Compendium of Abstracts

33rd Annual Conference of
Agricultural Economics Research Association (India)
on
Innovations in Agribusiness, Empowering Women, and Climate Resilient Agriculture

1-3 December 2025

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Agricultural Economics Research Association (India), New Delhi

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Rajendranagar, Hyderabad, Telangana

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Theme 1

Innovations in Agribusiness: Empowering Start-ups and Promoting Agricultural Exports

Growth Performance, Instability, and Trade Dynamics of Non-Basmati Rice: A Case Study of Chhattisgarh

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The "Rice Bowl of India," Chhattisgarh, makes a substantial contribution to the country's Non-Basmati rice production but is still underrepresented in exports. The growth performance, instability, and trade dynamics of Non-Basmati rice in Chhattisgarh from 2012-13 to 2023-24 are examined in this paper. The findings show a notable increase in production and yield, particularly over the period, 2020-2023. Although area under cultivation increased only marginally at a CAGR of 1.02%, there was significant increases in both production (3.89%) and yield (2.84%). Sharp swings were seen in export performance, with 2023 seeing the greatest export value (₹ 2,846.59 million and 83,429 tonnes). Nonetheless, Chhattisgarh's average share in India's exports of Non-Basmati rice stayed at 6.16%. Weak long-term trade linkages were shown by the inconsistent export destinations found by Markov Chain analysis.

Keywords: Non-Basmati, production, export, trends, growth rate, instability, trade direction and rice

Decomposition Analysis of Output Change under Apical Rooted Cuttings Technology and Traditional Method of Potato Cultivation in Karnataka, India

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The study examines the technological advancement of Apical Rooted Cuttings (ARC) technology and traditional potato cultivation in Karnataka by employing the Bisalaiah decomposition technique. A multistage purposive sampling method was used to collect data from a sample of 80 farmers, comprising 40 adopting the ARC method and 40 practicing traditional cultivation. Production function estimates revealed increasing returns to scale for both methods. In ARC method, gross returns were significantly influenced by ARC seedlings, farmyard manure and bullock labour. In contrast, traditional cultivation relied heavily on seed tubers, farmyard manure and plant protection chemicals. Decomposition analysis revealed that 32.02 per cent of the gross return advantage under ARC method was due to technological change, with the non-neutral component contributing 27.11 per cent. However, differences in input use negatively impacted on gross returns by -28.37 per cent. The study highlights the role of ARC technology in narrowing the yield gap in Karnataka's potato seed sector. Policy interventions that support wider adoption of ARC method through extension services and institutional support can significantly improve profitability, resource-use efficiency, and the sustainability of potato cultivation.

Keywords: Apical rooted cuttings, potato seed tuber, decomposition analysis, technological change, neutral component and productivity enhancement

An Analysis of Market Share and Promotional Strategies of Vegetable Seed Companies in Durg District, Chhattisgarh

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The present study analysed vegetable seed marketing in Durg district, Chhattisgarh during 2024-25, with a focus on examining current market shares of seed companies in selected vegetables and promotional strategies adopted by them in the study area. Data were collected using structured interviews, supplemented with field observations and dealer interactions. Analytical tools used included percentage analysis for analysing current market share of vegetable seed companies and Likert scale for product promotion. The market was dominated by BASF (Nunhems) with a share of 25.6% followed by VNR (22.3%) and Syngenta (17.3%). Promotional strategies involving direct engagement proved most effective, with farmers' meetings (4.61), company representatives (4.49), and field days (4.38) ranking highest. Dealers preferred financial incentives such as cash discounts (4.26), advance booking (3.93), and deferred payments (3.80).

Keywords: Vegetable seed marketing, market Share, promotional activities

Examining the Circularity in Business Models of Waste to Wealth Enterprises: A case of Arecanut Leaf Sheath Units in Karnataka, India

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This study analyzes the economic viability and circularity of areca leaf sheath (ALS) product manufacturing units in Karnataka, a leading arecanut-producing state in India. The research, based on a survey of 15 manufacturing units, examines fixed and variable costs, returns, and benefit-cost ratios (B:C ratios), as well as key circularity metrics. All surveyed units were profitable, with B:C ratios greater than 1.0, and an average of 1.27. However, profitability and efficiency varied greatly depending on the scale of operation. Large-scale units demonstrated the highest B:C ratios, due to economies of scale, while smaller units operated with much tighter profit margins. While the business model is inherently circular in its use of agricultural waste to create products, the study found significant gaps in circularity practices. All units relied on virgin raw materials, and none used renewable energy. Furthermore, a majority of the units (13 out of 15) did not recycle their water, indicating a linear "take-make-dispose" approach for key resources. The study concludes that while the ALS industry is economically viable, there is substantial room to enhance its sustainability by transitioning to a more comprehensive closed-loop system that incorporates water recycling, waste valorisation (e.g., vermicompost), and renewable energy.

Keywords: Secondary agriculture, Circular economy, Waste to Wealth,Areca leaf sheath, Sustainability, Micro Small and Medium Enterprises, Firm behaviour

Empowering Agribusiness Innovation: A Behavioral Economics Analysis of Nano Liquid Fertilizer Adoption in India's Wheat–Rice Systems for Export-Driven Growth

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India's wheat–rice systems in Haryana and Punjab face nutrient use inefficiencies (NUE), with nitrogen recovery at 30-50% and phosphorus at 15-25%, costing over ₹ 1 lakh crore annually amid ₹ 1.75-2.25 lakh crore subsidies. Nano Liquid Fertilizers (NLFs), offering 20–30% efficiency gains through nano-encapsulated nutrient delivery, represent a transformative agribusiness innovation for startups to enhance productivity and export competitiveness. This study integrates behavioral economics, institutional analysis, and market transformation theory to assess adoption barriers and scaling pathways. Primary data from 358 farmer surveys and 83 dealer interviews (2025) across 13 districts reveal near-universal awareness (99.4%) and high trial rates (76.5%) but low sustained adoption (26.8%) due to perceived inefficacy (43-56%), lack of localized evidence, and price sensitivity. Adopters report 8-12% yield gains, unlocking a ₹ 1,680 crore market at 35% adoption over 10 years. Monte Carlo simulations estimate net present value (NPV) gains of ₹ 5,000-7,000/acre and internal rate of return (IRR) of 25-35%. Bass diffusion modeling projects 50% adoption by year 8, reducible to year 5 with startup-driven nudges. Proposed policies-Fertilizer Control Order (FCO) inclusion, QR-enabled demonstrations, and credit-linked incentives-foster startup ecosystems, reduce transaction costs, and enhance export-quality produce, supporting Sustainable Development Goal 2 (Zero Hunger) and climate resilience. This research offers actionable strategies for agribusiness startups to scale NLFs, strengthen value chains, and boost India's agricultural exports.

Keywords: Nano liquid fertilizers, behavioral economics, agribusiness startups, agricultural exports, nutrient use efficiency, market transformation, value chain innovation

Scope And Roadmap for Direct Retailing for Ramcides in Tamil Nadu Delta Districts and Pudukkottai Regions: A Hub and Spoke Model

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The agricultural input industry in India is rapidly evolving, with growing demand for personalized service, transparent pricing, and timely availability of quality inputs. In this context, Ramcides Crop Science Pvt. Ltd. seeks to enhance its market presence through Direct Retailing in the Tamil Nadu Delta and Pudukkottai regions. This study aims to assess the scope and develop strategic insights for implementing a Hub-and-spoke retail model that ensures improved farmer engagement, and efficient product distribution. The study involved primary market survey across seven locations like Trichy, Kulithalai, Pettavathalai, Thanjavur, Mannargudi, Pudukkottai, and Keeranur. Along with that competitive landscape, retailer insights were analysed. Key factors such as market potential, cost dynamics and customer preferences were evaluated to identify scope for ideal Hub and spoke locations. Findings suggest that adopting a retail model with Company-Owned, Company-Operated (COCO) hubs in high- potential areas like Trichy and Thanjavur can significantly boost operational efficiency and brand loyalty. Suggestions include implementation, beginning with pilot hubs and spokes, followed by digital integration, localized advisory services, and farmer loyalty programs to ensure long-term sustainability and competitive advantage.

Keywords: Direct retailing, Hub-and-Spoke Model, retail feasibility, COCO Model, FOFO Model, COFO Model

Productivity, Efficiency, and Profitability Dynamics of Tamil Nadu's Food Processing Industry: An Empirical Assessment

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This study evaluates the performance of Tamil Nadu's food processing industry through various measures such as capital productivity, value addition, output–input conversion efficiency, and profitability across major sub-sectors using data compiled from Annual Survey of Industries. Using sector-level ratios, the analysis reveals significant heterogeneity in operational and financial efficiency. Fruits & Vegetables sector led in value addition (17.97%), conversion efficiency (1.22), and profit margins (7.41%), reflecting strong processing intensity, product diversification, and brand value capture. Conversely, Grains and Oils & Fats remain closer to commodity processing, with limited differentiation and thin margins. Output–input ratios was close to unity in Meat (1.04) and Other Food (1.05), which highlight the sector's input costs absorbing most of the output value, constraining profitability. Meat (7.16) and Oils & Fats (6.43) exhibit the highest capital productivity, indicating rapid asset turnover, but profitability outcomes diverge sharply, Meat suffers negative margins despite high throughput. The findings emphasize that high capital productivity is necessary but insufficient for sustained profitability; strategic interventions in product mix, procurement systems, by-product utilization, and market channels are essential for long-term sectoral resilience.

Keywords: Tamil Nadu, food processing industry, capital productivity, profitability, sectoral efficiency

Casting a Wider Net: The Economic Trajectory of Motorized Fishing in Ernakulam

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Motorized fishing, a vital part of Kerala's small-scale fishing sector, faces significant challenges characterized by economic vulnerabilities, declining fish stocks, and environmental degradation apart from rising operational costs and external shocks. Fishermen, operating small motorized boats are less equipped to absorb the shocks of low-income months or unexpected events. Time series analysis applied to the daily fishing income data from 2017 to 2023 revealed distinct temporal patterns, including upward and downward income trends in specific years and strong seasonal fluctuations aligned with fishing cycles and monsoon effects, confirming the dynamic nature of income in the sector. The study uncovered critical patterns in income dynamics, including both long-term trends and distinct seasonal fluctuations, offering valuable predictive insights. The study underscores the need for policies that not only boost overall income but also help mitigate the impact of seasonal and irregular income fluctuations. Recommended strategies include providing targeted support during lean months, offering insurance schemes against income loss due to extreme climate events, and encouraging fishermen to diversify their income sources. Ultimately, the goal should aim to implement adaptive management strategies to build a more sustainable and resilient future for the fishing communities of Ernakulam.

Keywords: Motorised fishing, income, trend, economic vulnerability, extreme climate events, insurance

Analysis of Food Processing Industries' Performance: Evidence from India

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This study evaluates the efficiency of India's food processing industry, a crucial sector that contributes 10-12% to the country's GDP and employs millions of workers. Using Data Envelopment Analysis (DEA) for 15 years (2008–2023) of firm-level data from the Annual Survey of Industries (ASI), the research assesses technical, allocative, scale, and cost efficiencies across key sub-industries. Results reveal widespread inefficiencies, with the highest cost efficiency score of 0.28 (aquatic industry). Animal-based sectors (meat, dairy, aquatic) outperform plant-based industries (fruits, vegetables, grain mills) due to adoption of advanced technologies and better resource management. Scale inefficiencies persist, with many firms operating sub-optimally, either too fragmented or overexpanded. Spatial analysis highlights regional disparities, with states like Odisha and Karnataka excelling, while northeastern states lag due to fragmented operations. The findings underscore the urgent need for technological upgrades, process optimization, and policy interventions to enhance productivity and align the sector with India's Viksit Bharat 2047 vision.

Keywords: Food processing industry, Data Envelopment Analysis (DEA), technical efficiency, allocative efficiency, manufacturing sector

The Role of Artificial Intelligence in Indian Agriculture: An Economic Perspective

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Artificial Intelligence (AI) in agriculture is transforming farming activities by improving productivity, minimizing costs, and encouraging sustainability. An attempt has been made to explore the potential of artificial intelligence for shaping the future of farming in India. Secondary sources of various information were collected purposively for the study. Findings of the study revealed that ICRISAT and Microsoft have utilized AI-based predictive analysis to offer farmers real-time sowing advisories, irrigation advisories, and pest management advisories, increasing crop yields by 30%. Drone-based monitoring and intelligent irrigation systems are estimated to save water by 20-30% and improve productivity. AI penetration lowers input costs by 15-20 % through improved resource planning by boosting farmer revenues. Programs such as "AI for Agriculture," initiated by the government, have already demonstrated the ability to reduce post-harvest losses by 10-15%, raising the efficiency of the supply chain. Through successful replication, AI-driven agriculture has the potential to add another $50-60 billion to India's GDP by 2030. Low levels of digital literacy and infrastructural constraints, however, hinder its proliferation. Policymakers advocate public-private partnerships to make AI tools affordable for smallholder farmers. Strategic investments in agri-tech innovation and skill-building are necessary to leverage the maximum economic gains from AI while fostering equitable growth in India. Moreover, AI has a tremendous capacity to revolutionize agriculture into a more productive, sustainable, and profitable industry.

Keywords: Agri-tech innovation, artificial intelligence, economic gains, resource planning, revolutionize agriculture

Access to Digital Services and Its Impact on Farm Income: Empirical Evidence from Eastern India

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Digitalization in the agriculture sector of developing nations acts as a stepping stone to improve efficiency, productivity and profitability of this sector by enabling the farmers' access to crucial information on prices, weather-based agro-advisory and extension services. The current study focussed on the access of digital technologies to the farmers of Eastern India and their impact on the income level. Primary data were collected from 3,375 farmers from thirty-four districts of five states *viz*. Bihar, Uttar Pradesh (East), Jharkhand, Odisha and West Bengal. The findings from the probit model highlighted the importance of better education, proportion of peers using these technologies within the village, access to credit via the government's Kisan Credit Card scheme in enabling access to online digital services of UPI/net banking and those related to agriculture. Using two-stage least square instrumental variable regression, we find that these services have a significant positive effect on per-acre agricultural income. However, there is a disparity in the access to these technologies across farm sizes; marginal farmers lag in the digitalization process. Policies promoting education, particularly digital and financial literacy in schools, could address critical barriers. Additionally, easier access to credit could help farmers invest in smart devices once they understand their benefits. Furthermore, the availability of agro-advisory services in local languages could enhance the familiarity and accessibility of these digital services among the farmers. There should be a strengthened policy framework to improve capacity-building for Indian farmers to adopt and utilize these digital services to boost the performance of the agriculture sector.

Keywords: Access, agri related apps, digital services, farm income, impact, eastern India

Are Returns to Adoption of Modern Rice Technology Heterogeneous? Evidence from Paddy Growers in Eastern India

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This paper investigates the welfare effects of modern rice technology adoption and checks whether the returns from adoption are scale-neutral or scale-biased in Eastern India. Using an endogenous switching regression model, the study has found that the adoption of modern rice technology has augmented the gross margins of adopters only. The non-adopters, if they were adopters of modern rice technology, could have gained in terms of gross margin. However, we observe a considerable heterogeneity in returns to modern rice technology adoption across the farming groups. There is a positive scale bias among the farmers. Hence, the immediate policy implication.

Keywords: Agriculture, technology adoption, heterogeneity, endogenous switching regression

Time Series Analysis of Prices of Potato in India

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Potato has emerged as an important crop in India after rice, wheat and maize and is the highest produced vegetable with 56,173 million metric tons. However, volatility in production and market arrivals has led to price volatility over seasons and is a major concern for the farmers and consumers. The present study examined the price volatility using a price modelling and forecasting approach, which involved secondary data from Indiastatagri and National Horticulture Board. The estimated Compound Annual Growth Rate (CAGR) of 6.54 per cent indicates a positive trend, while uneven cycles from the cyclical component indicates wider fluctuations in prices. The seasonality component identified above-average prices of potato for the first and last three months of the year, with November having the highest seasonal index of 1.34. The prices of potatoes were forecasted for 10 months of 2023 using a Box-Jenkins Auto-Regressive Integrated Moving Average (ARIMA) model. The results indicated a gradual decrease in the prices with fewer fluctuations over the months. The findings of the study will help potato farmers to plan their production and marketing and the government to take measures for price stabilization measures benefiting both farmers and consumers.

Keywords: Price volatility, trend, seasonality, ARIMA, forecasting

Assessing Market Participation and Economic Viability of Tomato Cultivation under High-Tech Tomato Farming in Chhattisgarh

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Market participation plays a pivotal role in determining the profitability and sustainability of vegetable cultivation under protected conditions. This study analyzes the marketing behavior, costs, price spread, and farmer's share in consumer rupee for high-tech vegetable growers in Chhattisgarh, with a focus on tomato crop. Primary data were collected from 240 farmers across five districts using a structured interview schedule, and appropriate analytical tools such as marketable surplus estimation, marketing participation index, and price spread analysis were employed. Results indicated that vegetables under protected cultivation exhibited a high marketable surplus, with tomatoes recording an overall average of 607.22 quintals per hectare. Marketing costs were found to vary across channels, being lowest in direct producer–consumer sales (Rs. 86.00/q) and highest in multi-intermediary channels (Rs. 289.50/q). Price spread analysis further highlighted that the producer's share in the consumer rupee was maximized under direct marketing and minimized in channels involving wholesalers and commission agents. The findings suggest that efficiency and profitability in high-tech vegetable cultivation can be substantially improved by strengthening direct marketing channels, collective marketing through FPOs, and providing infrastructural support for transportation, storage, and market access.

Keywords: Market participation, price spread, high-tech vegetable farming, marketing efficiency

Spatial Inequalities in Digital Access and Skills: Empirical Insights from the Himalayan States of India

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The rapid expansion and integration of digital interventions in the local governance is transforming the world, yet spatial and structural bottlenecks are roadblocks in bridging the gaps in digital divide. Using 79th round of CAMS survey, this paper investigates the nature and determinants of digital divide in Himalayan states of India. We constructed the indices of digital access, basic ability and advanced ability for 48,885 households (2,16,061 individuals). Findings reveal that the rural-urban digital gaps are bridging across the states but significant differences in using the digital devices persist prominently The fractional logit regression model and Oaxaca blinder decomposition analysis reveals the role of various factors in contributing to rural urban digital divide**.** Socio-economic factors are strong determinants of the digital divide where younger men with education and higher income are more likely to have advanced skills to use digital device. Households with better income and development level have better digital abilities. The study suggests that bridging the digital divide in Himalayan states needs integrated strategies that combine targeting 'hotspot of digital divide' districts, developing intervention in local language and enhancing the digital capabilities of marginalised communities.

Keywords: Digital divide, digital skills, ICT access and skills, development, hilly regions

Effectiveness of Late Sowing Technology of Onion in Garo Hills Region of Meghalaya: An Empirical Economic Analysis

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The present study assessed the economic profitability of late sowing nursery technology in onion cultivation in the Garo Hills region of Meghalaya. A total of 57 marginal farmers from West and South-West Garo Hills who adopted the technology were selected purposively. The study was based on primary data collected during April and May 2025 through personal interviews using a pre-tested interview schedule. The analytical tools employed were cost and return analysis, Benefit-Cost Ratio (BCR), and the MoSCoW prioritisation technique for identifying major production constraints. The findings revealed that the average cost of cultivation was ₹ 1,71,158.70 per hectare, with operational costs forming the major share (69.19%), particularly family labour. The gross return stood at ₹ 2,97,320.00 per hectare, and the Benefit-Cost Ratio was calculated to be 1.73. Major challenges reported included low participation in farmer organisations and disease management. The study concluded that the technology is economically viable and suited for smallholder farmers in the region. Recommendations include improved access to better extension support.

Keywords: Onion, late sowing technology, cost and return, Garo Hills, BCR, Meghalaya

Role of Innovating Policies for Rural Transformation: Scope of Agribusiness in Northeastern States of India

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Strategic transformation, from agricultural production to agribusiness, from supply push to demand pull is the needs of the day for India and specifically to the north eastern states of India. The northeastern states of India, characterized by diverse agro-climatic conditions and rich biodiversity, hold immense potential for agribusiness-led rural transformation. However, challenges such as poor infrastructure, limited market access, and inadequate policy support hinder the growth of agribusiness in the region. This paper explores the role of innovative agribusiness models in driving rural transformation and examines enabling policies that can facilitate this process. In the Northeastern states of India, where small and marginal farmers face high uncertainty due to climate variability, market fluctuations, and infrastructure challenges, agribusiness technology and innovation can help maximize the trade-off between higher income and greater security. Expanded market access through digital platforms have the potential to reduce income volatility by offering flexible earning opportunities and enhancing financial inclusion. Through (digital) integrating technology into agriculture should provide comprehensive support to the agricultural community by addressing challenges faced by small and marginal farmers. This innovative platform leverages Information and Communication Technology (ICT) by providing comprehensive support to the agricultural community. India's development needs a strong foundation in digital public infrastructure underscore India's potential for sustained medium-term growth and continued social welfare gains.

Keywords: Agriculture, agribusiness technology, digital technology, inequality, innovation

Agricultural Startups to Unicorns Status – Opportunities in India to Address the SDGs and (*Viksit Bharat)* Developed India Status in 2047

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The Government of India is targeting 30 trillion United States Dollar economy in the year 2047. As compared to China, India is having efficient service sector growth in Information and Communication and soft technologies; it also has efficient macro-economic stability to support inclusive global development perspectives. In the recent years, the Agri-startups play an important role in the Indian economy with access to Information and communication technologies, data analytics, and precision farming techniques to enhance agricultural productivity. In the background to address the opportunities of the new generation "Agri-tech" startups in India and the United Nation Organization'(UNO)s Sustainable Development Goals (SDGs), a study was conducted with 120 agricultural start-ups across the country in the year 2022. Secondary information sources and case study analysis were also used. The study found that, the agri-business Incubators in India played vibrant role in strengthening startups and its' ecosystem in India. The agricultural exports increased with the support of digital technologies based startups, Artificial Intelligence and Machine Learning prominence through internationalization of Indian Agricultural startups. Also, to empower smallholder farmers through fostering innovation for sustainable agriculture to address the SDGs related to food security, poverty alleviation, and environmental sustainability, promotion of the agricultural startup ecosystem in to unicorn status is very much important. The Unicorn status agricultural startup companies also attract Foreign Direct Investment for growth and development in global perspectives. It also strengthens science, technology, and innovation, gender specific Agri-startups improve social entrepreneurship process. Hence, promotions of high valued startups with new generation technologies are needed in the agricultural sector. Despite these challenges, several agri-startups act as a social enterprises based social startups to address the SDGs for the sustainable development of the country.

Keywords: Agri-startups, new generation technologies, SDGs, sustainable development

Leveraging Geographical Indication for Enhancing Livelihoods and Economic Prosperity: The Case through *Madurai Malli*

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Geographical Indications is a community-based IP to protect the products from a specific geographical origin and are in possession of certain qualities or have gained a reputation due to the place of origin. It is covered under the Article 1(2) and 10 of Paris Convention for Protection of Industrial Property and is also covered under TRIPS (Article 22.1). Use of GI as IP has been successfully implemented in developed countries and increasingly in developing countries. India implemented the Act from 15th September, 2003 and the GI tag is awarded in sectors such as handicrafts, textile, agriculture, food stuff, natural stuff, manufactured products. GI in the area of agricultural commodities are of prime importance as it provides the farmers and the rural communities to protect and cultivate products and earn extra income. Among the horticultural crops, maximum GIs have been accorded to the fruit crops (50) followed by vegetables (26), plantations (16), spices (15), flowers (6) & aromatic plants (9). Under the floriculture, *Jasmine* or *Madurai Malli* is the first horticultural product from Tamil Nadu to get the GI tag in 2013. The study discusses about the recognition and marketing opportunities of *Madurai Malli* transforming the livelihoods of SHGs/rural women of Madurai. The role of the technological intervention and value addition on the business leading to exports of the product is highlighted.

Keywords: Geographical indications, IP, Madurai Malli

Application of SARIMAX Model to Forecast the Maize Wholesale Price in India

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Maize, as a staple crop, plays a critical role in global food security and agricultural economies. However, its price fluctuations, driven by factors such as seasonal production cycles, market demand, transportation costs, and climate uncertainties, create challenges for farmers, traders, and policymakers. Accurate forecasting of maize prices is essential for improving market planning, mitigating risks, and ensuring economic stability in the agricultural sector. This study applies the Seasonal Autoregressive Integrated Moving Average with Exogenous Factors (SARIMAX) model to analyze historical maize price data and predict future price trends. The model incorporates external economic variables such as inflation, fuel prices, and policy interventions to enhance forecast accuracy. The results reveal that maize prices exhibit strong seasonal patterns, with higher prices observed during certain months due to supply-demand imbalances and external economic pressures. The findings indicate that SARIMAX outperforms traditional forecasting models by capturing both seasonality and external market influences, making it a valuable tool for agricultural decision-making. The study provides actionable insights for policymakers, helping them design price stabilization mechanisms and develop strategies to protect farmers from extreme price volatility. Additionally, traders and agribusinesses can leverage these forecasts to optimize procurement and storage decisions. By bridging the gap between agricultural economics and predictive analytics, this research contributes to improved market efficiency and informed policymaking. Future studies can integrate climate variables and real-time data collection to further enhance predictive accuracy and resilience in maize price forecasting.

Keywords: Maize, forecasting models, SARIMAX model, time series

Economic Analysis of the Dry Chilli Value Chain in North Eastern Karnataka

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The present study was undertaken in the Raichur and Ballari districts of the Kalyana Karnataka region since these districts are among the most productive in terms of dry chilli crop acreage and production. Primary data was obtained from the farmers and value creators in the dry chilli value chain and mapped to identify the actors, their roles, interactions, and value generation activities. Primarily three value chains were identified: value chain I and II for dry chilli and value chain III for processors. The findings of the study revealed that marketing efficiency is higher in value chain II (2.43) and lower in value chain III (1.14). Furthermore, the producer's share in the consumers' rupee was considerably smaller (42%) in value chain III than in value chain II (54.07%), owing primarily to the absence of middlemen. The share of value added cost was larger at the processor level (value chain III) and also the degree of value addition. As it affects the form of the product, the value addition of chilli at the processing stage is substantially higher than at any other step. Hence, more processing facilities for chilli products other than chilli powder are required and appropriate government policies may encourage capacity growth of existing units.

Keywords: Dry chilli, marketing cost, marketing efficiency, value chain analysis, value addition

Millets Value Addition: Improvising Farmers Income through FPOs in Karnataka

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The present study found that there was an increase in income of the millet farmers after their participation in FPOs due to adoption of improved technologies, better market linkages and other supports provided by the promoters of FPOs. The increase in income ranged from 37 per cent for foxtail millet to 51.20 per cent in the case of maize. Further, the promoters of FPOs also supported the millet FPOs in terms of processing and value addition. As a result, the increase in the incomes of the farmers was overwhelming. The enhancement of income in the case of millet rice processing was more than two folds *i.e.* it ranged from 114.65 per cent in the case of little millet rice production and 186.33 per cent in the case of foxtail millets. Similarly, value addition into khakra production resulted in still higher incomes to the farmers. The magnitude of increase in per acre income of the farmers was astonishingly higher by 20 to 30 times than what farmer getting in just producing millet and selling it as a raw materials. These findings underscore the immense potential of value addition in the millet value chain. Transitioning from traditional production to processing and ready to eat value added products can substantially enhance the farmers income, drive rural entrepreneurship and contribute to sustainable agricultural development, particularly in the millet growing regions. The study concluded that the value addition in millets helps the farmers to get maximum returns and enabled the farm to earn higher incomes by establishing the millet based processing units in potential millet producing districts of Karnataka through FPOs.

Keywords: Millets value addition, FPOs, millet rice, millet khakra

Catch and Bycatch Economics: A Perspective on Kerala's Marine Fishing Systems

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Understanding the economics of catch and bycatch is essential for improving fishers' livelihoods while ensuring the long-term sustainability of marine fisheries. This study assessed the economics of five fishing systems in Kerala, namely multiday trawl (MDT), single-day trawl (SDT), inboard ring seine (IRS), outboard ring seine (ORS) and single-day gillnet (SDG), along with their associated bycatch. Primary data were collected from 195 fishers, representing about 15% of total crafts at Neendakara (south), Munambam (central) and Puthiyappa (north) fishing harbours, selected as representative of the state's diverse marine fishing practices. Cost–benefit and economic efficiency analyses indicated that all systems were viable (BCR > 1), with SDT being the most efficient (operating ratio 0.57) and ORS the least (0.75). MDT had the highest annual cost (₹259.23 lakh) and SDG the lowest (₹16.73 lakh). Net incomes ranged from ₹5.70 lakh (SDG) to ₹77.79 lakh (IRS). Bycatch contributed ₹17,333.33 to ₹20,666.67, with the highest share in MDT (9.37%) and the lowest in ORS (1.11%). Although bycatch provided supplementary income, juvenile dominance in these catches poses sustainability risks. Strengthening MLS enforcement is therefore critical to reduce juvenile exploitation, safeguard fish stocks and maintain the long-term economic viability of marine fisheries.

Keywords: Economic efficiency, bycatch economics, Kerala fisheries

Innovations and Economic Viability of Piggery as an Agribusiness Enterprise: A Case Study of Farmer Producer Company in Punjab

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Piggery holds significant potential for rural income diversification, market expansion, and value addition in India. This case study examines the economics and marketing strategies of the Farmway Farmer Producer Company Limited (FFPCL), an innovative collective model integrating breeding, finishing, processing, and direct marketing of pork and processed meat products. A detailed cost analysis reveals an annual net return of ₹12.53 lakh equivalent to ₹3,627 per animal per month with feed constituting over 86% of variable costs by operating a 22-sow and 2-boar breeding-cum-finisher unit. Value addition through on-farm processing of raw pork into sausages, pickles, and frozen cuts enhances profitability and enables penetration into premium markets, including hotels, retail outlets, and direct consumer sales. The study highlights piggery's potential for sustainable, farmer-led rural development in India and positioning livestock-based FPCs as replicable models for sustainable agricultural diversification in India. However, there is a need for targeted policy support, modern slaughterhouse infrastructure, affordable credit, and R&D on natural preservatives to meet domestic safety norms and tap into global pork markets.

Keywords: Piggery, farmer producer company, value addition, agribusiness innovation, economic analysis, Punjab

An Empirical Analysis of Export Competitiveness and Market Concentration in India

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India's export sector is a vital driver of economic growth, contributing significantly to foreign exchange earnings and global trade integration. Understanding its market position and competitive advantage is crucial for policy and strategic planning. This study analyses India's export performance from 2016–17 to 2024–25 using two key measures the Revealed Comparative Advantage (RCA) Index to assess competitiveness in major markets, and the Herfindahl–Hirschman Index (HHI) to evaluate market concentration. The analysis focuses on the top ten export destinations individually, with all other markets grouped under "Others" to capture diversification. RCA results indicate strong competitiveness in key destinations such as the USA, China, and Bangladesh, where values consistently exceeded 2, while some markets, such as Mundra Sea in 2024–25, showed lower competitiveness with an RCA of 0.65. HHI trends reveal variations between quantity- and value-based measures: concentration in quantity peaked in 2016–17, while value-based concentration was highest in 2018–19, reflecting the influence of price fluctuations and product composition. In some periods, high export volumes coincided with lower values, indicating disparities in unit prices and market demand. These findings highlight that while India holds a competitive edge in several high-value markets, dependence on a limited number of destinations increases vulnerability. Diversification into emerging markets, improving value addition, and reducing over-reliance on a few key buyers are essential for sustaining competitiveness, enhancing market resilience, and achieving balanced long-term export growth.

Keywords: Agricultural exports, revealed comparative advantage, CAGR, Herfindahl-Hirschman Index, trade competitiveness

India's Agricultural Trade strategy under proposed Indo-Peru Free Trade Agreement (IPFTA): An RCA-BRCA Approach

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Currently India is in process of negotiating lot of trade agreements and seven rounds of negotiation took place between India and Peru for a proposed free trade agreement. This study assessed the opportunities and challenges that will emerge and need to be dealt properly under this agreement. Potential and defensive list of products were identified using standard Revealed Comparative Advantage (RCA) and Bilateral RCA (BRCA) indices at HS-6 digit level data for recent three years (2021-2023). Thirty three agricultural products such as beet sugar, frozen shrimps and prawns, frozen edible offal, molluscs, medicinal plant parts, mustard seeds and capsicum were identified as potential products where India can gain if properly negotiated during talks. Conversely, thirteen products such as cranberries, bilberries, cocoa beans, asparagus, avocadoes, grapes, coffee and food preparations were identified as sensitive products which should be kept either in exclusion list or subjected to gradual reduction in tariffs. This study provides granular level insights for trade negotiations particularly for agricultural sector. It also contributes to the literature on Global South-South trade agreements.

Keywords: FTA, RCA, BRCA, potential products, defensive products

Role of Incubators and Accelerators in Fostering Agribusiness Entrepreneurship: Case Study from India

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India's agricultural landscape is at a crossroads, confronted by challenges such as climate change, declining farm incomes, and fragmented value chains, yet also buoyed by emerging technologies and an expanding agritech startup ecosystem. In this context, Incubators and Accelerators (I&As) have emerged as pivotal institutional mechanisms or special purpose vehicles (SPVs) to nurture Agri-entrepreneurship and catalyze the transformation of the rural economy. This paper examines the strategic role played by I&As in enabling innovation, technology validation, and market readiness for agritech startups, thereby addressing the "last-mile" disconnect between innovation and impact. This study explores the role of I&As in fostering agribusiness entrepreneurship through insights from 30 agritech startups and 5 incubators across India. The analysis highlights that I&As contribute significantly to field validation, grant access, infrastructure support, and community engagement, though their impact in areas like regulatory navigation and investment readiness is perceived as moderate. The integration of incubation models with academic and government systems has helped strengthen regional innovation capacity, especially in non-metro regions. The findings underscore the need for adaptive incubation approaches, expanded ecosystem linkages, and targeted capacity-building to further empower agritech startups and accelerate India's transition to a resilient, inclusive, and innovation-driven agricultural economy.

