradun.

https://doie.org/10.10346/AE.2026934028

INNOVATIONS IN SEED, CROP PROTECTION & PRECISION INPUT DELIVERY SYSTEMS SAURABH SINGH

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ABSTRACT

Agriculture worldwide grapples with climate change, diminishing resources, and rising food demands, where innovations in seed technology, crop protection, and precision input delivery systems hold transformative potential. Entrepreneurship in agritech bridges critical gaps, yet their adoption by smallholder farmers remains underexplored, particularly in regions like India. This study addresses how these innovations drive sustainable farming and entrepreneurial scalability. The primary aim is to analyze entrepreneurial ventures developing climate-resilient seeds, biopesticide solutions, and AI/drone-based precision applicators, evaluating their impact on productivity, cost-efficiency, and environmental sustainability. A mixed-methods design was applied across India (Prayagraj region focus) and the US, involving case studies of 12 startups, surveys with 250 farmers, field trials (2023–2025), and data analytics using GIS and econometric models. Results reveal 30–45% yield increases, 35% input cost reductions, and 55% lower chemical use via precision systems achieving 92% accuracy. Startups reported 2.5x ROI in 18 months, with smallholders gaining most from hybrid seeds and nano-delivery tech. These outcomes highlight agritech entrepreneurship's role in resilient food systems, urging policy support for incubators, subsidies, and farmer training to scale innovations globally. Implications include enhanced rural economies and policy rameworks for sustainable agriculture.

Keywords: - Agritech Entrepreneurship, Precision agriculture, Seed Innovation, Crop Protection, Input Delivery, Sustainable Farming.

https://doie.org/10.10346/AE.2026934028

STUDY ON BRABD PROMOTION OF HYBRID PADDY IN REWA DISTRICT OF MADHYA PRADESH

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ABSTRACT

Hybrid paddy has emerged as an important innovation in Indian agriculture due to its potential to increase rice productivity and farmers' income. In districts like Rewa in Madhya Pradesh, where paddy cultivation is a major source of livelihood, the adoption of hybrid paddy largely depends on how effectively seed brands are promoted and perceived by farmers. Despite the availability of several hybrid paddy brands in the market, many farmers face confusion in selecting suitable varieties because of limited awareness, unequal access to information, and strong dependence on local input dealers. Therefore, understanding brand promotion practices in this region is essential from an entrepreneurial perspective. The primary objective of this study is to examine the existing brand promotion strategies of hybrid paddy seeds in Rewa district and to assess farmers' awareness, preferences, and factors influencing their purchase decisions. The study also aims to identify the role of agri-entrepreneurs and input dealers in promoting hybrid paddy brands. The research follows a descriptive methodology and was conducted in selected blocks of Rewa district, Madhya Pradesh. Primary data were collected from paddy-growing farmers and seed dealers through structured questionnaires and personal interviews. Simple statistical tools such as percentage analysis and ranking methods were used for data interpretation. The study finds that field demonstrations, dealer advice, and farmers' previous experiences are the most influential promotional tools. Well-known brands enjoy higher trust, while new brands struggle with visibility. The study highlights the need for farmer-oriented promotion and stronger local entrepreneurship to improve hybrid paddy adoption.

Keywords: - Hybrid paddy, Brand promotion, Farmer awareness, Agri-entrepreneurship, Seed marketing, Rewa district.

https://doie.org/10.10346/AE.2026934028

ABSTRACT ON- "RABI & KHARIF CROPS; AGRICULTURE PRODUCTION IN INDIA

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ABSTRACT

Indian agriculture is primarily based on two major cropping seasons; Kharif and Rabi which together play a vital role in ensuring national food security. Kharif crops sown during the monsoon season, include rice, maize, millets, cotton, and oilseeds, and largely depend on rainfall. Rabi crops grown in the winter season, comprise wheat, pulses, mustard, and barley, relying mainly on irrigation and residual soil moisture. In recent years, India has recorded high and stable agricultural production, with significant contributions from both seasons.
Improved irrigation facilities, modern farming practices, and supportive government policies have led to increased production of major cereals, pulses, and oilseeds, strengthening food availability and rural livelihoods in the country.

Keywords: - Rabi crops, Kharif crops, Cropping seasons, Foodgrain production, and Indian agriculture.

https://doie.org/10.10346/AE.2026934028

EMPOWERING RURAL YOUTH THROUGH AGRIPRENEURSHIP: INTEGRATING TECHNOLOGY, POLICY, AND MARKET ACCESS

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ABSTRACT

Rural India faces persistent youth unemployment amid agricultural stagnation and limited non-farm employment opportunities. This study explores the potential of agripreneurship as a transformative pathway for empowering rural youth in Uttar Pradesh by integrating digital technologies, supportive policy frameworks, and efficient market linkages. From precision seed systems to global exports such interventions are vital for fostering sustainable livelihoods and economic resilience. The primary objective is to assess how technological adoption, policy support, and market access collectively facilitate the scaling of youth-led agripreneurial ventures, promote sustainable agribusiness models, and strengthen agricultural value chains. A mixed-methods research design was employed, involving a structured survey of 450 rural youth across ten districts of Uttar Pradesh, complemented by focus group discussions with agripreneurs, policymakers, and market intermediaries. Logistic regression analysis was used to examine key drivers influencing agripreneurial adoption, while thematic analysis helped identify structural and operational barriers. The findings indicate that access to digital technologies, including digital payment systems and precision agricultural inputs, enhances startup success rates by 42 percent. Policy incentives and subsidies increase youth participation by 35 percent, while market linkages through e-platforms raise incomes of women-led agripreneurial ventures by 28 percent. Collective youth enterprises demonstrated notable resilience in emerging sectors such as aquaculture, post-harvest storage technologies, and agri-logistics. The study underscores agripreneurship's significant role in rural economic revitalization on technology incubation, skill development, and exportoriented branding to foster inclusive growth and enhance agribusiness competitiveness.

Keywords: - Agripreneurship, Rural Youth, Technology Integration, Policy Support, Market Access, Sustainable Agribusiness.

https://doie.org/10.10346/AE.2026934028

THE ROLE OF AGRICULTURE IN THE INDIAN ECONOMY (2026)

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ABSTRACT

Agriculture continues to play a pivotal role in the Indian economy in 2026, despite a declining share in gross domestic product. The sector remains the primary source of livelihood for a large proportion of the population and is central to food security, rural employment, and poverty reduction. In recent years, Indian agriculture has undergone significant changes due to technological advancements, policy reforms, climate variability, and increased integration with markets. However, challenges such as low productivity, small and fragmented landholdings, income instability, and regional disparities persist. The sector's performance has a strong multiplier effect on the overall economy through its linkages with industry and services. This study highlights the continued importance of agriculture for inclusive and sustainable economic growth in India and emphasizes the need for sustained public investment, technological innovation, and institutional support to enhance productivity, resilience, and farmers' incomes.

Keywords:- Economic development, rural employment, food security, public investment, Indian agriculture

https://doie.org/10.10346/AE.2026934028

A STUDY ON BUYING BEHAVIOUR OF RURAL CONSUMERS TOWARDS BIOFERTILIZERS IN JAUNPUR DISTRICT, UTTAR PRADESH

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ABSTRACT

The present study was conducted to examine the buying behaviour of rural consumers towards the use of biofertilizers in the Jaunpur district of Uttar Pradesh. The primary objective of the study was to analyze the level of awareness, adoption, and factors influencing the purchase and use of biofertilizers among rural farmers, in the context of increasing concerns over soil health and environmental sustainability. The study adopted a descriptive research design, and primary data were collected from rural consumers through structured questionnaires, while secondary data were obtained from journals, reports, and related literature. The collected data were analyzed using appropriate statistical tools such as percentages and averages to interpret the buying behaviour patterns. The results revealed that awareness about biofertilizers among rural consumers was moderate, and purchasing decisions were largely influenced by factors such as perceived benefits, availability, price, and recommendations from agricultural extension services and fellow farmers. However, limited technical knowledge, traditional dependence on chemical fertilizers, and uncertainty regarding effectiveness were identified as major constraints affecting adoption. The study concluded that increased awareness programs, training initiatives, and improved distribution channels are essential to enhance the acceptance and usage of biofertilizers among rural consumers. The findings of the study are significant for policymakers, agricultural extension agencies, and marketers in promoting sustainable agricultural practices in rural areas.

Keywords:- Biofertilizers, Buying Behaviour, Rural Consumers, Sustainable Agriculture, Jaunpur District.

https://doie.org/10.10346/AE.2026934028

INTEGRATING E-COMMERCE WITH AGRICULTURAL SUPPLY CHAINS FOR MARKETING OF BUTTON MUSHROOM.

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ABSTRACT

Button mushroom farming (Agaricus bisporus) is an important source of income and nutrition for rural households in Uttar Pradesh, yet its potential is undermined by weak supply chains marked by high post-harvest losses, volatile prices, and farmer dependence on intermediaries who erode profits. This study examines how integrating e-commerce into the mushroom supply chain can address these challenges by enabling direct-to-consumer sales and data-driven decision-making. Conducted in Mahoba district during 2024–2025, the research used a mixed-methods approach involving surveys, interviews, focus groups, and field observations with 200 farmers, evenly split between e-commerce adopters and non-adopters. Quantitative techniques such as regression and difference-in-differences analysis were complemented by qualitative insights and the use of digital tools including AI-based pricing applications, IoT sensors for transport monitoring, and blockchain-enabled traceability. The findings reveal that e-commerce adoption reduced the number of intermediaries by about half, lowered post-harvest losses to 12%, increased net returns by 38%, and expanded market access by 65%, particularly into urban areas. Enhanced transparency through blockchain improved consumer trust, while demand analytics significantly raised farmer satisfaction and confidence in marketing decisions. Overall, the study demonstrates that e-commerce can play a transformative role in building more efficient, resilient, and inclusive agricultural supply chains, underscoring the need for supportive policies focused on rural digital infrastructure, farmer training, and targeted subsidies to strengthen food security and sustainable agribusiness in emerging economies.

Keywords:- e-commerce integration, button mushroom, agricultural supply chain, post-harvest losses, digital agriculture, rural marketing.

https://doie.org/10.10346/AE.2026934028

ADOPTION OF AI, IOT AND DRONE TECHNOLOGIES IN SMART FARMING: OPPORTUNITIES FOR YOUTH-LED AGRI-STARTUPS IN INDIA

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ABSTRACT

The rapid advancement of digital technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and drones is transforming Indian agriculture from a traditional system to a technology-driven smart farming model. With the growing emphasis on innovation, sustainability, and youth entrepreneurship under the vision of Viksit Bharat @2047, the adoption of these technologies presents significant opportunities for youth-led agri-startups in India. Smart farming tools enable precision decision-making, efficient resource utilization, and improved farm productivity, thereby creating a conducive ecosystem for agripreneurship and rural employment.This paper examines the role of AI, IoT, and drone technologies in promoting smart farming and fostering youth-led agri-startups in India. It highlights how AI-based analytics, sensor-based IoT systems, and drone-enabled monitoring can enhance crop management, irrigation efficiency, pest control, and yield prediction while reducing input costs and environmental impact. The study also explores emerging business models in agri-tech startups, including drone service providers, farm advisory platforms, precision input suppliers, and digital farm management solutions led by young entrepreneurs. The study is based on secondary data sourced from government reports, research publications, industry case studies, and policy documents related to digital agriculture and agri-startups. It identifies key opportunities such as improved farm efficiency, scalable startup models, and increased rural employment, while also addressing challenges including high initial investment, digital literacy gaps, and limited infrastructure in rural areas. The paper concludes that with adequate policy support, skill development, and access to finance, AI, IoT, and drone technologies can significantly empower youth-led agri-startups and contribute to a resilient, sustainable, and technologically advanced agricultural sector in India.

Keywords: - Smart Farming; Artificial Intelligence; Internet of Things; Drones; Youth Agrienterpreneurship; Agri-Startups.

https://doie.org/10.10346/AE.2026934028

"SUSTAINABLE AGRICULTURE IN VIKSIT BHARAT 2047"

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ABSTRACT

Sustainable agriculture forms the cornerstone of India's Viksit Bharat 2047 vision, transforming the sector from a food security focus to a resilient, tech-driven engine of inclusive growth. By integrating climate-smart practices, precision farming, and regenerative techniques, it addresses challenges like soil degradation, water scarcity, and smallholder vulnerabilities while boosting productivity to record levels, such as 353.96 million tonnes in 2024–25. Realizing Viksit Bharat requires policy reforms like agri-tech incentives, institutional convergence, and capacity building to scale adoption, positioning agriculture as a self-reliant pillar for a developed India by 2047.

Keywords: Sustainable agriculture, Vikisit bharat 2047, Soil degradation, Water scarcity, Biodiversity loss, Smallholder empowerment, Environmental health, Precision farming.

https://doie.org/10.10346/AE.2026934028

AGRI-BIOTECHNOLOGY & BIO-INNOVATION FOR NEXT-GEN ENTREPRENEURS

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ABSTRACT

Imagine a world where young farmers and scientists team up to engineer drought-proof crops and super-efficient microbes that could feed billions without wrecking the planet— that's the promise of Agri-biotechnology and bio-innovation for next-gen entrepreneurs. As climate change bites and populations boom, traditional farming just isn't cutting it anymore, leaving huge gaps in food security that innovative minds can fill with tools like CRISPR for tweaking plant DNA, synthetic biology for custom microbes, and smart bio-fertilizers. This paper dives into how these breakthroughs are sparking a new wave of startups, especially in places like India, but spotlights real hurdles: tough regulations, scarce funding, and the tricky jump from lab to field. Our goals? Map out the path from idea to market, spotlight trailblazing companies, and share practical tips for budding Agripreneurs on grabbing patents, pitching investors, and winning over sceptical farmers. We pulled this together with a hands-on mix: deep dives into 50 startups like Indigo Ag's nitrogen-fixing bacteria wizards and pairwise seedless berries, chats with 300 young hustlers across Asia and Africa, plus wisdom from top experts via Delphi rounds, all crunched with SWOTs, diffusion models, and yield forecasts. The numbers are exciting—think 20-50% yield jumps, 40% less pesticides, and a $500 billion startup bonanza by 2030. Success stories hinge on incubators blending universities with big ag corps, open-source gene hacks, and AI for pinpoint farming. Bottom line: by easing rules, pumping in venture cash, and building bridges between labs and lands, we can unleash these entrepreneurs to grow a greener, fairer food future for all.

Keywords: agri-biotechnology, bio-innovation, next-gen entrepreneurs, CRISPR, sustainable agriculture, startup ecosystems.

https://doie.org/10.10346/AE.2026934028

NATURAL FARMING PRACTICES FOR SUSTAINABLE AGRICULTURE

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ABSTRACT

Natural farming has gained increasing attention as a sustainable agricultural approach in response to the ecological and economic challenges posed by chemical-intensive farming systems. Excessive dependence on synthetic inputs has led to declining soil health, environmental degradation, and rising cultivation costs, necessitating alternative practices that are environmentally benign and farmer-friendly. The present study aims to evaluate the effectiveness of natural farming practices in achieving sustainable agriculture with respect to soil fertility, crop productivity, and ecological balance. The study adopted a descriptive and analytical research design and was conducted in selected agricultural regions practicing natural farming. Primary data were collected from a sample of farmers using structured questionnaires and field observations, while secondary data were sourced from scientific literature and institutional reports. The results reveal that natural farming practices, including the use of bio-inputs, on-farm resources, and minimal external inputs, improve soil biological activity, reduce input costs, and enhance farm sustainability. The study concludes that natural farming holds significant potential for sustainable agriculture and should be supported through policy interventions, extension services, and capacity-building programs.

Keywords: Natural farming, Sustainable agriculture, Soil health, Eco-friendly farming, Farm sustainability.

https://doie.org/10.10346/AE.2026934028

ORGANIC FARMING PRACTICES FOR SUSTAINABLE AGRICULTURE

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ABSTRACT

Organic farming has emerged as a viable alternative to conventional agriculture due to growing concerns over soil degradation, environmental pollution, and long-term food security. Excessive use of synthetic fertilizers and pesticides has adversely affected ecosystem health and farm sustainability, necessitating the adoption of eco-friendly practices. The present study aims to examine the role of organic farming practices in promoting sustainable agriculture by improving soil health, crop productivity, and environmental quality. The research was conducted using a descriptive and analytical approach based on both primary and secondary data. Primary data were collected from selected organic farmers through structured interviews, while secondary data were obtained from published reports, journals, and institutional records. The findings indicate that organic farming practices such as crop rotation, use of organic manures, and biological pest management enhance soil fertility, reduce production costs, and support biodiversity. The study concludes that organic farming contributes significantly to sustainable agricultural development and should be promoted through supportive policies, farmer training, and market incentives.

Keywords: Organic farming, Sustainable agriculture, Soil health, Eco-friendly practices, Biodiversity.

https://doie.org/10.10346/AE.2026934028

DEVELOPING SUSTAINABLE SUPPLY CHAINS IN THE AGRIBUSINESS SECTOR

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ABSTRACT

Sustainable supply chains have become increasingly important in the agribusiness sector due to growing concerns related to environmental degradation, resource inefficiency, post-harvest losses, and unequal value distribution among stakeholders. Traditional agribusiness supply chains are often characterized by high wastage, excessive intermediaries, limited traceability, and negative environmental impacts. In this context, developing sustainable supply chains is essential to ensure food security, enhance farmer incomes, and promote environmentally responsible agricultural practices. The primary objective of this study was to examine the role of sustainable supply chain practices in improving the efficiency, resilience, and sustainability of the agribusiness sector. The study also aimed to identify key strategies and challenges associated with the adoption of sustainable supply chain models in agribusiness. The study employed a descriptive and analytical research approach based on secondary data collected from research journals, government reports, policy documents, and case studies related to agribusiness supply chains. In addition, selected primary insights from agribusiness firms, Farmer Producer Organizations (FPOs), and supply chain stakeholders were reviewed to understand practical implementation aspects. The key findings revealed that sustainable supply chain practices, such as improved post-harvest management, adoption of digital technologies, value addition, cold chain infrastructure, and direct market linkages, significantly reduced losses and enhanced operational efficiency. The study also found that sustainability-oriented supply chains improved traceability, reduced environmental impacts, and strengthened market access for farmers. However, constraints such as high initial investment, lack of infrastructure, and limited awareness were identified as major challenges. The study concluded that developing sustainable supply chains is critical for the long-term growth of the agribusiness sector. Supportive policies, capacity building, and investment in infrastructure were found to be essential for scaling sustainable agribusiness supply chain models.

Keywords: Sustainable Supply Chains, Agribusiness, Value Chain Management, Post-Harvest Loss Reduction, Farmer Income, Environmental Sustainability.

https://doie.org/10.10346/AE.2026934028

KNOWLEDGE EXTENT OF FARMERS REGARDING IMPROVED PRODUCTION PRACTICES OF ORGANIC FERTILIZERS IN SITAPUR DISTRICT OF UTTAR PRADESH

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ABSTRACT

The present study entitled "Study on about knowledge and adoption of organic fertilizers among the farmers in Ailiya Block of Sitapur District (Uttar Pradesh)". The study was conducted in Ailiya Block of Sitapur district selected purposively. A total number of 120 respondents were selected through proportionate random sampling from five villages on the basis of land holding size. The structured schedule was developed keeping in view the objectives and variable to be studied. The respondents were contacted personally for data collection. The analysis of data was done with the use of correlation coefficient to collection. The percentage, mean and standard deviation was also used for drawing the inference. The results of the study depicted that the majority of the respondents' mobile phone (100%) and T.V. (69.16%) was found as main communication media with the respondents of experience in agriculture. In information sources use pattern of respondents, the maximum contact was observed Gram pradhan (4.15 mean score) with Kisan sahayak (3.57) mean score under formal sources, family members (5.70) under informal and mobile (5.12) mean score under mass media exposure. The maximum number of respondents was found in medium level of scientific orientation, economic motivation, risk orientation with 42.50%, 61.66% and 64.16%, respectively. The variable like social participation, Extension contact, scientific orientation, economic motivation and risk orientation were found highly significant and positive correlated with improved production practices of organic fertilizers. While, age, education, caste, type of family, land holding housing pattern and annual income were found non-significant and positive correlated with knowledge extent improved production practices of organic fertilizers.

Keywords: Knowledge, Organic fertilizers, Sustainable Cultivation Practices and Correlation coefficient.

https://doie.org/10.10346/AE.2026934028

ROLE OF UNDERUTILIZED FRUITS FOR MAINTAINING HUMAN HEALTH

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ABSTRACT

Underutilized fruit species are scattered around the country. These fruits have their own specialty and uniqueness. Many of these fruit species have not been fully exploited and no proper documentation of the status and distribution of them are done in the country so these are called underutilized fruits. Underutilized fruits are quite nutritious in terms of their vitamin C, carotenoid and antioxidant contents like flavonoids, phenolic acid, betacyanin. They are naturally fat free and high in fibre. They may lower the blood sugar level and can strengthen your immune system. Being especially rich sources of minerals, these serve well as emergency or alternative fruits and are well adopted to the marginal or waste lands. Some of the underutilized fruit species are *Aegle marmelos, Embllica officinalis, Artocarpus hetrophyllus, Syzygium cuminii, Carissa carandas, Grewia subinaequalis, Garcinia indica, Feronia limonia, Annona spp., Amranthus spp. Tamarindus indica, Bassia latifolia, Artocarpus lakoocha, Punica granatum and Trapa natans var. bispinosa,* etc. Some of them have distinct flavor and are easy to cultivate under harsh conditions as compared to exotic fruits. The underutilized fruits are naturally disease tolerant and have medicinal properties. They are adopted in hot and hardy climatic conditions. These lesser-known plants are in common use especially in rural areas which have not been fully exploited and are commonly used by local people. These species, thus, need to be exploited at the national and international levels to improve the socio-economic and health status of the society.

Keywords: Underutilized, Unexploited, Antioxidant, Nutrition, Human health.

https://doie.org/10.10346/AE.2026934028

AN ANALYTICAL STUDY OF THE SOCIO-ECONOMIC CHARACTERISTICS OF FARMERS IN PRAYAGRAJ DISTRICT, UTTAR PRADESH

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ABSTRACT

The present study examines the socio-economic characteristics of farmers who are beneficiaries of the Kisan Credit Card (KCC) Scheme in Prayagraj district of Uttar Pradesh. Kisan Credit Card (KCC) Scheme in Prayagraj district of Uttar Pradesh. the socio-economic profile of farmers in selected areas of the district. The study was conducted in the Chaka and Bahadurpur blocks of Prayagraj district, representing typical agrarian conditions of eastern Uttar Pradesh. A total sample of 120 farmers was selected from these two blocks using appropriate sampling techniques to ensure representation of different farm categories. Primary data were collected through a structured interview schedule, while secondary data were obtained from government reports, census records, and relevant research publications. The data were analysed using simple statistical tools such as percentages and averages. The analysis focused on key variables including age, education, family size, landholding pattern, occupation, annual income, cropping pattern, irrigation facilities, access to institutional credit, adoption of modern agricultural inputs, and participation in government schemes. The findings indicate that most farmers belong to small and marginal landholding categories with limited economic resources. Low educational levels, inadequate irrigation facilities, rising input costs, and limited access to timely credit constrain farm productivity and income. Although agriculture is the main occupation, many households depend on supplementary non-farm activities to sustain livelihoods.

Keywords: Kisan Credit Card, Agricultural Credit, Beneficiary Farmers, Socio-Economic Status.

https://doie.org/10.10346/AE.2026934028

FROM ANNADATA TO AGRIPRENEUR: REIMAGINING INDIAN FARMERS FOR VIKSHIT BHARAT 2047

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ABSTRACT

The Indian agricultural landscape has long revered the 'Annadata'—the farmer who feeds the nation—as the backbone of food security. However, evolving market dynamics, technological advancements, and policy reforms are catalysing a paradigm shift from subsistence farming to entrepreneurial ventures, redefining the Annadata as an Agripreneur. In line with the Viksit Bharat 2047 vision, agriculture is increasingly viewed as a rural economic powerhouse, with small and marginal farmers constituting nearly 85% of the farming community. Drawing upon NSSO surveys and NITI Aayog reports, the study highlights that adoption of direct-to-consumer models and digital platforms such as e-NAM can enhance farmer incomes by approximately 20–25% while reducing post-harvest losses estimated at 20–30%. Despite structural challenges including fragmented landholdings, gender disparity (with women-led Agri-enterprises accounting for less than 15%), and climate variability, the paper proposes a four-pillar strategy. The proposed framework focuses on Skill-based Agri-Hubs, Risk Mitigation Mechanisms, Digital Market Linkages, and Climate-Resilient Practices to integrate farmers into higher segments of the Agri-value chain. Strengthening Farmer Producer Organizations and women-led self-help groups is emphasized for value addition and income diversification. This Annadata-to-Agripreneur transition supports inclusive rural development and contributes to India's long-term goal of a self-reliant and resilient agricultural economy by 2047.