Keywords: Incubators, accelerators, innovation, agriculture

Innovations in Agri Business: Impact of NCDFI eMarket on Dairy Market

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Efficient marketing is a pre-requisite in the development process of any economy. NCDFI eMarket is an electronic marketplace for efficient buying and selling of bulk commodities and services across the country. Mainly, the commodities being traded are dairy products, cattle feed ingredients, edible oils, packaging materials, sugar, chemicals, scrap, etc. apart from manpower and transport services and warehousing. eMarket combines trust and patronage of dairy cooperatives throughout the country and state of the art technology and efficient business development practices to offer an efficient marketplace for bulk trading. The utilisation of the NCDFI eMarket has proved to be beneficial decision for most of the dairy cooperatives and at the same time this has enabled them to plough back higher returns to their member farmers from the additional revenue generated through the e-market. Moreover, the transaction through e-portal is much faster as compared to the traditional tendering process. This also helped them to make prompt payments to their dairy farmers pouring milk regularly at the affiliated societies.

Keywords: Innovation, agribusiness, market structure

Innovations in Agri-Input and Services Market Towards Sustainable Agriculture in India: A Systematic Literature Review

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This study provides a systematic literature review on innovations in agri-input and services markets aimed at fostering sustainable agriculture in India. Climate change presents substantial challenges to agricultural productivity, particularly for smallholder farmers with limited adaptive capacities. Innovations such as agroforestry, precision agriculture, climate-smart practices, and digital agricultural extension services have demonstrated the potential in enhancing the resilience and productivity of farming systems. This review identifies significant advancements in agri-inputs and market services, including the adoption of improved seed varieties, efficient irrigation techniques, and the establishment of Farmer Producer Organizations (FPOs) that enhance market access and financial support for farmers. The study examines the socio-economic, climatic, structural, institutional, and political factors influencing the adoption of these innovations. Additionally, it evaluates the contributions of these innovations to several Sustainable Development Goals (SDGs), including poverty reduction, zero hunger, economic growth, climate action, and sustainable land management. The findings highlight the need for enhanced data analytics, integration of advanced technologies, policy support, and gender-sensitive approaches to further promote sustainable agricultural practices. Addressing gender biases and promoting clean energy solutions are crucial for achieving broader developmental goals. The findings suggest future research avenues in data analytics, advanced technologies, sociocultural studies, policy support, climate-smart agriculture, and market services to further enhance the resilience and sustainability of agricultural systems. This review underscores the critical role of collaborative efforts among governments, private sectors, and international organizations in advancing sustainable agriculture in India.

Keywords: Systematic review, innovative agri inputs, sustainable agriculture, ICT

From Soil to Market: Assessing Sustainable Agriculture Practices and Market Linkages in Groundnut Farming in Andhra Pradesh

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India has 54.2 lakh hectares under groundnut cultivation (FAOSTAT), 2021). Andhra Pradesh accounts for 6.20% of India's total groundnut production. This study evaluates the economic and marketing potential of groundnut following Sustainable Agriculture Practices (SAPs). A mixed-methods approach is used to collect data from 180 farmers across 12 villages in two districts of Andhra Pradesh through stratified multi- stage sampling. Based on farmers' point of sale, three major value chains have been identified, which are extensively used by farmers in the potential districts. Of them, the best value chain suggested is VO/FPC driven and by directly selling it to Hullers and MNCs, having primary processing at village level through VOs/FPCs. Best Priced Received by Selling to MNCs and Hullers of about ¹ 59.56~60 Per KG [₹5956/ Quintal] - to Hullers ₹59.21 Per KG [₹5921/ Quintal] - to MNCs, having margin of - 1) 40% in branded consumer price, 2) 49% of Local produce consumer price, and 3) 32 % of Organic Consumer Price. While awareness of Sustainable Agriculture Practices (SAPs)—such as zero tillage, natural farming, organic methods, and protective cultivation—is low, farmers who adopt them see clear benefits like higher yields, better soil health, and increased income. Despite relatively easy access to credit through SHGs and Grameen banks, high investment costs and weak market linkages for Groundnut limit the entrepreneurial uptake of SAPs. Most farmers depend on local traders due to ease and marginally better prices, but they remain unaware of certification systems and their potential value.

Keywords: Certification, SAPs, market linkage, producer share, consumer price, value addition

Assessing the Impact of Farmer Producer Organization (FPOs) on Agricultural Outcomes: A Binary Logit Model Analysis

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This study analyses the impact of farmer producer organizations by using binary logit model. The multistage sampling method was used for selection 252 samples from the Western Region of Maharashtra during 2022-23; 126 are the member and 126 are the non-member famers of FPOs. BinaryLogit model was used as dependent variable is qualitative in nature. The results revealed that several factors appear to influence FPO participation. These include age, experience, access to marketing and input facilities provided by FPOs, and income level. However, other factors like gender, marital status, education, landholding, and family size didn't show significant associations with FPO participation.. AIC was 32.168 showed the best fit of model.

Keywords: Logit model, AIC- Akaike Information Criterion, farmer producer organizations, logit regression

Global Investment Insights: A Triangulated Approach to Understanding Foreign Direct Investment Inflows in the Top 10 Economies

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Serving as a global market integrator, foreign direct investment intricately interweaves economies, fostering the seamless flow of goods, services, and ideas while diversifying revenue streams and instigating the transfer of skills and management practices. A meticulous analysis of the top 10 countries in foreign direct investment in 2022 underscores India's prominence securing the tenth position. Employing sophisticated econometric techniques such as Fully Modified Ordinary Least Squares, Dynamic Ordinary Least Squares, and Canonical Cointegration Regression, the study delves into determinants of foreign direct investment inflows among the top 10 investors from 1990 to 2022. It particularly focuses on foreign direct investment outflows, Carbon Dioxide (CO_2) emissions, exchange rates, trade openness, and population. Through unit root tests, cross-sectional dependence tests, and cointegration tests, the research unravels nuanced associations and correlations, shedding light on intricate insights. The findings underscore positive association between foreign direct investment inflows with its outflows, exchange rates, larger population, and more open trade policies, in stark contrast to CO_2 emissions. Robustness checks utilizing a Fixed Effects model and diagnostic tests meticulously validate the findings, ensuring the reliability and stability of identified determinants. The study concludes by emphasizing interconnectedness between economic and environmental factors and thus, offer critical indicators for policymakers in navigating the labyrinth of complex forces shaping international investments and formulating strategies that foster sustainable economic development through foreign direct investment.

Keywords: Foreign direct investment inflows, trade openness, carbon dioxide emissions, panel cointegration, panel cross-sectional dependence, fully modified ordinary least squares, dynamic ordinary least squares, canonical cointegration regression

Optimizing Cost, Returns, and Employment in Dairy Farming: A Comparative Analysis of Integrated Farming Systems in Madhya Pradesh

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Madhya Pradesh was purposively chosen for the study, in which Umaria and Anuppur district was selected. In 12 selected villages all beneficiaries 120 (12 x10) under IFS have been selected for the study. Ten equal number of non-beneficiaries having similar socio-economic status was also being selected for the study. To estimate cost and returns of milk production budgeting technique was used and it was concluded from the analysis that dairy farming under FS-II was most profitable one as compared to FS-I, FS-III and FS-IV. The return per animal per year was found highest for FS-II since the productivity was more as compared to FS-I, FS-III and FS-IV . Among beneficiaries highest employment generation through FS-II (60 labour days/year) followed by FS-III (52 labour days/year), FS-I (50 labour days/year) and FS-IV (42 labour days/year), respectively. The major constraints faced by respondents are low investment capacity under crop cultivation, unavailability of green fodder under dairy enterprises. The study highlights the economic and employment benefits of FS-II and underscores the need for addressing key challenges to enhance productivity and sustainability within IFS models.

Keywords: Milk production, employment generation, cost and returns, farming system

Exploring Greenwashing in the Global Agricultural Sector: A Mixed-Methods Analysis of Misleading Sustainability Narratives and Country-Level Regulations

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Greenwashing—strategic misrepresentation of environmental sustainability—poses a growing challenge to the integrity of global agricultural transitions. The research problem addressed in this study is the lack of empirical insight into how greenwashing shapes sustainability narratives, influences consumer trust, and escapes regulatory scrutiny across the agricultural sector. The objectives are to identify patterns of greenwashing, classify deceptive claims using the "Seven Sins of Greenwashing" framework, and assess how country-level regulations address these practices. To achieve this, a mixed-methods approach combining bibliometric analysis (via Bibliometrix in R) and text mining of global media and policy documents was performed. The study also integrates in-depth case analysis of Mantria Corporation (USA), NeuRizer (Australia), and JBS (Brazil) to contextualize greenwashing practices across agri-food systems. Results reveal recurring patterns of unverifiable claims, vague certifications, and selective environmental messaging, often enabled by weak or fragmented legal frameworks. Findings also show that such practices distort sustainable value chains, mislead stakeholders, and reduce the effectiveness of climate-resilient agricultural policies. This research contributes actionable insights for regulators, start-ups, and agri-exporters, and aligns with AERA's conference themes by recommending stronger policy tools, verification mechanisms, and transparent communication to build truly sustainable agricultural futures.

Keywords: Greenwashing, agriculture, text mining, media, bibliometric analysis

Agri-Tech for Inclusive Growth: A Critical Review of Startup-Led Market Integration in Indian Agriculture

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Agri-tech startups in India are emerging as key enablers in transforming agricultural value chains by improving market linkages, enhancing price realization, and reducing transaction costs for smallholder farmers. This study uses secondary data from DPIIT's Startup India portal, Economic Surveys, and industry reports (e.g., NASSCOM, Bain & Company) to assess the impact of agri- tech startups on rural incomes and agri-market access. Innovations such as digital marketplaces, AI-based crop advisory, precision farming, and farm-gate logistics are being increasingly adopted to streamline supply chains. Case examples like Ninjacart, DeHaat, and AgroStar demonstrate improved farmer participation in digital markets and better income outcomes through price transparency and reduction of intermediaries. Despite the supportive policy ecosystem, including initiatives like Startup India and Agri Infra Fund, major constraints persist—such as limited rural digital literacy, uneven infrastructure, and low investment in underserved regions. The study emphasizes the need for greater public-private partnerships, regional incubators, and gender- inclusive digital training programs. Findings suggest that strengthening agri-tech ecosystems can accelerate farmer inclusion in high-value markets and promote sustainable agricultural entrepreneurship.

Keywords: Agri-tech startups, market linkages, digital agriculture, value chains, rural incomes, India

Determinants and Potential of Indian Rice Exports: An Application of Poisson Pseudo Maximum Likelihood and Heckman Gravity Approach

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This study identifies the determinants of Indian rice exports and evaluates its export potential through the application of the Poisson Pseudo Maximum Likelihood (PPML) and Heckman Gravity models. The analysis is based on 34 years of panel data (1988-2021) for 37 export countries. The results show that the Gross Domestic Product (GDP) of India and its trading partners, population, common border, and language have a positive and significant impact on Indian rice exports. Conversely, distance, rice production in importing countries, exchange rate, and average applied tariff have a negative and significant impact. It is to note that the Regional Trade Agreements (RTA) have no discernible positive impact on Indian rice exports. The results of export potential revealed that, India exceeded its rice export potential in 26 out of the 37 countries as of 2021. India's rice export potential remains substantial, particularly to countries such as the United Arab Emirates, Kuwait, the Netherlands, South Africa, Cote d'Ivoire, Iran, Qatar, the United Kingdom, Oman, and Australia. Study recommends that India has to explore new markets for rice exports by diversifying its customer base to reduce reliance on a few markets.

Keywords: Rice exports, India, gravity model, PPML, Heckman selection

Investment Pattern and Lifecycle Dynamics of Agri-startups in India: A Sectoral Analysis

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India has witnessed remarkable growth in the startup ecosystem in the past decade and has become the third largest in the world. Despite global funding contractions, India's agri-startup ecosystem has shown resilience. This study pertains to agri-startups in India which came into existence during 2000 to 2024. Utilizing data from Tracxn, the findings revealed that Non-tech agri-startups dominate in number, yet Tech startups attract significantly higher investments, averaging $11.15 million compared to $5.83 million for Non-tech ventures. Tech agri-startups exhibit higher survival rates when funded (95.23% alive) but greater vulnerability when remain unfunded (70.05% alive). Association Rule Mining identifies key failure predictors, including small employee size (≤100) and lack of funding. It was also observed that 52% of deadpooled startups failed within 0–3 years of incorporation. Geographically, Maharashtra and Karnataka lead in startup activity, while Tier I cities host 50.06% of Tech ventures. Recommendations include strengthening infrastructure, bridging funding gaps, and fostering scalable, tech-enabled solutions to enhance the sustainability of agri-startup ecosystem in the country.

Keywords: Agri-startup, investment, deadpool, Association Rule Mining (ARM)

Assessing India's Trade Competitiveness and Patterns within BIMSTEC

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This study evaluates India's trade competitiveness and patterns within the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), with a focus on agricultural exports. Utilizing secondary data from UN Comtrade, World Bank, and ITC Trade Map (2004–2023), we assess trade dynamics through key indices including Revealed Comparative Advantage (RCA), Trade Intensity Index (TIE), Trade Specialization Coefficient (TSC), and Compound Annual Growth Rate (CAGR). The findings reveal that India holds a strong comparative advantage in primary agricultural commodities like onions, rice, and cotton, with high RCA values, but faces challenges in high-value exports such as edible oils and seafood due to competition from countries like Peru, Thailand, and the UAE. Bangladesh emerges as India's primary trade partner within BIMSTEC, exhibiting the highest TIE, while trade with Nepal, Myanmar, and Thailand shows stable but fluctuating growth. The TSC analysis indicates India's export specialization in traditional commodities, with potential for diversification into processed agricultural products. Growth trends show a slowdown in export expansion from 2014-2023 compared to 2004-2013, coupled with increased trade volatility in Nepal and Bhutan. The study highlights the need for India to enhance post-harvest infrastructure, implement proactive trade policies, and strengthen regional agreements to boost competitiveness and promote sustainable agricultural trade within BIMSTEC. These strategies can drive inclusive economic growth and regional cooperation.

Keywords: BIMSTEC, agricultural trade, revealed comparative advantage, trade intensity index, trade specialization coefficient, trade competitiveness, regional cooperation

Onion Price Nexus: A GIS-based Price Transmission and Causality of Onion Markets in India

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Onion prices in India are highly volatile, drawing significant policy attention due to frequent and unpredictable fluctuations. This study analyzes wholesale prices from 2009 to 2023 across five major markets - Pimpalgaon, Lasalgaon, Bangalore, Hubli, and Delhi - to assess market integration. Co-integration analysis confirms that prices move together over the long term, indicating strong integration. Unit root tests reveal non-stationarity at levels but stationarity at first differences, while Trace and Maximum Eigen-value tests validate long-term equilibrium. Granger causality tests show bidirectional causality between some market pairs (e.g., Hubli-Bangalore), where prices influence each other, and unidirectional causality in others (e.g., Bangalore-Delhi), where price changes flow in one direction. This robust integration suggests that targeted government interventions in key onion markets can efficiently stabilize prices, with positive spillover effects minimizing price volatility and reducing overall stabilization costs across the market network.

Keywords: Causality, co-integration, markets, onion price

Performance of e-NAM in India and Telangana

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The electronic National Agricultural Market (e-NAM) was launched in April 2016 by the Government of India, which aims to integrate APMC mandis through a unified digital platform for transparent and efficient agricultural marketing. The present study evaluates the performance of e-NAM in India with a special focus on Telangana using secondary data from 2016–17 to 2023–24. As of June 2025, 1,522 APMC mandis across India were integrated under e-NAM, where Tamil Nadu (213), Rajasthan (173), Uttar Pradesh (162), and Gujarat (144) are the leading states. Telangana contributed 57 mandis, accounting for 3.75 percent. Among 1.82 crore registered stakeholders in India, Telangana's share was 0.18 crore (10.01%), comprising 18.23 lakh farmers, 6,371 traders, 5,161 commission agents, and 137 FPOs. Uttar Pradesh leads in farmer participation with 33.05 lakh, followed by Madhya Pradesh with 30.25 lakh and Haryana 27.27 lakh. In Telangana, Nizamabad market recorded the highest farmer registration 3.23 lakh, followed by Kesamudram, Suryapet and Warangal. The growth rate in volume and value of quantity traded found to be significant at 16.95 percent and 26.05 percent respectively. In Telangana the value of quantity traded found to be significant at 8.69 per cent, volume (3.33%) found to be non-significant. Paddy, turmeric, chilli, cotton and maize are the major commodities traded under e-NAM in Telangana.

Keywords: e-NAM, farmers, markets

Digital Transformation in Indian Agriculture: Role of AI, IoT, and Block Chain Technology

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Digital agriculture is transforming the traditional farming landscape through the integration of emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and block chain. This review paper explores the synergistic roles of these technologies in enhancing productivity, sustainability, and decision-making in modern agriculture. IoT enables real-time data collection through smart sensors that monitor soil, climate, and crop health. AI utilizes this data to drive predictive analytics, optimize input usage, detect diseases early, and automate tasks. Block chain ensures data transparency, security, and traceability in agricultural supply chains, empowering farmers with ownership and control over their information. Together, these tools support precision farming, reduce environmental impact, and improve market access for farmers. The paper also discusses current limitations including infrastructure gaps, high technology costs, data privacy concerns. Future directions highlight the importance of low-power edge AI systems, interoperable platforms, and inclusive policies to scale digital agriculture sustainably.

Keywords: Agriculture, digital technology, AI, IoT, block chain

Role of Innovating Polices for Rural Transformation: Scope of Agribusiness in Northeastern States of India

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Strategic transformation, from agricultural production to agribusiness, from supply push to demand pull is the needs of the day for India and specifically to the north eastern states of India. The North eastern states of India, characterised by diverse agro-climatic conditions and rich biodiversity, hold immense potential for agribusiness led rural transformation. However challenges such as poor infrastructure, limited market access, and inadequate policy support hinder the growth of agribusiness in the region, This paper explores the role of innovative agribusiness models in driving rural transformation and examines enabling policies that can facilitate in the process, In the North eastern states of India, where small and marginal farmers face high uncertainty due to climate variability, market fluctuations, and infrastructure challenges. Agribusiness technology and innovation can help maximize the trade-off between higher income and greater security. Expanded market accesses through digital platforms have the potential to reduce income volatility by offering flexible earning opportunities and enhancing financial inclusion. Through (digital) integrating technology into agriculture should provide comprehensive support to the agricultural community by addressing challenges faced by small and marginal farmers. This innovative platform leverages Information and Communication Technology (ICT) by providing comprehensive support to the agricultural community. India's development needs an revenue potential, a strong foundation in digital public infrastructure underscore India's potential for sustained medium –term growth and continued social welfare gains.

Keywords: Agriculture, agribusiness technology, digital technology, inequality, innovation

Effects of FTAs on Agriculture Trade: Findings from Augmented Gravity Model

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The paper examines the relationship between corruption and trade in agriculture for a group of countries over 2001–2020. We employ OLS and PPML methods to estimate augmented gravity model. To control for country-specific factors we add importer and exporter country fixed effect dummy variables. This paper uses Corruption Perceptions Index data for gravity analysis which is its main strength. The estimates present a mixed picture across the models. For the OLS estimates, we find a positive relationship between the level of corruption and bilateral agricultural trade for the exporter countries. In case for importer country, it report inverse relationship. For PPML estimates, the coefficient of CPI for the importer and exporter country shows inverse relationship between corruption and bilateral agricultural trade. This relationship is explained by, firstly, high tariffs on agricultural products; and secondly, the fact that most developing countries that are also exporters of agricultural products rank low in the CPI. The time fixed effect model indicates strong trade creation effects for AIFTA, MERCOSUR and EU-15 countries. For the time and country fixed effect model, trade creation results in higher welfare among member countries, which suggests that agricultural trade liberalisation is welfare-enhancing for FTA partner countries.

Keywords: Agricultural trade, FTA, corruption perceptions index, gravity model

From Farm to Foreign Markets: Analysing Tamil Nadu's Role in India's Mango Pulp Export Value Chain

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India is the world's largest producer of mangoes, yet its supply chain remains fragmented and inefficient, limiting value addition and export potential. Tamil Nadu, despite contributing only 6.20% of the mango cultivation area and 4.38% of production, accounts for 48.48% of mango pulp export quantity and 41.98% of its export value. This study investigates the mango pulp supply chain in Tamil Nadu through primary and secondary data, focusing on production economics, marketing channels, and processing dynamics. The Benefit-Cost Ratio (BCR) was estimated at 2.14, while the Marketing Efficiency Ratio (MER) was found to be 2.08, indicating substantial gains from efficient market integration. The analysis highlights infrastructure bottlenecks, high perishability, and fragmented farmer–processor linkages. As a key policy recommendation, the establishment of cluster-based mango processing units with integrated cold chain systems is proposed. Such clusters, especially in production-rich zones, can reduce post-harvest losses, improve price realization, and enhance rural income through strengthened forward linkages and export competitiveness.

Keywords: Mango supply chain, agro-processing, marketing efficiency, cold chain, value addition

Agri-Intelligence: Shaping Sustainable Farming in India

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Farming is just one industry where artificial intelligence (AI) is proving to be a game- Artificial Intelligence (AI) is now reinventing the agricultural sector to feed expanding populations, adapt to climate change, and deal with limited resources. This paper focuses on the impact of applying the trends in artificial intelligence to the farming sector and the resulting benefits of precision in resource utilisation and overall production. Today, technologies like artificial intelligence, learning, robotics, drones, and analytics help farmers to check the quality of the soil, predict the production result, automatize systems and logistics – all with higher efficiency. AI applications are substitutes to human labour, they cut on the environmental effects, and increase the yield in crop production. Furthermore, it has also revealed its importance especially in climate smart agriculture where it helps the farmers by availing information which helps in farmers in adaptation of new weather conditions and practices such as use of biochar, and carbon credits. We are experiencing a new reformation called AI agriculture, this implies that the agriculture of the future is going to be revolutionized by DATA that would help the farmers in making good decisions, without which food insecurity is inevitable, making agriculture sustainable.
Keywords: Artificial intelligence, agriculture, CSA, sustainable, productivity

Do Marine Fish Markets Move Together? Evidence of Domestic Market Integration in Coastal Maharashtra

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Market integration buffers the impact of environmental and economic shocks on prices, with integrated markets showing greater resilience compared to fragmented ones. In this backdrop, this study investigates spatial price integration across five major marine fish markets in Maharashtra (Mumbai, Thane, Raigad, Ratnagiri, and Sindhudurg) using 25 years of annual price data (1997–2022). The analysis employed Autoregressive Distributed Lag (ARDL) bounds testing and the Law of One Price (LOP), six key species were analyzed: Mackerels, Penaeid prawns, *Harpadon nehereus*, Non-penaeid prawns, *Otolithoides* spp., and *Loligoduvauceli* to examine long-run market relationships and price transmission patterns. The study reveals strong long-run price convergence for most species, with perfect transmission for Penaeid prawns and Otolithoides spp. Loligoduvauceli showed weak integration, likely due to its export-driven, fragmented market. A notable finding is the unidirectional cointegration for several species, where prices in Mumbai significantly influence those in other markets but not vice versa, highlighting Mumbai's role as a dominant price setter in the state. The study concludes that several coastal fish markets in Maharashtra function as an integrated market space, enhancing price stability and market efficiency. These findings underscore the need for species-specific market strategies and robust regional price intelligence to support efficient fisheries governance and informed policymaking in India.

Keywords: Fish market, market integration, Maharashtra

Augmenting Farmers' Income through Blockchain in India

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India's agriculture sector faces persistent challenges including inefficient supply chains, limited market access, post-harvest losses, lack of transparency and traceability, dependence on intermediaries, and inadequate access to institutional credit and modern technology. With over 46 percent of India's workforce engaged in agriculture (PLFS, 2023-24), technological innovation holds significant promise for sectoral transformation. This paper explores the potential of blockchain as a Fourth Industrial Revolution technology to address systemic inefficiencies in Indian agriculture. It examines global use cases and identifies key applications of blockchain in enhancing traceability, supply chain transparency, access to finance and insurance, and improving risk management. Drawing on global best practices, the study maps these to the Indian context, identifying sector-specific bottlenecks and adaptation strategies. A focused case study of the Kalp Vriskha model illustrates how blockchain can operationalize value-chain integration and enhance farmer income. While the technology offers transformative potential, issues related to technical complexity, lack of infrastructure, scalability, and inadequate regulatory frameworks remain key barriers. The paper argues that user-friendly design, institutional support, expansion of physical infrastructure and an enabling policy ecosystem are critical for mainstreaming blockchain in Indian agriculture.

Keywords: block-chain, supply-chain, traceability, AI, infrastructure

Growth, Challenges, and Financial Impact of Agri-tech Startups: Some Early Evidences from Indira Gandhi Krishi Vishwavidyalaya RKVY-RAFTAAR Agribusiness Incubator (IGKV R-ABI), Raipur, Chhattisgarh

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India's agri-startup ecosystem is rapidly reshaping farm productivity, market access, and rural livelihoods. This study analyses a sample of thirty-four agri-tech startups admitted to the IGKV R-ABI, Raipur cohorts between 2019 and 2024, evaluating their growth trajectories, operational challenges, and financing outcomes. Employing a mixed-methods design, it examines longitudinal financial data from FY 2021–22 to FY 2024–25, alongside innovation outputs, socio-economic impacts, and impact of grant on number of farmers benefitted and incubatees. The findings reveal a remarkable increase in aggregate revenues from ₹130.66 lakh in FY 2021–22 to ₹1,055.25 lakh in FY 2024–25, reflecting a compounded annual growth rate (CAGR) of 115.4%. The startups collectively launched 138 market-ready products, averaging 4.06 innovations per firm, and directly benefited 35,191 farmers while generating 252 direct jobs. A Garrett ranking analysis identifies "low farmer awareness/skills" (score = 87) and "high equipment cost" (score = 83) as the most significant barriers to agri-tech adoption, surpassing issues such as connectivity and market linkages. These insights align with national policy objectives focused on promoting agripreneurship and inform targeted recommendations for cost subsidization, digital literacy enhancement, and technology scouting within next-generation incubator programmes. The evidence underscores the strategic importance of the RKVY-RAFTAAR scheme in transforming agrarian challenges into scalable business opportunities and offers a robust empirical benchmark for assessing incubator performance across India.

Keywords: Agri-tech, start-up, agribusiness, innovation

Government and NABARD's Initiatives to Revolutionising the Agribusiness Start-up Ecosystem

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This paper explores the transformation of India's agri-startup landscape, emphasizing the strategic involvement of the Government and NABARD in nurturing rural entrepreneurship and innovation-led agricultural growth. Utilizing secondary data from institutional reports—such as those published by NABARD, the Reserve Bank of India, and the Ministry of Agriculture—the study examines key policy instruments, financial interventions, and structural enablers driving the sector. It investigates how programs like RKVY-RAFTAAR and the Agriculture Infrastructure Fund, alongside targeted investments supported by NABVENTURES and the AgriSURE Fund, are influencing startup incubation, funding flows, and value chain development. While the ecosystem has seen remarkable expansion in agri-tech ventures and investor confidence, persistent challenges remain, including limited access to long-term finance, fragmented markets, and low technology penetration among smallholders. The analysis reveals a critical need for cohesive ecosystem-building, deeper capital engagement, and replicable models that integrate small and marginal farmers into modern agricultural systems.

Keywords: Agri-startup, entrepreneurship, innovation, agricultural growth

Dynamics of Bovine and Ovine Population and Milk Production in Jammu and Kashmir, UT

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The Union Territory of Jammu and Kashmir & Ladakh has diversity in agro-climatic zones ranging from fertile plains to higher altitude cold deserts. The total area of land in UT accounts for 5.23 Lakh hectare, whereas Jammu division accounts for 82.7% followed by Kashmir region with 17.33 %. In recent years, dairy farming has assumed a role as a vital livelihood source, with milk production in the Kashmir Valley increasing by 250% over the past two decades. Over the past decade livestock sector has grown significantly at the rate of 5.6% per year which is greater than the growth of agricultural sector at 3.3%. According to the 20th Livestock Census, J&K has a livestock population of about 8.32 million, which is dominated by sheep (36.84%), cattle (30.41%), goats (21.93%), and buffaloes (8.03%); of total bovine population nearly 1.76 million of the cattle population is indigenous and the rest (0.77 million) belongs to crossbred or exotic population. Jammu district tops the list of livestock population with the population of 1.59 lakhs.The livestock in the valley is not just a source of milk and meat, but they are an integral part of nearly 80% of the rural population of Jammu and Kasmir. The earnings from livestock has exceeded ₹8,656 crore annually. The meat production reached 9.3 thousand tonnes in 2024 and 33 lakh metric tonne of milk has been produced in 2025. The diversity of J&K ranges from Ladakhi and Gurezi cattle to Zanskari horses, Bactrian camels, yaks, and indigenous poultry. These breeds have evolved exceptional adaptive traits such as disease resistance (bovine tuberculosis, Johne's disease, Brucellosis etc.), tolerance to hypoxia and the ability to with stand environment with limited resources, making them crucial assets for climate resilient agriculture in mountainous regions. However, changes in production, habitat pressures, threat their existence and economic potential. This article will try to examine the diversity in animal population composition and dynamics across the districts of Jammu and Kashmir and Ladakh with adaptive traits of breeds, emphasizing their role in enhancing agricultural resilience to climate variability. It proposes how these breeds can act as critical tools in sustaining food production and in advancing climate resilient agriculture in J&K.

Keywords: Climate resilient agriculture, livestock, rural livelihood, women in agriculture, rural women, dairy farming

Economic Viability of Cold Storage Infrastructure as an Agribusiness Innovation: Evidence from North Karnataka

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Cold storage infrastructure significantly enhances agricultural profitability by reducing post-harvest losses and enabling better price realization. This study evaluates the economic performance and technical efficiency of cold storage units in Ballari and Vijayapura districts of North Karnataka. A total of 30 units (15 per district) were surveyed, along with 90 farmers and 90 traders. Storing high-value commodities such as chillies and dry fruits yielded significant net benefits. In Ballari, chilli storage gave net returns of ₹70,443/ton, while dry fruits provided ₹2,34,783/ton. The Benefit–Cost Ratios were 1.38 and 1.67, with IRRs of 14.43% and 24.81% in Ballari and Vijayapura, respectively. High power charges emerged as the main constraint. Promoting energy-efficient technologies and integrated cold chains could enhance efficiency, reduce losses, and improve farm incomes.

Keywords: Cold storage infrastructure post-harvest losses, agricultural profitability, technical efficiency, north Karnataka

An Economic Analysis of India's Agriculture Sector's Contribution to Exports

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About half of India's population is employed in agriculture, which also contributes significantly to the country's GDP. By 2024, the sector will account for about 17% of India's GDP and 12–14% of its overall export value. With vast tracts of land, India the world's second-largest producer of agricultural products, is committed to the production of a variety of crops and animal husbandry, including breeding, poultry and aquaculture. In addition to providing vital raw materials for domestic and industrial usage, the agriculture sector boosts rural economies and ensures national food security. This study examines the effects of India's economic changes, including the Liberalization, Privatization and Globalization (LPG) strategy, on the growth of agricultural exports. The analysis highlights the importance of agricultural export policies and strategies in fostering export diversification and increasing global market competitiveness. The study uses regression analysis and revealed comparative advantage (RCA) models to identify key agricultural exports that have seen a significant growth. Grain, spices, fruits, vegetables and marine products are some of these exports. Along with evaluating the potential and challenges brought about by changes in global demand and the Sustainable Development Goals (SDGs), the study also evaluates the role of horticulture to India's export accomplishments.

Keywords: Agricultural exports, horticulture, comparative advantage, liberalisation, export strategies

Rastriya Krishi Vikas Yojana (RKVY) in India: An Empirical Study of State-level Funding, Project Impact, and Farmer Training

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This paper explores the influence of national and state-level economic empowerment programs on the agricultural sector of India with a specific focus on the dairy industry in Chhattisgarh. Despite extensive funding through initiatives like the Rashtriya Krishi Vikas Yojana (RKVY), Chhattisgarh's dairy sector remains underdeveloped. The study presents financial allocations, farmer training data, and comparative investment trends to identify policy gaps and propose actionable recommendations to harness the state's untapped dairy potential.

Keywords: Economic empowerment, dairy sector, Chhattisgarh, RKVY, agriculture, rural development, women SHGs, smart farming, cold-chain, IoT, AI

Market Integration and Causality: A Price Behaviour Analysis of Major Tomato Markets in India

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This study analyzed the transmission and spatial integration of tomato-producing (Nashik, Kolar, Mandanapalle, and Solan) and consuming (Azadpur, Bangalore, Kolkata, and Chandigarh) markets using monthly price arrival data from January 2012 to December 2023. Econometric tools such as the Augmented Dickey-Fuller test, Phillips-Pierron test, Johansen's cointegration test, Granger causality, and principal component analysis were employed. Monthly variations in price were assessed using seasonality indices. Johansen's co-integration test revealed strong integration among the selected markets. The Granger causality test identified Kolkata as the key market influencing the price movements in the other markets. Most markets exhibited a unidirectional or non-price movement relationship, while a few showed bidirectional price movements. A seasonality index greater than one was observed in July, August, and November for all markets, indicating farmers received a higher-than-average price. Principal Component Analysis revealed that only one component had an eigenvalue greater than or equal to one.