Keywords: Agripreneurship, Annadata, Viksit Bharat 2047, Rural Development, Farmer Empowerment, Agribusiness Innovation.

https://doie.org/10.10346/AE.2026934028

EMERGING POST-HARVEST TECHNOLOGIES FOR POMELO PEEL-BASED NUTRACEUTICAL INGREDIENTS

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ABSTRACT

Pomelo (Citrus maxima), a nutritionally and therapeutically significant fruit of the Rutaceae family, results in substantial peel waste during post-harvest processing despite the peel being a rich source of bioactive compounds. The present study aims to evaluate the potential of pomelo peel as a sustainable nutraceutical resource and to highlight the role of emerging post-harvest technologies in its effective utilization. This review systematically examines recent literature on the compositional profile of pomelo peel and advances in post-harvest processing techniques, including optimized drying, innovative extraction methods, and functional food formulation strategies. Emphasis is given to technologies that enhance the recovery, stability, and bioavailability of peel-derived bioactive compounds. The findings indicate that pomelo peel contains significant levels of vitamin C, dietary fibre, flavonoids, essential minerals (calcium, potassium, and magnesium), and natural antioxidants with proven health-promoting properties. Advanced post-harvest processing approaches were found to improve the functional performance and bioavailability of these compounds, enabling their incorporation into fortified confectioneries, beverages, jams, and dietary supplements. Such applications demonstrate potential benefits in the management of lifestyle-related disorders, including obesity, diabetes, and cardiovascular diseases. The study concludes that valorization of pomelo peel through emerging post-harvest technologies offers a promising strategy for sustainable nutrition, reduction of agro-industrial waste, and development of value-added, health-oriented nutraceutical products. These findings contribute to advancing circular economy approaches in fruit processing and functional food development.

Keywords: Post-harvest technologies, Nutraceutical ingredients, Bioactive compounds, Waste valorization, Sustainable nutrition.

https://doie.org/10.10346/AE.2026934028

MEDICINAL PROPERTIES OF BLACK TURMERIC: UTILIZATIONS AND THERAPEUTIC USES

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ABSTRACT

Black turmeric (Curcuma caesia Roxb.) is a rare and highly valued medicinal plant of the family Zingiberaceae, traditionally used in Ayurvedic and folk medicine for the treatment of numerous ailments. Owing to its rising therapeutic demand and indiscriminate harvesting from natural habitats, the species has been classified as endangered by the Central Forest Department of India (2016), underscoring the need for conservation and sustainable utilisation. The rhizomes of C. cassia, characterised by their bluish-black colour, strong aroma, and bitter taste, are of significant commercial and medicinal importance. They exhibit diverse pharmacological activities, including antifungal, antibacterial, anti-inflammatory, antioxidant, and antimicrobial effects, largely due to the presence of curcuminoids, camphor-rich essential oils, and other bioactive phytochemicals. Recent scientific interest has focused on the anticancer potential of black turmeric. Preclinical studies indicate that its bioactive constituents can induce apoptosis, inhibit cancer cell proliferation, suppress metastasis, and enhance the efficacy of chemotherapy and radiotherapy in in vitro and in vivo models, although clinical validation in humans remains limited. Traditionally, black turmeric is consumed in various forms, including standardised extracts in capsule or tablet form (250–500 mg once or twice daily), fresh or dried rhizomes chewed or ground into a paste, herbal teas, and alcohol-based extracts. Ethnomedicinally, C. caesia rhizomes are used to manage respiratory disorders such as pneumonia, cough, cold in children, asthma, and bronchitis, as well as digestive ailments including indigestion, bloating, diarrhoea, menstrual disorders, piles, fever, and vomiting. Externally, rhizome paste is applied for wounds, sprains, bruises, arthritis, migraine, skin disorders, and inflammation, highlighting its broad therapeutic significance.

Keywords- Black turmeric, Utilizations, Medicinal Properties, Antioxidant, Health Benefits.

https://doie.org/10.10346/AE.2026934028

TRANSFORMING INDIAN AGRICULTURE FOR VIKSIT BHARAT 2047: IMPOWERING STARTUP, ENHANCING SKILL DEVELOPMENT AND FOSTERING AGRIPRENEURSHIP FOR YOUTH

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ABSTRACT

The realization of Viksit Bharat 2047 is intrinsically linked to the comprehensive transformation of Indian agriculture into a knowledge-intensive, innovation-driven, and globally competitive sector. This study conceptualizes agricultural transformation as a multi-dimensional process encompassing technological modernization, institutional restructuring, and human capital advancement, with a specific emphasis on startup empowerment, skill development, and youth-centric agripreneurship. The analytical framework integrates endogenous growth theory, innovation systems approach, and value-chain economics to examine the role of agritech startups as catalysts for technology diffusion and entrepreneurial dynamism. Advanced digital and biophysical technologies—including artificial intelligence, machine learning, geospatial analytics, Internet of Things (IoT), blockchain-enabled traceability, and climate-smart agricultural systems—are evaluated for their potential to enhance total factor productivity, reduce transaction costs, and mitigate climate-induced production risks. Concurrently, the study underscores the importance of competency-based skill development architectures in agribusiness management, Agri-logistics, post-harvest engineering, and financial technology to facilitate the transition of rural youth from agrarian labour to entrepreneurial agents. Institutional mechanisms such as innovation clusters, Agri-incubation centres, blended finance models, and public–private–academic partnerships are identified as critical enablers for entrepreneurial ecosystem development and market integration. The synthesis of technological innovation, skilled human capital, and enabling policy regimes is posited to generate positive externalities in terms of inclusive rural growth, employment elasticity, and sustainable intensification. The findings contribute to policy discourse by proposing a scalable and replicable agripreneurship-led development paradigm capable of strengthening food system resilience and accelerating India's progression toward a high-income, knowledge-based agrarian economy under the Viksit Bharat 2047 vision.

Keywords: Bharat @2047, Agriculture Transformation, Sustainable Agriculture, Climate-Resilient Farming, Agri-innovation.

https://doie.org/10.10346/AE.2026934028

IMPORTANCE OF SOIL HEALTH IN AGRICULTURE

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ABSTRACT

Soil health is a fundamental component of agricultural sustainability, directly influencing crop productivity, environmental quality, and food security. However, intensive farming practices, imbalanced fertilizer use, and land degradation have led to a decline in soil physical, chemical, and biological properties, posing serious challenges to long-term agricultural production. This study examines the importance of soil health in agriculture with a focus on its role in enhancing productivity and sustainability. The primary objective of the research is to assess the relationship between soil health indicators and agricultural performance, and to evaluate management practices that support soil resilience. The study adopts a descriptive and analytical approach, based on field surveys conducted in selected agricultural regions. Soil samples were collected and analyzed for key parameters such as organic carbon, nutrient availability, soil structure, and microbial activity using standard laboratory techniques. The findings indicate that soils with higher organic matter content and balanced nutrient status exhibit improved crop yields, better water retention, and enhanced resistance to degradation. The study concludes that maintaining soil health is essential for sustainable agricultural systems. Promoting integrated nutrient management, conservation practices, and soil health monitoring can support farmers' livelihoods and inform agricultural policy aimed at long-term resource conservation.

Keywords: Soil health, Sustainable agriculture, Soil fertility, Crop productivity, Soil management.

https://doie.org/10.10346/AE.2026934028

COMPUTER VISION IN POST-HARVEST QUALITY CONTROL: DETECTING INTERNAL DEFECTS NON-INVASIVELY

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ABSTRACT

Post-harvest losses represent a critical inefficiency in global food systems, with a significant portion of wastage attributed to undetected internal defects in horticultural produce. Traditional quality control methods rely predominantly on manual inspection or external optical sorting. These methods are effective for surface blemishes but fail to identify internal pathologies-such as hollow heart, internal browning, or early-stage rot-leading to economic losses and reduced consumer trust in premium agricultural supply chains. This study aims to develop and evaluate the efficacy of a non-invasive computer vision system utilizing Hyperspectral Imaging (HSI) for the automated detection of internal defects in potatoes (Solanum tuberosum). The primary objective is to transition from simple external automation to an intelligent, autonomous system capable of making internal quality decisions without destructive testing. The research employed a near-infrared (NIR) hyperspectral imaging system (400–1000 nm) to acquire spectral data from a sample of 1,200 tubers, comprising both healthy specimens and those with varying degrees of internal defects. A deep learning approach using Convolutional Neural Networks (CNN) was utilized to feature-extract and classify spectral signatures. The model's predictions were validated against ground truth data obtained through destructive cutting of the samples. Results indicate that the AI-driven HSI system achieved a classification accuracy of 94.8% in detecting internal voids and rot, significantly outperforming traditional RGB-based external sorting methods. Notably, the system successfully identified defects at incipient stages invisible to the human eye. The processing speed was optimized to match industrial conveyor standards, demonstrating high throughput potential. The integration of hyperspectral computer vision into post-harvest operations offers a transformative solution for quality assurance. By enabling the non-destructive assessment of internal quality, this technology reduces food waste and enhances the export competitiveness of agribusinesses. The study advocates for the adoption of such autonomous grading systems to ensure food safety and maximize economic returns.

Keywords: Post-Harvest Technology, Computer Vision, Hyperspectral Imaging, Internal Defects, Non-Destructive Testing (NDT), Deep Learning.

https://doie.org/10.10346/AE.2026934028

FROM AUTOMATION TO AUTONOMY: AI-DRIVEN DECISION SUPPORT SYSTEMS IN PRECISION IRRIGATION

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ABSTRACT

Global water scarcity and climate variability pose significant threats to agricultural productivity, necessitating a paradigm shift from traditional irrigation methods to intelligent water management. While conventional automation relies on pre-programmed schedules, it often fails to account for real-time environmental fluctuations, leading to either water wastage or crop stress. There is an urgent need to transition towards autonomous systems that utilize artificial intelligence (AI) to optimize water use efficiency dynamically. This study aims to evaluate the efficacy of an AI-driven Decision Support System (DSS) in precision irrigation compared to traditional timer-based automation. Specifically, the research seeks to quantify improvements in Water Use Efficiency (WUE), assess the impact on crop yield, and analyse the economic viability of autonomous irrigation for large-scale agribusiness operations. The research employed a comparative field experiment conducted over a single crop cycle for potatoes (Solanum tuberosum) in a semi-arid region. The study utilized a network of IoT-enabled soil moisture sensors and local weather stations feeding data into a machine learning algorithm trained to predict crop water requirements. The experimental design consisted of three treatment groups: manual irrigation, sensor-based automation (threshold-based), and the proposed AI-driven autonomous DSS. Results indicate that the AI-driven DSS reduced water consumption by 22% compared to sensor-based automation and 35% compared to manual irrigation, without compromising crop yield. Furthermore, the autonomous system successfully predicted micro-climatic stress events 24 hours in advance, allowing for pre-emptive irrigation. Economic analysis suggests a return on investment (ROI) period of fewer than three cropping seasons due to savings in water and energy costs. The findings demonstrate that transitioning from simple automation to AI-driven autonomy in irrigation significantly enhances resource sustainability and farm profitability. This study recommends the integration of predictive analytics into standard irrigation policies to ensure food security in water-stressed regions.

Keywords: Precision Agriculture, Artificial Intelligence, Water Use Efficiency, Internet of Things (IoT), Decision Support Systems, Sustainable Agribusiness.

https://doie.org/10.10346/AE.2026934028

BANANA BLOSSOM VALORIZATION

(Indias Next Frontier in Agricultural Waste Management)

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ABSTRACT

India is one of the most populous countries in the world, with a population of about 1.4 billion, equivalent to 17.79% of the total world population. Despite India being a developing country or emerging economy, there is still a large population living in poverty and struggling for basic needs. Bananas belong to the Musaceae family and are extraordinary tropical fruits that are cheap, easily digestible, tasty, nutritious, high-energy, low-fat, and loaded with fibre. Globally, the banana is one of the most widely produced, traded, and consumed fruits. India is the world's largest banana producer, as production reached 37.8 million tonnes (2023-24). The massive production leads to a large amount of agricultural waste residue; every ton of bananas harvested generates approximately 4 tons of agricultural waste residue. Banana blossom, also known as "banana heart" and "banana flower," is one of the agricultural waste residues of bananas, enriched with nutrients and bioactive compounds. The review paper mainly focused on banana blossom's diverse valorization pathways and also highlights the nutritional and functional properties of banana blossom. Despite the fact that banana blossom is edible, it is still considered agricultural waste residue. Disposing of the huge agricultural waste residue is a problem and causes pollution. The waste valorization approach emphasizes the conversion of food and agro-industrial waste into value-added products, thereby addressing environmental sustainability, resource efficiency, and nutritional enhancement within a circular economy framework. Banana blossom valorization is one of the sustainable solutions to cope with agricultural waste residue, poverty, zero hunger, and food security, helpful towards achieving the Sustainable Development Goals-2030 of India. The banana blossom is considered underrated because of a lack of advanced knowledge and technology. The future requires more focus on research regarding banana blossom volarization and technology development.

Keywords: India, Agricultural waste residue: Banana blossom, Nutritional properties, Functional properties, Waste valorization pathways, Sustainable Development Goals-2030.

https://doie.org/10.10346/AE.2026934028

EFFICACY OF BIO-INTENSIVE INSECTICIDES AGAINST HELICOVERPA ARMIGERA HUB

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ABSTRACT

The present investigation was carried out to evaluate the "efficacy of bio-intensive insecticides against gram pod borer, Helicoverpa armigera Hub" was accomplish at Students' Instructional Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during rabi season 2023-2024. The experiment was conducted in Randomized Block Design with three replications and eight treatments. According to the investigations, under field conditions. Eight treatments comprising Chlorantraniliprole 18.5 SC @ 80 ml ha^{-1}, Spinosad 45 SC @ 60 ml ha^{-1}, Flubendiamide 20 WG @ 25 g ha^{-1}, HaNPV @ 1000 ml ha^{-1}, Azadirachtin 1500 ppm @ 5000 ml ha^{-1}, Metarhizium anisopliae @ 1250 g ha^{-1}, Bacillus thuringiensis var. kurstaki @ 1250 ml ha^{-1} and an untreated control were tested in two sprays. Larval population was recorded at 3, 7 and 10 days after spray (DAS). the results of the first spray revealed that Chlorantraniliprole 18.5 SC was the most effective treatment, recording the lowest mean larval population (0.33 larvae $plant^{-1}$) with the highest reduction over control (80.39%), followed by Spinosad 45 SC (0.43 larvae $plant^{-1}$) and Flubendiamide 20 WG (0.54 larvae $plant^{-1}$). Among the bio-agents, HaNPV showed comparatively better efficacy, while Metarhizium anisopliae and Bacillus thuringiensis were least effective. The second spray revealed that, Chlorantraniliprole again proved superior with a minimum mean larval population (0.25 larvae $plant^{-1}$) and maximum reduction over control (87.02%), followed by Spinosad (0.53 larvae $plant^{-1}$), Flubendiamide (0.67 larvae $plant^{-1}$) and HaNPV (0.89 larvae $plant^{-1}$). All the treatments were significantly superior to the untreated control. The findings are in conformity with earlier reports indicating higher efficacy of Spinosad and Chlorantraniliprole against H. armigera. Based on benefit–cost ratio, Spinosad 45 SC was found to be the most economical treatment.

Keywords: Helicoverpa armigera, bio-intensive insecticides, Chlorantraniliprole, Spinosad, Flubendiamide.

https://doie.org/10.10346/AE.2026934028

SMART ENTOTECH STARTUPS: DRONE-BASED STRATEGIES FOR PRECISION INSECT PEST CONTROL

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ABSTRACT

This study explores the application of aerial drones in insect pest management, focusing on their role in surveillance, monitoring, and precision control. The aim is to evaluate drones as a sustainable alternative to conventional pest management practices. Multispectral imaging and AI-driven analytics were employed through drone-mounted sensors to detect pest populations and crop damage in guava orchards. Field trials compared drone-based surveillance with traditional ground scouting, while targeted spraying and release of biocontrol agents were tested using drone platforms. Drone surveillance significantly improved detection accuracy and reduced monitoring time by over 40% compared to manual methods. Targeted spraying minimized pesticide use by 25%, while drone-assisted release of parasitoids enhanced biological control efficiency. Spatial mapping of pest hotspots enabled predictive modeling for timely interventions. The integration of drones into pest management enhances precision, reduces chemical inputs, and supports sustainable integrated pest management (IPM). Drones provide real-time data that strengthens decision-support systems and improves ecological outcomes. Aerial drones represent a promising tool for modern pest management, offering efficiency, sustainability, and adaptability. Their dual role in surveillance and control positions them as a cornerstone of precision agriculture, contributing to food security and environmental protection.

Keywords: Drones, aerial surveillance, insect pest management, precision agriculture, integrated pest management (IPM).

https://doie.org/10.10346/AE.2026934028

AGRI-TOURISM, RURAL TOURISM AND COMMUNITY-BASED ENTERPRISES

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ABSTRACT

Agri-tourism, rural tourism, and community-based enterprises play an important role in income diversification and employment generation in rural areas. These activities involve the integration of agriculture with tourism through farm visits, rural homestays, traditional food, cultural programs, and recreational activities, which provide additional sources of income to farmers and rural households. In recent years, Agri-tourism has gained attention as a means of promoting rural entrepreneurship, especially among rural youth and women. However, the growth of Agri-tourism enterprises is constrained by several factors such as lack of infrastructure, inadequate training, poor marketing facilities, limited awareness, and insufficient institutional support. The present study aims to examine the scope of Agri-tourism and rural tourism, assess their role in rural livelihood improvement, and identify the major constraints faced by rural entrepreneurs. The study is based on secondary data collected from published reports, research papers, and government sources. Simple analytical tools were used for interpretation of the data. The study concludes that Agri-tourism and community-based enterprises have considerable potential to enhance rural income and employment if supported by proper infrastructure development, capacity building, marketing support, and suitable policy measures.

Keywords: Agri-tourism, Rural tourism, Community-based enterprises, Rural development, Rural entrepreneurship.

https://doie.org/10.10346/AE.2026934028

DIGITAL AGRICULTURE AND AI-DRIVEN SOLUTIONS FOR YOUTH LED STARTUPS

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ABSTRACT

Digital agriculture influence AI, IoT, and drones to modernize farming, creating opportunities for youth-led startups in smart farming ventures. In India, where agriculture supports 45% of the workforce amid challenges like water scarcity and climate change, these technologies enable precision practices that cut costs by 20-30% and boost sustainability. These abstract aims to highlight AI-driven tools for crop optimization, explore youth-led agritech models using IoT sensors and drones, and outline pathways for startups to achieve scalable impact in regions like Uttar Pradesh through real-time data analytics and resource efficiency. Analysis draws from case studies of startups like Fuselage Innovations (AI drones mapping 4,100 hectares) and Bharat Rohan (hyperspectral tech for 50,000 farmers), combined with government schemes such as RKVY-RAFTAAR grants (₹25 lakh) and STRY drone training. Integration of AI for predictive modelling, IoT for field monitoring, and drones for aerial interventions forms the core framework. Youth ventures demonstrate 30% yield gains, 40% water savings via IoT-drone synergies, and access to $24B agritech market by 2030. Low-cost entry via sensor kits empowers beginners, fostering rural entrepreneurship. AI, IoT, and drones position youth as leaders in digital agriculture, driving food security and profitability. Startups should prioritize local solutions like water management, supported by policy ecosystems, for sustainable growth.

Keywords: AI, IoT, Drones, Smart Farming Ventures

https://doie.org/10.10346/AE.2026934028

POST-HARVEST MANAGEMENT AND LOSS REDUCTION TECHNOLOGIES

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ABSTRACT

The world population is increasing rapidly, and to meet these growing needs, pesticides are widely used to protect crops. Pesticides pose a significant threat to the environment and to human health as they accumulate in the food chain. To address this concern, scientists have developed a botanical insecticide, a natural alternative derived from plants and plant extracts. Integrated Pest Management is a significant component of modern agriculture that tends to minimise the use of pesticides and replace them with eco-friendly bioinsecticides. Bioinsecticides work by targeting biological systems in insects, such as their nervous, respiratory, and endocrine systems, which are crucial for their survival. They are classified based on how they enter the insect's body: stomach poisons are ingested, contact poisons are absorbed through the skin, and fumigants are gases that can be inhaled. Plant-based bioinsecticides offer a sustainable and economically viable approach within the framework of bio innovation. Such innovation can contribute to sustainable agriculture while fostering green startups and rural bio enterprises.

Keywords: Pesticide, Botanical insecticide, Integrated Pest Management.

https://doie.org/10.10346/AE.2026934028

"ENHANCING NUTRIENT USE EFFICIENCY IN WHEAT THROUGH SLOW-RELEASE NITROGEN FERTILIZERS FOR SUSTAINABLE AGRICULTURE"

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ABSTRACT

Wheat is a principal cereal crop in India and plays a crucial role in maintaining national food and nutritional security. Nevertheless, the inefficient utilization of nitrogen fertilizers continues to be a significant constraint in wheat cultivation, leading to low nutrient use efficiency (NUE) and considerable nitrogen losses through processes such as leaching, volatilization, and denitrification. In the context of *Transforming Indian Agriculture for Viksit Bharat @2047*, the adoption of innovative and sustainable fertilizer technologies is essential to enhance productivity while safeguarding environmental resources. Slow-release nitrogen fertilizers offer an advanced approach to precision nutrient delivery, enhancing nitrogen use efficiency in crops. The present study examines the effect of slow-release nitrogen fertilizers on nutrient use efficiency in wheat. These fertilizers are formulated to provide controlled and sustained nitrogen release, thereby synchronizing soil nitrogen availability with the crop's stage-specific physiological demand. Such regulation enhances nitrogen uptake efficiency and agronomic efficiency, improves biomass accumulation and nutrient translocation, and ultimately results in higher grain yield compared with conventional nitrogen fertilizers. The steady supply of nitrogen also supports better root development, increased photosynthetic activity, and improved grain filling in wheat. Furthermore, use of slow-release nitrogen fertilizers helps in reducing the frequency of fertilizer application, thereby lowering labour requirements and input costs for farmers. It reduces environmental externalities by minimizing nitrate leaching and suppressing nitrogen losses in the form of nitrous oxide (N_2O) emissions, thereby enhancing agroecosystem sustainability and resilience to climate variability. The integration of slow-release fertilizers in wheat cultivation aligns with national goals of sustainable intensification, resource conservation, and precision nutrient management. Overall, the findings suggest that slow-release nitrogen fertilizers can significantly enhance nutrient use efficiency and productivity of wheat while promoting environmental sustainability. Their adoption can support innovation-driven agriculture, encourage Agri-input entrepreneurship, and strengthen India's journey towards a resilient, efficient, and sustainable agricultural ecosystem envisioned under *Viksit Bharat @2047*.

Keywords: Wheat, slow-release nitrogen fertilizer, nutrient use efficiency, sustainable agriculture, precision input delivery.

https://doie.org/10.10346/AE.2026934028

WOMAN AGRIPRENEURS: INCLUSIVE SKILL DEVELOPMENT & STARTUP ECOSYSTEMS *(Focused Incubation and Leadership)*

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ABSTRACT

Women contribute significantly to agricultural production and allied activities; however, their participation as agripreneurs remains limited due to structural barriers embedded within skill development frameworks and startup ecosystems. Existing studies largely focus on access-related challenges but provide limited analysis of how ecosystem design influences women's entrepreneurial transition from labour participation to enterprise ownership and leadership. This study examined the role of inclusive skill development and gender-focused incubation in strengthening women-led agribusiness ventures. The primary objective was to assess how targeted skill interventions and supportive startup ecosystems influenced entrepreneurial capacity, business performance, and leadership outcomes among women agripreneurs. A mixed-methods research design was adopted, combining primary survey data from women-led agribusiness enterprises in selected rural and peri-urban regions with qualitative interviews involving incubator managers, mentors, and institutional stakeholders. Quantitative analysis evaluated indicators related to skill acquisition, market participation, and enterprise sustainability, while qualitative insights explored ecosystem responsiveness and leadership development processes. The findings indicated that women agripreneurs engaged in gender-focused incubation programs demonstrated higher levels of business formalization, improved access to markets and finance, and greater enterprise stability compared to non-incubated counterparts. Inclusive skill development in financial management, digital engagement, and leadership emerged as a key determinant of entrepreneurial success. The study concluded that gender-responsive startup ecosystems function as essential institutional mechanisms rather than supplementary support systems. The findings underscore the need for policy-driven redesign of skill development programs and incubation models to institutionalize equity-oriented ecosystem design, thereby promoting sustainable women-led agripreneurship and inclusive rural economic development.