Keywords: ADF, integration, market, tomato, co-integration, price

Urban Gardening in Dhaka: Practices, Constraints and Impacts

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The production of fruits and vegetables by urban residents can enhance food security and provide various additional benefits, but empirical data to support these claims is limited. This study uses questionnaire-based data from 1,320 households in Dhaka, Bangladesh, including 1,079 gardeners and 241 non-gardeners, to examine urban gardening practices, challenges, and impacts on fruit and vegetable consumption and income. The analysis distinguishes between rooftop and land-based gardens and employs propensity score matching (PSM) to correct selection bias in the impact estimation. The study finds that women manage 83% of gardens in the study sample, often with assistance from their spouses. Urban gardeners report benefits such as increased food availability and income, along with personal enjoyment, aesthetic value, family cohesion, and social interaction. However, they face challenges, including a lack of knowledge, pests and diseases, insufficient gardening supplies, and limited soil. The study finds that rooftop gardeners have 5% more vegetable intake ($p=0.041$) and 6% more fruit intake ($p=0.026$) than non-gardeners with access to a rooftop. No significant impact on fruit and vegetable intake is found for land-based gardeners, likely because they are more oriented toward selling than their own consumption. The effect on income was small but significant for both garden types. Gardeners also reported multiple other benefits. Raising the productivity of urban gardens by addressing the main challenges through training can further enhance their contribution to diets.

Keywords: Urban agriculture, Rooftop garden, Food security, Fruit and vegetable, Propensity score matching

Assessment of Agricultural Trade Dynamics of India through Markovian Chain Analysis Framework

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This study assesses India's agricultural export performance from 2017–18 to 2024–25 using a first-order Markov-chain framework to measure market stability and directional trade shifts across major agricultural commodity groups, with a particular case study on dairy export and import performance. Transition-probability matrices, computed using mean absolute deviation minimization with row-sum and non-negativity constraints, quantify year-on-year market retention and movements. Findings reveal agricultural exports climbed at a 4.68% CAGR (from USD 36.72 billion to USD 42.06 billion), while imports rose at 8.16% (from USD 23.25 billion to USD 31.51 billion), decreasing the trade surplus from USD 16.33 billion to USD 10.56 billion. Dairy exports, despite instability, rebounded to USD 0.42 billion in 2024–25 as compared to USD 0.23 billion in 2023-24. Stable markets are Iran for rice, Vietnam and Saudi Arabia for meat and dairy, and Nepal for cereal preparations, whereas Iraq, Egypt, and the UAE display severe volatility. Policy recommendations include encouraging stable markets via bilateral agreements, strengthening cold-chain and quality standards, and diversifying imports. The paper offers practical insights for agribusinesses in targeted market selection, investment, and technology adoption.

Keywords: Agricultural exports, Markov-chain analysis, trade stability, market dynamics, dairy products, transition-probability matrix

Knowledge and Attitude Towards Harvest and Post-Harvest Fish Handling: Insights from Aquaculture Farmers of Minor Irrigation Ponds in Odisha

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Qualitative and quantitative fish loss from handling during harvest and post-harvest is an important concern in aquaculture. To ensure better fish handling, assessing the existing knowledge and attitude trait of the fish farmers and looking at the association of demographic factors with knowledge and attitude level of better fish handling acts as precursor to bringing down the avoidable fish loss. Using cross section data in minor irrigation ponds of Odisha and applying item response theory (IRT) and regression analysis, the study highlights that fish farmers possess lower than the average score for most of the knowledge and attitude items relating fish handling during harvest and post-harvest. The findings of the study further point out that demographic factors such as education, possession of smart phone, being membership of farmer organization and family size are important determinants for realizing higher knowledge and attitude towards better harvest and post-harvest fish handling. Based on the findings, the study recommends imparting training for the producers that emphasizes better fish handling practices during harvest and post-harvest. The training participants may preferably be selected with specific target groups of fish farmers who have at-least basic education and have membership of farmer organization for better training outcome.

Keywords: Knowledge and attitude, post-harvest loss, item response theory, training, aquaculture, Odisha

Determinants of Chilli Technologies Adoption Among Smallholder Farmers in Andhra Pradesh

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Chilli is one of India's most important commercial spice crops, widely cultivated for its economic importance and export potential. The adoption of improved chilli technologies holds significant potential to enhance productivity, profitability, and sustainability in chilli farming, particularly for smallholder farmers. The present study aims to identify the factors affecting the adoption of chilli technologies by smallholder farmers in Andhra Pradesh. A multistage random sampling method was employed to select a sample size of 288 smallholder chilli farmers. Based on the technology adoption index, the study found full adoption of micronutrient spraying and plant growth regulators among smallholder chilli farmers. Based on the adoption index total sample size was categorized as low (18.40%), medium (68.75%), and high (12.85%) adopters. The ordinal logistic regression results indicated that educational status, farm size, occupational status, organizational membership, and the number of extension sources had a significant positive influence on the adoption of chilli technologies. In contrast, the farmer's age and family size were found negative influence on the adoption of chilli technologies. The findings highlight the importance of socio-economic and institutional factors in enhancing the uptake of improved agricultural technologies among smallholder chilli farmers.

Keywords: Chilli, Ordinal logistic regression, Smallholder farmers, and Technology adoption.

Empowering Smallholders through Farmer Producer Companies: A Case Study of Input Facilitation and Capacity Building in Dharwad District, Karnataka

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Agriculture supports over half of India's population and contributes 18.2 percent to the national GDP. Most farmers are smallholders with limited access to markets and inputs. To address this, the Government introduced Farmer Producer Companies (FPCs) to improve farmers' bargaining power and income. This study examines the facilities provided by FPCs in Dharwad district. Data were collected from 120 member farmers. The findings show that fertilizers had the highest impact, with up to 84.14 percent of members benefiting. FPCs helped reduce input costs—up to 17 percent on fertilizers and up to 47 percent on tarpaulins. They also provided training, exposure visits, better price realization, and crop insurance. However, issues like low output procurement and lack of branding remain. Strengthening marketing, branding, and policy support can further improve FPC effectiveness.

Keywords: Farmer producer companies, input savings, smallholder farmers, market access, branding, crop insurance

Effectiveness of Agri-Entrepreneurs in Enhancing Farmers Income from Allied Activities in Maharashtra

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A scheme of setting up of agri-ventures by agriculture graduates was launched by the Government of India in 2002. The scheme not only strengthens technology transfer but also public extension system and helps in employment generation in rural areas. Despite the fact that the scheme was launched about a couple of decades ago, its effectiveness is yet to be known. Therefore, the present study attempts to evaluate the extent to which the agri-ventures established under the Scheme in Maharashtra are successful in augmenting farmers' income, especially through allied activities. The study showed a positive impact of agri-ventures established by agri-entrepreneurs in the state of Maharashtra since their beneficiaries generated substantial income from various animal reared by them. The major reasons that led beneficiaries to derive significantly higher income were scientific methods of rearing animals, higher yield, prices, and, consequently higher value of output from animals, etc. Various types of inputs and extension services provided by agri-ventures worked as catalyst in enhancing income of beneficiary farmers. Although beneficiaries of agri-ventures were facilitated with suitable extension services and also with respect to purchase of inputs at reasonable prices, the non-beneficiaries in this respect depended on other alternate sources of purchase of inputs and extension services, and they also showed concern for the untimely availability of fertilizer and lack of water availability. This resulted in low yield of their crops and subsequently affected availability of green and dry fodder as wall as concentrate required for animal feeding. Since agribusiness entrepreneurs played a significant role in supplementing farmers' income, it is felt that their outreach needs to be strengthened so that more farmers can avail their services. Another suggestion is in favour of easily access to loans so that more clinics/ventures may be established.

Keywords: Agri-ventures, agri-entrepreneurs, farmers' income, Maharashtra

Growth and Instability in Export of Orange in India

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Fruit farming plays an important role in India's agricultural economy and trade. Major fruits cultivated in India are mango, banana, papaya, apple, oranges, etc. India's occupies second position in fruits cultivation in the world. Oranges are widely grown in different regions of the world. The present study analysed orange export performance among major countries and examined the growth and instability in export of orange from India. The study period was form 2004-05 to 2023-24. Secondary data were collected from different sources like APEDA. ITC, DGCIS and NHB; analytical tools used were CAGR, CV, CDVI and CII. The results revealed positive growth in export volume and value. Bangladesh and Nepal were the major destinations showing a sustained growth rate, and UAE and Kuwait showed highest instability. Efforts to stabilize exports could include better storage, packaging and market strategies. It underlined India's potential to enhance its export contribution through strategic interventions.

Keywords: Orange, growth, instability, export

Economic Viability of Coffee Cultivation among FPO and Non-FPO Farmers: Evidence from Visakhapatnam District, Andhra Pradesh

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This study analyzed the cost-returns, economic viability and long-term profitability of coffee plantations in Visakhapatnam district, Andhra Pradesh, with a focus on both Farmer Producer Organization (FPO) members and non-members. Using a multi-stage random sampling technique, primary data were collected from 120 respondents. Cost and returns were calculated and Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR) and payback period were used to evaluate the economic viability of coffee plantations. The results showed that the annual cost of cultivation for FPO members and non-FPO members was Rs.55649.89/ha and Rs.52024.03/ha, respectively. The net returns for FPO farmers were Rs.129584.94/ha, while non-FPO farmers earned Rs.75462.70/ha. FPO farmers achieved higher yield of 606.33 kg/ha (parchment coffee), compared to 578.83 kg/ha in non-FPO farmers. Additionally, FPO farmers received significantly better price for their produce (Rs.305.50 per kg) compared to non-FPO farmers (220.25 per kg), a benefit attributed to the collective marketing practices. The NPV for FPO farms (Rs.640760.65/ha) was higher than that of non-FPO farms (Rs.332636.63/ha) indicating superior long-term financial returns, making them a more profitable investment. The IRR was 56.84 per cent for FPO farms and 39.10 per cent for non-FPO farms, both exceeding the typical cost of capital (12%), confirming high profitability, with FPO farms generating greater returns. The BCR was 3.07 for FPO farms and 2.13 for non-FPO farms, showing that each rupee invested returns over three rupees in FPO farms and two rupees for non-FPO farms. The payback period for FPO farms was 4.74 years while non-FPO farms required 4.73 years, indicating that both recover their investment in a relatively short time, with minimal difference. The findings revealed that although both FPO and non-FPO coffee plantations are profitable, participation in FPO significantly improved yield, price realization, economic efficiency and long-term financial viability.

Keywords: BCR, coffee plantations, FPO, IRR, NPV

Designing Risk Assessment Insurance Product for Asian Seabass Aquaculture Using Machine Learning Models

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Asian seabass, *Lates calcarifer* (Barramundi) is one of the economically important fish species which can be farmed in wide salinity variation waters and farming systems with the estimated national production of 15,000 tonnes by year 2030. The fish has the high consumer preference worldwide fetching higher economic returns with IRR of 70-80%. The hatchery, nursery, pre-grow out and grow out farming of the fish is being practiced throughout the coastal states of the country under hapa, cage and pond conditions. The production systems are vulnerable to various risk factors like, diseases, environmental alterations and natural disasters. Mitigating the risk factors through effective insurance products is highly essential for economic sustainability of the seabass farming in the country. In line with the existing shrimp crop insurance, a comprehensive risk assessment framework could be developed leveraging both traditional statistical models and advanced machine learning (ML) techniques to support evidence-based insurance product. Statistical techniques, including logistic regression can be used to identify and quantify key risk drivers and estimate time-to-failure probabilities. A stochastic simulation using Monte Carlo methods can be employed to model a wide range of potential loss scenarios and assess the probability distributions of financial outcomes. To enhance prediction and classification accuracy, modern ML algorithms such as Support Vector Machines (SVM), and Artificial Neural Networks (ANN) could be applied and evaluated using AUC, confusion matrices, and cross-validation. The model outputs is expected to include a farm-specific risk index, premium calculator, and insurance pay-out simulation tool, providing insurers and policymakers with a data-driven foundation to develop adaptive, affordable, and targeted insurance schemes. This approach can enhance risk-sharing and strengthens the financial resilience of seabass farmers in the face of uncertainties.

Keywords: Risk assessment, insurance policy design, machine learning models

Exploring Agrotourism as an Agribusiness Innovation: Insight from Gujarat

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India lives in its villages and agriculture is the backbone of it. Here, agrotourism is a pathbreaking concept that is going to bring a bouquet of opportunities in the sector through portfolio diversification in which farmers will have more choices for its customers. One of the consultancies reports also highlighted about global agritourism market was valued at USD 73.2 billion and grow at a CAGR of 10.9 percent between 2025 and 2033 and India should take its advantage in this domain of prospects. States like Maharashtra, Rajasthan, Kerala are forefront in agrotourism interventions whereas Gujarat is at its nascent stage and are observed in some of the remote pockets. When a study was undertaken in the middle Gujarat and the results pointed out towards dearth in literature, safety and security, and clear-cut standard operating practices to run the enterprise, effectively. Maintenance charges and labour management issues were also there in the agrotourism centers and for that sake, many strategic initiatives were carried out there by the owners to make it efficient one. Even, demographic variations were also observed in agrotourism centers that need to be explored in near future.

Keywords: Agribusiness innovation, agrotourism

Small Area Estimation of Annual Rural Unemployment Rates in West Bengal at Disaggregate Level

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At the district level, annual rural unemployment rates were estimated using Small Area Estimation (SAE) techniques, with the Fay-Herriot model serving as the primary method. Periodic Labour Force Survey (PLFS) unit-level data for the year 2023-24 were used for the study whereas variables from 2011 census were utilized as covariates. This model effectively combined survey data with auxiliary information, addressing a high variability often observed in direct estimates from districts with small sample sizes. The Fay-Herriot model significantly reduced the coefficients of variation (CV) across districts, making the estimates more reliable and actionable. The results revealed notable regional disparities in unemployment rates. High-unemployment districts such as those in Northern parts of West Bengal like Kalimpong, Darjeeling, Alipurduar, and Jalpaiguri emerged as critical areas requiring urgent policy attention. In contrast, districts such as Purba Medinipur and South 24 Parganas consistently reported low unemployment rates, reflecting more stable labour market conditions. The Fay-Herriot model's ability to stabilize estimates underscores its utility in identifying vulnerable districts and supporting decentralized planning.

Keywords: Annual rural unemployment rate, small area estimation (SAE), periodic labour force survey (PLFS), Fay-Herriot model

Eco-Agribusiness 2030: Aligning Sustainable Practices with Global Trade Requirements

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As climate change, biodiversity loss, and resource scarcity threaten global food systems, sustainable agribusiness models have become critical for balancing environmental integrity with market competitiveness. By 2030, it is projected that over 60% of agricultural exports will need to meet advanced sustainability certifications (WTO Trade Outlook, 2024). This shift requires an integrated approach combining eco-friendly cultivation practices, resource-efficient post-harvest management, and transparent supply chain governance. In India, organic farming acreage has increased by 22% since 2020, with a parallel rise in certification standards such as Fairtrade and Rainforest Alliance. Simultaneously, blockchain-enabled traceability is gaining adoption among exporters of spices, tea, and coffee to meet European Union deforestation-free supply chain laws. This paper analyzes strategies for aligning sustainable practices with global trade protocols, focusing on public–private collaboration, capacity-building initiatives, and green investment financing. Successful models, including the Sikkim Organic Mission and Kenya's sustainable flower export program, demonstrate the economic and environmental benefits of integrated eco-compliance systems. The discussion aligns with SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), emphasizing the need for coordinated policy frameworks that reward sustainability-linked export readiness. The study recommends for embedding sustainability metrics into trade negotiations, enhancing producer awareness, and leveraging international cooperation to maintain competitiveness in an evolving global marketplace.

Keywords: Sustainable trade, eco-certification, agribusiness competitiveness, blockchain, climate action, SDGs

Economic Incentives as Catalysts: Transforming Agricultural Systems through Policy and Governance

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Agricultural transformation in developing economies requires an integrated approach that combines well-designed policies, effective governance structures, and targeted economic incentives. Economic incentives—ranging from subsidies and credit schemes to price support and carbon payments—serve as critical levers for influencing farmer behavior and accelerating the adoption of sustainable practices. According to FAO (2024), countries that align agricultural subsidies with sustainability objectives achieve, on average, a 20–25% higher adoption rate of resource-efficient technologies compared to those with conventional, input-intensive subsidy models.

In India, the reorientation of fertilizer subsidies towards balanced nutrient application and the introduction of the PM-KUSUM scheme for solar-powered irrigation have demonstrated the potential of incentives to drive both environmental and economic benefits received much attention.. Globally, evidence from OECD countries shows that linking payments directly to ecosystem services—such as biodiversity conservation or soil carbon sequestration—can deliver dual outcomes of productivity growth and climate resilience. However, the effectiveness of incentives depends heavily on robust governance and institutional capacity. Fragmented policy implementation, lack of coordination between central and local agencies, and weak monitoring mechanisms often dilute the intended impact. Various institutional innovationsoffer new pathways for accountability and efficiency.

This paper reviews case studies from India, Brazil, and Kenya to illustrate how governance frameworks can amplify the impact of incentives. It highlights the role of participatory policy design, where farmer feedback loops are integrated into program evaluation, and discusses how multi-stakeholder platforms can foster institutional learning. Aligning policy instruments with Sustainable Development Goals—particularly SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action)—ensures that agricultural incentives contribute to broader social, economic, and environmental outcomes. The analysis concludes that transformative change in agriculture is not achieved by incentives alone but by embedding them within coherent, transparent, and inclusive governance systems.

Keywords: Agricultural policy, economic incentives, governance, institutional innovation, sustainable agriculture, SDGs, FPOs.

Exporting Green: Leveraging Post-Harvest Technologies for Sustainable Global Agribusiness Competitiveness

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Sustainability is now a market entry requirement rather than a competitive advantage in global agribusiness. Exporters face mounting pressure to reduce environmental footprints while ensuring compliance with international quality and safety standards. Advanced post-harvest technologies—such as solar-powered dehydration, AI-driven grading, ozone-based sanitization, and reusable pallet systems—offer scalable solutions that address both environmental and market challenges. In 2024, India's agricultural exports reached USD 53.1 billion (APEDA, 2024), but nearly 30% of perishable produce destined for export markets still faces rejection due to non-compliance or quality deterioration. This paper evaluates the role of green post-harvest technologies in enhancing global competitiveness, drawing on examples from Vietnam's shrimp sector, Peru's avocado industry, and India's floriculture exports. Integration of these technologies through Farmer Producer Organizations (FPOs) and export cooperatives has demonstrated cost reductions of up to 18% and extended shelf life by 25–40%. Linking such innovations to SDG 2 (Zero Hunger), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action) positions agribusinesses for long-term trade viability while contributing to environmental goals. The paper concludes with policy recommendations for incentivizing green technology adoption, integrating sustainability metrics into export credit programs, and strengthening international cooperation for technology transfer.

Keywords: Green technology, export competitiveness, post-harvest solutions, sustainable trade, SDGs.

From Pilot to Practice: Addressing Bottlenecks in Climate-Smart Agriculture Adoption

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Climate-Smart Agriculture (CSA) offers an integrated approach to increase agricultural productivity, enhance climate resilience, and reduce greenhouse gas emissions. While numerous pilot projects worldwide demonstrate CSA's potential, scaling these practices to reach millions of farmers remains a persistent challenge. According to the FAO (2024), over 1,000 CSA pilot initiatives have been implemented globally in the last decade, yet fewer than 30% have transitioned into large-scale programs, primarily due to technical, social, and institutional barriers.

One major obstacle is the limited transferability of pilot models across diverse agro-ecological and socio-economic contexts. Practices such as conservation agriculture, climate-resilient seed adoption, and micro-irrigation systems often require site-specific adaptation, which is resource-intensive and slow. Social factors, including limited farmer awareness, risk aversion, and gender disparities in access to inputs, further constrain uptake. Institutional bottlenecks—fragmented policies, inadequate financial incentives, and weak extension linkages—compound these challenges. In many cases, CSA remains a project-driven intervention rather than being mainstreamed into national agricultural strategies. Evidence from African and South Asian countries suggests that when CSA is embedded in broader rural development programs, adoption rates can increase by up to 60%. Bridging the gap between pilot success and large-scale adoption requires: (i) developing adaptable CSA toolkits for different farming systems, (ii) strengthening farmer-to-farmer knowledge exchange networks, (iii) aligning subsidies and credit schemes with climate-resilient practices, and (iv) leveraging ICT tools for real-time climate advisory services. Integrating CSA into multi-sectoral policy frameworks supports progress toward Sustainable Development Goals (SDG 2: Zero Hunger, SDG 13: Climate Action, and SDG 15: Life on Land). This paper reviews case studies from India, Kenya, and Latin America to identify enabling conditions for scaling CSA.

Keywords: Climate-smart agriculture, scaling, pilot projects, agricultural resilience, inclusive policies, SDGs, technology transfer

Governance for Growth: Integrating Policy, Economic Incentives, and Innovation in Agri-Sector Reform

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The transformation of agricultural systems requires a holistic strategy that weaves together sound governance, forward-looking policies, and well-targeted economic incentives. Governance acts as the structural backbone for policy execution, while incentives serve as behavioral triggers to align farmer decisions with sustainability and productivity goals. In India, policy reforms such as the e-NAM, PM-Kisan, and the scaling of Farmer Producer Organizations (FPOs) have showcased how innovation and incentives can converge to strengthen market access and farmer incomes. Yet, several challenges persist—ranging from policy incoherence between agricultural and environmental ministries to delayed disbursement of benefits due to weak institutional capacity. Without transparent monitoring systems and cross-sector coordination, incentive schemes risk inefficiency and inequity. Emerging institutional innovations—like blockchain-based supply chain verification, AI-driven crop monitoring, and participatory governance platforms—offer opportunities to close these gaps.

This paper synthesizes global best practices and contextualizes them within India's reform trajectory. It emphasizes the need for coherent policy ecosystems where incentives are not isolated interventions but part of a governance continuum that includes market regulation, environmental safeguards, and capacity-building measures. Aligning these reforms with Sustainable Development Goals, particularly SDG 1 (No Poverty), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action), ensures both economic and ecological dividends. The findings underline that growth-oriented agri-sector reform is contingent upon governance models that are adaptive, transparent, and innovation-driven.

Keywords: Governance, agricultural policy, economic incentives, institutional innovation, agri-sector reform, sustainable development, FPOs.

Greening the Value Chain: Eco-Friendly Practices and Post-Harvest Innovations for Sustainable Agribusiness

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The transformation of agribusiness towards environmental sustainability is essential to ensure long-term productivity, competitiveness, and climate resilience. Eco-friendly agricultural practices, including organic farming, integrated pest management, precision irrigation, and renewable energy adoption, are increasingly being recognized as strategic imperatives in value chain management. In India, the adoption of bio-inputs has grown by 18% annually between 2020 and 2024, while solar-powered cold storage units have reduced post-harvest losses in perishable commodities by up to 25% (FAO, 2024). Post-harvest innovations—such as vacuum packaging, AI-enabled sorting, and blockchain-based traceability—are revolutionizing quality preservation and market transparency. Globally, export markets are becoming more stringent, with the EU Green Deal and Codex Alimentarius setting higher sustainability and safety standards, creating both challenges and opportunities for emerging economies. This paper examines integrated strategies for "greening" the agricultural value chain by aligning on-farm eco-practices with post-harvest technological advancements. It highlights successful models, including Farmer Producer Organizations (FPOs) leveraging collective investment in solar dehydration units, and export-oriented Agri-clusters adopting zero-waste processing techniques. Aligning these efforts with SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 2 (Zero Hunger) ensures economic viability alongside environmental stewardship. The paper concludes with policy recommendations for scaling eco-innovations through public–private partnerships, targeted subsidies, and green finance mechanisms to enhance global trade readiness while safeguarding ecological resources.

Keywords: Sustainable agribusiness, eco-friendly farming, post-harvest technology, value chain, export standards, SDGs

Sustainability at Scale: Innovations in Post-Harvest Management for Meeting International Export Standards

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Global agricultural trade is increasingly shaped by stringent export standards, with buyers prioritizing quality, safety, and sustainability. For developing economies, meeting these benchmarks requires scalable innovations in post-harvest management that minimize losses and maintain quality from farm to market. In India, post-harvest losses in horticultural crops average 15–20%, translating to an annual economic loss of over USD 13 billion (ICAR, 2024). Recent advancements such as controlled-atmosphere storage, non-chemical fumigation, IoT-based warehouse monitoring, and biodegradable packaging are reducing these losses while meeting compliance with standards like GLOBALG.A.P. and ISO 22000. Case studies from Maharashtra's grape exporters and Andhra Pradesh's mango clusters demonstrate how Farmer Producer Organizations (FPOs) and agri-export hubs are adopting these technologies to meet European Union pesticide residue limits and U.S. Food Safety Modernization Act (FSMA) protocols. This paper assesses pathways for scaling such technologies across value chains by integrating government incentives, export-oriented training, and financial instruments such as green credit lines. Aligning these strategies with SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 17 (Partnerships for the Goals) can create a resilient and competitive agribusiness export sector. Policy implications include strengthening cold chain infrastructure, facilitating technology adoption grants, and enhancing farmer–exporter coordination to meet sustainability-linked market demands.

Keywords: Post-harvest innovation, export compliance, sustainable agriculture, cold chain, FPO, SDGs

Economic Analysis of "Jashpure Tea" as an Emerging Agricultural Brand in Chhattisgarh

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Jashpur district in north-eastern Chhattisgarh is emerging as a promising non-traditional tea-producing region due to its cool climate, moderate rainfall, acidic soils, and hilly terrain. Supported by state horticulture initiatives and active participation of women's Self-Help Groups (SHGs), small and marginal farmers have adopted tea as a commercial crop, marketed under the developing brand "Jashpure Tea." This study analyses the production economics, value chain and socio-economic impacts of tea cultivation in Jashpur using data from farmer surveys, SHG activities, local processing units and secondary sources. Results indicate that plantations of 0.5–2 hectares yield 1,200–1,800 kg of made tea per hectare annually, generating net incomes of ₹ 1.2–2.5 lakh/ha substantially higher than traditional crops. Local processing units and SHGs have reduced transportation costs and contributed to packaging, marketing and direct sales, although seasonal capacity constraints remain. Through SHG-led initiatives, rural women have gained year-round employment and income stability, while also enhancing their social and economic empowerment. However, challenges include limited processing capacity, modest marketing budgets and the absence of Geographical Indication (GI) registration. Policy measures such as processing expansion, capacity building, GI registration and stronger market linkages could strengthen "Jashpure Tea" as a specialty brand, fostering agricultural diversification and community-based rural development in Chhattisgarh.

Keywords: Jashpure tea, SHGs

Role of AI in Enhancing Farmer Income Through Market Price Forecasting in India

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In India, changes in agricultural prices have a major impact on farmers' earnings, particularly for small and marginal farmers who rely primarily on timely and profitable sales. Market volatility is caused by a variety of factors, including changing domestic policy, global trade trends, unpredictable weather, and changing supply and demand. Through accurate market price forecasting, artificial intelligence (AI) provides a practical solution that empowers farmers to make well-informed decisions regarding marketing and production. This study examines AI-driven forecasting methods, such as hybrid ARIMA-LSTM models and machine learning algorithms including Random Forest, Gradient Boosting, and Long Short-Term Memory (LSTM) networks. These models are able to capture intricate linear and non-linear trends. With the help of AI-based price prediction, farmers can choose the best crop varieties, modify their planting and harvesting dates, determine when to sell, and lessen their dependence on middlemen. According to information obtained from private AI services and Indian Agri-tech platforms like e-NAM, accurate price forecasting can increase market transparency, reduce post-harvest losses, and increase farmer income by 10% to 20%. Challenges remain, including limited quality datasets, inadequate rural digital infrastructure, and low awareness of AI applications among farmers. The paper recommends targeted policy interventions such as farmer training, open-access price databases, and public–private partnerships to expand AI adoption in agricultural marketing.

Keywords: Artificial intelligence, price forecasting, farmer income, agriculture

Role of New Agriculture Policies in Promoting Diversification and Export-Oriented Farming

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The National Agriculture Policy of 2000 marked a strategic shift in Indian agriculture by encouraging a move from low-value cereals to high-value crops such as horticulture, spices, fisheries, and agro-processing. This diversification has significantly increased farm incomes and rural employment. Despite this focus, cereals remain crucial for food security and agricultural productivity. By 2023–24, India produced 122 million tonnes of cereals (rice, wheat, maize, and millets) and 205 million tonnes of vegetables, with cereals contributing nearly 35% of total crop production by volume. Spices have emerged as an important source of farm income and export revenue. As the world's largest producer and exporter of spices, India generated over ₹ 45,000 crore in 2022–23 from turmeric, chili, cumin, coriander, and black pepper. Horticulture has grown rapidly, with area rising 28% and production 49% between 2007–08 and 2018–19. By 2023–24, fruits and vegetables accounted for 30.4% of agricultural GDP while occupying only 13.1% of cropped area, reflecting high productivity and value. Agricultural exports rose from ₹ 53,000 crore in 2001 to ₹ 4.41 lakh crore in 2022–23, with a trade surplus of ₹ 1.45 lakh crore. Major export gains came from marine products (₹ 67,064 crore), rice (₹ 92,462 crore), sugar (₹ 47,891 crore), spices (₹ 45,000 crore), and wheat (₹ 30,000 crore). Policies such as the National Horticulture Mission, Agricultural Export Policy 2018, APMC reforms, export incentives, and cold-chain investments have improved market access, value addition, and global competitiveness. Nevertheless, challenges like post-harvest losses, limited storage, volatile demand, and strict quality standards remain. This study evaluates these policies to recommend strategies for sustainable, export-led agricultural growth that strengthens rural livelihoods while reinforcing India's global presence in cereals, spices, fruits and vegetables.

Keywords: Agriculture Policy, Crop Diversification, Horticulture, Spices, Exports.

Does Water Quality Affect Foodgrain Yield? Evidences from Northern and Western India

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With the advent of the Green Revolution in India, irrigation has played a crucial role in transforming India's agricultural production from food deficit to food surplus. Over the years, emergence of groundwater irrigation as a dominant irrigation source and over-extraction has led to lowering water table and deterioration of water quality. Major issues for worsening water quality are manifestation of salinity, ion toxicity and infiltration that induces water stress in crops causing significant reduction in yield. For the study, water quality index (WQI) was constructed at district level accounting key water quality parameters using factor analysis. Anchored on standard classification, districts with WQI value less than 40 were considered as poor irrigation water and out of these nearly forty per cent of districts are in northern and western India.

In the study area, 31 per cent of total districts categorised in poor irrigation water and foodgrain yield is significantly lower (16.67%) compared to other districts with relatively good irrigation water. The estimate shows that switching from poor to good irrigation water significantly increases the foodgrain yield by 13.66 per cent. Other predictor variables like rainfall and irrigation share shows significant positive influence on yield. The dummies for state fixed effect were included in the model to absorb state specific variations. Therefore, for sustainable crop production in the districts with poor irrigation water, the prime focus should be on growing salt-tolerant crops and judicious use of groundwater.

Keywords: Irrigation, water quality, yield, India

Climate-smart Agriculture: Strategies for Resilience and Adaptation

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Climate change poses significant risks to agricultural productivity, threatening food security and rural livelihoods worldwide. According to the Food and Agriculture Organization (FAO), climate-resilient agriculture refers to the capacity of farming systems to anticipate, adapt to, and recover from climate-related shocks and stresses. Without adaptation, projections for 2020–2039 indicate yield declines in irrigated rice (–3%), rainfed rice (–7 to –28%), wheat (–3.2 to –5.3%), and maize (–9 to –10%), with a modest increase expected in soybean yields (+2.5 to +5.5%). In response, countries have pledged to reduce greenhouse gas emissions, such as the Marshall Islands' commitment to cut carbon emissions by 32% by 2025 and achieve net-zero by 2050. A climate-smart agricultural approach integrates farmer practices with supportive technologies, policies, institutions, and financial mechanisms to enhance resilience. Key strategies include site-specific crop selection, development of climate-resilient varieties, diversification of cropping systems, integration of forecasting tools, and effective community-level resource management. Technological advancements, such as geospatial analysis and eco-friendly farming technologies, plays a crucial role in optimizing land use and enhancing food security. These measures collectively strengthen the capacity of agriculture to withstand and recover from the adverse impacts of climate variability and change.

Keywords: Climate change, agricultural productivity, climate-smart agriculture, forecasting

Unpacking the Barriers: Overcoming Technical, Social, and Policy Challenges in Scaling Climate-Smart Agriculture

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Climate-Smart Agriculture (CSA) has emerged as a strategic framework for achieving food security while addressing the dual challenges of climate change mitigation and adaptation. However, despite strong global advocacy, scaling up the CSA remains hindered by interconnected technical, social, and policy bottlenecks. Technical barriers include limited access to climate-resilient seed varieties, inadequate irrigation infrastructure, and insufficient availability of real-time agro-climatic advisories. For instance, India's Pradhan Mantri Krishi Sinchayee Yojana has improved water use efficiency in targeted areas, yet irrigation coverage disparities continue to slow CSA uptake in rainfed regions. Social constraints—such as low awareness levels, entrenched traditional practices, and limited participation of women and marginalized communities—further restrict the reach of CSA technologies.