Keywords: Women agripreneurs; inclusive skill development; gender-focused incubation; startup ecosystems; rural entrepreneurship.

https://doie.org/10.10346/AE.2026934028

STUDY ON USE OF BIOFERTILIZER AND BIOPESTICIDES FOR SUSTINABLE CROP PROTECTION

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ABSTRACT

Sustainable crop protection is essential for meeting the rising food demand while maintaining environmental balance. Over-reliance on chemical fertilizers and pesticides has resulted in soil nutrient imbalance, reduced microbial activity, pest resistance, and ecological pollution. To overcome these challenges, the use of biofertilizers and biopesticides has gained importance as a sustainable crop protection strategy. Biofertilizers such as Rhizobium, Azotobacter, Azospirillum, and phosphate-solubilizing microorganisms enhance nutrient uptake, improve soil fertility, and encourage beneficial microbial interactions in the soil. Biopesticides including Trichoderma, Bacillus thuringiensis, neem-based formulations, and entomopathogenic fungi provide effective control of pests and plant pathogens without causing harm to beneficial organisms or the environment. The combined application of biofertilizers and biopesticides supports healthy crop growth, increases yield stability, and strengthens plant tolerance to biotic stresses. Additionally, these biological inputs reduce dependency on synthetic agrochemicals, promote biodiversity, and contribute to long-term soil sustainability. Adoption of bio-based inputs plays a vital role in achieving environmentally safe, economically viable, and sustainable agricultural production systems.

Keywords: Biofertilizers, Biopesticides, Sustainable Crop Protection , Soil Health.

https://doie.org/10.10346/AE.2026934028

AGRI-STARTUPS AND RURAL ENTREPRENEURSHIP: A NEW ENGINE OF ECONOMIC GROWTH

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ABSTRACT

Agriculture is no longer just about traditional farming, it is steadily evolving into a modern, business-oriented sector. In recent years, Agri-startups and rural entrepreneurship have emerged as powerful forces driving economic growth and rural transformation. These enterprises bring innovative solutions such as smart farming technologies, digital marketing platforms, food processing ventures, and efficient supply chain systems that increase productivity and reduce post-harvest losses. By minimizing the role of intermediaries and improving direct market access, Agri-startups help farmers receive better prices for their produce. In addition to raising farm incomes, these ventures create employment opportunities for rural youth and promote self-reliance. Government initiatives like Startup India, Agri-Infrastructure Fund, and various financial support schemes have further encouraged young entrepreneurs to explore agriculture-based businesses. However, challenges such as limited access to capital, inadequate infrastructure, and lack of technical skills continue to slow progress. Despite these constraints, Agri-startups have immense potential to strengthen the rural economy and ensure sustainable development. By promoting innovation, skill development, and policy support, rural entrepreneurship can reduce unemployment, improve farmers' livelihoods, and serve as a strong engine of inclusive and long-term economic growth.

Keywords: Agri-startups, Rural entrepreneurship, Economic growth, Agricultural innovation, Sustainable development.

https://doie.org/10.10346/AE.2026934028

E-COMMERS BUSINESS MODELS FOR MARKETING

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ABSTRACT

E-commerce, also known as electronic commerce or internet commerce, it refers to the buying and selling of goods or services using the internet, and the transfer of money and data to execute these transactions. E-commerce has revolutionized the way businesses operate, providing seamless, cost-effective, and efficient trading opportunities. Providing a quick and convenient way of exchanging goods and services both regionally and globally, e-commerce has boomed. As consumer behaviours shift toward convenience, personalization, and real time engagement, businesses must adapt to these changing demands. In the rapidly evolving digital landscape of 2026 e-commers has shifted from being a simple alternative to physical retail to becoming a multi-trillion-dollar global ecosystem. In this way, e-commerce business models are the strategic frameworks that determine how companies sell products and services online, primarily categorized by the nature of the transaction participants. The most common models include Business-to-Consumer (B2C), where businesses sell directly to end-users; Business-to-Business (B2B), involving transactions between companies; and Consumer-to-Consumer (C2C), where individuals trade via third-party platforms. Additionally, models like Consumer-to-Business (C2B) allow individuals to sell value to companies, while specialized approaches like Drop shipping and subscription-based services focus on inventory management and recurring revenue. Together, these models leverage digital platforms to streamline supply chains, expand market reach, and offer diverse shopping experiences tailored to modern consumer needs.

Keywords: E-commers, Business models and Market.

https://doie.org/10.10346/AE.2026934028

DIGITAL AGRICULTURE AND AI-DRIVEN SOLUTIONS FOR YOUTH-LED STARTUPS

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ABSTRACT

Indian agriculture is at a critical crossroad, facing challenges such as climate variability, resource depletion, and declining farm profitability, which demand innovative and technology-driven solutions. The integration of digital technologies and artificial intelligence into agriculture has emerged as a transformative force capable of reshaping India's farming landscape and empowering the next generation of Agri-entrepreneurs. The artificial intelligence (AI), Internet of things (IoT), remote sensing, drone, and data-driven decisions support systems has enabled the emergence of precision agriculture, which enhances resource-use efficiency and improves farm management practices. These digital innovations have become particularly important in addressing the needs of small and marginal farmers while ensuring sustainable agricultural growth. In the recent years, youth- led Agri-startups have played a crucial role in accelerating the adoption of digital agriculture by developing scalable, affordable, and technology-enabled solution tailored to diverse agro-ecological conditions. AI-based tools such as crop health monitoring, yield prediction, weather forecasting, and smart irrigation systems empower young entrepreneurs to bridge the gap between traditional farming practices and modern technological advancement. Such innovations not only improve agricultural productivity and profitability but also generate employment opportunities and promote rural entrepreneurship. These abstract highlights the transformative potential of digital agriculture and emphasized the role of youth-led startups in shaping the future of Indian agriculture under the framework of sustainable development and Viksit Bharat 2047 vision.

Keywords: Digital Agriculture, artificial intelligence, youth-led startups, Internet of Things.

https://doie.org/10.10346/AE.2026934028

AGRI-STARTUPS, DIGITAL MARKETING AND PRICE STABILITY: AN ECONOMIC PATHWAY FOR TRANSFORMING INDIAN AGRICULTURE TOWARDS VIKSIT BHARAT @2047

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ABSTRACT

The present study was conducted to examine the role of Agri-startups and digital agricultural marketing platforms in improving price stability, market efficiency and farmers' income in India under the vision of Viksit Bharat @2047. Indian agriculture has been facing persistent challenges such as price volatility, long marketing channels and limited access to organized markets, which adversely affect farm profitability. The study analysed how digital innovations such as Agri e-commerce platforms, e-NAM, direct-to-consumer marketing models and startup-led supply chain interventions contributed to better price discovery and reduced market inefficiencies. The study was based on secondary data collected from government publications, research reports, Agri-startup case studies and published literature. Analytical tools such as descriptive analysis and comparative assessment were used to evaluate the impact of digital marketing interventions on price behaviour and farmers' welfare. The results indicated that Agri-startups significantly reduced the role of intermediaries, improved access to real-time price information and enhanced farmers' share in the consumer's rupee. Digital platforms were found to reduce price spread, minimize post-harvest losses and create new employment opportunities for rural youth. The study concluded that strengthening the Agri-startup ecosystem and promoting digital marketing infrastructure are crucial for achieving price stability, inclusive growth and sustainable agricultural transformation. Policy support, skill development and institutional linkages were identified as key drivers for leveraging Agri-startups in building a resilient and competitive agricultural economy aligned with the goals of Viksit Bharat @2047.

Keywords: Agri-startups, Digital agriculture, Price stability, Agricultural marketing, Viksit Bharat @2047.

https://doie.org/10.10346/AE.2026934028

INNOVATIVE ANTIMICROBIAL AND SOIL-DEGRADABLE BIOPLASTICS FROM AGRICULTURAL AND FRUIT WASTES: A SUSTAINABLE SOLUTION FOR CROP MULCHING AND ECO-PACKAGING

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ABSTRACT

The present study entitled "Development of Antimicrobial and Soil-Degradable Bioplastic Films from Agricultural and Fruit Waste for Sustainable Crop Mulching and Packaging" was undertaken to explore an eco-friendly alternative to synthetic plastics. The major objective was to utilize locally available agricultural residues and fruit wastes for producing biodegradable plastic films with added antimicrobial properties. The study aimed to promote circular economy and sustainable agricultural practices by converting waste materials into value-added products. Agricultural wastes such as maize husk and rice bran, along with fruit wastes like banana and orange peel, were collected and processed to extract starch and cellulose. The extracted materials were blended with natural plasticizers derived from fruit extracts and neem leaf extract to impart antimicrobial characteristics. Films were prepared by casting and drying techniques and tested for their mechanical strength, flexibility, water absorption, and degradability through soil burial tests. Antimicrobial efficacy was evaluated against Escherichia coli and Aspergillus Niger using standard microbiological assays. The results revealed that the developed bioplastic films showed good tensile strength, higher degradation rate in soil, and significant inhibitory activity against microbial growth. These characteristics make them suitable for use as biodegradable mulch films in agriculture and as safe packaging materials for perishable products. In conclusion, the study demonstrates the potential of combining agricultural and fruit wastes to produce multifunctional bioplastics that are cost-effective, sustainable, and environmentally compatible.

Keywords: Bioplastic, Agro-waste, Antimicrobial, Soil Degradation, Sustainability.

https://doie.org/10.10346/AE.2026934028

POST-HARVEST MANAGEMENT & LOSS REDUCTION TECHNOLOGIES

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ABSTRACT

Post-harvest losses remain a major concern for agricultural productivity, food security, and farmers' income, especially in developing regions where proper infrastructure and modern technology are limited. A large share of agricultural produce is lost after harvest due to poor handling practices, inefficient processing methods, and inadequate storage facilities. Post-harvest operation and loss reduction technologies concentrate on perfecting essential operations similar as drying, grading, sorting, packaging, and storehouse in order to save both the quality and volume of ranch yield. Scientific drying ways, including the use of solar and mechanical dryers, help reduce humidity content to safe situations, thereby limiting microbial growth, nonentity infestation, and enzymatic deterioration. The use of bettered grading and sorting systems grounded on machine vision, detectors, and artificial intelligence helps achieve better product uniformity, reduces dependence on homemade labour, and increases request value. In addition, ultramodern storehouse results similar as cold chain systems, controlled and modified atmosphere storehouse, and deep storehouse technologies play an important part in reducing losses, pest damage, and quality declination during storehouse and transportation. The integration of IoT- grounded monitoring systems allow real- time shadowing of storehouse conditions, leading to better decision- making and bettered force chain effectiveness. Overall, strengthening post-harvest structure through affordable, scalable, and energy-effective technologies is essential for sustainable husbandry, reduced food waste, and meeting the growing global demand for safe and quality food.

Keywords: Post-harvest losses, post-harvest management, drying technologies, grading and sorting, storage innovations, cold chain systems.

https://doie.org/10.10346/AE.2026934028

CLIMATE CHANGE: A GROWING CONCERN FOR AGRICULTURE IN INDIA AND BEYOND

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ABSTRACT

Climate change has emerged as a major challenge for Indian agriculture, which supports the livelihoods of a large proportion of the population and remains highly dependent on climatic conditions. Rising global temperatures influence crop growth and physiology by shortening crop duration, disrupting grain development, and increasing evapotranspiration rates, thereby intensifying crop water stress. Altered monsoon patterns, characterized by erratic rainfall, frequent droughts, and localized flooding, adversely affect sowing schedules, soil moisture availability, and irrigation requirements, particularly in rain-fed regions. The increasing frequency of extreme weather events such as heatwaves, cyclones, and unseasonal rainfall further exacerbates yield instability and damages agricultural infrastructure. Climate change also accelerates the spread of pests, weeds, and plant diseases across agro-climatic zones, increasing production risks for farmers. Livestock systems face rising heat stress, reduced fodder productivity, and water scarcity, leading to declines in animal health and output. Small and marginal farmers are especially vulnerable due to limited resources and adaptive capacity. Promoting climate-smart agriculture, including drought- and heat-tolerant varieties, improved water-use efficiency, conservation practices, and climate-informed advisory systems, is crucial for enhancing resilience and ensuring food security in India under changing climatic conditions.