Policy bottlenecks often stem from fragmented institutional frameworks, misaligned subsidy structures, and inadequate extension services. While climate-smart policy roadmaps exist, their execution is frequently hampered by weak inter-departmental coordination and limited budgetary prioritization. Addressing these challenges requires a multi-pronged strategy: enhancing technology dissemination through digital platforms, fostering inclusive community-based adaptation models, reforming subsidies to incentivize climate-resilient practices, and strengthening public–private partnerships for CSA research and deployment. Embedding CSA within national development agendas also aligns directly with Sustainable Development Goals (SDGs) such as SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land). This paper synthesizes evidence from South Asia and Sub-Saharan Africa to identify scalable solutions that overcome current adoption bottlenecks. It argues that CSA's transformative potential lies not merely in technological innovation but in the harmonization of technical, social, and policy dimensions to enable systemic change in agricultural resilience.

Keywords: Climate-smart agriculture, adaptation, policy bottlenecks, smallholder farming, sustainable development, technology adoption, SDGs.

Eco-friendly agriculture strategies for long term food security

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Sustainability refers to sustainable development that meets present needs without compromising the ability of future generations to meet theirs, while minimising environmental degradation and resource depletion. Rapid population growth demands enhanced agricultural productivity through eco-friendly practices. However, the sector faces challenges such as slowing productivity growth, rising cultivation costs, declining food quality and safety, and the adverse impacts of climate change. Advanced post-harvest innovations—including cold storage, value addition to surplus produce, and e-commerce platforms—offer practical solutions by improving market connectivity, reducing food wastage, and limiting environmental harm. Policy intervention, capacity building, and stronger market linkages are essential to scale these practices. Encourage precision agriculture, micro-irrigation and use of renewable energy such are solar pumps, biogas. Adoption of drought resistant and pest resistant crops. Alignment of subsidies and trade policies with sustainable goals. Regular training of farmers on improved technology. Sustainable and well-integrated agribusiness strategies are pivotal for ensuring long-term food security, reducing ecological footprints, and fostering resilient agricultural development.

Keywords: Sustainability, eco-friendly practices, adoption, e-commerce, value-addition

Growth and Instability in Area, Production, Productivity and Export of Cashew in India

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Cashew (*Anacardium occidentale L.*), an economically valuable plantation crop, contributes substantially to India's foreign exchange earnings and rural livelihood. The crop is cultivated across 1.19 million hectares, with major producing states including Maharashtra, Andhra Pradesh, Odisha and Kerala. This study examined area, production, productivity and export of cashew from India. Using secondary time series data spanning from 2004-05 to 2023-24. Compound Annual Growth Rate (CAGR) was used for the analysis to see the growth rate and for variance Coefficient of variation (CV), Cuddy-Della Vella Index and Coppock's Instability Index. The Compound Annual Growth Rate (CAGR) method revealed that the area under cashew cultivation in India increased significantly at 2.09% and production at 1.62% per annum, both statistically significant at 1% level. Export-wise, export quantity increased at 17.76% CAGR, while export value rose by 31.52% CAGR, both significant at the 1% level. Country wise analysis revealed that during the overall period of the study Malaysia showed the highest export growth, followed by the USA. India demonstrated moderate stability in production parameters. Export data revealed significant instability, particularly in export value (CV: 85.77%) and export quantity (CV: 66.19%), Exports to the USA showed high instability in both value and quantity.

Keywords: Cashew, export performance, instability, CAGR, India, USA, Malaysia, CDVI

Innovation in Reducing Post Harvest Losses in Maharashtra: A Farmer Level Approach

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Post-harvest losses in India are substantial, with an estimated [1] 1.53 lakh crore worth of food lost annually. This wastage, particularly of perishable commodities like fruits, vegetables, and livestock produce, significantly impacts the economy, food security, and farmer livelihoods. Addressing these losses in perishable commodities like fruits 19%, vegetables 18%, livestock products 22% and around food grains 10% loss are crucial for India's agricultural sector and overall development. Post-harvest losses in Maharashtra are significant, particularly for fruits and vegetables, with estimates ranging from 20-30% of the total production. There are different causes of post-harvest losses likewise improper harvesting, drying, cleaning, and packaging methods, poor storage facilities, inadequate transportation networks, limited cold chain infrastructures contribute to spoilage and damage, lack of proper market linkages, fluctuating prices, limited processing capacity especially during peak harvest seasons. To significantly reduce post-harvest losses a multi-pronged approach is needed that involves strengthening storage facilities is crucial for minimizing post-harvest losses, improving transportation system/networks especially for perishable crops, processing facilities in optimal condition, minimizing spoilage and damage during transit. These include technologies like optical sorting, freeze-drying, and high-pressure processing, packaging, cold chain management, and digital monitoring systems. Specifically, investments in climate-controlled storage, modernizing transportation, and promoting agro-processing units are crucial.

Keywords: Post-harvest losses**,** packaging, transportation, cold chain storage, drying

Integrating Blockchain Technology and Artificial Intelligence for Advanced Fisheries Management

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Blockchain technology has emerged as a pivotal tool for enhancing transparency and traceability within global supply chains, particularly in the food industry. Its features of immutability, transparency, auditability, and incentivization facilitate secure tracking of product origins, preventing unauthorized data alterations and fostering stakeholder trust. This is particularly crucial in the fish supply chain, which faces significant challenges such as rising seafood demand, economic pressures, and increased consumer awareness of product authenticity. Despite its potential, the adoption of blockchain faces challenges, including high implementation costs, especially for small-scale fishers, and ensuring the reliability of data input. However, initiatives like Fishcoin demonstrate blockchain's potential to incentivize data sharing and improve traceability. The integration of Artificial Intelligence (AI) with Blockchain Technology (BCT) further enhances supply chain operations by improving data consistency, resource optimization, and overall efficiency. AI and machine learning are transforming fisheries management by enabling precise decision-making, enhancing environmental monitoring, and optimizing aquaculture practices. This integration addresses technological challenges such as data consistency and interoperability, facilitating the transformation of raw data into actionable insights. Although still in the early stages, the combined use of AI and BCT holds significant promise for advancing transparency, sustainability, and ethical practices in supply chains, particularly in complex sectors like the fish industry. This unified approach is essential for overcoming the multifaceted challenges of modern supply chains and fostering sustainable global food systems.

Keywords: Blockchain technology, supply chain management, traceability, artificial intelligence, sustainability

Variability and Growth in Production of Linseed in Major Producing States of India

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Linseed (*Linum usitatissimum L.*) is an important oilseed crop in India, valued for its nutritional and industrial uses, yet it remains under-researched compared to other major oilseeds. Understanding the dynamics of its production is critical for improving farm income and ensuring sustainable oilseed supply. This study aims to examine the variability and growth in the area, production, and productivity of linseed across major producing states in India. Using secondary time-series data spanning 2000-01 to 2024-25, the analysis focuses on quantifying trends and identifying the primary drivers of production changes. The study employs compound growth rates to assess long-term growth patterns, decomposition analysis to determine the relative contribution of primary sources of production i.e. area, yield, and their interaction effect. By analyzing state-wise and national-level trends, the study intends to provide insights into production performance and highlight regions with potential for yield improvement. The findings are expected to be benefitting policymakers, researchers, and stakeholders about strategic interventions required to enhance linseed production and farmer profitability in India.

Keywords: Linseed, growth analysis, variability, decomposition analysis, compound growth rate, oilseed production

Exploring the Relationship Between Technological Advancement and Carbon Emission in Agricultural Systems: A Systematic Literature Review

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This study systematically reviews the existing literature to explore the relationship between technological advancement and carbon emissions in agricultural systems. Drawing on a dataset of 1,008 peer-reviewed articles sourced from the Scopus database (1997–June 2025), the review focuses on key themes such as technological adoption, sustainability, and emissions mitigation. The data was filtered to include studies across relevant disciplines including environmental science, agriculture, economics, business, and social sciences. The findings reveal a significant acceleration in research activity since 2020, reflecting increased global attention to sustainable agriculture and climate change. China leads global research output, followed by the United States, the United Kingdom, and India. Subject area analysis indicates a multidisciplinary approach, with dominant contributions from environmental science and agricultural and biological sciences. The most influential journals include *Sustainability (Switzerland)* and *Environmental Science and Pollution Research*. Bibliometric analyses—including co-citation networks and keyword co-occurrence—highlight sustainability, climate change, precision agriculture, and technology adoption as central research themes. The growing prominence of digital technologies such as machine learning and remote sensing in climate-smart agriculture points to a maturing research field with significant implications for policy and practice. This review provides a structured foundation for future investigations and policy interventions aimed at leveraging technology for carbon emission reduction in agriculture.

Keywords: Technological adoption, carbon emissions, sustainable agriculture, climate change, precision agriculture, greenhouse gas mitigation

Constraints in the Adoption of PBNS-12 Safflower Variety in Parbhani District of Maharashtra

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This study identified the constraints faced by growers and non-growers in adopting the improved safflower variety PBNS-12 in Parbhani district. Using Garrett's ranking technique, data from 120 respondents (60 growers and 60 non-growers) revealed that high input costs (mean score: 51.83 for growers, 62.18 for non-growers) and labour scarcity during harvesting (42.77 and 59.23, respectively) were the most critical barriers. Other constraints included poor soil fertility, inadequate irrigation facilities, lack of timely information, insufficient extension support, and high market price fluctuations. Technological challenges like low mechanization and non-availability of quality inputs further hindered adoption. Addressing these barriers through improved extension services, input subsidies, and assured minimum support price could enhance PBNS-12 adoption and profitability.

Keywords: PBNS-12 safflower, constraints analysis, Garrett ranking, adoption barriers, Marathwada.

DEA: An Analytical Approach to Estimate the Resource Use Efficiency in Cocoon Production of Sericulture Venture

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The current investigation primarily delves into the resource use efficiency in cocoon production. Sericulture is the rearing of silkworm in order to produce the quality silk. Being an agro-cottage industry sericulture is suitable for weaker sections of the society by adopting the basic technical knowledge for getting sustainable income and employment. A multistage sampling design was used for selection of study area in Marathwada region. The Data Envelopment Analysis technique was employed in estimating the resource use efficiency. The current paper implies that majority of farmers i.e. 217 having the efficiency level of 81-99 which implies that near about 90 per cent of farmers are more efficient than other farmers that indicates by having an optimum use of available resources, sericulture could be an efficient enterprise for adopting to the small and marginal farmers whereas, only 17 farmers have 100 per cent efficiency level, which suggested that with a minimum wastage of available resources these farmers have efficiently utilized all the inputs for obtaining the profitable output. The results of highest slack mean value was observed under the mulberry leaves followed by the chemical fertilizer i.e. 619.21, 50.87 respectively. Therefore, by reducing the excess use of given inputs, farmers can enhance the optimum farm productivity with less input usage and fetches less production cost. In addition to this about 177 farmers having increasing returns more than 70 per cent i.e. 73.75 per cent which depicted that the farmer can get higher production by proper allocation and efficiently utilization of all the available scarce resources. The paper tries to enlighten the importance of an efficient allocation of key inputs to the farmers, researchers and policy makers in order to provide the technical knowledge, appropriate sericulture trainings, extension services and development of sericulture advisory is necessary.

Keywords: Resource use efficiency, cocoon production, sericulture, agro-cottage industry, sustainable income and employment

Analysis of Procurement and Market Arrivals of Foodgrains: A State Wise Comparative Study

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This study examines state-wise patterns in the procurement and market arrivals of rice and wheat in India from 2020 to 2025, focusing on the effectiveness and inclusiveness of the agricultural marketing system. Using secondary time-series data from the Food Corporation of India (FCI), the Ministry of Agriculture & Farmers Welfare, and Agmarknet, the research analyzes spatial and temporal variations across major grain-producing states. Employing descriptive statistics and trend analysis, the study reveals significant interstate disparities. States such as Punjab and Haryana exhibit high procurement levels under the Minimum Support Price (MSP) regime, while other major producing states show higher market arrivals but lower procurement, indicating uneven policy implementation and market access. The findings underscore the need to expand procurement coverage, strengthen mandi infrastructure, and harmonize policy interventions for more equitable and efficient grain marketing. Such measures are crucial to advancing food security and improving farmer welfare by establishing a more balanced and inclusive procurement system.

Keywords: Foodgrains, procurement, market arrivals, minimum support price (MSP), agricultural marketing, state-wise comparison

Impact of Resource Conserving Technology on Livstock Lactation in Punjab and Haryana

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India has the world's largest livestock population accounting for over 37.28 per cent of cattle, 21.23 per cent of buffalo, 26.40 per cent of goats and 12.17 per cent of sheep. The study examined the growth and export dimension of livestock sector in India, the factors affecting livestock output and the trends, performance and determinants of the livestock sector in India.

Keywords: Farm system simulator model, integrated farming system

A Study on Socio-economic Characteristics of Buffalo Milk Producers in Kolhapur District of Maharashtra

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The present study aims to document the socio-economic characteristics of buffalo milk producers in Kolhapur district of Maharashtra. Multi-stage purposive sampling technique was used to select 90 buffalo milk producers spread across Karvir, Panhala and Kagal tahsils of Kolhapur district. Average family size was 5.80 at overall level consisting 47.76% male, 38.10% female and 14.83% children. All heads of buffalo milk producer family were from middle age group and the average age of head of sample buffalo milk producer family was 50.86 years at overall level. It was evident that, more than 90% family members of the buffalo milk producers were literate at overall level among that 33.10% of family members had completed higher education, followed by secondary level (21.38%), primary level (20.17%) and degree level of education (17.59%). About 8.23% family members were illiterate at overall level. Majority of the buffalo milk producers had farming as the main occupation without any subsidiary occupation at overall level (72.23%). Average size of land owned by sample buffalo milk producers was 0.99 hectares at overall level among that 0.88 hectares of land (88.89%) was found to be irrigated and remaining 0.11 hectares of land (11.11%) was unirrigated. The farm investment in capital assets was Rs. 22.63 lakh at overall level. The value of total assets was maximum in case of medium herd size group (Rs. 24.99 lakh), followed by small herd size group (Rs. 21.85 lakh) and large herd size group (Rs. 21.15 lakh). Sugarcane was the most common crop in the study area, accounting 44.72% of the gross cropped area at overall level. The average number of livestock owned at overall level was 8.3, whereas, average number of buffaloes observed to be 1.63, 3.63 and 7.20 in small, medium and large size herd group, respectively. It was noticed that number of livestock and number of buffaloes owned increases as size group increased.

Keywords: Socio-economic characteristics, buffalo milk producers, Kolhapur

Telangana's Agri-Startup Revolution: Exploring Innovation, Ecosystem Dynamics, and Growth Potential

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The agricultural sector in India is experiencing a paradigm shift with the emergence of agri-startups offering innovative, scalable, and tech-driven solutions to farmers and allied stakeholders. Telangana, known for its vibrant entrepreneurial landscape and proactive innovation policies, has seen significant growth in this domain. In recent years, agri-startups have emerged as key drivers of innovation and transformation in India's agricultural sector, offering tech-enabled, scalable, and market-oriented solutions to farming challenges. This study aims to critically analyze the agri-startup ecosystem in Telangana by evaluating the profile, performance, influencing factors, and constraints of selected ventures. With India recognized as the third-largest startup ecosystem globally and over 1.14 lakh startups registered under DPIIT as of December 2023 (GoI, 2023), the study holds significant relevance for advancing agri-entrepreneurship and rural transformation. As of April 10, 2023, DPIIT recognised approximately 374 startups in the agriculture industry, operating across 490 districts, providing employment to around 38,000 people. As of 2023–24, Telangana had 98 agri-startups supported under the Rashtriya Krishi Vikas Yojana (RKVY) program. Independent industry sources estimate that Telangana hosts approximately 150 agritech startups as of early 2025, placing the state 5th nationally in terms of agritech ecosystem size.

Keywords: Agri-startups, innovations, agri-startup ecosystem, DPIIT

A Study on Circular Economy Startups among University Led Incubation Centers of J&K, India

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The global shift toward circular economy models is fostering innovation focused on resource efficiency, waste reduction, and sustainability. India, through its circular economy mission and SDG commitments, envisions adding $2 trillion to its economy and creating 10 million jobs by 2050. In this transition, university-led incubation centers play a pivotal role in supporting environmentally responsible startups. This study examines the landscape of circular economy startups within incubation centers across J&K, India; a region with significant potential for green innovation. As of 2024–25, over 150 startups have been supported by 10+ incubation centers, mainly at SKUAST-K, University of Kashmir, NIT Srinagar, and IUST. However, only a small fraction aligns with circular economy sectors such as bio-waste management, eco-packaging, and renewable energy. Using an exploratory research design, the study combines incubator data and stakeholder interviews to assess policy awareness, funding access, mentorship quality, and institutional support. Key gaps include the absence of sustainability-focused incubation modules and weak local resource integration. The paper recommends targeted policy action, cross-sector collaboration, and embedding circular economy principles in incubation curricula to position J&K as a regional hub for sustainable entrepreneurship.

Keywords: Circular economy, university incubation, green startups, waste-to-wealth

Role of Sustainable Disease and Pest Control in Influencing Crop Yields– A Systematic Review

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Sustainable disease and pest control plays a vital role in maintaining agricultural productivity while minimizing environmental degradation. Traditional farming often relies heavily on chemical pesticides, which can lead to soil degradation, water pollution, the development of pest resistance, and harm to beneficial organisms. In contrast, sustainable plant protection practices focus on safer, long-term solutions that protect both the crops and the ecosystem.

The review is based on findings from multiple research studies. It explores various sustainable approaches to pest and disease management, such as integrated pest management (IPM), biological control, and cultural practices-such as crop rotation and timely planting, and their influence on crop yield performance. These methods not only help reduce pest and disease attacks but also improve soil health and biodiversity, making crop production more resilient to climate and environmental changes.

Keywords: Sustainable plant protection, integrated pest management, yield, systematic literature review

Blockchain for Agribusiness Innovation: Enhancing Transparency and Traceability in Indian Agricultural Value Chains

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Blockchain Technology (BCT) is redefining agricultural value chains by offering transparency, traceability, and trust in transactions. Globally, over 100 blockchain-based agricultural projects are operational, and the blockchain market valued at $26.91 billion in 2024 is projected to reach $1,879 billion by 2034. In India, the blockchain market is expanding rapidly at a CAGR of 32.1%, expected to reach $1.87 million by 2030. States such as Andhra Pradesh, Maharashtra, Tamil Nadu, and Telangana have initiated blockchain pilots in land records, crop insurance, seed distribution, and commodity traceability. The construction of agricultural blockchain systems involves data collection via IoT, analysis through machine learning, and secure storage on decentralized systems like IPFS. BCT functions through distributed ledgers and smart contracts, enabling real-time tracking from farm to market. This study employs a notable initiative is the chilli value chain blockchain pilot in Guntur, Andhra Pradesh, where over 5,000 smallholder farmers benefited through improved price realization, reduced middlemen, and faster payments. Government initiatives such as AgriStack, IDEA, and e-NAM blockchain integration are laying the foundation for nationwide adoption of BCT. Blockchain empowers India's 85% small and marginal farmers by enhancing price transparency, access to formal credit, and consumer trust aligning with SDGs 2, 9, 12, and 15.

Keywords: Blockchain, agribusiness innovation, AgriStack, smart contracts, digital agriculture, traceability, Andhra Pradesh, chilli supply chain

Potential Key Areas of Indian Agribusiness Start-ups : An Analysis of their Trends and Fund Disbursement

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India's agribusiness sector is undergoing a significant transformation driven by technological advancements and changing consumer preferences, encouraging a surge in start-up activity. This study explores key areas within agribusiness where start-ups are gaining traction, analyses evolving trends and examines patterns of fund disbursement across the sector. Secondary data for the analysis was sourced from the official government portal on Agri-startups for the period 2019 to 2023. Trend and comparative analysis of available data reveal high-potential domains that are attracting entrepreneurs and investor interest. Leading sectors include food technology and value addition, farm mechanization and innovation, and waste-to-wealth initiatives, as indicated by the increasing number of start-ups in these areas. Start-ups in precision farming and organic farming are also gaining momentum, driven by sustainability concerns and market demand. The study also compares fund disbursement efficiency across different sectors, using total turnover relative to released funds. Organic farming stands out, showing the highest efficiency in fund utilization and promising returns over time. The targeted fund allocation and capacity-building initiatives are essential to scale and sustain growth in agribusiness. This study offers a foundation for policymakers, investors, and entrepreneurs to identify and support high-impact sectors within the agribusiness start-up ecosystem.

Keywords: Agribusiness, potential domains, fund disbursement, efficiency, increasing

Rewiring Agribusiness: A Systematic Review of Agri-Tech Start-ups and Value Chain Innovation

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Agri-tech start-ups are at the forefront of transforming traditional agribusiness by introducing innovative business models that drive digitalization and efficiency across the agricultural value chain. These start-ups leverage advanced technologies such as artificial intelligence, data analytics, machine learning, IoT, and blockchain to address long-standing challenges in agriculture, including low productivity, market access barriers, and supply chain inefficiencies. Precision farming solutions provided by start-ups like CropIn and Satyukt empower farmers to optimize input usage and enhance crop yields by as much as 30%, while digital market places such as DeHaat and Ninjacart facilitate direct connections between farmers, buyers, and suppliers, bypassing inefficient intermediaries and ensuring fairer pricing. Innovative models like Software-as-a-Service (SaaS), direct-to-consumer channels, and e-marketplaces not only improve operational transparency but also foster inclusivity by integrating smallholders and marginalized groups into broader agri-value networks. Furthermore, agri-tech start-ups promote sustainability through technologies that support resource conservation, climate-smart agriculture, and post-harvest loss reduction. The rapid proliferation and investment in agri-tech highlight its disruptive potential not just in boosting individual farm profitability, but in reshaping the entire value chain for greater resilience and food system security. As the sector evolves, policy support and stakeholders collaboration will be crucial to maximize both economic and social impact, setting a precedent for scalable innovation in global agriculture.

Keywords: Artificial intelligence, digitalization, market places, precision farming, supply chain

Sustainable Practices in Agricultural Production in Mizoram, India

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Mizoram, located in the North Eastern Hill Region of India, presents unique challenges and opportunities for sustainable agricultural development. Characterized by hilly terrain, shifting cultivation (jhum), high rainfall and rich biodiversity, the state has traditionally relied on subsistence farming systems. However, in recent years, there has been a gradual transition toward more sustainable agricultural practices aimed at conserving natural resources while improving productivity and farmer livelihoods. This paper examines the adoption of sustainable practices in Mizoram, including agro-forestry, organic farming, terrace cultivation, vermin-composting, integrated farming systems and soil and water conservation methods. Supported by programs such as the Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), Rashtriya Krishi Vikas Yojana (RKVY) and initiatives of the Mizoram State Agriculture Department, these practices are helping to address issues like soil erosion, declining productivity, and environmental degradation. Despite growing awareness and institutional support, challenges such as limited infrastructure, market access and dependence on jhum cultivation persist. The study highlights the need for locally adapted technologies, farmer training and stronger value chain integration to scale up sustainable agriculture in the region. By blending traditional ecological knowledge with modern innovations, Mizoram has the potential to serve as a model for sustainable agriculture in fragile hill ecosystems.

Keywords: Sustainable practice, agriculture, hilly region and production

From Aroma to Advantage: Export Competitiveness and Market Orientation of Chilli and Cardamom — Policy Insights from India

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Spices constitute a cornerstone of India's economy, propelled by robust global demand for their distinctive aroma, flavor, and reputed medicinal qualities. The export trade of Indian chilli and cardamom significantly underpins national economic growth. This study conducts a comprehensive examination of their international competitiveness and trade dynamics, employing secondary data sourced from the Spices Board, FAO STAT, and The World Integrated Trade Solution (WITS) spanning 2009–10 to 2023–24. The analysis reveals that India sustains a pronounced comparative advantage in global chilli exports throughout this period, as demonstrated by the overall Revealed Symmetric Comparative Advantage (RSCA) index. In the 2023–24 timeframe, principal competitor nations exhibiting comparative advantages comprise the European Union, China, Mexico, Peru, and Saudi Arabia, with India confronting formidable challenges particularly from the European Union and Mexico, while China, Peru, and Saudi Arabia emerge as salient rivals. Regarding cardamom, Saudi Arabia has remained the most stable and lucrative market for Indian exports from 2009–10 to 2023–24, succeeded by Malaysia, the UAE and Australia. Although India experiences a comparative disadvantage relative to Guatemala in the cardamom trade, it retains superiority over Indonesia, the UAE, Saudi Arabia, and the Netherlands. Collectively, the persistent challenge of spice overproduction necessitates rigorous regulatory oversight by the Spices Board to judiciously manage output and calibrate it in accordance with export demand, thereby safeguarding sustained competitiveness and stability in the global marketplace.

Keywords: Chilli, cardamom, trade competitiveness, direction of trade, lucrative market

Policy and Ecosystem Support: Government Initiatives to Promote Agri-Enterprises and Agribusiness Startups in Jammu & Kashmir

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The agrarian landscape of Jammu & Kashmir (J&K) is undergoing a major shift propelled by visionary policy frameworks and catalytic interventions that aim to transform the Union Territory into a competitive, resilient, and knowledge-driven agri-economy. With the launch of the Holistic Agriculture Development Program (HADP) and the Jammu & Kashmir Competitiveness Improvement Project (JKCIP), the Government of J&K has set in motion a dual-pronged reform strategy aimed at embedding entrepreneurship, sustainability, and inclusivity into the core of agricultural development. This abstract synthesizes the conceptual architecture, institutional scaffolding, implementation pathways, and early impacts of these landmark programs using a mixed-methods approach. The establishment of the Agricultural Value System (AVS) under HADP aims to re-engineer the farm-to-market ecosystem by synchronizing logistics, post-harvest infrastructure, and digital platforms, while JKCIP operationalizes a grassroots enterprise architecture through seed grants, business incubation, and credit intermediation mechanisms. The role of state agricultural universities (SKUAST-K and SKUAST-J) in providing R&D support, curriculum-aligned capacity-building, and scientific validation to entrepreneurial ventures marks a strong example of institutional symbiosis in collaboration with the development departments of Agricultural Production Department, GoJK.

On the ground, the results are both impressive and instructive. More than 5000 agri-enterprises have been incubated under HADP in sectors ranging from floriculture and organic vegetables to trout fisheries and walnut processing, many led by first-generation entrepreneurs. JKCIP, within its initial phase, has supported 350 youth-led startups and seeded 85 business-led ventures with demonstrable impacts on income generation, gender inclusion, and employment creation. Over 4300 hectares have been brought under high-value and niche crops, bolstered by 150+ buyer-seller interfaces, 12 multi-stakeholder platforms, and the emergence of over 150 localized brands—some of which have acquired GI status and e-commerce footprints.

Yet, formidable challenges persist. Credit absorption is hampered by low financial literacy, risk-averse banking norms, and weak business proposal quality. The institutional mechanism is being created to overcome these issues at apex level.

Keywords: Agri-enterprises, agricultural value chain, startups

Mapping the Trout Trail: Value Chain Assessment, Economics, and Constraints of Trout Culture in Sikkim

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Sikkim's cold-water ecosystems offer ideal conditions for rainbow trout farming, a sector gaining attention for its high market value and nutritional benefits. Despite increasing production, local consumption and market reach remain limited, underscoring the need for a comprehensive value chain analysis. This study aims to map key actors, assess the structure of the trout value chain, evaluate stakeholders' economic viability, and identify major constraints affecting trout farming in the state. A purposive sampling method was employed to survey 119 respondents, including trout farmers (n=107), retailers (n=6), and hatchery operators (n=6), covering both government and privately managed units across East and West Sikkim. The methodology included descriptive statistics, value chain mapping, cost–return analysis, and constraint prioritization using the Normalized Response Priority Index (NRPI). Retailers earned ₹ 222.71/kg (BCR 1.4) in East and ₹102.38/kg (BCR 1.2) in West Sikkim. Trout farming showed strong viability in both districts with a BCR of 1.7. Key constraints faced by trout farmers include high feed costs (NRPI: 0.97), inadequate marketing infrastructure (0.93), and high price of seed (0.85). To improve the sector, the Department of Fisheries should operationalize idle infrastructure, promote organic feed, and support higher stocking densities with better management practices. Strengthening retail units, processing facilities, and tourism linkages, alongside data-driven policy support, is vital for sustainably scaling trout aquaculture in Sikkim and boosting consumption.

Keywords: Trout culture, value chain, economic viability, constraints analysis

Promotion of Agripreneurs in North East India: Challenges and Way Forward

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North East is the hotspot of a diverse number of flora and fauna which is endemic to the region. Various high value indigenous and underutilized fruits and crops are grown viz. gingsen, black ginger, lemon grass, sohiong, shitake mushroom, etc which has high market potential and demand in the global market. Currently, there are 21 number of high value crops which are having Geographical Indication (GI) tag in the region. The region produces nearly 93 per cent of the total kiwi of the country and 95 percent of the total passion fruit of the country. The Agri Business Incubation Centre (ABI) of ICAR Manipur Centre has 82 number of entrepreneurs enrolled from various part of the states and also from other states as well. The entrepreneurs are involved in various activities like food processing, crop farming, livestock rearing, fish farming, mushroom cultivation, apiculture, etc. Some of the selected unique products include Herbal hair shampoo with a shelf life of upto 3 months, ghamsa produced from lotus stem fibre, Chakhao gula, juice concentrate of *Prunus nepalensis*, etc. Of the total entrepreneurs, 41 percent are women. The value-added products of these agripreneurs are showcased and sold in various local and regional exhibition and expo. Various training and capacity building programme on value addition, food processing and expert interaction were arranged by ABI for the promotion of these agripreneurs.

Keywords: Agripreneurs, agriculture, Manipur

Catalyzing Agripreneurship: Government Initiatives Promoting Agribusiness Start-ups in India

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Agribusiness start-ups are emerging as transformative agents in the Indian agricultural sector, fostering innovation, value addition, and improved market linkages. Recognizing their potential, the Government of India has introduced several strategic initiatives to nurture and promote agripreneurship *(Ministry of Agriculture & Farmers Welfare 2024)*. Key programs such as the Rashtriya Krishi Vikas Yojana-RAFTAAR, Start-up India, and the Agri-Clinics and Agri-Business Centres (ACABC) Scheme aim to provide financial support, skill development, incubation, and market access to aspiring agribusiness entrepreneurs (*NABARD 2023*). These initiatives not only encourage youth participation in agriculture but also enhance rural employment, sustainable farming practices, and the modernization of the agri-value chain. Government-backed incubation centers, grants, and credit facilities have played a pivotal role in empowering start-ups that address issues like post-harvest losses, supply chain inefficiencies, and climate-resilient farming *(Start-up India 2024)*. This review examines the scope and impact of these initiatives, analyzing success stories and challenges faced by agribusiness start-ups. It highlights how proactive policy support can bridge the gap between traditional farming and modern agribusiness, ultimately driving inclusive rural growth *(FAO 2022)*.

Keywords: Agribusiness start-ups, agricultural innovation, agripreneurship, farmer empowerment, government schemes

An Artificial Neural Network Approach for Price Forecasting of Turmeric in Hingoli APMC of Marathwada Region of Maharashtra

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Turmeric is an ancient spice, a native of South East Asia, used from antiquity as dye and a condiment. Increasing demand for turmeric owing to the increasing use of turmeric in the food industry, demand for herbal cosmetics products coupled with the increasing its use in cosmetic products is the other factor expected to fuel the market growth in the forecast period. The fluctuating phenomenon for the prices of turmeric created need for predicting an accurate turmeric price. The objective of the study was to propose the appropriate model for forecasting prices of turmeric. The data was collected from monthly prices of Turmeric in Hingoli APMC. Non-probabilistic models such as Artificial Neural Network models for forecasting which includes ELM, Multilayer Perceptron's (MLP), NNAR were used. We observed that data contains trends and fluctuations that cannot be predicted in plain view, so NNAR forecasting methods are needed to make these predictions as accurately as possible. Hence NNAR forecasting approach was adopted and on the basis of lowest value of RMSE, candidate NNAR (1,1,2) has found best fitted model to predict turmeric prices in Hingoli APMC. It was observed that the forecasted turmeric prices are more accurate in Hingoli APMC. However, many times in agriculture, data contains trends and fluctuations that cannot be predicted in plain view, so advanced statistical approach like Artificial Neural Network prediction techniques is found more reliable and efficient to produce most accurate price forecasting.

Keywords: Artificial neural network, ELM, multilayer perceptron's (MLP), NNAR

Leveraging Smart Farming Technologies for Export-Quality Agricultural Produce: Innovations and Global Market Readiness

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The increasing global demand for high-quality, residue-free agricultural products necessitates the adoption of smart farming technologies that enhance productivity while meeting international quality standards (Klerkx, L., Jakku, E., & Labarthe, P. 2019). This review explores the role of precision agriculture, IoT-enabled monitoring systems, AI-based decision-making tools, and automated post-harvest management in producing export-ready crops. These technologies allow real-time monitoring of soil health, crop status, pest incidence, and irrigation needs, leading to optimized resource use and minimized chemical inputs. Furthermore, digital traceability tools and blockchain applications ensure transparency and compliance with export certification requirements such as Global G.A.P. and HACCP (FAO 2022). By integrating smart technologies from production to supply chain logistics, farmers can reduce post-harvest losses, enhance shelf-life, and meet the aesthetic and nutritional standards demanded by international markets (Singh, R. et al.2021). Case studies from India and other developing nations highlight successful implementation models, underscoring the potential of smart farming as a strategic lever for boosting agricultural exports. The study concludes with policy suggestions to scale up these technologies through public-private partnerships, farmer training, and export incentives (APEDA 2023).