Keywords: Climate change, Indian agriculture, Evapotranspiration, Food security, Monsoon variability, Climate-smart agriculture.

https://doie.org/10.10346/AE.2026934028

ROLE OF E - COMMERCE AND DIGITAL MARKET LINKAGES IN ENHANCING FARMER'S INCOME IN INDIA

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ABSTRACT

Agricultural marketing plays a decisive role in determining farmers' income and the overall efficiency of the agricultural value chain. In India, traditional agricultural marketing systems are often constrained by fragmented markets, multiple intermediaries, limited price transparency, and inadequate access to distant markets, particularly for small and marginal farmers. In recent years, the emergence of e-commerce platforms and digital market linkages has offered new opportunities to address these challenges by integrating technology with agricultural marketing systems. The present study aims to examine the role of e-commerce and digital market linkages in enhancing farmers' income and improving market access in India. It also seeks to analyse how digital platforms contribute to price discovery, reduction of marketing inefficiencies, and greater participation of farmers and Farmer Producer Organizations (FPOs) in modern agricultural markets. The study adopts a descriptive research design based on both primary and secondary data sources. Primary data were collected from selected farmers, FPO members, and agribusiness stakeholders using a structured questionnaire, while secondary data were obtained from published research articles, policy reports, and government publications. The study area was selected purposively, and data were analysed using simple statistical tools such as percentage analysis and comparative interpretation. The findings reveal that e-commerce and digital market linkages significantly improve price transparency, reduce dependence on intermediaries, and expand market reach, thereby contributing to higher income realization for farmers. However, challenges such as limited digital literacy, inadequate infrastructure, and uneven access to technology continue to restrict their full potential. The study concludes that strengthening digital infrastructure, promoting farmer awareness, and providing targeted policy support are essential for leveraging digital agricultural marketing as a sustainable income-enhancing strategy.

Keywords: Agricultural Marketing, E-Commerce, Digital Market Linkages, Farmers Income, FPOs, Price Transparency.

https://doie.org/10.10346/AE.2026934028

DAIRY FARMING INTEGRATED WITH BIO GAS PLANT FOR AGRI-BUSINESS STARTUP

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ABSTRACT

Dairy farming integrated with a bio gas plant represent sustainable and economically viable business startup model. In this system, cattle dung, urine and other organic wasted generated from dairy unit are utilized in bio gas digester to produce renewable energy in the form of methane rich gas. The produced bio gas is used for cooking, lighting, and small-scale power generation, reducing dependence on fossil fuel. This integrated approach not only improve farm profitability by generating multiple income streams-milk production, energy saving and sell of organic manure. Main concept of integrated farming system to achievement of agro ecological equilibrium by optimum management of all natural resources, effectively recycling of waste and residues of one component to another component and effective recycling of organic waste to generate green pollution free energy like bio gas plant. Therefore, dairy farming combined with bio gas technology offers a promising entrepreneurship opportunity that promote rural employment, energy self-sufficiency and sustainable agriculture development.

Keywords: Dairy farming, Rural entrepreneurship, Livestock based business, Integrated farming system.

https://doie.org/10.10346/AE.2026934028

FISHERIES, AQUACULTURE & BLUE ECONOMY INNOVATIONS

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ABSTRACT

Amid global overfishing and climate pressures, fisheries and aquaculture contribute 17% to animal protein supply, yet face sustainability challenges like water scarcity and disease outbreaks. This study addresses gaps in scaling blue economy innovations—recirculatory aquaculture systems (RAS), value-added fish products, and aqua-health startups—to enhance productivity and economic resilience in emerging markets. The primary aim was to evaluate these innovations' potential for sustainable growth, assessing technological efficacy, economic viability, and barriers to adoption. A mixed-methods approach was employed, including a survey of 250 stakeholders across coastal India (Andhra Pradesh and Tamil Nadu), case studies of 15 RAS farms and 10 startups, econometric modelling of value chains, and lab analysis of product yields. Tools encompassed GIS mapping, SWOT analysis, and cost-benefit simulations using SPSS and R software. Key findings revealed RAS achieving 90-95% water savings and 25% higher yields; value-added products (e.g., fish collagen) generating 40% profit margins from by-catch; and aqua-health startups reducing mortality by 45% via probiotics. Adoption barriers included high capital costs (₹5-10 crore for RAS) and skill gaps. These results underscore opportunities for a $500 billion blue economy by 2030, advocating policy incentives like subsidies and training. Implications include enhanced food security, rural employment, and export revenues, urging integrated frameworks for innovation scaling in developing nations.

Keywords: recirculatory aquaculture, blue economy, value-added products, aqua-health startups, sustainable fisheries, innovation adoption.

https://doie.org/10.10346/AE.2026934028

AGRI-BIOTECHNOLOGY AND BIO-INNOVATION: A SUSTAINABLE APPROACH FOR NEXT-GENERATION AGRIPRENEURS

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ABSTRACT

The present study entitled "Agri-Biotechnology and Bio-Innovation: A Sustainable Approach for Next-Generation Agripreneurs" was conducted to analyse the role of biotechnology-based innovations in promoting sustainable agriculture and entrepreneurship among rural youth. The study aimed to identify potential areas where biofertilizers, biopesticides, and molecular breeding techniques could enhance productivity and environmental resilience. Secondary data were collected from published research papers, agricultural biotechnology reports, and government policy documents. The analysis indicated that the adoption of biotechnological tools significantly reduced dependency on chemical inputs, improved soil health, and increased crop yield stability. Moreover, bio-innovation-based startups showed promising results in cost efficiency and market expansion. However, major challenges observed were limited awareness, inadequate training, and lack of credit access for small-scale entrepreneurs. The study concluded that strengthening biotechnology incubation centres, capacity-building programs, and financial support mechanisms could foster sustainable growth in the agribiotech sector, thereby empowering the next generation of agripreneurs.

Keywords: Agri-biotechnology, Biofertilizers, Sustainable agriculture, Agripreneurship, Innovation.

https://doie.org/10.10346/AE.2026934028

INNOVATIVE PROCESSING TECHNIQUES TO REDUCE POST HARVEST FOOD LOSS

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ABSTRACT

Post-harvest food loss poses a major threat to global food security, economic sustainability, and environmental health particularly in developing food systems. significant losses occur between harvest and consumption due to microbial spoilage, physiological deterioration, mechanical damage and inefficient storage and processing practices. recent advancements in food processing focus on innovative, low-impact and digitally supported techniques to reduce these losses while maintaining nutritional and sensory quality. emerging non-thermal processing technologies, including high-pressure processing (hpp), pulsed electric field (pef) and cold plasma treatment have demonstrated effectiveness in controlling spoilage microorganisms and delaying degradation without the adverse effects associated with conventional thermal methods.Innovative hybrid dehydration technologies such as microwave-assisted, infrared and controlled-atmosphere drying, enhance drying efficiency and minimize nutrient losses in highly perishable commodities like fruits and vegetables. in parallel advances in active and intelligent packaging systems, including antimicrobial films, oxygen scavengers and freshness indicators, enable real-time control of storage environments and slow physiological aging. the integration of internet of things (iot) sensors and data-driven analytics allows continuous monitoring of temperature, humidity and gas composition facilitating predictive decision-making and reducing losses during transportation and storage.Additionally, bioprocessing and valorization approaches, such as fermentation and bio-conversion of surplus produce into functional foods and bio-based ingredients support circular economy principles by converting waste into value-added products. despite these innovations, challenges related to cost, scalability and adoption—especially among smallholder producers—remain. addressing these constraints through policy support and technology transfer is essential for sustainable post-harvest loss reduction.

Keywords: post-harvest food loss, non-thermal processing, hybrid drying, intelligent packaging, iot monitoring, circular bio economy, food waste reduction.

https://doie.org/10.10346/AE.2026934028

SUSTAINABLE UTILIZATION OF RICE BRAN

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ABSTRACT

Rice bran is an abundant by-product of the rice milling industry that has traditionally been underutilized due to its susceptibility to enzymatic rancidity and limited commercial applications. In the context of increasing global focus on sustainable food systems, rice bran is now being reconsidered as a valuable raw material rather than an industrial residue. This abstract examines the sustainable utilization of rice bran by highlighting its transformation into value-added ingredients through scientific and technological interventions. Rice bran contains a diverse profile of nutritionally and functionally important components, including dietary fiber, essential fatty acids, γ-oryzanol, tocopherols, and bioactive phenolic compounds. Recent developments in stabilization strategies, such as thermal and enzymatic inactivation, along with eco-friendly extraction and bioprocessing techniques, have enhanced the feasibility of preserving these compounds while reducing environmental burden. The incorporation of rice bran-derived ingredients into food formulations has demonstrated potential benefits in improving nutritional quality, oxidative stability, and functional performance of products. Furthermore, valorization of rice bran supports waste minimization and resource efficiency within agro-industrial systems, contributing to a circular economy model. From an economic perspective, sustainable rice bran utilization offers opportunities for diversification of income streams for rice processors and rural stakeholders. Overall, transforming rice bran into functional and health-promoting ingredients represents a practical and innovative approach to aligning food production with sustainability goals, while addressing challenges related to food security, environmental impact, and agro-industrial waste management.

Keywords: Rice bran; Sustainable utilization; Agro-industrial by-products; Value-added ingredients; Circular economy; Food sustainability.

https://doie.org/10.10346/AE.2026934028

Biological Studies on Brinjal Shoot and Fruit Borer, (*Leucinodes orbonalis* Guenee) in Ayodhya district of Uttar Pradesh

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ABSTRACT

Brinjal (Solanum melongena L.) is an important vegetable due to its economic and nutritional value. It is widely grown in India and many other countries. One of the most affecting pests, which causes significant yield losses. A laboratory study was conducted in 2024-2025 to investigate the biology of L. orbonalis over four generations, using naturally infested brinjal fruits as food. The female laid eggs either singly or in groups of up to ten on brinjal fruit slices, muslin cloth, or filter paper. The incubation period ranged from 4.29 to 5.86 days, with an average of 4.85 days. The hatchability rate was about 83.80%. After hatching, the larvae went through five stages in approximately 17.60 days, actively feeding to gain energy for pupation. The pre-pupal period lasted around 2.36 days, followed by a pupal period of 12.22 days. Adult emergence varied from two to four individuals per generation. Females lived longer, averaging 6.21 days, while males lived about 5.03 days. The total life cycle lasted about 41.50 days for males and 43.50 days for females.

Keywords: Shoot and Fruit Borer, Biology, Brinjal, Life Cycle.

https://doie.org/10.10346/AE.2026934028

EXPRESSION STUDY OF SIAOS1 AND SIAOS2 DURING ROOT GROWTH IN TOMATO.

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ABSTRACT

Tomato (Solanum lycopersicum L.) is an important horticultural crop, and understanding gene expression during root development is essential for elucidating molecular mechanisms regulating plant growth. The present study was undertaken to analyze the expression pattern of two candidate genes, Solyc10g007960 and Solyc01g109140, during root growth in tomato using quantitative real-time PCR (qRT-PCR). For expression analysis, total RNA was isolated from tomato root tissues using the CTAB method. Root samples were finely ground in liquid nitrogen, followed by extraction using 2× CTAB buffer and incubation at 65 °C. The samples were subjected to chloroform: isoamyl alcohol extraction to remove contaminants, and RNA was precipitated using lithium chloride. Further purification was carried out through phenol, phenol–chloroform, and chloroform: isoamyl alcohol extractions. RNA was precipitated with ethanol and sodium acetate and washed with 70% ethanol. The RNA pellet was dissolved in Tris-EDTA buffer and treated with DNase to remove genomic DNA contamination. The quality and integrity of the isolated RNA were confirmed by agarose gel electrophoresis. DNase-treated RNA (3–5 µg) was used for cDNA synthesis. Reverse transcription was carried out using 3′-AP primers, dNTPs, RNase inhibitor, reverse transcription buffer, and reverse transcriptase enzyme. The reaction conditions included primer annealing at 72 °C, followed by incubation at 42 °C for cDNA synthesis. The synthesized cDNA was stored at −20 °C for further analysis. Quantitative real-time PCR was performed to study gene expression in tomato roots at different developmental stages, namely 15 days and 1 month. SYBR Green dye was used as the fluorescent reporter for amplification detection. Each reaction was carried out in a final volume of 10 µL containing diluted cDNA, SYBR Green master mix, gene-specific primers, and nuclease-free water. The reactions were performed with three biological replicates and three technical replicates for each sample. Melting curve analysis was conducted to confirm the specificity of the amplified products. The Ct values obtained for the target genes were normalized against the internal control gene (CAC). Relative expression levels were calculated using the ΔCt and ΔΔCt methods, and fold changes in gene expression were determined using the $2^{-}\Delta\Delta Ct$ method, assuming ideal PCR efficiency. This study provides a systematic approach for analyzing the expression of Solyc10g007960 and Solyc01g109140 during tomato root development and lays the foundation for further functional characterization of these genes in root growth and development.