Keywords: Agri-export, export-quality produce, global standards, IoT in agriculture, precision agriculture, quality assurance

Digital Agricultural Technology for Rural Livelihood Enhancement in North East Region of India- An Empirical Analysis

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The adoption of digital agricultural technologies (AgriTech) is revolutionizing in rural livelihoods by enhancing of productivity, income stability, and resilience against climate risks. An attempt has been made to identify the role of digital agricultural technology for betterment of rural livelihood in NE India. From the findings of the study, it was observed that in Northeast India, an area known for its smallholder farming, dispersed landholdings, and susceptibility to climate change, digital agricultural technology has become a game-changer in improving rural livelihoods. The study of AgriTech assesses the effects of digital tools on agricultural production and increase income levels, including remote sensing, IoT-based weather and soil monitoring, mobile advisory services (such eNAM and Kisan Suvidha), and AI-driven crop prediction models. The study uses secondary data from research articles, official reports (such as Ministry of Agriculture & Farmers' Welfare, NITI Aayog), and NGO evaluations to identify important patterns. While mobile-based market links have decreased post-harvest losses by 10-12%, precision farming adoption has increased agricultural yields by 15-20% in places like Assam and Sikkim (ICAR, 2022). Although there is development in this technology, some issues also arises, such as low internet penetration (35% in rural Northeast compared to the national average of 48%), a lack of digital literacy, and disjointed policy implementation (TRAI, 2023). Scalable approaches for enhancing resilience are illustrated by case studies of Tripura's AI-powered pest management programs and Nagaland's smart village projects. Targeted policy initiatives are recommended by the report, such as incorporating farmer cooperatives into digital ecosystems, subsidizing IoT devices, and increasing rural broadband access through the BharatNet program. Northeast India can use digital agriculture to combat poverty, guarantee food security, and close the gap between urban and rural areas by removing these obstacles.

Keywords: AI, agriculture, eNAM, agricultural technology

Price Behaviour and Seasonal Variations of Onion in Selected Markets of Gujarat

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This study analyses trends in arrivals and prices of onion in Gujarat. Market selection was based on the highest volumes of onion arrivals. The process involved calculating the average of triennium average arrivals across markets, arranging these in descending order, and selecting the top five markets: Mahuva, Ahmedabad, Gondal, Surat and Vadodara. Data collection covered monthly onion arrivals and prices from these five major markets over a 15-year period (2007 to 2021). Linear trend analysis to examine trends in arrivals and prices, centered moving average methods to compute seasonal indices and the residual method for assessing cyclical variations were employed.

Analysis revealed that onion arrivals and prices showed upward trends across all markets studied. Specifically, arrivals of onions increased over the years in each market. Prices of onions also exhibited an increasing trend in Ahmedabad, Gondal, Surat and Vadodara, whereas a declining trend was observed in Mahuva. Seasonally, prices were lowest during April and May, thereafter gradually rising. From September onward, prices increased at a faster rate, peaking around November. Post-November, prices declined gradually due to the onset of new onion arrivals from the kharif and rabi crops. Throughout the study period, onion arrivals peaked during January to May, coinciding with the peak season, and then declined steadily. This reduction in arrivals was associated with rising prices. Analysis of cyclical indices revealed that the inter-year cyclical troughs did not follow a consistent pattern, which could be attributed to changes in import policies and the timing of import arrivals during different periods.

Keywords: Onion production, prices, arrivals, linear trend, centered moving average method

Status of Readinesss and Adoption of Artificial Intelligence in Agriculture in Arid Region of Rajasthan

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Digital technology advancements, particularly in artificial intelligence (AI), have a significant positive impact on the agriculture industry. There is a growing expectation that agriculture would guarantee food safety and security while also taking environmental factors into account. The application of AI in agriculture has the potential to both feed the world's expanding population and help the UN achieve its Sustainable Development Goals (SDGs). AI is still not widely used in agriculture, despite its benefits. Given the variety of foods, supply networks, climates, and land in the agricultural sector, we contend that the slow adoption is caused by the various ways AI affects the agri-food industry. Using a mixed-methods approach, the study explores factors influencing technology readiness, such as access to digital infrastructure, education levels, and exposure to AI applications like precision irrigation, pest management, and yield prediction.

The findings of the research reveal a growing interest in AI tools, driven by their potential to address water scarcity, unpredictable weather patterns, and declining productivity. However, significant barriers persist, including limited access to affordable technology, inadequate training, and skepticism about AI's reliability. The study underscores the need for tailored policy interventions, robust extension services, and localized AI solutions to bridge the gap between technology availability and farmer adoption. This research highlights the importance of empowering farmers through capacity-building initiatives and fostering partnerships among stakeholders to ensure sustainable agricultural practices in Rajasthan's arid regions.

Keywords: Artificial intelligence, sustainable farming, smart intelligence systems, farmers readiness, technology adoption

Theme 2

Empowering Women in Agriculture: Bridging Gaps and Advancing Gender Equity in Farming and Agribusiness

Gender Wage Disparity in Market-Led Agriculture: Evidence from Contract Farming in North India

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This study examines gender-based wage disparities among agricultural labourers engaged in contract and conventional wheat farming systems in Haryana, North India. Using survey data from 563 farm workers, the analysis applies the Blinder–Oaxaca decomposition and the Machado–Mata–Melly (M–M–M) quantile decomposition methods to examine the extent and pattern of wage differentials between male and female labourers. Results show that significant gender wage disparities persist across both systems, though the gap is wider under conventional farming compared to contract farming. The findings suggest that while market-oriented contract farming reduces inequality to some extent, it does not eliminate it. The quantile decomposition highlights a continuing "glass ceiling" effect, where female labourers at the higher end of the wage distribution face greater discrimination. This indicates that structural gender biases remain even in market-led agricultural systems. The study underscores the need for stricter enforcement of minimum wage laws, effective implementation of anti-discrimination policies, and enhanced opportunities for rural women to access secure and fair employment in agriculture.

Keywords: Wage disparity, farm sector, decomposition analysis, Haryana

Gender, Labour, and Mechanisation Dynamics in Sorghum (Millet) Farming under Semi-Arid Maharashtra

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Millets are climate-resilient and nutrient-rich crops that provide sustainable livelihoods in rainfed regions. In Maharashtra, about 80% of labour in sorghum cultivation comprises women workers. Mechanisation enhances productivity and reduces drudgery but may also displace labour, particularly in labour-intensive crops like millets. This study analyses the gendered impact of mechanisation on labour use in sorghum cultivation in semi-arid Maharashtra. Using village-level data from the VDSA-ICRISAT project for 2009–2014 and a two-stage least squares instrumental variable (2SLS IV) panel regression model, the study examines disaggregated labour responses by gender and hiring status. Results indicate that a one-hour increase in mechanisation per acre raises family male labour by 1.52 hours while reducing hired female labour by 1.87 hours. This shows that mechanisation complements family male labour but displaces hired female labour. The displacement of women workers is especially concerning given the limited alternative employment opportunities in rural areas, leading to increased unpaid work for women. The findings highlight the need for gender-sensitive mechanisation policies and the development of women-friendly equipment to reduce drudgery and enhance women's participation in productive employment. Promoting inclusive mechanisation is crucial for sustainable agriculture and equitable rural livelihoods in semi-arid regions.

Keywords: Rainfed areas, food security, sorghum cultivation, drudgery, farm mechanisation, gender, labour displacement

Mapping the Gendered Landscape of Technological Adoption in Indian Agriculture: A Bibliometric Analysis of Women's Heterogeneity

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Indian agriculture has undergone major technological changes, yet adoption by women remains uneven due to social, economic, and regional factors. This study conducts a bibliometric analysis of 1,915 publications (1974–2025) to examine how academic research has addressed women's heterogeneity in agricultural technology adoption. Using SPAR-4-SLR protocols and the TCCM framework, along with VOSviewer and R-Biblioshiny tools, the analysis identifies key research contexts, theoretical approaches, and methodological trends. Findings show a sharp rise in gender-related studies after 2015, in line with the Sustainable Development Goals. However, most research treats women as a single group, with limited attention to differences based on social position, household structure, or region. The review finds empowerment and productivity as dominant themes, while issues such as technological access, labour reallocation, and regional disparities remain underexplored. The study calls for more disaggregated and participatory approaches that capture the diversity of women's experiences in farming. Such evidence-based insights can guide future research and policymaking for inclusive agri-technology transitions in India.

Keywords: Women in agriculture, technology adoption, heterogeneity, bibliometric analysis, SPAR-4-SLR, TCCM, gender, empowerment, intersectionality, sustainable ddevelopment

Invisible Hands: Unveiling the Economic Contribution of Rural Women in Agriculture in North-East India

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Rural women form the backbone of agriculture in India's North-East, where their participation in the agricultural labour force often exceeds 60%. Despite this, their significant economic contribution remains largely unrecognized. This study critically examines the role of women in North-East Indian agriculture, assessing both their value addition and the systemic barriers they face. Drawing on secondary data from official reports, agricultural surveys, and scholarly publications, the analysis adopts a descriptive analytical framework. The findings reveal that although about 80% of rural women work in agriculture, they own only 11.7% of farmland, reflecting deep gender inequities in ownership and decision-making. Women are mostly engaged in low-paid or unpaid labour and face persistent challenges in accessing credit, modern technology, and extension services. States such as Meghalaya record the highest average monthly agricultural household income (₹29,348), yet gender income gaps remain large. The study highlights that recognizing and valuing women's contributions is vital for equitable and sustainable agricultural development. Strengthening women's access to productive resources, markets, and institutional support is essential to enhance their economic empowerment and improve the overall well-being of rural communities across the North-East region.

Keywords: Economic contribution, gender equality, north-east India, rural women, sustainable development

Goat Farming as a Pathway to Tribal Women's Empowerment: A Socio-Economic and Policy Perspective from Rajasthan

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This study explores the role of goat rearing in sustaining household income, improving nutrition, and promoting the empowerment of tribal women farmers in Rajasthan. The research was conducted in Baseri and Sarmathura blocks of Dholpur district, one of the native tracts of the Karauli goat breed. Primary data were collected from 400 women goat farmers from 12 villages with tribal populations ranging from 60% to 100%. Most respondents belonged to the Meena tribe. Results show that agriculture was the main occupation (96.5%), with goat rearing contributing about 40% of total household income. The average flock size was 17 goats, dominated by adult females. Regression analysis identified housing type, SHG/NGO membership, grazing hours, and access to veterinary services as significant determinants of flock size. Goats accounted for 72.53% of total investment, followed by sheds (27.22%) and equipment (0.25%). Feed and fodder made up the main variable cost (18.21%), while interest on capital was the largest fixed cost (46.63%). Medium flocks had the highest cost efficiency (B:C ratio 1.49). Despite positive returns, constraints such as feed scarcity, limited veterinary care, and weak market access persist. The study emphasizes targeted policy support to make goat farming a sustainable path for tribal women's empowerment.

Keywords: Goat farming, sustainable livelihood, tribal women empowerment

Gender-Differentiated Impacts of Climate-Smart Agriculture: Evidence from Bihar

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This study examines the gender-differentiated impacts of Climate-Smart Agriculture (CSA) interventions in Patna district, Bihar—an agrarian region marked by high climate vulnerability and increasing feminisation of agriculture due to male out-migration. Data from 60 households in Bihta and Athmal Gola blocks were analysed using ordinal logistic regression to evaluate how shifts in female labour participation in CSA activities affect household food security, nutritional diversity, climate resilience, and decision-making power. The findings indicate that when women engage in conservation tillage, crop rotation, livestock management, and water conservation, household nutrition and women's role in decision-making improve significantly. Similarly, active female involvement in organic farming and integrated pest management strengthens food security. However, systemic challenges persist, including limited access to training, socio-cultural restrictions, and lack of land ownership. The study suggests that CSA strategies must be backed by gender-sensitive policies that ensure equitable access to institutional support and training for women. These insights can help shape sustainable and inclusive agricultural practices that promote both climate resilience and women's empowerment.

Keywords: Climate-smart agriculture, gender-differentiated impacts, gender-responsive policies, feminisation of agriculture, ordinal logistic regression

Unlocking Economic Inclusion: How Women-led Agricultural Enterprises Utilize Credit, Markets and Digital Technologies

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Women-led agricultural enterprises are key to economic inclusion in rural areas, yet structural barriers limit their access to credit, markets, and digital technologies. This study explores how women entrepreneurs use digital platforms, financial tools, and market linkages to enhance productivity, profitability, and community resilience. Through case studies from self-help groups, Farmer Producer Organisations (FPOs), and MSMEs, the paper highlights innovative financing strategies, team-based marketing, and the role of mobile-based solutions in closing gender gaps. Evidence shows that when targeted credit is combined with market-oriented training and digital literacy, women's bargaining power and income diversification improve significantly. The study also examines enabling policy environments such as gender-responsive value chain development and public-private partnerships (PPP). The findings underline the importance of integrated approaches that link markets, finance, and technology to achieve rural transformation and women's economic empowerment in agriculture.

Keywords: Women entrepreneurs; economic inclusion; market connections; credit availability; digital tools; rural transformations

Empowering Women through Agricultural Innovations in Manipur: A Case Study

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Women in Manipur play a central role in agriculture, yet socio-economic constraints limit their access to modern technologies and financial support. This case study examines how agricultural innovations, institutional support, and government initiatives contribute to women's empowerment. Schemes like the NAMO Drone Didi equip women-led Self-Help Groups (SHGs) with advanced tools, while programs on scientific farming, agri-tech, and financial literacy strengthen women's participation. The study highlights several women-led ventures: Bijiyashanti Tongbram's lotus silk initiative, Chokhone Krichena's floriculture marketing venture, Yangmila Zimik's "Shirin Products," Catherine Soyamphi's food processing unit "Soyam," and Subhra Devi's Meira Foods. These cases illustrate how access to innovation systems fosters entrepreneurship and rural development. Despite their active socio-economic participation, Manipuri women remain underrepresented in agricultural decision-making. The study calls for inclusive innovation systems that provide access to resources, training, and leadership roles to unlock the full potential of women in sustainable agricultural development in Manipur.

Keywords: Women empowerment, NAMO Drone Didi scheme, Self-Help Groups (SHGs), sustainable agricultural development, Manipur

Bridging Gender Gaps for Empowering Women in Agriculture in the North-Eastern Region of India – An Overview

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Women contribute significantly to agriculture, with 80% of rural women engaged in the sector. Yet, gender inequalities persist in land ownership, access to resources, and decision-making. This paper synthesises evidence from 2018–2025 on women's empowerment in the North Eastern Region (NER) of India. Although women account for 30% of farmers and 40% of agricultural labourers, only 14% hold operational farm land. The study identifies key socio-economic and climate-related barriers impacting women and highlights the role of education and new technologies in enhancing their productivity. It discusses successful initiatives focused on skill development and women-oriented training, demonstrating alignment with UN Sustainable Development Goals. The authors call for gender-responsive budgeting and inclusive policies to close gender gaps in NER agriculture. The paper also highlights research gaps, advocating for women-centric data systems and targeted training modules. Bridging gender disparities is essential to building equitable and sustainable agricultural systems in North-East India.

Keywords: Agriculture, climate vulnerability, gender gap, SDGs, northeast India, socio-economic

Determinants of Women's Participation in Agricultural Value Chains: Evidence from Southern Tamil Nadu

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Women make up 80% of India's female agricultural workforce, with 48% self-employed and 33% as labourers, yet only 13% own land. Enhancing women's participation in agricultural value chains can drive growth and reduce gender inequality. This study examines factors affecting women's empowerment in agricultural value chains across Ramanathapuram and Thoothukudi districts. Using multi-stage sampling, data were collected from two Farmer Producer Organisations (FPOs) focusing on three crops: black gram (RFPCL), and chili and sunflower (VPPPCL), with 150 women farm households surveyed. The Composite Empowerment Index (CEI) revealed medium empowerment for black gram (0.624) and chili (0.615), but lower for sunflower (0.538). Ordinal logit regression showed education, land ownership, and credit access significantly influence empowerment. The study stresses the importance of policies promoting financial inclusion, education, and land rights to bridge gender gaps. Strengthening women's roles in value chains aligns with SDG 5 and promotes sustainable, inclusive growth.

Keywords: Women's empowerment, agricultural value chain, composite empowerment index, farmer producer organizations, ordinal logit regression

Measuring Women's Empowerment in Agricultural Value Chains using WEAI Approach: Evidence from Tamil Nadu

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This study examines the participation of men and women in agricultural value chains in Tamil Nadu using the Women's Empowerment in Agriculture Index (WEAI), which includes the 5 Domains of Empowerment (5DE) and the Gender Parity Index (GPI). Using the Alkire-Foster multidimensional poverty framework, the research evaluates empowerment across production, resources, income, leadership, and time. WEAI scores for black gram, chilli, and sunflower value chains were 0.798, 0.808, and 0.786 respectively, suggesting medium to high levels of women's empowerment in Farmer Producer Organisation (FPO)-based chains. Disempowerment was most pronounced in income, production, and leadership domains. While men showed advantages in most indicators, women were better empowered in resources and time use. The study recommends gender-sensitive policy support and training programmes to strengthen women's roles in decision-making and improve access to land, credit, and assets for improved household productivity.

Keywords: Agricultural value chain, women empowerment, gender parity index, WEAI, household productivity

Female Labour Dynamics in India: Sectoral Trends and Social Group Disparities

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This study investigates shifts in female labour force participation in India over the past three decades, focusing on rural sectoral trends and social group disparities. Using data from NSSO and PLFS (1993–2024), it explores patterns across education levels, caste groups, and employment sectors. Rural female labour force participation (LFPR) rose from 24.6% in 2017–18 to 47.6% in 2023–24, with Scheduled Tribe (ST) women recording the highest rate (67.7%) and women from the 'Others' category the lowest (38%). Interestingly, educated women exhibit lower participation (29.4%) than illiterate women (54.7%), reflecting limited rural job opportunities. Agriculture remains the dominant sector for female employment (76.9%), although gradual shifts to services are visible. The study highlights the need for targeted policies that align education with rural employment opportunities and reduce structural barriers based on social group and gender. Improving labour force inclusivity will be key to equitable rural development.

Keywords: Female labour force participation, rural employment, social group disparities, workforce gender gap, sectoral employment shifts

Status of Women Employment in Small-Scale Units in Karnataka

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This study assesses the status of women's employment in small-scale industries in Karnataka based on data from 'Karnataka at a Glance' reports (2019–20 to 2022–23). Small-scale industries play a vital role in employment generation, particularly for women. The number of such units declined by 2.64% in 2020–21 due to COVID-19 but increased sharply by 40.38% in 2021–22 and 8.32% in 2022–23. The share of women employed rose from 25.49% in 2019–20 to 31.07% in 2022–23. Among industries, textiles employed the highest share of women (42.05%), followed by food & intoxicants (35.99%), other units (32.39%), and service activities (29.46%). Although women's employment has grown, disparities persist, with male employment continuing to dominate. The study highlights the need for gender-responsive industrial development policies to reduce employment gaps and promote inclusive growth in the small-scale sector.

Keywords: Gender gap, small-scale units, status, women employment

Petals to Profit: Empowering Women through Rhododendron Value Addition in Sikkim

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This study examines the impact of rhododendron value addition, particularly wine production, on women's economic empowerment in Sikkim. Conducted in Gyalshing district with 28 trained women participants, the study used paired t-tests, Cohen's d test, and Garrett ranking technique to analyse changes in household income and employment status. Results showed significant income gains and a benefit-cost ratio of 3.51, with a medium effect size (Cohen's d = 0.67). The intervention helped transform non-earning women into income generators. Despite challenges such as seasonal raw material availability and market access, the programme created viable livelihood options. The study advocates for expanding technical support, improving resource access, and linking women with better markets to foster gender equity and sustainable agri-based enterprises.

Keywords: Rhododendron, Cohen's d test, Garrett's ranking technique, paired t test

Formalisation of Women Farmers through Digital Tools: Capturing Increased Participation under Natural Farming

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As per the 2021–22 Periodic Labour Force Survey (PLFS), women's participation in agriculture stands at 62.9%, yet women remain largely excluded from land ownership and recognition as farmers. Andhra Pradesh's Community Managed Natural Farming (APCNF) programme addresses this gap by leveraging SHGs and village organisations to train women in sustainable farming. ICT tools like the URVI application institutionalise women's participation by digitally registering them as owners and practitioners of natural farming. This ensures visibility and recognition, enhancing women's agency and participation in decision-making. The programme also strengthens women's roles in livestock integration and natural input preparation. By linking digital formalisation with sustainable agriculture, the intervention creates structural shifts that recognise women as both beneficiaries and implementers. The study underscores the need for scalable digital solutions to address gender gaps in Indian agriculture.

Keywords: Women's empowerment, sustainable agriculture, APCNF, digital divide, digital literacy

Examining Intra-Household Access to Productive Resources and Decision-Making to Promote Gender Equality in Rural Karnataka

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The role of women in rural economies is both diverse and critical, with responsibilities spanning caregiving, household management, and agricultural production. Despite their extensive contributions, women often face restricted access to productive resources and are underrepresented in household decision-making, largely due to prevailing cultural and patriarchal norms. This study investigates gender disparities in intra-household access to productive resources and decision-making in rural Karnataka.

Findings show that men had significantly greater access to resources such as land, large livestock, and farm equipment. Conversely, women more frequently owned poultry and small livestock, which, though important, offer lower economic returns. Despite their active role in farming and related tasks, women's participation in decisions related to production, finances, and resource allocation remained limited. However, a positive association was observed between women's access to resources—such as land titles, group membership, and access to agricultural information—and their involvement in decision-making processes.

The study highlights the urgent need to address these intra-household inequalities to promote inclusive and equitable rural development. Policy recommendations include enforcing joint land titles, introducing gender-sensitive institutional training, and launching awareness campaigns to challenge restrictive social norms. Ensuring legal backing for these measures is essential to foster gender equality and empower women within rural households.

Keywords: Gender, decision-making, resource access, participation

Gendered Perspectives in Organic Millet Cultivation: Economics and Adoption Dynamics in Rural Telangana

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Women contribute significantly to sustainable agriculture, but gender disparities in access to resources continue to affect their productivity and income. This study uses farm-level survey data from 240 millet farmers in rural Telangana to examine the economics of sorghum cultivation under organic and inorganic systems from a gender perspective. It also explores factors influencing the adoption of organic practices.

The results show that female farmers manage smaller landholdings, depend more on family and hired labour, and have less access to farm mechanization. Although their cultivation costs are lower, their yields and net incomes are significantly below those of male farmers, with the gender gap more pronounced in organic systems. Logistic regression analysis reveals that women are 2.8 times more likely than men to adopt organic practices, highlighting their potential as key agents of sustainable agriculture. Despite its environmental advantages, organic farming is currently less profitable than conventional farming, especially for women. This raises concerns about long-term adoption unless structural barriers are addressed. The study concludes that gender-responsive interventions—such as improving access to quality inputs, providing targeted training, and simplifying organic certification—are essential to enhance both sustainability and equity. Without addressing these inequalities, the potential of women in promoting organic and climate-resilient agriculture may remain underutilized.

Keywords: Gender gap, organic millet farming, cost of cultivation, adoption determinants, sustainable agriculture, logistic regression

Wage Inequality and Unpaid Labor Burdens of Tribal Women in the Agriculture Sector: A Case Study of Sundargarh District of Odisha

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This study explores the wage inequality and unpaid labor burdens faced by tribal women engaged in agriculture in Sundargarh district of Odisha. The region has a high tribal population, with women actively involved in organic farming, vegetable cultivation, and millet production—particularly in field and post-harvest activities. Despite their significant contribution, most women lack land ownership, receive lower wages than men, and have limited decision-making power and market access.

The study is based on primary data collected from 400 households using stratified sampling across four blocks: Hemgir, Tangarpali, Kutra, and Nuagaon. In addition, four Focus Group Discussions (FGDs) were conducted in each block to assess gender disparities in wages, land rights, and participation in decision-making. Findings reveal that more than 85% of agricultural land is male-owned, while only 4.5% is individually owned by women and 5.5% jointly. A t-test analysis confirmed a significant gender wage gap, with women earning on average 35% less than men. Multivariate regression identified that wage disparities are strongly influenced by gender, caste, low education levels, lack of land ownership, limited access to farm machinery, and concentration in low-skilled manual work.

Logistic regression results further indicated that women with no education and childcare responsibilities are significantly more likely to engage in unpaid work. The study recommends targeted interventions in education, infrastructure, childcare services, and shifting gender norms to enhance tribal women's participation in paid employment and promote their economic empowerment.

Keywords: Wage inequality, Gender disparity, Unpaid labour burden

Bridging the Gender Divide: Empowering Women in Agriculture and Agribusiness

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Women make up a large part of the global agricultural workforce, yet they continue to face significant barriers in accessing land, finance, extension services, and technology. This review synthesizes insights from 50 peer-reviewed studies on women's empowerment in agriculture. It highlights major challenges such as unequal land rights and limited access to productive assets. Promising approaches include integrating women into value chains, applying climate-smart practices, using the Women's Empowerment in Agriculture Index (WEAI), and organizing collective action through cooperatives and self-help groups (SHGs). These strategies show potential in improving gender equity in agribusiness and rural development. The paper concludes with key policy suggestions and areas for further research to strengthen women's roles in agricultural systems.

Keywords: Rural development, agribusiness inclusion, gender equity in agriculture, women's empowerment

Understanding Drivers and Disparities in Rural Female Labour Force Participation in India: A Panel Data Analysis of state level dynamics

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This study examines the factors influencing rural female labour force participation rate (RFLFPR) across 24 Indian states from 2017 to 2023 using panel data and fixed effects models. Results show that higher average daily casual wages for women significantly improve RFLFPR, with stronger effects in Empowered Action Group (EAG) states. Trend analysis indicates a rising trajectory in RFLFPR, especially in EAG regions. A simulation suggests that a 10% increase in women's median casual wages could raise RFLFPR by 1.86 percentage points in EAG states and 0.70 in non-EAG states. The findings support wage enhancement and targeted policy efforts as effective tools to improve rural female labour participation and address regional disparities.

Keywords: Gender equality, labour force participation, panel data, women empowerment

Enterprise Promotion and Women Empowerment: Evidence from Dairy Enterprises in India

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This paper explores whether the promotion of dairy enterprises through government initiatives contributes to the empowerment of women in India. Specifically, it evaluates the National Dairy Plan (NDP), launched in 2012 across 14 major dairy-producing states, which aimed to enhance milk production and farmer incomes through improved breeding, feeding, and rural infrastructure. Using nationally representative data from the National Family Health Surveys (NFHS) conducted in 2015–16 and 2019–20, the study examines how exposure to NDP interventions influenced women's decision-making autonomy in areas such as financial control, healthcare, mobility, and contraceptive use.

The identification strategy uses variation in exposure duration to the NDP across states while accounting for district-year fixed effects and household-level characteristics. Findings show that women in states with longer NDP exposure had higher levels of autonomy across most dimensions, particularly in financial and mobility-related decisions. However, over time, states with shorter exposure also improved, indicating convergence. The only exception was contraceptive autonomy, where the gap between long and short exposure states persisted.

The study highlights that promoting women-centric enterprises like dairying can positively influence women's agency. It suggests that future interventions should include gender-focused design and monitoring to ensure more equitable and lasting empowerment outcomes.

Keywords: Women empowerment, enterprise promotion, dairying, national dairy plan

Women Participation in Rural Workforce in Bastar Plateau of Chhattisgarh

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This study examines women's participation in the rural workforce in three districts—Bastar, Kondagaon, and Dantewada—located in the Bastar Plateau region of Chhattisgarh. Using multistage random sampling, data were collected from 400 tribal households across 10 villages through structured interviews. The study focuses on women's engagement in agricultural and allied activities, the level of their participation across social groups, and the reasons for non-participation.

Findings reveal that women contribute significantly to agriculture, participating in all stages of farming. On average, tribal women contribute 363.63 person-days annually, higher than male counterparts. However, the study also highlights several challenges. Despite their contribution, women face low wages, limited awareness of government schemes, low education levels, poor health, and minimal decision-making power. These factors act as major constraints to their economic empowerment.

Women's involvement in Self-Help Groups (SHGs) has created new livelihood avenues, but more needs to be done. The study suggests that extension services should be strengthened to enhance women's knowledge and access to government support. Emphasis on training, capacity building, and improved access to institutional credit could increase their participation and improve household incomes.

The paper concludes that recognizing women's contributions and addressing structural constraints is essential for inclusive rural development in tribal regions.

Keywords: Women in agriculture, Gender studies, Workforce participation rate (WPR)

The Feminization of Agriculture in India: Challenges and Opportunities

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This paper investigates the phenomenon of the feminization of agriculture in India between 2017 and 2023. Using data from Periodic Labour Force Surveys (PLFS) conducted by the Government of India, the study documents a rising trend in women's participation in agriculture, particularly as male workers migrate to urban areas or shift to other sectors. Female labour force participation in agriculture increased from 57% to 64.4%, while male participation declined significantly during the same period.

However, the study cautions that this rise does not necessarily indicate empowerment. Women continue to be concentrated in unpaid, low-productivity roles as family helpers, while men are more likely to be own-account workers with better access to land, technology, and institutional support. The shift, therefore, reflects a gendered restructuring of agricultural labour, where women bear a larger share of the work without corresponding gains in ownership or decision-making power.

The paper argues that without addressing the gender gap in resource access and institutional support, the feminization of agriculture may exacerbate existing inequalities. The findings call for gender-sensitive agricultural policies, including better land rights, targeted extension services, and access to credit and markets for women.

Addressing these structural issues is critical to turning the feminization of agriculture into an opportunity for genuine empowerment and improved rural livelihoods.

Keywords: Feminization of agriculture, gender wage gap, female labor force participation

Post-Covid Trends and Determinants of Rural Female Labour Force Participation in Indian Agriculture: A Socio-Regional Perspective

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This study examines trends and determinants of rural Female Labour Force Participation Rate (FLFPR) in Indian agriculture from 2016–17 to 2022–23. Using data from the Periodic Labour Force Survey (PLFS), the research applies statistical tools such as trend analysis, coefficient of variation, correlation analysis, and shortfall analysis to investigate how socio-economic factors like literacy, poverty, and policy initiatives influence female labour force participation across states.

Findings reveal a significant national improvement in rural FLFPR post-2017. States like Himachal Pradesh, Chhattisgarh, and Tamil Nadu showed consistent growth driven by localised self-employment initiatives and support for women's collectives. In contrast, states such as Gujarat, Tripura, and Jharkhand reported lower participation due to limited asset ownership, inadequate access to credit, and restrictive social norms.

Interestingly, the study notes that higher female literacy does not necessarily correspond with increased agricultural labour force participation. Instead, poverty emerges as a stronger driver of women's workforce involvement in agriculture, suggesting a distress-led participation pattern.

The findings underscore the need for region-specific and gender-sensitive policy interventions. Strategies to improve recognition of women's work, enhance access to productive assets and credit, and invest in skilling initiatives are critical. The study contributes to policy discourse on inclusive rural development and aligns with SDGs 1 (No Poverty), 5 (Gender Equality), and 8 (Decent Work and Economic Growth).

Keywords: Female Labour Force Participation (FLFPR), Rural Employment, Gender Disparities, State-wise Analysis, PLFS Data, Women in Agriculture, Sustainable Development Goals

Harvesting Equality: Expanding Women's Access to Agricultural Resources and Opportunities

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Closing the gender gap in access to agricultural resources could raise global agricultural output by up to 4% and reduce undernourishment by 150 million people (FAO, 2023). Despite such transformative potential, women in South Asia continue to face structural inequalities—owning less land, receiving fewer loans, and having limited access to modern inputs and technologies.

This study explores institutional and policy-based approaches to expand women's access to land, inputs, credit, and extension services in agribusiness. It examines the impact of targeted schemes such as the Mahila Kisan Sashaktikaran Pariyojana (MKSP) and Stand-Up India, as well as innovations in digital finance platforms offering gender-specific loan products. Data and field insights suggest that integrating women into value-added processing, branding, and export-linked agribusiness leads to income diversification, enhanced economic agency, and greater resilience in rural livelihoods.

Despite some progress, women still hold only 7% of formal agricultural leadership roles in India (UNDP, 2024). The study calls for deeper investments in skill training, ICT-enabled extension, and gender-responsive value chain development. It advocates for targeted subsidies, supportive credit frameworks, and more inclusive monitoring metrics to accelerate progress toward SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 5 (Gender Equality).

Keywords: Gender-inclusive agriculture, women's empowerment, land access, rural finance, SDGs

Empowering Women in Agriculture: Bridging Participation Barriers and Decision-Making Constraints in Chhattisgarh's Dairy Farming Sector

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Women constitute nearly 50% of the rural population in Chhattisgarh and are actively involved in agriculture, especially dairy farming. However, their participation in decision-making remains limited due to deep-rooted structural and social constraints. This study assesses the barriers faced by women in dairy farm decision-making using primary data from 360 respondents across selected districts. Principal Component Analysis (PCA) was employed to categorize the constraints into five dimensions: social perception (48%), resource ownership (34%), knowledge gaps (28%), institutional barriers (23%), and attitudinal factors (19%).

The analysis reveals that all women respondents showed medium-level involvement (46.4%–88.2%) in decision-making, with none achieving high levels, indicating systemic limitations. Participation in Self-Help Groups (SHGs), especially in vermicompost production, emerged as a key enabler of economic contribution and community recognition. However, significant challenges related to asset ownership, information access, and institutional responsiveness persist.

The study recommends gender-sensitive policy interventions including land rights reforms, access to timely and affordable credit, targeted extension services, and institutional capacity building. These measures can help enhance women's agency in agricultural decisions and contribute to broader rural development objectives.

Keywords: Women empowerment, farm-level decision-making, dairy farming, gender constraints, Chhattisgarh, rural development

Promises and Outcomes: Policy Awareness vs. Policy Impact among Telangana Farmers

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Agriculture remains the backbone of the Indian economy, especially in states like Telangana where a large share of the population depends on farming. Recognizing its critical role, the Government of India has launched several schemes aimed at improving farmer welfare. However, the actual awareness, uptake, and perceived impact of these schemes at the grassroots level remain uneven. This study investigates farmers' awareness of key agricultural policies, their perceptions and attitudes towards these schemes, the extent of utilization, and the barriers faced in accessing benefits.

Primary data were collected using a structured questionnaire administered to farmers across selected villages in Telangana. A convenience sampling approach was adopted to ensure participation from farmers with varied socio-economic backgrounds. The responses were analyzed using descriptive statistics, t-tests, and regression techniques to identify relationships between policy awareness and demographic factors.

The results show that most respondents are familiar with major schemes such as PM-KISAN, Kisan Credit Card (KCC), and the Pradhan Mantri Fasal Bima Yojana (PMFBY). In contrast, awareness of newer initiatives like e-NAM and digital platforms remains limited. The study highlights the need to strengthen communication channels, simplify scheme procedures, and enhance transparency in delivery mechanisms to bridge the gap between policy intent and on-ground impact.

Keywords: Agricultural policy, farmer awareness, government schemes, Telangana, policy impact

Enhancing Market Linkages for SHG Products: Insights into Patterns, Constraints, and Corrective Strategies

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This study explores the marketing patterns and constraints faced by Self-Help Groups (SHGs) in promoting and selling their products. Using data from selected SHGs, it assesses marketable surplus, income generation, and preferences across different marketing channels. Four primary marketing routes were identified: direct to consumers, sales to other SHGs, local stores, and C-Mart. Among these, direct sales emerged as the most effective, accounting for 52.62% of the total marketable surplus and generating the highest income (₹ 4,39,150).

The total annual production of 14 SHG products stood at 7,460 kg, of which 7,293 kg was surplus. Garrett ranking revealed key production constraints, such as inadequate equipment, infrastructure deficits, and raw material price fluctuations. On the marketing side, inconsistent demand, lack of advertising, and packaging limitations were dominant barriers.

To address these issues, the study proposes targeted strategies including better promotion through media and exhibitions, improved packaging and branding, increased credit limits, stronger links with supermarkets, and regular entrepreneurial training. These interventions can enhance the viability and sustainability of SHG enterprises, thereby contributing to women's empowerment and rural livelihood diversification.

Keywords: Self-help groups, marketable surplus, direct marketing, production constraints, marketing constraints, rural women empowerment

From Inequality to Empowerment: A Study on Women's Role and Challenges in the Cashew Industry of Kerala

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Women are central to India's agricultural economy but continue to face systemic gender disparities in wages, working conditions, and access to welfare schemes. In Kerala's cashew industry, women dominate labour-intensive tasks such as shelling, peeling, grading, and packing. This study draws on a field survey of 120 cashew workers to examine these disparities.

Findings indicate significant gaps in wages, job security, health outcomes, and workplace infrastructure. Despite their centrality in the value chain, women workers receive low compensation and face limited avenues for skill development and career advancement. The lack of social protection mechanisms, occupational health safeguards, and union representation further compounds their vulnerabilities.

The study highlights that while the cashew sector provides critical livelihood opportunities for women, it often does so under conditions that entrench gender-based inequities. It calls for a multi-pronged strategy involving strict policy enforcement on minimum wages, workplace upgrades, health insurance, and targeted skill-building programs. By improving conditions and access to rights, the cashew sector can be repositioned as a platform for genuine empowerment rather than subsistence-based employment.

Keywords: Cashew labourers, gender, wages, income, welfare

The Gender Wage Gap in Indian Agriculture: Panel Analysis Using a Difference-in-Differences Approach

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This study investigates the gender wage gap in Indian agriculture using panel data and a Difference-in-Differences (DiD) approach. It assesses the impact of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which mandates equal pay for men and women in public works, on wage disparities in the informal agricultural sector.

Employing a random effects model with clustered standard errors, the analysis identifies persistent gender wage gaps across agricultural activities. Male workers consistently earn more than female workers, even after controlling for various demographic and regional variables. However, the implementation of MGNREGA positively influenced wage levels across the board. While DiD estimates do not conclusively show a statistically significant narrowing of the gender wage gap, the policy's broader effects include a rise in rural agricultural wages without worsening gender disparities.

The study emphasizes the need for gender-responsive monitoring of wage practices in agriculture and suggests introducing targeted certification and skill development programs for women to improve their employability and bargaining power. These measures are essential for reducing wage inequality and fostering inclusive rural growth.

Keywords: Gender wage gap, Indian agriculture, MGNREGA, panel data analysis, difference-in-differences (DiD)

Empowering Rural Women for Climate-Resilient Agriculture: Evidence from India's Namo Drone Didi Scheme

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The Namo Drone Didi Scheme (NDDS) is a recent initiative by the Government of India that aims to empower women-led self-help groups (SHGs) by promoting drone-based services in agriculture. This study assesses the economic and operational viability of NDDS across 16 Indian states, focusing on the scheme's contribution to climate-resilient agriculture and women's empowerment. Findings reveal that women trained under NDDS have gained new skills, improved self-confidence, and expanded income opportunities. However, economic viability varies across regions, with the Western zone showing better outcomes. Operational challenges include poor GPS connectivity, high maintenance costs, and lack of timely repair support. The study recommends differentiated pricing models, decentralized repair hubs, and stronger post-training support systems to ensure scalability. NDDS holds potential as a model for integrating technology with rural livelihoods, provided it is supported with a regionally responsive institutional framework.

Keywords: Women's empowerment, drone technology in agriculture, climate-resilient farming, rural innovation in India

Bridging the Gender Gap: Women's Access to Land, Credit, Technology, and Markets in Agriculture

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Women farmers often face multiple barriers in accessing productive resources such as land, credit, technology, and markets. This paper examines the nature of these barriers and explores policy interventions that can close the gender gap in agriculture. The analysis draws from national and international literature, highlighting the need for reforms in legal frameworks, financial inclusion, and digital access. Case studies show that targeted interventions—such as land titling, digital literacy drives, and inclusive financial services—can substantially enhance women's participation in agriculture and improve household welfare. The study argues that gender-responsive agricultural policy is essential not just for women's empowerment but also for ensuring food security and sustainable rural development. Without equal access to resources, women farmers will remain marginalized, limiting the sector's overall productivity and resilience.

Keywords: Agricultural resources, credit access, digital divide, gender equality, inclusive agriculture, land rights, women's Empowerment

Seeds of Equality: Land Tenure, Financial Inclusion, and Digital Access for Women Farmers

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Despite their significant contributions to agriculture, rural women in India face critical barriers in accessing land, finance, and digital services. This paper reviews existing data and policies to evaluate gaps and opportunities in promoting gender-inclusive agricultural growth. Only a small fraction of rural women hold joint land titles or access institutional credit via Kisan Credit Cards. Furthermore, digital exclusion remains stark, with limited access to smartphones and internet services. The study analyzes national programs such as Digital India, PM-Kisan, and SHG-based credit linkages to assess their reach and limitations. It recommends a three-pronged strategy focusing on legal reform, targeted financial access, and digital capacity building. The paper argues that public–private partnerships and gender-responsive governance are key to aligning agricultural policy with the Sustainable Development Goals (SDGs), particularly SDGs 5, 9, and 10.

Keywords: Land tenure, women farmers, digital inclusion, financial access, gender equality, SDGs

The Rise of Women-Led Startups in India: Role of Public Policy in Shaping Inclusive Growth

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Women-led startups are gaining traction in India, supported by government schemes such as Startup India, Stand-Up India, RKVY-RAFTAAR, and the Women Entrepreneurship Platform (WEP). This paper explores how these schemes have shaped opportunities for women entrepreneurs in agriculture and agribusiness. It identifies key enablers—such as mentoring, access to seed funding, and incubation—as well as barriers including limited outreach, socio-cultural norms, and lack of awareness in rural areas. Based on field evidence and secondary data, the paper calls for gender-disaggregated policy evaluation, long-term handholding, and customized ecosystem support for women founders. It emphasizes that policies must consider intersectional disadvantages and regional variations. Strengthening women-led startups is not just a gender goal but a catalyst for inclusive economic growth and innovation in agri-value chains.

Keywords: Women entrepreneurs, women-led startups, public policy, government schemes, inclusive growth, startup ecosystem, gender equity, stand-up India, WEP, RKVY-RAFTAAR

Bridging Gaps: Impact of Tribal Development Programmes and Schemes on the Economic Well-being of Soliga Women

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This study assesses the socio-economic impact of tribal development schemes on Soliga women in Chamarajanagar district, Karnataka. Using an ex-post facto design, data were collected from 180 respondents across five taluks. The schemes have improved access to basic amenities, including drinking water, housing, and food security. Livelihood diversification has increased, with more women engaged in poultry, goat rearing, and horticultural crops. Annual incomes have nearly tripled. However, some challenges persist—particularly access to forest resources due to legal restrictions. Cultural participation has slightly declined. The study underscores the importance of secure land rights, sustainable resource use, and integrated rural development to achieve inclusive tribal upliftment.

Keywords: Soliga tribal women, tribal development programmes, socio-economic impact, crop diversification

Leveraging Digital Tools and Emerging Technologies to Empower Women Farmers

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Women farmers play a vital role in agriculture worldwide but often lack access to knowledge, credit, training, and markets—factors that limit their productivity and economic potential. Digital tools and emerging technologies such as mobile phones, agricultural apps, e-commerce platforms, and digital payment systems offer new pathways to bridge this gender gap. These tools provide women with timely access to information on weather, market prices, and farming practices, while also enabling participation in value chains and decision-making. However, challenges such as digital illiteracy, poor infrastructure, cultural constraints, and affordability persist. Addressing these barriers through inclusive policies and targeted capacity building is essential to ensure that women benefit equally from technological advances. Empowering women farmers through digital innovation is critical for achieving inclusive growth and sustainable agricultural development.

Keywords: Women farmers, Digital agriculture, Technology adoption, Gender empowerment, Rural livelihoods

A Study on Status and Influence of Schemes on Women-led Startups: Towards Evidence-based Interventions for Advancing Women Entrepreneurship in Kashmir, India

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Women-led startups are increasingly recognized as pivotal contributors to inclusive economic growth. In conflict-prone regions like Jammu & Kashmir, however, these ventures face substantial hurdles. This study investigates the status of women-led startups and evaluates how government schemes influence their entrepreneurial journey. Primary data was collected from over 100 women entrepreneurs across four districts—Srinagar, Pulwama, Baramulla, and Anantnag—complemented with secondary data from schemes such as NRLM, PMEGP, UMEED, Stand-Up India, and JKEDI. The study finds that 62% of the women initiated their ventures post-2018, with government schemes playing a critical role in facilitating initial setup. However, only 28% of respondents earned over ¹ 15,000 per month, and 81% reported a lack of access to follow-up mentoring or business development services. Challenges included poor financial literacy, inadequate market linkages, bureaucratic inefficiencies, and socio-cultural constraints. The paper recommends more integrated, evidence-driven interventions—such as localized incubation models, continuous mentoring, and streamlined access to finance—tailored to the unique needs of women entrepreneurs. Findings offer useful policy insights to strengthen the ecosystem for women-led startups in Kashmir.

Keywords: Women entrepreneurship, startups, policy intervention, incubation, inclusive development

Women's Entrepreneurship Thrives through SHGs, Promoting Financial Freedom and Community Development

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This study evaluates the economic viability of traditional ethnic food products produced by the Gyandeep Self-Help Group (SHG), comprising 19 women in Raipur district, Chhattisgarh. The analysis focuses on seven food items—Thethri, Chila, Fara, Dal Bada, Airsa, Chousela, and Bhajiya—using both primary and secondary data sources. Cost-return analysis indicates that Dal Bada and Thethri offer the highest gross returns (₹ 390/kg), followed by Airsa (₹ 360/kg). The most cost-effective item was Chousela, with a Benefit-Cost (B:C) ratio of 1:1.80, while Chila had the lowest profitability (1:1.01). Net returns were highest for Thethri and Dal Bada, showing strong market potential for SHG-based enterprises. The study highlights that with appropriate interventions—such as training, branding, and improved market access—these microenterprises can significantly contribute to rural women's income and community development. The paper underlines the role of SHGs not just as income-generating units but also as platforms for enhancing women's social status and financial independence in rural areas.

Keywords: Women empowerment, SHG enterprises, traditional food, rural livelihood, microenterprise, cost-return analysis, Chhattisgarh

Redefining Women Empowerment through Self-Help Groups: Evidence from Kerala

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This study explores the subjective and culturally rooted understanding of women's empowerment within Self-Help Groups (SHGs) in Kerala. Drawing on data from 52 Focus Group Discussions (FGDs) and in-depth interviews conducted across two districts, the study investigates how SHG participation influences women's agency, economic roles, and decision-making within their households and communities. Using NVivo for qualitative coding, the analysis identifies diverse interpretations of empowerment. While some women associate empowerment with financial independence and mobility, others derive empowerment from fulfilling traditional roles within the family. A key finding is that support from family members significantly impacts women's perception of empowerment, often increasing once women contribute to household income. Participation in SHGs located outside the home is associated with greater confidence and agency than those limited to home-based activities. The paper argues for the need to adopt context-sensitive empowerment frameworks that account for women's varied experiences and aspirations, rather than imposing standardised metrics of success. This nuanced approach can better inform policy design and program implementation for women's development in Kerala and similar contexts.

Keywords: Women empowerment, SHG, Qualitative analysis, Kerala, Agency, Gender roles

From Margins to Mainstream: Empowering Rural Women through Resource Accessibility and Market Inclusion

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Women constitute nearly 43% of the global agricultural workforce, yet their access to productive resources remains limited, hindering rural economic growth. In India, only 14% of operational landholdings are owned by women (Agricultural Census, 2021), and less than 10% of formal agricultural credit is extended to them (NABARD, 2023). Further, women farmers earn 20–30% less than men, primarily due to restricted market participation (FAO, 2024). This paper explores how rural women can be integrated into mainstream agribusiness value chains through improved access to land, credit, and markets. Drawing on case studies of Farmer Producer Organizations (FPOs) in Maharashtra and Telangana, it illustrates how collective bargaining and digital marketplaces have enhanced women's market participation and bargaining power. The paper argues for gender-sensitive reforms in credit products, land titling, and the development of dedicated women's market zones. These interventions align with the Sustainable Development Goals (SDG 5, SDG 8, and SDG 10), highlighting how breaking down structural barriers can promote inclusive rural growth and sustainable agricultural transformation.

Keywords: Women farmers, land rights, gender equality, credit access, market inclusion, SDGs.

Goat Milk Value Chain and Marketing in Bundelkhand Region, Uttar Pradesh: A Pilot Study

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This pilot study investigates the goat milk value chain and marketing practices in the Bundelkhand region of Uttar Pradesh. Conducted across 50 randomly selected goat-rearing households in Banda and Mahoba districts, the study reveals significant underdevelopment in the value chain despite a large goat population and increasing demand for goat milk due to its nutritional and therapeutic benefits. Only 23% of farmers sold milk, primarily through informal channels such as local milkmen. Most of the milk was used for kid feeding or household consumption. Farmers lacked access to dairy cooperatives, collection centers, or institutional support. Major constraints included low milk yield, absence of organized processing and marketing systems, and inadequate awareness among producers. The paper recommends measures such as genetic improvement, farmer training, hygienic handling protocols, and establishment of small-scale processing units to promote commercialization and strengthen the value chain. Targeted interventions can unlock the potential of goat milk as a viable livelihood option in the region.

Keywords: Goat milk, marketing, value addition, Bundelkhand region, goat husbandry practices, Uttar Pradesh

Drivers of Income in Female-headed Agricultural Households in India

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This study investigates the socio-economic, institutional, and demographic factors influencing income among female-headed agricultural households (FHAHs) in India, using nationally representative data from the NSSO (2018–19). FHAHs constitute about 9.03% of India's agricultural households and are characterised by smaller landholdings, lower education levels, and limited access to key enablers such as Kisan Credit Cards (KCC), Soil Health Cards (SHC), and formal training. Regression results indicate that household income among FHAHs is positively associated with household size, landholding, age, education, and access to KCC, with stronger marginal effects than in male-headed households. Despite women's significant contribution to agricultural operations and livestock management, their income potential is constrained by low access to markets, information, extension services, and technology. Social and cultural norms further restrict decision-making autonomy and institutional participation. The study highlights the need for gender-responsive policy interventions that enhance women's access to credit, training, and market linkages. Addressing these barriers through inclusive institutional frameworks and capacity-building is essential to bridge the income gap and support the livelihoods of female-headed farm households. The findings offer evidence to inform policies promoting gender equity and sustainable agricultural development in India.

Keywords: Agricultural households, drivers of farm income, female-headed households

Does Gender Influence the Adoption of Climate-Smart Agriculture Technologies Among Smallholders in South Asia? Evidence from a Meta-Analysis

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The study aimed to investigate how gender influences the adoption of climate-smart agricultural (CSA) technologies among smallholder farmers in South Asian countries using a meta-analysis. The PRISMA guidelines were employed to identify and source relevant literature from reputable databases systematically. From an initial pool of 318 publications, 13 studies comprising 29 observations were selected for meta-analysis. The forest plot analysis revealed that gender has a minimal or non-significant effect on the adoption of CSA technologies, as indicated by the pooled effect size. Substantial heterogeneity (I^2 = 95.25%) indicates considerable variation in the gender effect across studies. The funnel plot, showing a relatively symmetrical distribution of studies around the mean effect size, suggests minimal publication bias. These findings indicate that, while gender may influence CSA adoption in specific contexts, it cannot be generalized. Further research employing diverse methodologies and larger sample sizes is recommended to gain a deeper understanding of the nuanced role of gender in CSA adoption across different regions.

Keywords: Climate smart agriculture, gender, meta-analysis, smallholders, south Asia

Tracking Women's Time Use in Agriculture: Evidence from 1998, 2019 and 2024

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Over the last three decades, both women and men have experienced a decline in participation in the agricultural sector. For men, this reduction has been offset by a significant rise in participation in non-agricultural work. However, women's participation outside agriculture has remained largely stagnant. This divergence points to an important structural asymmetry: while men have steadily transitioned from agriculture into higher-income, non-agricultural sectors, women's workforce participation has declined—driven not only by their withdrawal from agriculture but also by entrenched social norms, mobility restrictions, and limited access to skills and remunerative opportunities. Gender gaps in paid time use remain substantial, placing women at a structural disadvantage and leading to persistent undervaluation of their labor within the agricultural economy. These disparities carry far-reaching implications for labour markets, income security, and gender-equitable growth trajectories.

Against this backdrop, this paper analyses gender-differentiated patterns in participation and paid time use in agriculture across six Indian states—Haryana, Madhya Pradesh, Gujarat, Meghalaya, Odisha, and Tamil Nadu—for the years 1998/99, 2019, and 2024. It further examines the determinants of workforce participation and paid time use for both men and women to empirically understand the drivers of these disparities. The findings highlight the intertwined processes of structural transformation and gendered labour reallocation, raising fundamental questions about the visibility, valuation, and recognition of women's economic contributions in agriculture and the pathways toward gender-inclusive rural transformation.

Keywords: Women's labour, agricultural time use, structural transformation, gender disparities, paid and unpaid work, India

Inclusive Value Chains: Enhancing Women's Roles Across Agri Supply Chains and Enterprise

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Inclusive value chains are essential for sustainable agricultural development, especially when they empower women across all segments of the agri-food supply chain. Although women play a significant role in agriculture, they often face barriers such as restricted access to land, finance, training, and markets. This paper emphasizes strategies for enhancing women's roles in production, processing, marketing, and decision-making. It highlights the importance of gender-responsive policies, inclusive business models, and capacity building for improving productivity and income. Public-private partnerships, legal reforms, and targeted interventions are recommended to enable women's participation in value chains. Strengthening women's roles not only promotes equity and empowerment but also contributes to resilient, efficient, and sustainable agri-food systems. Inclusive value chains are thus critical to achieving rural development, gender equality, food security, and inclusive economic growth.

Keywords: Women in agribusiness, gender-responsive policies

Why Are Women Less Resilient? Evidence from a Gendered Decomposition of Resilience Indicators in Agri-Food Systems in Odisha, India

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Women in agri-food systems are disproportionately affected by climate shocks, yet the reasons their resilience consistently lags behind that of men remain insufficiently understood. This study investigates the underlying drivers of gendered resilience gaps using a multidimensional decomposition framework. Drawing on survey data from 584 respondents across climate-vulnerable regions of Odisha—including drought-prone, cyclone-prone, and flood-prone areas—we measure resilience through 24 binary indicators grouped into six domains: access to resources, economic participation, collective agency, capabilities, psychological resilience, and food security. Using a Blinder–Oaxaca decomposition adapted for logistic models, we disentangle gender differences into components arising from unequal endowments (education, assets, climate exposure) and unequal returns to those endowments (structural or institutional constraints). The results reveal that men outperform women on 20 of the 24 resilience indicators, with gaps ranging from 5 to 48 percentage points. In most domains, less than half of the gap is attributable to differences in endowments; the majority stems from women receiving lower "returns" to the same characteristics. For instance, a 10-percentage-point gap in climate-friendly technology adoption is driven almost entirely by women's reduced returns to education and climate exposure, while the largest gap—48 points in household decision-making power—arises overwhelmingly from structural inequities in how men's and women's capacities are recognized. Notably, even where women's raw access equals or exceeds men's—such as credit use or time allocation—they still experience weaker resilience gains. These findings demonstrate that improving women's resource access, though essential, is insufficient on its own. Closing gendered resilience gaps requires confronting the institutional biases and social norms that prevent women's capabilities from translating into equal resilience outcomes.

Keywords: Agri-food systems, resilience indicators, Odisha

The Feminization of Distress: Climate Shocks and Rural Women's Labor in SAT India

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Climate change and agrarian distress have emerged as dual challenges to rural livelihoods in India, particularly in the semi-arid tropical (SAT) belt that accounts for over 75 percent of the country's gross cropped area. Characterized by erratic rainfall, recurrent droughts, and fragile agricultural productivity, the SAT region represents a hotspot of climate vulnerability. This study examines women's occupational choices and labor market outcomes in SAT India using longitudinal data from 18 villages across five states between 2009 and 2014. The findings reveal a paradox: while female work participation rates in SAT states are significantly higher than the rural national average, women's engagement remains overwhelmingly distress-driven and concentrated in low-paid agricultural labor and unpaid domestic work. Men, by contrast, exhibit increasing diversification into non-farm employment. Climatic shocks such as droughts intensify these gender gaps, as women often retreat into unpaid domestic duties while men compensate through non-farm opportunities. Educational gains, though improving at the secondary level, do not translate into enhanced occupational mobility for women due to persistent barriers in higher and technical education. Caste and landholding patterns further shape these disparities, with disadvantaged groups relying heavily on insecure female labor. Overall, women's labor in SAT India reflects survivalist strategies rather than empowerment. The study underscores the need for policies that expand non-farm opportunities, strengthen skills and education, ensure wage parity, and enhance institutional support to foster inclusive and gender-responsive rural transformation.

Keywords : Gendered labor participation, semi-arid tropics, agrarian distress, climate shocks, rural livelihoods, occupational segregation, India

Unseen Burdens: Gendered Health and Labour Inequities in India's Water-Scarce Agriculture

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Groundwater, though invisible, is critical to rural livelihoods, fulfilling over 60% of irrigation needs globally. However, climate change and unsustainable extraction have severely diminished groundwater reserves, exacerbating rural distress. This study examines the gendered health impacts of groundwater depletion in Parbhani district, Maharashtra, focusing on women's increasing burden in water-scarce agricultural regions. Two villages—Babhulgaon (rainfed) and Pimpalgaon Thombare (partially canal-irrigated)—were studied with support from SOPPECOM to compare female labour conditions under contrasting irrigation regimes. Findings reveal significant physical drudgery among women who walk 2–3 km multiple times daily to fetch irrigation water. Over 90% reported chronic back pain, fatigue, joint aches, and dermatological issues. Many also reported symptoms of stress and anxiety ("damghat") due to increased workload, especially in kharif season. The feminisation of agriculture, driven by male migration and farm suicides, has further intensified this burden. The absence of accessible health infrastructure and lack of protective gear exacerbates these risks. For daily-wage women, seeking medical help is a costly and time-consuming affair. The study underscores that groundwater depletion is not just an environmental concern—it is a silent, gendered health crisis. It calls for integrated solutions including equitable water governance, rural healthcare strengthening, and technological interventions to alleviate women's drudgery in agriculture.

Keywords: Feminisation of agriculture, rural livelihood, water governance, health drudgery, gender equity

Access to Agricultural Services and Economic Well-being of Farm Women: Empirical Evidence from Rural India

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This study examines farm women's access to agricultural inputs and services, the key determinants influencing this access, and the resulting impact on their economic well-being. Using primary data from 559 farm women across five eastern Indian states—Bihar, Eastern Uttar Pradesh, West Bengal, Jharkhand, and Odisha—the study constructs a composite Agricultural Service Access Index (ASAI) based on four dimensions: financial access, informational access, asset ownership, and market access. Principal Component Analysis (PCA) revealed a structural imbalance, with women benefiting relatively more from financial and informational services such as credit, insurance, government schemes, and extension activities, while remaining significantly deprived of productive assets, mechanization, irrigation, cold storage, and market linkages.

A fractional logit model identified membership in farmer organizations, government support, and the share of farm income in total household income as the most influential determinants enhancing women's access. Distance to input markets emerged as a major barrier. To assess welfare impacts, the study used inverse-propensity-weighted regression adjustment (IPWRA), complemented by Coarsened Exact Matching (CEM) to ensure robustness. Both methods consistently showed that women with higher access to inputs and services experienced substantial improvements—per capita household income increased by 70–80%, and net farm income rose by 45–50%. The findings underscore the need for gender-responsive asset ownership reforms, improved market integration, and strengthened institutional mechanisms such as self-help groups and women-led collectives to advance farm women's economic empowerment and rural livelihood transformation.

Keywords: Agricultural service access index, impact assessment, IPWRA, farm women, eastern India

Policy & Leadership: Promoting Gender-Friendly Policies and Women's Leadership in Agribusiness

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Women constitute a significant share of the agricultural workforce—43% globally and over 33% in India—yet remain underrepresented in agribusiness leadership and face structural barriers in access to land, credit, markets, and information. Despite policy initiatives such as MKSP and Stand-Up India, gender gaps persist due to unequal land ownership, credit bias, and limited access to digital services. Strengthening gender-friendly policies requires integrating gender impact assessments, improving access to ICT-based market information, and incentivizing gender-equitable agribusiness practices.

Women-led FPOs, SHGs, and agri-entrepreneurship initiatives demonstrate the potential of women's leadership, with successful cases showing 25–40% higher profit margins through value addition and improved market linkages. Embedding leadership training, mentorship networks, and representation mechanisms can accelerate progress. Promoting women's leadership directly supports SDGs 2, 5, and 8 and contributes to resilient and inclusive agricultural growth.

Keywords: Gender-friendly policies, inclusive growth, rural development

Theme 3

Climate Resilient Agriculture: Strategies for Adapting to the Changing Climate and Ensuring Food Security

Impact of MSP on Crop Diversification: Evidence from the Plain Region of Nainital District, Uttarakhand

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The Minimum Support Price (MSP) is a major policy instrument aimed at ensuring price support for farmers and influencing their cropping decisions. This study assesses the impact of awareness of MSP on crop diversification in the plain region of Nainital district, Uttarakhand. Using primary data from 120 farmers, diversification was measured through the Simpson Index. The Shapiro–Wilk test indicated non-normal data distribution, which led to the use of the Mann–Whitney U test. Results revealed that there is no statistically significant difference in the diversification index between MSP-aware and unaware farmers, although aware farmers showed marginally higher value of diversification indices. These findings suggest that awareness alone may not lead to diversification, highlighting the need for timely dissemination of MSP information and improvement in procurement systems. By exploring the policy-influenced crop choices, the study offers insights into strategies for promoting climate-resilient cropping systems through informed diversification.

Keywords: MSP awareness, crop diversification, Simpson Index, Mann–Whitney U test, non-parametric analysis, Kumaon, Uttarakhand

Efficiency of Summer Paddy versus Winter and Autumn Paddy Cultivations in Assam: A Non-Parametric Approach

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The main objective of this paper is to examine the efficiency (technical, allocative, cost and scale efficiencies) in the cultivation of summer paddy vis-à-vis winter and autumn paddy in Assam. The study applied the non-parametric method of DEA (Data envelopment analysis) to calculate efficiencies. The study is based mainly on the primary survey data. Various factors influencing the efficiency in each season have also been identified using the Tobit regression model. Results show that the average technical efficiency, allocative efficiency and cost efficiency are higher for summer paddy compared to winter and autumn paddy. Many farm households are showing inefficiencies and on average, about 40% of the potential paddy output level is not produced. Over-use of each input in all seasons was observed, the labour input being the most important. Although summer paddy is emerging in recent decades, its area allocation is still low and winter paddy still dominates. The study provides few policy suggestions for sustainable summer paddy cultivation.

Keywords: Agriculture, efficiency, non-parametric approach, summer paddy, Tobit Model

Community-Based Fodder Land Development: A Case Study from the Drought-Prone Area of Madhya Pradesh

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This case study explores a sustainable community-based fodder land development initiative in the drought-prone Sheopur district of Madhya Pradesh, India, under the SLACC (Sustainable Livelihoods and Adaptation to Climate Change) project supported by DAY-NRLM. Faced with chronic water scarcity, degraded land, and low fodder availability, the intervention involved seven village organizations converting unused community lands (2 ha each) into productive pasture lands using local resources, self-help groups (SHGs), and convergence with government schemes like MGNREGS. Multiple grass varieties—both leguminous and non-leguminous—were introduced with technical support from ICAR-IGFRI. The initiative improved green fodder access, reduced open grazing, increased milk/meat production, and generated local income through seed and fodder sales. Despite challenges like social conflicts, encroachments, and initial irrigation shortages, the project demonstrated a replicable and ecologically sound model. Integration of gender equality, economic resilience, and climate adaptation makes this intervention a valuable contribution toward rural livelihood sustainability and ecological regeneration.

Keywords: Fodder, livelihoods, SHGs, common land, drought, SLACC

Sustainable Agriculture through Natural Farming: Assessing Input Efficiency in Sugarcane, Sorghum, and Maize Production

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India's agricultural sector, a key pillar of the economy, faces challenges such as high input cost, environmental degradation, and health risks from conventional farming practices. In response, Zero Budget Natural Farming (ZBNF) has emerged as a sustainable alternative, requiring low-cost and chemical-free cultivation. This study evaluates the resource use efficiency of natural farming in sugarcane, sorghum, and maize cultivation across Karnataka, using Cobb-Douglas production function. The study is based primary data from 180 farmers. Results indicate that organic inputs like Farm Yard Manure (FYM) and bio-fertilizers consistently had a highly significant positive impact on yields across all crops. For sugarcane, FYM (coefficient: 0.2596) and bio-fertilizers (0.3778) were most influential, while machine labour showed a moderate effect. In sorghum, FYM (0.1754) and bio-fertilizers (0.0839) were key, alongside labour (0.0169). Maize cultivation benefited most from FYM (0.0710) and machine labour (0.0610), with bio-fertilizers playing a secondary role. Notably, bio-pesticides and hired labour had negligible effects, suggesting limited efficacy in natural farming systems. The models demonstrated strong explanatory power, with R^2 values of 76.35% (sugarcane), 81.28% (sorghum), and 81.12% (maize), confirming robust fit. The sum of elasticities ("bi H" 1) indicated constant returns to scale, implying proportional yield increases with input expansion. The findings highlight that natural farming can enhance productivity sustainably when optimized for crop-specific needs, prioritizing organic inputs and selective mechanization. However, the minimal impact of certain inputs warrants further research to refine adoption strategies. Policymakers and farmers can leverage these insights to promote cost-effective, eco-friendly agriculture, aligning with India's goals of sustainable development and farmer welfare.

Keywords: Natural farming, ZBNF, resource use efficiency, Cobb-Douglas, sustainable agriculture, Karnataka

Building Resilience in Agriculture: An Economic Review of Climate-Smart Strategies and Policy Gaps

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Climate-resilient agriculture (CRA) has emerged as a critical strategy to address the twin challenges of climate change and food security. This review synthesizes recent literature from agricultural economics to examine the effectiveness, adoption barriers, and policy frameworks associated with CRA practices. Drawing on peer-reviewed studies, the article explores the socio-economic impacts of climate-smart interventions, highlighting their potential to improve yield stability, enhance income, and reduce vulnerability to climatic shocks. However, structural constraints—such as limited credit access, weak policy coordination, and lack of inclusivity—continue to hinder widespread adoption, especially among smallholders and marginalized groups. The review emphasizes the importance of aligning CRA efforts with supportive economic incentives, decentralized governance, and well-integrated value chains. It also underscores the need for innovative financial instruments and gender-responsive policies to make CRA both scalable and equitable. Case studies from Asia and Africa illustrate successful models of CRA implementation, while also revealing persistent policy and funding bottlenecks. The findings advocate for a holistic, systems-based approach that integrates farm-level resilience with broader institutional and market reforms. Ultimately, CRA represents a promising pathway toward sustainable, inclusive, and climate-adaptive agriculture.