Keywords: Tomato, Root development, QRT-PCR, Gene expression, RNA isolation, SYBR Green.

https://doie.org/10.10346/AE.2026934028

STRENGTHENING PINEAPPLE MARKETING SYSTEMS IN MANIPUR: PATHWAYS TO ENHANCED EFFICIENCY AND RURAL PROSPERITY FOR VIKSIT BHARAT @2047

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ABSTRACT

The present study was conducted across the major pineapple-producing clusters of Manipur. A total of 240 respondents were selected randomly to provide a unified state-wide perspective. The data were gathered using pre-structured interview schedules and interviews with various market intermediaries. The study revealed the dynamics of four primary marketing channels. The socio-economic profiling of the respondents highlighted a highly capable workforce, with 62 per cent of growers falling within the productive 31–50 age group. Furthermore, the community possesses an educational advantage, with 63 percent of growers being educated from Secondary to Graduate levels. Among the primary constraints identified, lack of proper transportation and fragmented logistics ranked first, significantly contributing to the high "Price Spread". This was followed by a high dependency on manual labour (48%) and the limitations of small and marginal landholdings, which affect the bargaining power of 77 per cent of the sample farmers. The study concludes that institutionalizing FPOs and leveraging the high literacy of the workforce are essential pathways to achieving the Viksit Bharat @2047 vision for rural prosperity.

Keywords: Pineapple Marketing, Manipur, PSCR, FPO, Viksit Bharat @2047, Value Addition, Price Spread.

https://doie.org/10.10346/AE.2026934028

NATURAL, ORGANIC & REGENERATIVE AGRICULTURE ENTERPRISES, CERTIFICATION, ECO-LABELLING, SUSTAINABLE PRODUCT VENTURES

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ABSTRACT

Natural, organic, and regenerative agriculture enterprises are increasingly recognized as viable pathways for achieving environmental sustainability, food safety, and inclusive rural economic growth. These enterprises integrate ecological farming practices with market-oriented mechanisms such as certification systems, eco-labelling, and sustainable product ventures. Despite growing consumer demand for sustainably produced food, farmers and agripreneurs face challenges related to certification complexity, market access, compliance costs, and limited awareness of value-added opportunities. This study examines the structure, performance, and potential of natural, organic, and regenerative agriculture enterprises, with a specific focus on certification frameworks, eco-labelling practices, and sustainable agri-product ventures. The primary objective of the research is to assess how certification and eco-labelling influence enterprise development, market competitiveness, and income sustainability, while identifying constraints and opportunities for scaling such ventures. The study adopts a descriptive and analytical research design, conducted in selected rural regions with active adoption of sustainable farming practices. Primary data were collected from a sample of certified and non-certified farmers, agripreneurs, and Agri-based enterprises using structured questionnaires and interviews, complemented by secondary data from policy reports and certification agencies. Key findings indicate that certified and eco-labelled products command higher market prices, enhance consumer trust, and improve enterprise visibility, though procedural and financial barriers limit wider adoption. The study concludes that strengthening institutional support, simplifying certification processes, and promoting market linkages can significantly enhance the growth of sustainable agriculture enterprises. These findings offer valuable implications for policymakers, development agencies, and agripreneurs aiming to promote resilient and sustainable agri-business models.

Keywords: Natural Agriculture; Organic Farming; Regenerative Agriculture; Certification Systems; Eco-Labelling; Sustainable Agribusiness.

https://doie.org/10.10346/AE.2026934028

VERMICOMPOST - AN ORGANIC GOLD (EARTHWORM FARM ENTREPRENEURSHIP)

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ABSTRACT

Vermicompost is nutrient- rich organic fertilizer produced by the breakdown of organic waste through earthworms. Vermicomposting is the process of using earthworms to convert organic waste materials into nutrient-rich Vermicompost. Vermicompost is a valuable resource that supports soil health, sustainable agriculture and environmental conservation. Its importance lies in its ability to provide plants with essential nutrients, improve soil structure, and reduce the ecological footprints of organic disposal. Vermicomposting is a low-investment, high - return opportunity, especially suitable for rural areas. Vermicomposting production is an advantageous solution that changes waste into "black-gold" (nutrient - rich fertilizer). By focusing on proper training, quality assurance and direct marketing it serves as a sustainable, eco-friendly livelihood, enhancing soil health while providing significant economic empowerment especially for women and Rural youth.

Keywords: Vermicompost, Nutrient-rich organic fertilizer, Sustainable agriculture

https://doie.org/10.10346/AE.2026934028

POST-HARVEST AGRONOMIC INTERVENTIONS TO REDUCE YIELD LOSSES AND IMPROVE PRODUCE QUALITY

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ABSTRACT

Post-harvest losses are a major constraint to agricultural development in many developing countries due to poor harvesting, handling, storage, and processing facilities, which reduce both marketable yield and farmer income. Along with quantity losses, quality deterioration through nutrient loss, microbial spoilage, and physical damage weakens food security and supply chain performance. This study evaluated selected post-harvest agronomic interventions for reducing losses and improving physical, nutritional, and market quality of produce. The research focused on improved harvesting techniques, on-farm grading, scientific storage, and low-cost preservation methods. A mixed-method approach was adopted in a major crop-producing region, combining field experiments, participatory farmer assessments, and controlled storage trials. Crop samples were treated using evaporative cooling storage, modified atmosphere packaging, and bio-based protective coatings. Loss levels, quality indicators, and economic returns were measured using standardized protocols. Results showed that scientific harvesting tools lowered mechanical damage by up to eighteen percent, while improved storage systems reduced quantitative losses by twenty-two to thirty-five percent. Natural coatings and systematic grading extended shelf life, improved appearance, and preserved nutrients. Cost–benefit analysis confirmed higher net returns for farmers using integrated post-harvest practices. The study concludes that affordable and scalable post-harvest interventions can significantly reduce waste, enhance produce quality.

Keywords: Post-harvest losses; Agronomic interventions; Storage technologies; Produce quality; Farmer income

https://doie.org/10.10346/AE.2026934028

CLIMATE-SMART AGRONOMIC PRACTICES FOR SUSTAINABLE CROP PRODUCTION

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ABSTRACT

Climate change poses a significant challenge to sustainable crop production by affecting rainfall patterns, temperature regimes, and the frequency of extreme weather events. Climate-smart agronomic practices offer an integrated approach to enhance agricultural productivity while ensuring environmental sustainability and resilience to climate variability. These practices focus on improving resource-use efficiency, adapting crops and cropping systems to changing climatic conditions, and reducing greenhouse gas emissions from agriculture. Key climate-smart agronomic interventions include conservation tillage, crop diversification, integrated nutrient and water management, use of climate-resilient crop varieties, and efficient irrigation techniques. Adoption of such practices helps in maintaining soil health, enhancing water-use efficiency, reducing production risks, and stabilizing crop yields under adverse climatic conditions. Furthermore, climate-smart agronomy contributes to sustainable intensification by balancing productivity with ecological conservation. Therefore, promoting climate-smart agronomic practices is essential for achieving sustainable crop production, ensuring food security, and supporting farmer livelihoods in the face of climate change.

Keywords: Climate change, Climate-smart agriculture, Sustainable crop production, Resource-use efficiency, Agronomic practices

https://doie.org/10.10346/AE.2026934028

AGRI-BIOTECHNOLOGY & BIO-INNOVATION FOR NEXT-GEN ENTREPRENEURS

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ABSTRACT

Agri-biotechnology and bio-innovation are becoming key forces in shaping the future of agriculture and agribusiness. As agriculture faces serious challenges like climate change, food security issues, declining soil health, and limited natural resources, innovative solutions are the need of the hour. In this context, next-generation entrepreneurs have a vital role to play by turning scientific ideas into practical, sustainable, and market-ready solutions. Agri-biotechnology combines advanced tools such as tissue culture, biofertilizers, biopesticides, genetic improvement, and molecular techniques to improve crop productivity, resilience, and sustainability. Bio-innovation helps develop eco-friendly agricultural inputs, stress-tolerant crops, and value-added bio-based products that benefit both farmers and the environment. For young entrepreneurs, this sector offers wide opportunities in agri-startups, agribusiness ventures, rural employment generation, and technology commercialization. With growing support from startup ecosystems, research institutions, and government initiatives, agri-biotechnology has the potential to transform traditional agriculture into a modern, innovation-driven industry. This approach not only supports sustainable farming but also creates new pathways for entrepreneurship, economic growth, and food security.

Keywords: agri-biotechnology, bio-innovation, sustainable agriculture, agri-entrepreneurship, agri-startups, bio- based products, next-generation entrepreneurs, food security

https://doie.org/10.10346/AE.2026934028

RESPONSE OF ROW RATIO AND NITROGEN MANAGEMENT ON YIELD OF WHEAT (*TRITICUM AESTIVUM* L.) AND INDIAN MUSTARD (*BRASSICA JUNCEA* L.) INTERCROPPING SYSTEM

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ABSTRACT

A field experiment was carried during *Rabi* seasons of 2024-2025 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.), India. The present experiment consist of three intercropping systems *viz*., wheat + Indian mustard (4:1), wheat + Indian mustard (6:1), wheat + Indian mustard (8:1), row ratios in replacement series and five nitrogen management *viz*., RDF to both Wheat + Indian mustard, 75% N to both wheat + Indian mustard + 1 Spray of Nano Urea, 75% N to both wheat + Indian mustard + 25% N through P.M., 75% N to both wheat + Indian mustard + 25% N through FYM and 50% N to both wheat + Indian mustard + 2 Spray of Nano Urea and two sole crops *viz*., wheat + Indian mustard. Results revealed that among the row arrangements, the maximum grain yield (4.350 t/ha) and straw yield (7.292 t/ha) of wheat, as well as the seed yield (1.047 t/ha) and stover yield (3.384 t/ha) of Indian mustard were recorded under the wheat + Indian mustard 8:1 row ratio. Whereas, among 50% N to both wheat + Indian mustard + 2 Spray of Nano Urea found to be superior over rest of the nitrogen levels tried. In the case of yield parameter of wheat and Indian mustard treatment combination of wheat + Indian mustard (8:1) + 50% N to both wheat + Indian mustard + 2 spray of Nano Urea found best among all treatment combinations tried.

KEY WORDS: Intercropping systems, Row ratio, Nitrogen management, Wheat, Indian Mustard and Yield

https://doie.org/10.10346/AE.2026934028

INFLUENCE OF SOWING DATES, SPACING AND SULPHUR LEVELS ON YIELD OF INDIAN MUSTARD (*BRASSICA JUNCEA* L.)

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ABSTRACT

A field experiment was carried out during *Rabi* seasons of 2024-2025 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.), India. The present experiment consists of three dates of sowing *viz*., 10th October, 25th October, 9th November, planting geometry *viz*., 30 cm X 15 cm, 40 cm X 10 cm, 50 cm X 10 cm and two level of Sulphur *viz*., Sulphur 30 kg/ha and Sulphur 45 kg/ha. Results revealed that among the date of sowing maximum yield of Indian mustard was recorded under 25th October and plant geometry maximum produced yield under 40 cm X 10 cm. Whereas, among Sulphur 45 kg found to be superior over rest of the Sulphur level. In case of seed yield of Indian mustard treatment combination of 25th October while stover yield 10th October recorded higher with 40 cm X 10 cm and Sulphur 45 kg/ha found best among all treatment combinations tried.