Keywords: Climate-resilient agriculture, climate-smart practices, policy bottlenecks, socio-economic impact

Impact of Crop Insurance on Chemical Inputs in India: Evidence from Endogenous Switching Regression Approach

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Crop insurance has become the effective risk management tool in the agricultural sector. Reduction in production risk brings adjustments in the farmers input decisions and influences the environmental sustainability. In this study, utilizing the nationally representative survey data of Indian agricultural households, we evaluated the impact of crop insurance on the chemical inputs per acre. Employing the endogenous switching regression framework to address the selection biases originating from observable and unobservable characteristics, this found that income per acre, access to technical services and irrigated land have positively influences the inorganic input expenses. Moreover, the estimated impact on chemical input use shows that farmers with insurance are incurring significantly higher expenditures on chemical inputs than uninsured farmers (insured farmers would have spent 11% less on chemical inputs if they decided not to adopt, similarly uninsured farmers would have spent 2.7 percent more expenses if they had insured). The estimated impact is higher among the farmers with larger landholding.

Keywords: Crop insurance, chemical inputs, environmental sustainability, India

Comparative Analysis of Bihar Agriculture with Modern Farming Regions: Challenges and Opportunities for Mechanization

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This research compares agricultural practices in Bihar, India, with modern farming regions (Punjab, Haryana, Tamil Nadu, USA, China, Israel, Germany, Netherlands, Australia), focusing on land area distribution, fragmented landholdings, and the limited adoption of large-scale machinery. Bihar's smallholder-dominated structure (85% of 5.6M ha 4 ha, $977/ha; Netherlands: 55.56 tonnes/ha). The analysis highlights how fragmentation constrains the use of machinery like combine harvesters (optimum: 20+ ha) and proposes cooperative farming, rental models, and small-scale machinery to enhance productivity. This study recommended that align with global models (e.g., Israel's drip irrigation, China's cooperatives) to modernize Bihar's agriculture, targeting 4–5 tonnes/ha by 2030.

Keywords: Modern farming regions, mechanization, Bihar

Non-tariff Barriers and Climate Resilience: Trade Performance of India's Shrimp Export Sector

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India's shrimp export sector is a cornerstone of the country's marine products trade, accounting for over 70% of marine export value in 2023 and generating substantial foreign exchange earnings while supporting rural livelihoods. Over the past two decades, shrimp exports have grown at a compound annual growth rate (CAGR) of 7.5% in volume and 8.9% in value (2000–2024), yet this trajectory faces mounting challenges. Non-tariff barriers (NTBs)—including stringent sanitary and phytosanitary (SPS) measures, maximum residue limits (MRLs), traceability mandates, and eco-label certifications have become increasingly prominent in major destination markets such as the USA, China, Japan, and the EU, which together account for over 76% of India's shrimp export value. This intersection of NTBs and climate-induced production variability poses risks to export volumes, price realization, and market diversification. The trade analysis executed based on the secondary data collected from 129 countries for past 20 decades over the years were collected related to quantity and value of shrimp export from India, exchange rate, countries NTB index, Climate risk index, sea route distance from India were used for this study to examines India's shrimp trade performance from 2000–2024 under the dual influence of NTBs and climate stressors. The analysis incorporates trade competitiveness indicator Herfindahl–Hirschman Index (HHI), alongside econometric analysis estimates quantifying NTB impacts on export value. The Transition Probability Matrix reveals low retention (USA 0.400, Japan 0.175) due to NTBs, yet significant switching to USA (from China 0.485, Japan 0.767), complicating diversification efforts. The findings highlight how NTBs impact export volumes, value realization, and market diversification. Policy recommendations are provided for enhancing climate resilience and compliance capabilities in the shrimp export value chain.

Keywords: Non-tariff barriers, shrimp exports, climate resilience, SPS measures, trade performance, India

An Economic Analysis of Sugarcane Trash Burning and Sustainable Alternatives in Selected Districts of Karnataka

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Sugarcane trash burning remains a common but environmentally detrimental practice in Karnataka, driven by economic and operational challenges. This study analyzes the factors influencing trash burning and evaluates sustainable alternatives among sugarcane farmers in Mandya and Belagavi districts. Primary data were collected from 128 farmers during the 2023–24 crop year using structured interviews. Analytical tools included logistic regression, correlation analysis and ranking techniques. Results revealed that educational status, farm implement possession, mass media exposure and social participation were significantly and positively associated with the adoption of sustainable trash management practices. Despite environmental awareness, many farmers still prefer burning due to quick land preparation, high machinery costs, labour scarcity and pest concerns. Benefits of adopting trash management included increased cane yield, soil moisture conservation, improved fertility and better soil structure. However, key constraints are: lack of knowledge, insufficient incentives and non-availability of equipments. The study emphasizes the need for policy support, financial incentives, training and machinery subsidies to encourage wider adoption of eco-friendly practices. Promoting sustainable trash management is crucial for improving farm economics, environmental health and long-term agricultural sustainability.

Keywords: Sugarcane residue management, crop residue burning, sustainable agriculture, adoption behavior, environmental economics

Economics of Food Fish Aquaculture: A Review and Bibliometric Analysis

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The scientific literature on aquaculture production economics has witnessed a notable expansion in the 21st century. This study presents a bibliometric analysis and detailed review of research specifically focused on this domain. A total of 183 original research articles published between 2001 and 2024 were selected from Google Scholar for analysis. The findings indicate a consistent increase in research output over time, with strong author collaborations. The highest number of publications originates from Asia, with Bangladesh being the most represented country. Journals such as *Aquaculture Economics & Management*, *Aquaculture*, and *Aquaculture International* emerged as the most preferred publication platforms. Among economic indicators, the benefit-cost ratio (BCR) was most frequently employed to assess financial viability. Most of the studies were based on monoculture production systems and adopted a field-based approach. The study concludes that while research output in aquaculture economics is expanding, there remains a need for broader use of rigorous economic indicators to capture the financial viability of production systems more comprehensively across diverse geographic contexts. Overall, this study offers a structured overview to guide researchers and practitioners in navigating the key themes and research trends in the domain of aquaculture production economics.

Keywords: Aquaculture economics, benefit-cost ratio, monoculture systems, bibliometric analysis

Climate Change and Agricultural Adaptation: An Empirical Study of Farmers' Behaviour in Central Brahmaputra Valley Zone of Assam

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The Central Brahmaputra Valley Zone (CBVZ) of Assam is highly vulnerable to the effects of climate change, prominent with flash floods, irregular rainfall and soaring temperatures. The study attempted to analyse long-term climatic trends (1992-2023) using the non-parametric Mann-Kendall test and Sen's slope estimator, investigate farmers' awareness, perception and adaptation strategies regarding climate change utilising primary data from 100 respondents. It was revealed that maximum temperature (Sen's Slope = 0.032 °C/ year), minimum temperature (0.038 °C/ year) exhibited statistically significant trend and marginally significant trend was observed in the case of relative humidity (0.016 % per year), while rainfall displayed a statistically significant declining trend (-28.21 mm/year). Insights from grassroots-level revealed that majority of the farmers perceived rising temperature and irregular rainfall as a consequence of climate change, which ultimately led to decline in crop productivity and, increased the cost of farming. To mitigate this, crop diversification and crop-livestock integration were prominently adopted. Education and farm-size emerged as the significant and positive determinants of adaptation behaviour of farmers. The findings thus emphasized on the reinforcement of policies that strengthen context-specific, low-cost technologies and capacity building in order to ensure long-term resilience and sustainability in CBVZ's agrarian economy.

Keywords: Climate change, climatic trends, adaptation strategies, farmers' perception, resilience

Costs of Soil Degradation and Determinants of Adoption of Soil Conservation Technologies in Kerala, India

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Soil security is emerging concept directly related to seven SDGs (sustainable development goals) pertaining to the food security. Measurable dimensions of soil security are physical (condition, capability), and socio economic characteristics (connectivity, capital and codification). This paper explores the socio-economic dimension of soil security, addressing degradation conservation and management. The study was conducted in the Kerala state in India. The state is highly consumer oriented, deficient in agricultural production also facing various types of soil degradation and land use changes. The study estimated economic cost of various forms of soil degradation. The cost of soil degradation is calculated by considering damage avoidance cost, damage to the crops identified by the farmers due to soil degradation and difference in net returns between the farmers adopting soil conservation and not adopting soil conservation. The difference of soil degradation cost between adopters and non-adopters of soil conservation in Idukki were found to be Rs.1,90,517.82/yr. The higher net returns of Rs.49,000/ha of lower kuttanad than Kari lands, which are more degraded due to inherent characteristics indicate the cost of soil degradation in Kuttanad. Age, education, perception of soil degradation, soil conservation costs and government support have significant effect on adoption decision among farmers on conservation activities.

Keywords: Soil security, soil degradation, endogenous switching regression, damage cost, soil conservation, adoption

Effectiveness and Scaling Pathways of Climate-smart Agriculture in Drought-prone Wayanad

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Adoption of climate-smart agriculture (CSA) practices is crucial under the new realities of climate change to achieve food security and sustainable agricultural development. This paper is intended to measure the effectiveness and upscaling potential of six CSA practices implemented under the NICRA project in the drought-prone village of Wayanad, Kerala. Primary data were collected from 133 farmers practicing different interventions under natural resource management, crop management, and livestock management. Effectiveness was measured using an index based on four indicators, viz, productivity, income, resilience, and mitigation. Upscaling potential is evaluated through technical feasibility, cost of technology, gender inclusivity, and synergy with government plans. The results reveal that there is a substantial variation in the effectiveness and scalability of CSA practices. Effectiveness index score of majority of the practices showed that they improved farmers' resilience towards the sustaining drought situation of the area and, also helped them to mitigate the climate induced-stresses. Results also describe that scalability of these technologies depend highly on the technical feasibility and cost of technology for each practice implemented under NICRA. Key adoption barriers included high initial costs, limited technical know-how, and inadequate institutional support, while financial incentives, access to custom-hiring services, and integration with government schemes emerged as critical enablers for scaling. The findings underscore the need for targeted policy interventions to address adoption constraints and promote context-specific CSA strategies for drought-prone regions.

Keywords: Climate-smart agriculture, effectiveness index, upscaling potential, NICRA, Wayanad, drought resilience

Assessing the Economics of Pomegranate Cultivation through Farmer Producer Organizations in Western Maharashtra

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Encouraging and supporting member-owned producer organizations is essential for providing farmers with the necessary tools to enhance productivity through efficient, affordable, and sustainable resource use, ultimately leading to higher returns. These organizations can achieve this through coordinated efforts, supported by government initiatives and successful partnerships with the private sector, academia, research organizations, societal groups, and public sector. For the study a total 126 pomegranate member farmers of FPO were selected for detail investigation. The present study used both primary and secondary data to understand the effectiveness of farmer-producer organizations. The results showed that per hectare total cost of pomegranate production was Rs. 270380.43 and net return obtained was Rs. 853307.57 per hectare. Input out ratio was found to be 3.15. FPOs provided free lab testing services and slurry culture to their member farmers, which helped the farmers save money on fertilizers and pesticides for plant protection.

Keywords: Famer producer organization, pomegranate, costs and returns, economics, net returns, amortization costs

Precision Agriculture in Hilly Regions: A Bibliometric Assessment of Global Research Trends

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In recent decades, the growing demand for sustainable farming practices has led to the emergence of precision agriculture (PA) as a key innovation to increase productivity while conserving natural resources. PA uses technology and data-driven methods to optimize agricultural inputs and outputs, making an essential tool in addressing global food security and climate change challenges. However, the majority of PA research and applications have been concentrated in flat, low land areas. At the same time, hill and mountain regions, despite their vast agricultural potential and vulnerability to climate impacts have received comparatively little scholarly attention.This study highlights a global bibliometric assessment of scientific research on precision agriculture in mountain regions between 2000 and 2025. The first objective is to systematically analyse the growth of this research field over time, identify and recognising publication patterns, and explore the geographical distribution of studies. The second objective is to uncover major research themes, highlight influential journals, and map out key networks of collaboration among countries and institutions. Tools such as VOSviewer and the Bibliometrix of R package were used to generate visual mappings of keyword co-occurrence, citation networks, and authorship clusters.The results provide valuable insights for developing countries like Nepal and Bhutan, where over 80% of the terrain is hilly or mountainous, and where agriculture remains the backbone of rural livelihoods. Yet, Nepal's presence in global PA research is limited, reflecting the wider neglect of mountain ecosystems in agricultural innovation. This study helps fill that gap by offering a broad picture of how precision agriculture has been studied in similar regions globally. It highlights opportunities for the mountainous region to benefit from targeted investments in PA technologies, locally relevant research, and international scientific collaboration. By identifying trends, gaps, and future directions, this bibliometric assessment supports researchers, policymakers, and development practitioners aiming to modernize agriculture in highland environments and promote more sustainable and resilient food systems in countries like Nepal and global level.

Keywords: Precision agriculture, hill regions, mountain agriculture, bibliometric analysis, sustainable agriculture, technological adoption, VOS viewer, bibliometrix

Climate and Policy Drivers of *Kharif* Bajra Yield in Gujarat: A Macro-level Analysis

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Climate change is a challenge for agriculture and food security. Bajra, a staple cereal crop in semi-arid regions, is grown in *kharif* and known for its resilience to drought, and therefore is gaining attention as adaptation strategy. However, the productivity of it is influenced not only by climatic patterns like rainfall but also by economic policy of minimum support price (MSP), shaping farmer's decisions, cropping choices and input use. This study attempts to analyse the macro-level interactions between climatic and economic variables that affect yield of *kharif* bajra in Gujarat over a two-decade period. Using secondary data on *kharif* bajra yield, seasonal total rainfall, and minimum support price (MSP) from 2005 to 2025, this paper employs trend analysis, compound annual growth rate (CAGR) analysis of yield, correlation and multiple regression techniques to assess the relationship between these factors. The study concludes that changes in weather, like rainfall, have little impact on bajra production. Instead, economic factors, particularly the minimum support price (MSP), significantly influence the cultivated area of bajra over time.

Keywords: Climate, minimum support price, total rainfall, kharif bajra yield, correlation analysis, regression analysis

Economic Vulnerability of Tribal Households in Manipur, India: The Role of Non-timber Forest Products

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The study assessed the economic vulnerability of tribal households the North-Eastern Region of Manipur, India with a specific focus on their dependence on Non timber Forest Products (NTFPs), (medicinal plants) as a primary source of livelihood. A survey of 160 tribal households was conducted and economic vulnerability index (EVI) was constructed based on three parameters: exposure, sensitivity and adaptive capacity. The results revealed that both male-headed households (MHH) and female-headed households (FHH) were highly dependent on Non-Timber Forest Products, particularly medicinal plants for their income. The income from NTFPs contributes approximately 60 % and 55% of their total household income, respectively. Economic vulnerability for Kamjong district was found to be significantly influenced by a number of factors, including medicinal plant as the only sources of income, gender, age and total income from medicinal plant to annual income whereas for Senapati district on level of education, number of earning members in the family and land ownership are found to be influencing factors. Kendall's concordance test was performed to determine the extent of agreement for the adaptation options among the households and disaster preparedness was the most preferred option among the households. Likert scale analysis revealed that community members perceived that given issues like, forest degradation, and only a few of the members perceived factors like climate change to cause decline in the resources. The study enhances empirical understanding of the socio-economic dynamics of forest-dependent tribal communities by examining the differing vulnerabilities of MHH's and FHH's. The findings underscored the vital contribution of medicinal NTFPs to strengthening livelihood resilience and support the formulation of gender-responsive, ecosystem-based adaptation measures.

Keywords: Economic vulnerability; medicinal plants, non-timber forest products (NTFPs); tribal livelihood; gender analysis; climate adaptation; perception; adaptive capacity

Exploring Tenancy and Financial Exclusion in Rural Andhra Pradesh

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This study explores the inter-connected challenges of agricultural tenancy and credit accessibility in the Guntur district of Andhra Pradesh. Based on a field survey of 240 farmers—comprising both tenant and owner cultivators—the analysis highlights deep-rooted socio-economic disparities. Tenant farmers, who represent the majority, face lower per capita incomes, heavier debt burdens, and restricted access to formal credit institutions. The study underscores notable differences in borrowing behavior, repayment capacity, and vulnerability to external shocks. These findings have critical policy implications, calling for targeted financial inclusion strategies and support for sustainable farming to mitigate the ongoing agrarian distress in the region.

Keywords: Tenancy, financial exclusion, Andhra Pradesh

Credit and Non-credit Needs of Farmers in Jammu and Kashmir: A Case Study of KCC Scheme

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The agrarian demography of Jammu and Kashmir is dominated by the marginal (< 1 ha) and small farmers (1-2 ha), accounting for 95% of the total farmer (14 Lakhs) in the UT. The agriculture and allied sector contributes 20-25% in the UT's GSDP, with agriculture accounting for 4-5%, horticulture 7-8% and Dairy/livestock about 6-6.5%. Although, this sector is the backbone of economy, yet before the 21st century, small and marginal farmers are facing challenges related to financial resources such as dependence on informal moneylenders, lack of timely access to affordable credit, complex banking procedures, which limited their ability to meet their production and livelihood needs. Hence, to boost up the credit facilities for the small and marginal farmers, a scheme "KISAN CREDIT CARD (KCC)" was launched. It provides both short term and long-term credit to the beneficiaries at 4 per cent rate of interest. Despite having a low interest rate, there are only 9 lakh farmers currently operational KCC accounts in the UT. Garrett ranking method was applied and, findings reveal that the major reason for the low adoption rate in KCC is problem of finding a guarantor followed by incomplete land records required for credit approval. Apart from these, the other reasons contributed to halt the uptake of KCC are: lack of awareness regarding scheme and prompt repayment incentive (PRI), negative influence of the peer group, illiteracy rate. While some farmers do not find need to take credit, yet rest of the others fear of taking loans due to feeling of indebtness. Moreover, due to high illiteracy rate, a proportion of farmers prefer informal source of credit over formal sources. As per the perspective of banks, agricultural loan waiver facilities and fear of accounts becoming NPA (non-performing assets) is one of the major concerns. In addition to this, the role of business correspondents is lacking due to poor incentives. Also due to poor CIBIL score of the residents of the specific area, banks sometimes find it difficult to provide loan to the farmers. The least factor for the poor adoption rate is the cultural and societal judgements for taking loans as for some section of the society it is against their pride.

Keywords: Credit needs, KCC scheme, constraints, policy and governance

Evaluating Agricultural Sustainability in India: A Composite Index-Based Framework for Regional and Policy Assessment

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Agricultural sustainability is vital for ensuring food security, environmental conservation, and livelihood resilience especially in India, where over 45% of the workforce depends on agriculture. As of 2023, India had 10.17 million hectares (2.6%) under organic cultivation, with Maharashtra contributing 0.72 million hectares (3.6%). However, only 18.17% of Maharashtra's cultivable area is irrigated, underlining the urgent need for micro-irrigation and climate-resilient farming. To meet the projected food grain requirement of 450–500 million tonnes by 2050, India must significantly raise its current production of 353 million tonnes (2024–25). This study employs a composite Agricultural Sustainability Index (ASI) to evaluate district-level sustainability using 28 indicators across six dimensions: physical, financial, human, social, livelihood, and information access. Each variable was normalized using the Min-Max method, weighted using Principal Component Analysis (PCA), and aggregated through arithmetic mean to generate district-wise ASI scores. A case study from Bihar highlights regional disparities: Saran ranked highest (ASI: 0.386) due to strong infrastructure and awareness, while Kaimur ranked lowest (ASI: 0.273). Key programs such as the National Mission for Sustainable Agriculture (NMSA), Soil Health Card Scheme, and Zero Budget Natural Farming (ZBNF) play a critical role in enhancing sustainability. The ASI framework supports region-specific planning and aligns with SDGs 2, 12, 13, and 15, offering a pathway to a more resilient and inclusive agricultural future.

Keywords: ASI, climate resilience, food security, organic farming, SDGs, India

Adaptive Strategies and Determinants of Climate Resilience in Shrimp Aquaculture: Evidence from Tamil Nadu, India

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Climate change poses significant challenges to the food production sector, including shrimp aquaculture, which is vital to India's seafood exports. Shrimp contributes 50% of India's total seafood export volume, with Tamil Nadu accounting for 7.5%. To mitigate the adverse effects of climate variability on *Penaeus vannamei* farming, shrimp farmers have implemented various adaptation measures. This study investigates the adoption of these measures and the factors influencing farmers' choices. Data were collected from 256 shrimp farmers across six coastal districts of Tamil Nadu using purposive sampling. Out of thirteen identified binary adaptation measures, five key strategies—feeding schedule adjustments, early harvesting, water conservation, water treatment, and aeration adjustments—were analyzed in detail using multivariate logistic regression. Findings indicate substantial regional variation in adaptation practices, with Tiruvallur leading in feeding schedules, early harvesting, and water treatment. Nagapattinam and Ramanathapuram demonstrated moderate adoption of shading and stocking density adjustments, while water exchange and pond lining practices were found to be underutilized. Regression results reveal that institutional support significantly enhances the adoption of stocking density adjustments, water conservation, and water treatment. Temperature and precipitation also influenced feeding practices and water treatment. Training positively impacted the uptake of water conservation measures, and farmer collaboration promotes stocking density adjustments and water treatment.

Keywords: Adaptive strategies, choice of adaption, climate resilience, shrimp aquaculture, multivariate logistic regression

Evaluating Climate Adaptation Strategies using Cost-benefit and Multi-criteria Analyses: A Case of Large Cardamom in East Sikkim

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This study was carried out to identify and evaluate different climate adaptations undertaken by the large cardamom farmers to cope up with the changing climate. The cost benefit and multi-criteria analysis were used for analysis. Study is based on primary data collected from 114 households in East Sikkim district of Sikkim. This study identified six major adaptation strategies practiced in the study area. Cost-benefit analysis of the adaptation strategies revealed that change in cultivar as adaptation strategies heled the famers in realizing the maximum net income for large cardamom farmers. This finding is also corroborated by the multi-criteria analysis. The study recommends that extension agencies may organize awareness programs on the benefits of cultivating *Seremna* variety in the state.

Keywords: Adaptation, CBA, climate, large cardamom, and MCA

CRIDA Horse Gram Varieties: Climate-resilient, Dual Purpose, and Profitable Option for Dryland Farmers

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Horse gram [(*Macrotyloma uniflorum* (Lam.)Verdc.] is an important drought resistant dual purpose crop and grown as a contingency crop due to its adaptability to poor soils and adverse climatic conditions which are unsuitable to many other crops. Being a leguminous crop, it also enhances soil fertility by fixing atmospheric nitrogen hence it is used as a green manure and cover crop. Horse gram is a nutritious forage crop for cattle as well as nutritious grain with high protein content which can provide nutritional security for small and marginal farmers in dry areas. ICAR-CRIDA has released four horse gram varieties namely, CRGH-18R, CRGH-4, CRGH-19. CRGH-22. CRIDA horse gram varieties are targeted for south Indian states of Karnataka, Kerala, Telangana, Andhra Pradesh and Tamil Nadu. The area covered under the CRIDA horse gram varieties in a State was estimated on the basis of seed sold from CRIDA to the States. The share of CRIDA horse gram varieties in total horse gram area in south India is 0.92%. The additional net returns from growing CRIDA horse gram variety over local variety was estimated as Rs.11,000/ha The additional benefits expected at farmer level estimated as Rs. 2.81 Crores per annum (11000x2552) and cumulative additional benefits from CRIDA horse gram variety at farmer level for last 15 years was estimated as 34.33 crores. Primary data on the benefits were collected form adopter farmers in Anantapur district. Results revealed that CRIDA variety were better in the yield and farmers received higher net returns from it especially as a contingency crop. These are highly tolerant to drought stress and is an important component of our preparedness as climate resilient crops in dry areas.

Keywords: Horse gram, climate resilient, dry lands

Post-harvest Losses in Vegetables and Their Implications on Food and Nutrition Security under Climate Stress in Chhattisgarh Plains

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Post-harvest losses (PHL) in vegetables are a major contributor to food and nutrition insecurity in India, particularly in climate-sensitive regions like the Chhattisgarh plains. Despite targeted policies and schemes such as PMKSY, MIDH, and RKVY, substantial losses—ranging from 25% to 33%—persist, especially during peak harvest seasons. This study surveyed 600 farmers across key districts using stratified sampling to quantify crop-specific and seasonal losses for tomato and brinjal. Results show that tomato experienced the highest average losses (33%), primarily due to inadequate storage, poor market access, and extreme weather variability. Analytical tools, including descriptive statistics and regression, highlighted critical gaps in infrastructure utilization and scheme outreach, with only 38% of respondents benefitting from post-harvest interventions. The study emphasizes the need for climate-resilient storage, aggregation, and market integration to minimize losses and improve food system sustainability. Policy recommendations call for enhanced last-mile delivery, decentralised cold-chains, and awareness programs to tackle structural inefficiencies and climate risks in the vegetable supply chain.

Keywords: Post-harvest losses, food security, climate change, vegetable supply chain, Chhattisgarh, agricultural policy, climate-resilient infrastructure

Assessment of Climate-driven Constraints in Telangana's Agricultural Systems

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In Telangana's diverse agro-climatic landscape, increasing climate variability impacts the stability and sustainability of farming practices. The present study thus aimed to ascertain and rank production constraints as perceived by the farmers to aid climate-resilient planning. Primary data pertaining to the 2023-24 agricultural year was collected from 48 villages (6 districts × 2 mandals × 4 villages) using household surveys and focus group discussions. Constraints were ranked by farmers based on severity and validated through consultations with Agricultural Officers. A Constraint Severity Index (CSI) was calculated to quantify and rank the severity of each constraint. The most critical climate-induced constraints were untimely rainfall (CSI: 4.1), pest and disease outbreaks (4.0) and fodder shortages (3.7). Constraints exacerbated by climate stress, such as labour scarcity (4.3) and rising input costs (3.6), were also ranked high. Additional issues reported were: moisture disputes in paddy procurement, low milk fat penalties and delayed dairy payments (CSI range: 2.8–3.2). Key recommendations of the study are: timely weather-based advisories, pest surveillance, fodder banks, transparent procurement systems and improved livestock services.

Keywords: Climate change, constraints, agricultural systems

Comparative Study of Open-Field and Indoor Cultivation of Saffron in the Union Territory of Jammu & Kashmir

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Indoor cultivation has huge prospects especially for the horticulture sector of UT of J&K. This advanced cultivation approach has significantly enhanced both production and productivity, particularly of high-value, low-volume crops. It has proven especially beneficial for the cultivation of quality seeds, planting materials, and off-season fruits and vegetables. Saffron being the most important high value & low volume cash crop of UT of J&K has tremendous potential to be cultivated under indoor cultivation. Various studies suggest that the production of saffron under indoor cultivation is higher than the production achieved under open-field cultivation. The present study explores the growing potential of indoor saffron cultivation as an alternative to traditional open-field methods. Selected purposively the Pampore block of Pulwama district, the only region in India known for saffron production. The study aims to compare the costs, returns, and overall profitability of saffron cultivation under open-field versus indoor conditions. It further seeks to evaluate the impact of indoor cultivation on saffron production and productivity. Findings indicate that while the cost of indoor cultivation is significantly higher (₹ 15905269/ha) compared to open-field cultivation (₹ 188716/ha), the returns from indoor farming are disproportionately greater than open-field (₹ 45941704/ha vs. ₹ 316691/ha). Indoor cultivation demonstrated remarkable productivity, yielding 208.5 kg/ha in a 6-tier system (34.75 kg/ha per tier), in stark contrast to 1.87 kg/ha from open-field cultivation.

Keywords: Indoor cultivation, controlled environment agriculture, saffron productivity, temperate agriculture, technology adoption, innovation in horticulture.

Assessment of Total Economic Loss of Post-Harvest Losses in Fish Value Chain: A Mixed Model Analysis

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Post-harvest loss (PHL) in fish remains a critical barrier to the development and sustainability of the fisheries sector, affecting both economic returns and food availability. This study assessed PHL at four key nodes (fishers, wholesalers, retailers, and fish vendors) of the marine fish supply chain in Ernakulam district, Kerala using mixed model approach. This approach integrates the Informal Fish Loss Assessment Method (IFLAM) and the Qualitative Loss Assessment Method (QLAM). Losses were estimated as physical loss, quality loss, and market force loss. The monetary value of PHL was calculated as total economic loss. Results show that physical loss was the predominant loss at the fisher and wholesaler levels, whereas quality loss and market force loss were more significant at the retailer level. For fish vendors, market force loss and quality loss were the main contributors of PHL. The estimated daily average total economic loss was ₹ 30,597, ₹ 23,430, ₹ 28,341 and ₹ 2,532 at fishers, wholesalers, retailers and at fish vendors level, respectively. The findings highlight the need for targeted specific interventions at various nodes of the fish value chain, to reduce both quantitative and qualitative losses through improved handling, cold chain infrastructure, and market stabilization strategies.

Keywords: Post-harvest loss, physical loss, quality loss, market force loss, qualitative and quantitative losses

How Rice Farmers in the Indo-Gangetic Plains Use Fertilizers: Lessons for Nitrogen Management

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This study examines the fertilizer usage patterns of rice farmers in the Indo-Gangetic Plains of India, with a focus on nitrogen management, which has become an important environmental concern in the region. The analysis is based on a primary survey of 906 farmers from 5 different states in the study region, identified using a stratified multi-stage random sampling method. The analysis shows that urea is the most commonly used fertilizer, utilized by 91.17% of farmers, while Diammonium Phosphate (DAP) is used by 66.78%. There are significant variations in the use of chemical fertilizers across different states. Farming experience, training, and contact with public extension agencies are key variables that help reduce the use of chemical fertilizers. The stochastic production frontier model identifies nitrogen, pesticides, labour, and land preparation as key inputs that enhance productivity, while excessive phosphorus application and irrigation lead to lower productivity levels. The mean technical efficiency score of 0.65 suggests the potential for improving rice yields by optimizing the use of inputs, including fertilizers. Optimal nitrogen use is identified at 100-200 kg/ha, with 37.31% of farmers exceeding this range. Lastly, the probit model helps identify the variables that can be valuable in managing the overuse of nitrogen. These findings highlight the significance of balanced fertilizer use through nitrogen management to achieve agricultural efficiency and sustainability.

Keywords: Fertilizer-use, IGP, SFA, probit model

Casting a Wider Net: The Economic Trajectory of Motorized Fishing in Ernakulam

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Motorized fishing, a vital part of Kerala's small-scale fishing sector, faces significant challenges characterized by economic vulnerabilities, declining fish stocks, and environmental degradation apart from rising operational costs and external shocks. Fishermen, operating small motorized boats are less equipped to absorb the shocks of low-income months or unexpected events. Time series analysis applied to the daily fishing income data from 2017 to 2023 revealed distinct temporal patterns, including upward and downward income trends in specific years and strong seasonal fluctuations aligned with fishing cycles and monsoon effects, confirming the dynamic nature of income in the sector. The study uncovered critical patterns in income dynamics, including both long-term trends and distinct seasonal fluctuations, offering valuable predictive insights. The study underscores the need for policies that not only boost overall income but also help mitigate the impact of seasonal and irregular income fluctuations. Recommended strategies include providing targeted support during lean months, offering insurance schemes against income loss due to extreme climate events, and encouraging fishermen to diversify their income sources. Ultimately, recommend the implementation of adaptive management strategies to build a more sustainable and resilient future for the fishing communities of Ernakulam.

Keywords: Motorised fishing, income, trend, economic vulnerability, extreme climate events, insurance

Evaluating the Impact and Risk Minimization Ability of Rural Farmers Under Pradhan Mantri Fasal Bima Yojana (PMFBY) in Coastal and Non-Coastal Regions of Odisha

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Ensuring the resilience of farmers is essential for promoting sustainable agriculture, especially in the face of climate variability and market instability. As climate change and economic uncertainties intensify, protecting farmers from yield losses has become increasingly important. This study seeks to examine the expansion and impact of the *Pradhan Mantri Fasal Bima Yojana* (PMFBY) in Odisha, with particular emphasis on coastal and non-coastal regions. The study employed primary data of 200 farmers gathered from 140 adopters and 60 non-adopters across two districts. The analysis was carried out using a combination of methods, including Compound Annual Growth Rate (CAGR), Cuddy-Della Valle Index (CDVI), Probit regression, Inverse Probability Weighted Regression Adjustment (IPWRA), Garrett's ranking technique, and Likert scale. The number of beneficiaries rose substantially in both *Kharif* (53.27%) and *Rabi* (57.56%) seasons. However, claim disbursements exhibited a declining trend and were marked with high instability. There is a significant increase in income for beneficiaries of PMFBY, with treated households in Kendrapara experiencing an increase of Rs. 22,094.31 and those in Bargarh seeing a larger rise of Rs. 56,897.15. The insured farmers primarily relied on insurance facility whereas non-insured farmers were fascinated towards crop diversification to manage risks. Farmers were aware of the existence of the scheme, the enrollment procedure, and the services provided by *Mo Seva Kendra*, though they were not very clear about the benefits offered by the scheme. Enhancing awareness through extension services, social media, and other communication channels, while tailoring insurance units to address farm-level risks, could improve risk coverage and increase the overall effectiveness of the scheme.