Keywords: Date of Sowing, Plant Geometry, Sulphur and Indian Mustard.

https://doie.org/10.10346/AE.2026934028

WOMEN AGRIPRENEURS: INCLUSIVE SKILL DEVELOPMENT & STARTUP ECOSYSTEMS

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ABSTRACT

Women agripreneurs play a pivotal role in transforming agricultural value chains, enhancing food security, and promoting inclusive rural development. Despite their significant contributions, women in agribusiness continue to face structural barriers such as limited access to skills training, finance, technology, markets, and supportive startup ecosystems. This study examines the importance of inclusive skill development and enabling startup ecosystems in empowering women agripreneurs to innovate, scale, and sustain agri-enterprises. It highlights how targeted capacity-building programs, digital literacy, mentorship, access to finance, and gender-responsive policies can bridge existing gaps and foster entrepreneurial resilience. The paper further explores the role of incubators, accelerators, cooperatives, and public–private partnerships in creating supportive environments that encourage women-led agribusiness startups. By strengthening inclusive ecosystems and aligning skill development initiatives with market needs, women agripreneurs can become key drivers of sustainable agriculture, rural employment, and socio-economic empowerment. The study underscores the need for integrated, gender-inclusive strategies to unlock the full potential of women in agripreneurship.

Keyword: Women agripreneurs play a pivotal role in transforming agricultural value chains, enhancing food security, and promoting inclusisve rural development

https://doie.org/10.10346/AE.2026934028

MODERN TECHNOLOGY AS A CATALYST FOR AGRICULTURAL TRANSFORMATION: DIGITAL AGRICULTURE AND AI-DRIVEN YOUTH STARTUPS

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ABSTRACT

The agricultural sector is experiencing a paradigm shift with the emergence of digital agriculture and artificial intelligence (AI)–driven solutions, particularly through youth-led agritech startups. Modern technologies such as precision farming, AI-based decision support systems, Internet of Things (IoT), drones, machine learning algorithms, and digital platforms are redefining traditional farming practices into data-driven, efficient, and sustainable production systems.Youth-led startups play a crucial role in accelerating this transformation by developing innovative solutions for crop monitoring, yield prediction, pest and disease detection, smart irrigation, and market linkage. AI-powered tools enable real-time analysis of soil health, weather patterns, and crop performance, allowing farmers to optimize resource use, reduce input costs, and enhance productivity. Digital platforms further bridge information gaps by providing access to advisory services, credit, insurance and transparent market.This abstract emphasizes modern technology as a catalyst for agricultural transformation, highlighting the role of digital agriculture and AI-driven innovations in promoting entrepreneurship, employment generation, and inclusive growth. The paper underscores the importance of skill development, supportive policies, and research–startup collaboration to empower youth-led agribusinesses and build resilient, future-ready agricultural systems.

Keywords: Artificial intelligence, Digital agriculture, Precision farming, Startups, Youth entrepreneurship

https://doie.org/10.10346/AE.2026934028

AGRICULTURAL SUBSIDIES AND THEIR IMPACT ON FARM PRODUCTIVITY AND SUSTAINABILITY

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ABSTRACT

This study examined the role of agricultural subsidies in influencing farm productivity and long-term sustainability within the agricultural sector. The primary objective of the research was to analyze how different forms of subsidies—such as input subsidies, price support mechanisms, and direct income support—affected farmers' production decisions, resource utilization, and environmental practices. The study employed a descriptive and analytical research design, using secondary data collected from government reports, agricultural statistics, and existing empirical studies. Comparative analysis was conducted to assess productivity trends before and after the implementation of major subsidy programs, while sustainability outcomes were evaluated in terms of soil health, water usage, and adoption of environmentally friendly practices. The results indicated that agricultural subsidies had a positive impact on farm productivity by reducing input costs, improving access to modern technology, and stabilizing farm incomes. However, the findings also revealed that excessive or poorly targeted subsidies sometimes encouraged overuse of chemical fertilizers, water, and other natural resources, thereby posing risks to environmental sustainability. The study highlighted that well-designed and targeted subsidy policies promoted sustainable farming practices, enhanced resource efficiency, and supported small and marginal farmers. Overall, the research concluded that agricultural subsidies played a significant role in improving farm productivity, but their long-term contribution to sustainability depended largely on policy design, effective implementation, and alignment with environmental objectives.

Keywords: Agricultural subsidies, farm productivity, sustainable agriculture, resource efficiency, agricultural policy.

https://doie.org/10.10346/AE.2026934028

NATURAL FARMING: A PATHWAY TO SUSTAINABLE AGRICULTURE AND ECONOMIC GROWTH IN INDIA

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ABSTRACT

Agriculture plays an important role in India's economy by providing livelihood to more than half of the population and contributing significantly to national income. However, excessive use of chemical fertilizers and pesticides has led to problems such as soil degradation, environmental pollution, and rising production costs. In this situation, natural farming has emerged as a sustainable and eco-friendly alternative to conventional farming methods. Natural farming focuses on chemical-free cultivation, use of local resources, improvement of soil health, and maintenance of ecological balance. This study explains how natural farming can support sustainable agriculture and contribute to economic growth in India. Government initiatives such as the National Mission on Natural Farming (NMNF) and Bharatiya Prakritik Krishi Paddhati (BPKP) are encouraging farmers to adopt natural farming practices across different states. These initiatives aim to increase farmers' income, reduce input costs, and promote environmentally safe farming systems. Natural farming helps farmers by lowering expenses on fertilizers and pesticides, improving soil fertility, conserving water, and reducing harmful environmental impacts. In addition, natural and chemical-free produce often receives higher market prices, which improves farm profitability. Although challenges such as lack of awareness, training, and market access exist, natural farming has the potential to improve rural livelihoods and strengthen India's agricultural economy in the long run.

Keywords: Natural Farming; Sustainable Agriculture; Indian Economy; Farmer Income; Environmental Protection.

https://doie.org/10.10346/AE.2026934028

PRECISION NUTRIENT AND WATER MANAGEMENT WITH BIOFERTILIZERS FOR ENHANCING PRODUCTIVITY AND CLIMATE RESILIENCE OF BAJRA.

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ABSTRACT

Bajra (*Pennisetum glaucum* L.) is a climate-resilient cereal crop extensively grown in arid and semi-arid regions of India, were erratic rainfall and poor soil fertility limit productivity. Precision nutrient and water management integrated with biofertilizers offers a sustainable agronomic approach to enhance yield, nutrient use efficiency, and climate resilience of bajra. The present study highlights the role of soil test–based fertilizer application combined with efficient irrigation scheduling and biofertilizer inoculation in improving crop growth and productivity. Application of biofertilizers such as *Azotobacter*, phosphate-solubilizing bacteria (PSB), and arbuscular mycorrhizal fungi (AMF) enhances nutrient availability, root development, and microbial activity in the rhizosphere. Precision irrigation at critical growth stages improves water use efficiency and reduces moisture stress. The integration of biofertilizers with precision agronomic practices reduces dependence on chemical fertilizers, improves soil health, and promotes sustainable crop intensification. Adoption of such integrated approaches can empower farmers, particularly in rainfed ecosystems, while contributing to food and nutritional security and climate-smart agriculture. This strategy aligns with the national vision of transforming Indian agriculture towards sustainability and resilience under the Viksit Bharat @2047 framework.

Keywords: Bajra, Pearl millet, Biofertilizers, Precision nutrient management, Water use efficiency, Climate-smart agriculture.

https://doie.org/10.10346/AE.2026934028

INFLUENCE OF SOWING DATES, SPACING AND SULPHUR LEVELS ON YIELD OF INDIAN MUSTARD (BRASSICA JUNCEA L.)

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ABSTRACT

A field experiment was carried out during *Rabi* seasons of 2024-2025 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.), India. The present experiment consists of three dates of sowing *viz*., 10th October, 25th October, 9th November, planting geometry *viz*., 30 cm X 15 cm, 40 cm X 10 cm, 50 cm X 10 cm and two level of Sulphur *viz*., Sulphur 30 kg/ha and Sulphur 45 kg/ha. Results revealed that among the date of sowing maximum yield of Indian mustard was recorded under 25th October and plant geometry maximum produced yield under 40 cm X 10 cm. Whereas, among Sulphur 45 kg found to be superior over rest of the Sulphur level. In case of seed yield of Indian mustard treatment combination of 25th October while stover yield 10th October recorded higher with 40 cm X 10 cm and Sulphur 45 kg/ha found best among all treatment combinations tried.

Key words: Date of Sowing, Plant Geometry, Sulphur and Indian Mustard.

https://doie.org/10.10346/AE.2026934028

NATURAL, ORGANIC & REGENERATIVE AGRICULTURE ENTERPRISES

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ABSTRACT

Natural, organic, and regenerative agriculture enterprises have gained increasing importance in recent years due to rising concerns over environmental degradation, soil health deterioration, climate change, and food safety. Conventional farming practices have often led to excessive use of chemical inputs, declining natural resources, and reduced sustainability of agricultural systems. In this context, enterprise-based models centred on natural, organic, and regenerative agriculture have emerged as viable alternatives for promoting sustainable production while ensuring economic viability for farmers. The primary objective of this study was to examine the role of natural, organic, and regenerative agriculture enterprises in supporting sustainable agricultural development and rural livelihoods. The study also aimed to analyze their contribution to soil health improvement, income generation, market opportunities, and environmental conservation. The study was conducted using a descriptive and analytical research approach based on secondary data collected from research journals, government reports, certification agencies, and documented case studies of natural and organic farming enterprises. In addition, selected field-level insights from farmers and agribusiness practitioners were reviewed to understand enterprise performance and adoption trends. The key findings revealed that natural, organic, and regenerative agriculture enterprises significantly enhanced soil fertility, reduced input costs, and promoted ecological balance. Enterprises involved in organic food production, bio-inputs, eco-labelling, and sustainable value chains were found to generate premium prices and stable income opportunities. The results also indicated growing consumer demand for chemical-free and sustainably produced food products, although challenges such as certification costs, market access, and knowledge gaps persisted. The study concluded that natural, organic, and regenerative agriculture enterprises hold substantial potential for sustainable agribusiness development. Strengthening policy support, capacity building, certification systems, and market linkages can further enhance their contribution to environmental sustainability, farmer income, and resilient agricultural systems.

Keywords: Natural Agriculture, Organic Farming, Regenerative Agriculture, Sustainable Enterprises, Rural Development, Eco-friendly Agribusiness.

https://doie.org/10.10346/AE.2026934028

WOMEN AGRIPRENEURS: INCLUSIVE SKILL DEVELOPMENT & STARTUP ECOSYSTEMS

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ABSTRACT

Women agripreneurs play a pivotal role in transforming agricultural value chains, enhancing food security, and promoting inclusive rural development. Despite their significant contributions, women in agribusiness continue to face structural barriers such as limited access to skills training, finance, technology, markets, and supportive startup ecosystems. This study examines the importance of inclusive skill development and enabling startup ecosystems in empowering women agripreneurs to innovate, scale, and sustain agri-enterprises. It highlights how targeted capacity-building programs, digital literacy, mentorship, access to finance, and gender-responsive policies can bridge existing gaps and foster entrepreneurial resilience. The paper further explores the role of incubators, accelerators, cooperatives, and public–private partnerships in creating supportive environments that encourage women-led agribusiness startups. By strengthening inclusive ecosystems and aligning skill development initiatives with market needs, women agripreneurs can become key drivers of sustainable agriculture, rural employment, and socio-economic empowerment. The study underscores the need for integrated, gender-inclusive strategies to unlock the full potential of women in agripreneurship.

Keyword: Women agripreneurs play a pivotal role in transforming agricultural value chains, enhancing food security, and promoting inclusisve rural development.

https://doie.org/10.10346/AE.2026934028

CLIMATE CHANGE, BIODIVERSITY AND ENVIRONMENTAL SUSTAINABILITY IN INDIA

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ABSTRACT

Climate change has become a critical global concern, exerting significant pressure on biodiversity and the sustainability of natural ecosystems. Variations in temperature regimes, shifting precipitation patterns, and the increasing incidence of extreme climatic events are disrupting ecological processes, contributing to species decline, and weakening ecosystem functions vital for human well-being. Biodiversity plays a key role in sustaining ecosystem stability and resilience, supporting essential services such as agricultural productivity, climate regulation, and water security. However, anthropogenic activities, including deforestation, pollution, and unsustainable use of natural resources, are intensifying the adverse effects of climate change and accelerating biodiversity loss. This study examines the interlinked dynamics between climate change, biodiversity, and environmental sustainability, underscoring the importance of integrated conservation strategies and sustainable development practices. Addressing these challenges requires coordinated global and regional efforts, evidence-based policy frameworks, and the promotion of nature-based solutions to conserve ecosystems and ensure long-term environmental sustainability.

Keyword: This study examines the interlinked dynamics between climate change, biodiversity, and environmental sustainability.

कृषि मंत्रणा 2026

AGRI EXPRESS