Keywords: Awareness level, crop insurance, Garett ranking, IPWRA, Likert scale, probit regression, risk mitigation

Climate-Resilient Agriculture in India and its Impact on Food Security and Food Prices: An ARDL Approach

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With rising climatic risks, countries all over the world are gradually transitioning to sustainable agriculture. In this regard, climate-resilient agriculture is crucial as it involves farming practices and technologies that adapt to changing climate conditions, such as drought-resistant crops, efficient irrigation, soil health management, and diversified cropping. In India, it enhances food security by ensuring stable production despite erratic weather, reducing crop losses and dependency on imports. It can stabilise or lower food prices by preventing supply shocks, benefiting both farmers and consumers, while promoting sustainable resource use and long-term agricultural productivity. This study explores how climate change can pose a potential threat to not just food security but also food inflation using an Autoregressive Distributed Lag (ARDL) approach. Rainfall (as a proxy for climate variability), yield per hectare of food grains, and area cultivated were examined to understand their influence on food price inflation, proxied by the Consumer Price Index (CPI). The analysis finds a long-run cointegrating relationship between these variables, with an error correction coefficient of -0.2252, indicating that approximately 22.5% of deviations from equilibrium are corrected annually. Finally, policy recommendations emphasize investing in climate-resilient agriculture to reduce food price volatility and enhance long-term food security.

Keywords: Climate resilient agriculture, food security, food prices, cointegration, ARDL

Impact of Climate-Resilient Technologies and Farmers' Perceptions in Drought-Prone Marathwada: Evidence from a Double-Difference Approach

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This study examines the impact of Climate-Resilient Agricultural Technologies (CRTs) introduced under the National Innovations in Climate Resilient Agriculture (NICRA) project in the drought-prone Marathwada region of Maharashtra, India. Using a quasi-experimental design and the double-difference (Difference-in-Differences) estimation method, data were collected from 240 farmers—120 NICRA beneficiaries and 120 non-beneficiaries—across six villages in Parbhani, Jalna, and Chhatrapati Sambhajinagar districts. The study assessed CRT impacts on key indicators including irrigation, cropping intensity, crop diversification, cost of cultivation, yield, and net farm income. The results reveal significant benefits for NICRA beneficiaries. Cropping intensity increased from 132% to 179%, irrigated area rose from 20.9% to 37.3%, and net income grew by over 200% (₹ 31,975 to ₹ 95,913), compared to a 103% increase for non-beneficiaries. Crop-wise yield improvements were notable: cotton (40.8%), soybean (43.1%), chickpea (40.9%), maize (23%), and sugarcane (31.2%). Diversification into horticulture, livestock, and high-value crops like turmeric and vegetables was prominent, with the crop diversification index increasing from 0.59 to 0.81. Perception analysis indicated that farmers recognize key climate risks such as erratic rainfall (83%), declining rainy days (92%), extreme heat (91%), and resource degradation. CRTs—including intercropping, micro-irrigation, soil health management, and drought-tolerant varieties—were perceived as effective adaptation strategies. The findings underscore the potential of CRTs to enhance resilience, productivity, and income in climate-vulnerable farming systems. Expanding such interventions through supportive policy frameworks, localized extension services, and investment in climate-smart infrastructure are critical for sustainable agricultural transformation in India.

Keywords: Climate resilience, NICRA, agricultural technologies, farm income, yield impact, DID, Marathwada, India

Economic Viability of the Protected Cultivation in Mid Hills of Uttarakhand

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Agriculture viability in hills is constrained by the climatic vulnerabilities, small size landholdings, low marketable surplus and weak market linkages. An overall decline in the cereal production highlights at reduced economic sustainability of traditional farming system and necessitate adoption of high value agriculture. The study assessed the economic viability of the vegetable production under protected structures in Bageshwar and Nainital districts of the Uttarakhand. A Survey of 110 beneficiaries under SCSP (Schedule caste Sub plan) scheme was conducted covering four villages. Beneficiaries received inputs such as polyhouse, polytanks, seeds, training etc. under the programme and started vegetable cultivation in 2021. Two different structure of polyhouse (62.4 m^2 and 100 m^2), design based on the land availability, were evaluated for the cost, returns, net present value (NPV) and benefit cost ratios (B:C). Economic estimation suggests that net returns over variable cost were Rs 8695 and Rs 18296 annually for small and large polyhouse owner, respectively. Regression analysis revealed that polyhouse size, availability of polytanks for irrigation, and training significantly enhanced net returns. Net present values and B:C ratios were positive for 10-year span under no subsidy to 90 percent subsidy scenarios, higher viability is observed with high subsidies. These results underscore the critical role of protected cultivation and targeted interventions in enhancing farmer income and ensuring the sustainability of hill agriculture.

Keywords: Protected agriculture, hill farming, profitability

Economic Impact of Improved Pigeon Pea Variety Godavari Developed by VNMKV Parbhani on Farmers' Field

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Pigeon pea is the world's fifth and India's second important pulse crop, plays an important role in supporting poor smallholders' major source of income in the tropics and subtropics and, adaptable pulse crop due to its drought resistant capacity. The pigeon pea production of India was 4.34 million/tons from an acreage of 5.05 million ha. with a productivity of 859 kg/ha. In India Maharashtra is leading producer of pigeon pea *i.e.* 1.37 million/tons with 1.34 million ha area and 1023 kg/ha yield. In Maharashtra under a guideline of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (VNMKV) several high yielding Pigeon pea varieties are released *i.e.* Badnapur-2, BSMR-736, BSMR-853 (Vaishali), BDN-708 (Amol), ICPL-87119 (Asha), BDN-711 (BDN-2004-3), BDN-716 with having high yielding and disease and pest resistant features. The present study was conducted in Parbhani district of Maharashtra state during the year 2022-2023 with the objective to assess the economic impact of improved pigeon pea i.e. Godavari developed by VNMKV Parbhani". Per hectare cost of cultivation *viz.*, Cost-C was Rs. 57392.72 and Rs. 53429.46 for adopter and non-adopter, and the per quintal cost of production Rs. 4515.56 and Rs. 4203.73 for adopter and non-adopter. The total gross return obtained by adopter and non-adopter was Rs. 121265.17 and Rs. 85064.75 per ha, respectively. The net profit for adopter and non-adopter was Rs. 63872.45 and Rs. 31635.29 respectively. The benefit cost ratio obtained was 2.11 and 1.59, respectively for adopter and non- adopter of Godavari (BDN 2013-41).

Keywords: Variety, Godavari, adopter, non-adopter, impact, determinants

Soil to Sensor: Environmental Outcomes of IoT Sensor Adoption in Grape Farming Evidence from Semi-Arid Regions of India

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Amid increasing environmental pressures on water-intensive crops in India, there is an urgent imperative for the adoption of climate-smart and resource-efficient agricultural practices. This study investigates the environmental impacts associated with the early adoption of Internet of Things (IoT) enabled sensor technologies in grape farming within the Nashik (Maharashtra) and Vijayapura (Karnataka) regions. Employing a cross-sectional survey of 225 grape farmers, comprising 125 adopters and 100 non-adopters, with adopters further categorized into full adopters, partial adopters, and non-adopters, forms the basis of the analysis. Two composite indices, the Composite Environmental Impact Index (CEII) and the Composite Resource Intensity Index (CRII), are developed to assess changes in water usage, fuel consumption, pesticide application, labor demand, and CO_2 emissions. The findings indicate that full IoT adopters achieved a 74 percent reduction in CEII and a 76 percent improvement in CRII, underscoring substantial advancements in environmental performance and resource efficiency. Partial adopters reported moderate benefits, suggesting that comprehensive system integration yields the most significant outcomes. Access to training and infrastructure emerged as critical enablers of successful adoption. By shifting the focus from yield maximization to environmental sustainability, this study contributes to the ongoing discourse on sustainable intensification, digital climate adaptation, and green transitions in agriculture. It also highlights the relevance of IoT technologies in advancing Sustainable Development Goals, particularly SDG 6, SDG 12, and SDG 13.

Keywords: Climate-resilient agriculture, IoT irrigation, composite environmental index, digital agriculture, precision farming, semi-arid, India

Potential, Feasibility and Institutional Framework for Co-Promoting Solar Energy and Micro-Irrigation in Uttar Pradesh

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Solar pump and micro-irrigation bear complementary association. Integration of micro-irrigation can significantly negate the anticipated risk of over-extraction of groundwater from the unregulated access to solar energy. This study has analysed techno-economic feasibility of bundling solar pumps with micro-irrigation and proposed an institutional framework for their joint-promotion in Uttar Pradesh which has highest potential but very less adoption of these technologies. The farm-level evidences from Jalaun district of Bundelkhand region reveal that available capacity of solar power irrigation system (SPIS) in PMKUSUM can effectively meet the required irrigation water of existing cropping pattern. Location specific customization of sizing and automation of system is required for improving technical compatibility with each other. The replacement of diesel-operated pumps with solar-powered micro-irrigation has been found to be economically viable, whereas it is uneconomical to replace electric-operated pumps getting highly subsidized electricity supply. Although guidelines of PMKSY-PDMC and PMKUSUM encourage joint promotion of micro-irrigation and solar pumps, there is little or no convergence in the implementation of these schemes. The adoption of proposed institutional framework can effectively integrate the ongoing schemes and co-promote both technologies.

Keywords: Solar pumps, micro-irrigation, convergence, techno-economic feasibility, institutional framework

Beyond Headcounts: A Distribution-Sensitive View of Child Undernutrition in India

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This paper employs unit-level data from the National Family Health Survey Rounds to compare intertemporal and spatial trends across Indian states. The analysis, in particular, relies on anthropometric measures of nutrition to assess nutritional status. This study adopts a novel approach to characterize the distribution of nutritional status among children. It helps to understand and assess how that distribution has changed over time and across states. This method builds on the poverty literature to construct the well-known Foster-Greer-Thorbecke measures for the incidence, depth and severity of undernutrition, which are based on deviations from the reference population group's median. For NFHS-4 (2015-16) and NFHS-5 (2019-21), I applied this approach to children aged between 0 and 59 months from various Indian states. The robustness of the traditional headcount ratios (or incidence measures) for different nutritional indicators is assessed, and the results show that patterns differ between measures. The findings demonstrate that the traditional measure of incidence only reveals part of the story. It is critical to look beyond this metric, and also consider the depth and severity of nutritional deprivation in children. A distribution-sensitive nutrition metric, such as the FGT index, assists to accurately represent nutritional deprivation over time and across sub-populations. The findings confirm that, while India has made incremental gains in reducing undernutrition, progress still remains uneven and fragile across states and indicators.

Keywords: India, FGT, nutrition, NFHS

Role of Minimum Support Price Policy for Ensuring Food Security- An Application of Supply Response Model

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The present paper explores the impact of the minimum support price (MSP) policy on food grain production in Karnataka based on the time series data covering the period from 2004–05 to 2023–24 with the help of area response and production response relations. The variables used in the model were tested for stationarity based on the ADF test and found that the time series for the selected variables are stationary; hence, Nerlove's price expectation cum area adjustment model was used for both acreage and production equations estimated with the help of OLS. The findings revealed that the area allocation decision of the farmers for food grain production is positively influenced by the technology, price, lagged output, risk, lagged area, lagged yield and negative effect of rainfall. Short-run elasticities (SRE) of output response for ragi, weak responsiveness across all factors, very low price, and technology elasticities. The study suggested the need for reducing the risk factor, especially price and weather risk, by enhancing the MSP and irrigation facilities, resulting in reduced price volatility and weather risk so that the farmers will be motivated to increase the allocation of area under the food crop and, in turn, enhance the production to meet the food and nutritional security demand.

Keywords: MSP, Food security, supply response model

Integrating Gender into Climate Adaptation in Indian Agriculture: A Review of State Action Plans on Climate Change

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Climate change is now a reality and is affecting farming and farmers in many ways. There is an urgent need to scale out adaptation which calls for adoption of adaptation measures in the form of climate resilient agricultural technologies. Climate change impacts, vulnerabilities and the adaptation needs vary with biophysical and socioeconomic characteristics of the economic entities being exposed to climate change. Gender is an important factor in this regard. In order to plan and implement effective adaptation to climate change, it is important to consider gender as an important dimension and mainstream gender into development and adaptation programmes. SAPCCs are important policy documents that guide priorities and actions of state and local governments whose role is critical in dealing with climate change. However, the SAPCCs, by and large, were found to not adequately address 'gender' which is a key gap. There is a need to build the capacity of institutions concerned to address this gap adequately going forward to make these policy documents more gender-transformative.

Keywords: Climate change, gender, adaptation, resilient, agriculture, India, SAPCC

Assessing Climate Vulnerability and Adaptation Strategies of Fruit Crop Growers in Kalyana Karnataka

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Climate change has emerged as a significant challenge to horticultural production, particularly affecting fruit crops like mango and guava. This study was conducted in the Koppal and Bidar districts of Karnataka to examine the perceptions of mango and guava growers regarding the effects of climate change and, to assess their vulnerability. A total of 160 respondents were selected through multistage random sampling. The study used composite indices to estimate exposure, sensitivity, and adaptive capacity, ultimately deriving the Climate Vulnerability Index (CVI). Results showed that the majority of growers perceived significant impacts of temperature and rainfall variability on flowering, fruit set, pest incidence, and fruit quality. The average exposure and sensitivity indices indicated moderate to high vulnerability, while adaptive capacity remained at a moderate level. Koppal district exhibited slightly higher vulnerability than Bidar. Major constraints faced by growers included lack of early warning systems, increased pest and disease pressure, and limited access to technical support. The study highlights the urgent need for climate-resilient cultivation practices, institutional support, skill development, and better forecasting mechanisms to mitigate climate risks and enhance the resilience of fruit growers.

Keywords: Climate change, vulnerability index, fruit crops, mango and guava, adaptive capacity

Temperature and Rainfall Pattern Variability as Indicators of Climate Change: A Study in Tamil Nadu

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This paper analysis the secondary data on rainfall from 1990 – 2023 and, the minimum and maximum temperature of six districts in Tamil Nadu spanning 20 years (2005-2024). The study used the simple descriptive statistics for the rainfall data and a box whisker plot for the temperature using the pythan matplatilb. Our descriptive statistics revealed that the south west monsoon as the most reliable season, while the north east monsoon will be wetter season with high rainfall which is unpredictable, winter to be an erratic season while hot weather period will be transitional season. The temperature stability is reflected in the standard of deviation for night time Chennai city (6.64ÚC) is having the highest stability while for day time. The stability is the recorded in Coimbatore (0.76ÚC). The box plot study shows that the coastal cities, Chennai and Nagapattinum, show elevated night time temperature while the inland cities, Madurai and Tiruchirapalli exhibit higher variability and day time heat stress. This study could be used as a basis for further analysis on the shifting of cropping pattern due to climate variation.

Keywords: Descriptive statistics, box plot, line graph, variability

Agriculture and The Rising Ecological Footprint in India

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This study investigates the growing ecological footprint of India and explores why the agricultural sector—despite its potential to act as a carbon sink—has instead become a major source of environmental degradation. It aims to understand the uneven impact of agricultural growth on ecological sustainability. Using annual time-series data from 1961 to 2022, the study applies a Non-Linear Autoregressive Distributed Lag (NARDL) model to examine the asymmetric relationship between agricultural value-added and ecological footprint. It also incorporates control variables such as energy consumption, trade openness, and urbanization to provide a comprehensive assessment. The results reveal that positive shocks in agricultural GDP have a significantly larger adverse impact on the ecological footprint than negative shocks. This indicates that agricultural growth in India, rather than easing environmental stress, exacerbates it due to the sector's dependence on energy-intensive and unsustainable practices. The findings underscore the urgent need for a policy shift toward sustainable agricultural practices. They offer evidence-based guidance for redesigning subsidies, incentives, and regulations to promote climate-smart agriculture, renewable energy use, and efficient resource management in India's diverse farming systems. By quantifying the asymmetric effects of agricultural growth on ecological footprint, this study provides new empirical evidence relevant to India's climate commitments and sustainable development goals. It highlights the paradox of agricultural expansion and contributes to the broader discourse on human-environment interactions.

Keywords: Agriculture, ecological footprint, NARDL, India

Mapping the Trout Trail: Value Chain Assessment, Economics, and Constraints of Trout Culture in Sikkim

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Sikkim's cold-water ecosystems offer ideal conditions for rainbow trout farming, a sector gaining attention for its high market value and nutritional benefits. Despite increasing production, local consumption and market reach remain limited, underscoring the need for a comprehensive value chain analysis. This study aims to map key actors, assess the structure of the trout value chain, evaluate stakeholders' economic viability, and identify major constraints affecting trout farming in the state. A purposive sampling method was employed to survey 119 respondents, including trout farmers (n=107), retailers (n=6), and hatchery operators (n=6), covering both government and privately managed units across East and West Sikkim. The methodology included descriptive statistics, value chain mapping, cost–return analysis, and constraint prioritization using the Normalized Response Priority Index (NRPI). Retailers earned ¹ 222.71/kg (BCR 1.4) in East and ¹ 102.38/kg (BCR 1.2) in West Sikkim. Trout farming showed strong viability in both districts with a BCR of 1.7. Key constraints faced by trout farmers include high feed costs (NRPI: 0.97), inadequate marketing infrastructure (0.93), and high price of seed (0.85). To improve the sector, the Department of Fisheries should operationalize idle infrastructure, promote organic feed, and support higher stocking densities with better management practices. Strengthening retail units, processing facilities, and tourism linkages, alongside data-driven policy support, is vital for sustainably scaling trout aquaculture in Sikkim and boosting consumption.

Keywords: Trout culture, value chain, economic viability, constraints analysis

Climate Risk and Agricultural Vulnerability in Karnataka: A District-Level Assessment for Adaptation Strategies

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This study presents a comprehensive climate risk assessment in agriculture across Karnataka, employing a Tier-1 approach based on secondary data. The analysis covers all 30 districts, categorizing them into low, medium, and high levels of vulnerability, hazard, and overall risk. The vulnerability index identified Yadgir as the most vulnerable district with a score of 0.84, while Belagavi ranked lowest at 0.42. Key drivers of vulnerability included per capita income, cropping intensity, and forest area coverage. The risk assessment further classified districts based on their exposure and sensitivity, revealing Kolar as the most at-risk district for agriculture (0.64) and Shivamogga as the least (0.41). These findings highlight spatial variations in climate risk and underline the need for targeted adaptation planning. The study provides valuable insights for policymakers to prioritize investments in irrigation infrastructure, market access, and price stabilization. It also recommends promoting low water-intensive crops and enhancing climate resilience through district-specific strategies, making this assessment a critical tool for sustainable agricultural planning in Karnataka.

Keywords: Agricultural risk, climate vulnerability, hazard assessment, risk profiling, adaptation strategies

Strategic Climate Risk Management in Agriculture: Assessment, Forecasting, and Adaptive Measures for Biotic and Abiotic Stresses

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Climate variability and extreme weather events pose significant threats to agricultural productivity and food security. Effective climate risk management in agriculture involves a comprehensive understanding of both biotic (*e.g.,* pests, diseases) and abiotic (*e.g.,* droughts, floods, heatwaves) stresses that impact crop and livestock systems. This review paper explores integrated strategies for risk assessment, forecasting, and adaptive management to enhance resilience in the face of climate uncertainties. Tools such as remote sensing, climate models, and early warning systems are critical in identifying risk zones and forecasting potential hazards. Risk assessment frameworks help prioritize interventions based on vulnerability and exposure. Adaptation strategies include diversification of crops, improved water management, conservation agriculture, and climate-resilient varieties. Furthermore, strengthening institutional support, capacity building, and farmer-centric decision-making are essential for successful implementation. Public-private partnerships and policy support also play pivotal roles in scaling climate-smart practices. By adopting a proactive and science-based approach, climate risk management can reduce losses, protect livelihoods, and ensure sustainable agricultural development under changing climatic conditions.

Keywords: Abiotic stress, agricultural resilience, biotic stress, climate-smart agriculture, early warning systems, risk mitigation

Policy Governance in Practice: Evaluating PM-KISAN and MSP Through Field Survey Data in Karnataka

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This paper explores and compares the effectiveness of the *Pradhan Mantri Kisan Samman Nidhi* (PM-KISAN) scheme and the Minimum Support Price (MSP) policy in supporting farmers in Karnataka in terms of famers' welfare. PM-KISAN provides uniform income support to all eligible farmers, independent of crop choice or market conditions, enabling them to meet current agricultural and non-agricultural expenditures. While the cash transfer amount does not offset full production costs, it has contributed to stimulating rural demand. MSP, by contrast, offers targeted price support but benefits only those farmers who sell to government procurement agencies, making its benefits to crop-specific and inconsistent over time. Analysis of Karnataka's data reveals that for crops such as paddy, tur, and bengal gram, MSP growth has outpaced input cost inflation, and high MSP, farm harvest price correlations indicate its role as a genuine income protection tool in segments with significant procurement. However, low procurement coverage limits these benefits to a minority of farmers. PM-KISAN's universality ensures broad coverage, but without mitigating production risk or influencing market prices. The findings highlight a trade-off between MSP's selective yet deeper support and PM-KISAN's wider but shallower reach, framing the policy choice as one between efficiency and coverage in agricultural income support.

Keywords: Policy governance, PM-KISAN, MSP, Karnataka

Understanding Crop Insurance Decisions in The Context of Climatic Risks: Evidence from Central India

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Incidents of unseasonal rainfall and droughts, heatwaves, and rise in temperature have increased due to severe climate moderations and climate change. Crop insurance transfers the risks of losses from systematic risks, such as rainfall and drought to the market, acting as a safeguard by providing farmers with indemnity to ensure a stable income for farmers. Although crop insurance is heavily subsidized, its adoption rate remains persistently low. This study analyses the determinants of crop insurance adoption in soybean producing regions of Madhya Pradesh using survey data of 396 farmers using a double hurdle model approach. Our main finding is the role of socio-economic indicators such as age, education, social status, land size and financial factors such as credit, and informal risk management strategies such as income from off-farm activities and livestock rearing, in the decision towards adoption of crop insurance and area under insurance by farmers. Our findings indicate that age, education, and credit increase the likelihood of adoption and area under insurance, highlighting the importance of financial inclusion and understanding of crop insurance. Conversely, availability of alternative income such as livestock rearing and off-farm income does not affect adoption of crop insurance, however, it discourages farmers to insure larger areas. Furthermore, we find that social hierarchies continue to affect the access to insurance and coverage, with farmers from marginalized communities insuring significantly less, reflecting inequities in access to crop insurance.

Keywords: Crop insurance adoption, risk management, double hurdle model

Climate Change and Agricultural Adaptation: An Empirical Study of Farmers' Behaviour in Central Brahmaputra Valley Zone of Assam

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The Central Brahmaputra Valley Zone (CBVZ) of Assam is vulnerable to the effects of climate change, prominent with flash floods, irregular rainfall and soaring temperatures. The study attempted to analyse long-term climatic trends (1992-2023) using the non-parametric Mann-Kendall test and Sen's slope estimator, investigate farmers' awareness, perception and adaptation strategies regarding climate change utilising primary data from 100 respondents. It was revealed that maximum temperature (Sen's Slope = 0.032 °C/ year), minimum temperature (0.038 °C/ year) exhibited statistically significant trend and marginally significant trend was observed in the case of relative humidity (0.016 % per year), while rainfall displayed a statistically significant declining trend (-28.21 mm/year).Insights from grassroot level revealed that majority of the farmers perceived rising temperature and irregular rainfall as a consequence of climate change, which ultimately led to decline in productivity and increased the cost of farming. To mitigate this, crop diversification and crop-livestock integration were prominently adopted. Contact with extension agents and farm-size emerged as the significant positive determinants of adaptation behaviour of farmers. The findings thus emphasized on the reinforcement of policies that strengthen context-specific, low-cost technologies and capacity building in order to ensure long-term resilience in CBVZ's agrarian economy.

Keywords: Climate change, climatic trends, adaptation strategies, farmers' perception, resilience

Climate Resilience in Agriculture: An Empirical Analysis of Farmers' Adaptation Strategies and Influencing Factors in Haryana, India

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Climate change poses a significant challenge to agriculture, particularly in regions where farming is the primary livelihood. Haryana, a key agrarian state in northern India, is highly vulnerable to climate-induced risks such as temperature fluctuations, erratic rainfall, and resource depletion. This study examines farmers' adaptation mechanisms and the factors influencing their adoption of climate-resilient strategies in Hisar and Sonipat districts. Primary data were collected from 120 farmers through a structured interview schedule using a multi-stage random sampling technique. Descriptive statistics and a probit regression model were employed to analyse adaptation mechanisms and the determinants influencing their adoption. The findings reveal that the most frequently adopted adaptation measures include increased irrigation (65.83%), enhanced fertilizer application (63.33%), and adjustments in crop sowing time (60.83%). Other strategies, such as crop insurance (58.33%), soil and water conservation techniques (38.33%), and intercropping (36.67%), were also observed. Probit regression analysis identified key determinants influencing adaptation decisions. Age exhibited a negative impact, suggesting that older farmers are less likely to adopt adaptation strategies. Conversely, landholding size, education level, income level, and access to climate change information positively influenced adaptation decisions. However, family type and occupation type did not significantly impact adaptation choices. The study highlights the need for targeted policies to enhance climate adaptation, particularly through improved access to climate-related information, education, and financial resources. Strengthening extension services and promoting sustainable adaptation mechanisms can improve farmers' resilience and ensure agricultural sustainability in Haryana.

Keywords: Adaptation strategies, agriculture, climate resilience, probit model

District-Level Climate Risk Assessment in Bihar: Identifying Climate-Risk Hotspots

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Climate change poses a significant threat to Bihar, an agrarian state in eastern India. A comprehensive climate risk evaluation at the district level in Bihar was conducted using the IPCC AR5 framework, which includes four essential elements: hazard, exposure, sensitivity, and adaptive capacity. A total of 33 indicators related to socio-economic factors, environmental conditions, and infrastructure were chosen and, then normalized. Principal Component Analysis (PCA) was used to assign objective weights and develop a composite Climate Risk Index (CRI). The findings show significant spatial variations in risk levels, with eleven districts classified as "very high risk" due to flood exposure, socio-economic vulnerabilities, and restricted adaptive capacity. Areas like Arwal, Patna, and Gaya demonstrate a "low risk" profile due to improved infrastructure, varied livelihoods, and enhanced institutional backing. A sensitivity analysis that compares PCA-weighted and mean-weighted indices highlights key indicators that significantly contribute to risk, such as population density, poverty, gender disparities, and access to electricity and financial services. The study emphasizes the need for tailored, region-specific approaches in climate adaptation and disaster risk mitigation. Integrating this risk index into Bihar's State Action Plan on Climate Change (SAPCC) and District Disaster Management Plans can enhance a proactive, localized, and data-informed approach to climate governance.

Keywords: Climate-induced risk, IPCC-AR5, PCA, Bihar, vulnerability, exposure

Climatic Impact on Livestock Rearers: Assessing Vulnerabilities and Adaptation Strategies in Bageshwar District of Uttarakhand

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Climate change is one of the most serious global environmental challenges of the present century. Nestled in the Indian Himalayan Region, the state of Uttarakhand faced various climate change impacts that have emerged over the past decades, such as rising temperatures, increasing glacial melt, and changing rainfall patterns, which are further projected to intensify over the course of this century. The present study was conducted in Bageshwar district of Uttarakhand through a survey of 90 livestock rearers, with the objective to assess the socio-economic status of the livestock rearers, to identify the effect the climate change perceived by livestock rearers, to assess vulnerability of livestock rearers to climate change, and to examine adaptation strategies practiced by them against climate change. The socio-economic profile of the livestock rearers revealed that most livestock rearers (73.34%) were aged 41–60 years, had an average family size of 5.43, and were largely literate. They were mainly marginal farmers with small landholdings, earning ¹ 1.02–1.11 lakh annually, mostly from livestock. Fodder was primarily sourced from forests or mixed sources. Livestock rearers reported rising temperatures, uneven rainfall, and water scarcity, worsened by forest fires that reduced fodder and degraded pastures. These changes reduced milk yields, especially in crossbred cattle, and increased lumpy skin disease, thereby indirectly decreasing livestock productivity. The average vulnerability index of livestock rearers was 0.615, with the highest value in Kapkot (0.782), followed by Bageshwar (0.588) and Garur (0.476). Adaptation measures included purchasing fodder, selling or removing unproductive animals, shifting to small ruminants, diversification, insurance, and religious rituals. The study suggests income diversification, community-based adaptation, location-specific contingency plans, and fodder banks through public-private partnerships.

Keywords: Vulnerability, climate change, livestock rearers, adaptation

Assessing the Economic Performance of Climate Resilient Technologies in Major Crop Rotations in Punjab Agriculture

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The study focused on evaluating the profitability of various Climate Resilient Technologies (CRTs) in Punjab. The study used primary data by personally interviewing 120 farmers from the Mansa and Sri Muktsar Sahib districts through a multi-stage sampling technique. The sample was equally divided between farmers practicing paddy-wheat (P-W) and cotton-wheat (C-W) crop rotations. Additionally, the study categorized Climate Resilient Technology Adopters (CRTA) into specific scenarios for both crop sequences. The results showed that in P-W crop rotation, CRTs have shown profitability in all three scenarios by a range of one to three %. The highest profitability was observed in the second scenario, i.e., PDSR+CRM+WMT, with a yield of Rs. 154870.43/ha. In the case of C-W crop rotation, CIPM+WCT showed an increase in profitability by 14 % compared to the non-adopter category. The adoption of CRTs significantly reduced land preparation and sowing costs up to 67 % and 65 % respectively, under the P-W system, while integrated pest management in the C-W cropping system lowered agrochemical use by nearly 13 %. The results highlight that most CRTs are profitable for farmers. Their adoption can be boosted through stronger institutional and government support, including demonstrations, training, and financial incentives

Keywords: Climate resilient technologies, cotton, paddy profitability, one way ANOVA, wheat

Comparative Analysis of Small Landholders' Income Under Drip, Sprinkler and Flood Irrigation in Belagavi District, Karnataka

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The present study was conducted to compare the income of small landholders adopting different irrigation methods in the Belagavi district of Karnataka. A multi-stage purposive sampling technique was employed to collect primary data from 120 sample farmers across Athani and Gokak taluks in Belagavi district. Information regarding costs, returns, and water used per crop per time for four major crops, viz., sugarcane, sorghum, groundnut, and maize, was taken from sample farmers. Income sources and income inequality across three irrigation methods were analysed using the Gini coefficient and the Lorenz curve based on the crop yield, resources used, and quantity of water applied. Results indicated that the greater diversity and high income are from the agriculture sector in drip (6,45,438), followed by sprinkler (5,45,793) irrigated farmers over their counterparts adopting flood (5,03,901) irrigation method, compared with the other sources of income, namely livestock, labour employment, and petty shop. The increase in farm income under the drip and sprinkler method of irrigation over the flood method was 1,41,536 and 41,892, respectively. Lowest income inequality is evidenced from drip (0.49) irrigation and sprinkler (0.51) irrigation, followed by flood (0.53) irrigation. Incentivizing the adoption of micro irrigation systems through subsidies, farmer training, and infrastructure support to increase productivity, income, and efficiency.

Keywords: Farm income, Irrigation, Gini coefficient, Lorenz curve

Maharashtra Farmers Embrace High Income Sustaining Climate Resilient Solutions

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The Government of Maharashtra (GoM) launched the Project on Climate Resilient Agriculture (PoCRA) in 2018-19 in 5220 highly climate variability vulnerable villages to devise strategies for climate adaptation and promotion of climate resilient agricultural technologies. Through the project, 5,06,281 farmers were trained, and Direct Benefit Transfers (DBT) of matching grants for on-farm climate resilient technologies were provided to 4,85,669 farmers. Water use efficiency and productivity had increased among project farmers, as evident from crop diversification, higher crop intensity, and higher crop yield. Major crops like sorghum, cotton, pigeon pea, and chick pea had substantially higher yields than the baseline in the project area. The project also brought spatial and temporal yield uniformity in the project area. The net farm income of project beneficiaries was Rs . 75,395 per annum, 46% higher than that of non-project farmers. The project's Internal Rate of Return (IRR) was estimated at 45% and Economic Rate of Return (ERR) at 35%. The annual sequestration capacity as carbon net balance was estimated at -32,28,417 tCO_2-eq. ERR with greenhouse gas (GHG) accounting was estimated at 54%. PMU at the project management level coordinated the multi-pronged achievement of the project through ensuring flawless planning, people participation, partnerships, and ICT/GIS/Digital outreach solutions.

Keywords: People participation, planning, climate resilience technology, adoption, ICT backbone

Agrarian Tenancy and Climate-Induced Livelihood Vulnerability in Andhra Pradesh and Telangana

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This study explores how climate change shapes the vulnerabilities of tenant farmers in Andhra Pradesh and Telangana, focusing on agricultural productivity, tenancy arrangements, and livelihood security. Using primary data from tenant cultivators and landowners, the findings reveal that sharecropping dominates in relatively stable regions, while farmers in water-scarce areas face greater risks of crop failure and income instability. Rental burdens are shaped by land fertility, irrigation access, and climatic variability, creating uneven exposure to risk. The absence of formal tenancy documentation restricts access to credit, insurance, and agricultural support, undermining resilience despite government interventions. Weak incentive structures within sharecropping further reduce cultivation efficiency. The study underscores the need for policy reforms that ensure legal recognition of tenancy, strengthen climate-resilient agricultural practices, and expand equitable access to irrigation, thereby improving the long-term viability of tenant farming systems.

Keywords: Tenant farmers, climate change, tenancy practices, agricultural resilience, livelihood security, policy interventions

Economics of Diversified Crops in Bagalkote District

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The present investigation was undertaken to study the economics of diversified crops in the Bagalkote district. Crop diversification enhances resilience to climate change by spreading risk across different crops with varied climatic requirements. The study was based on primary data, and a stratified random sampling procedure was adopted to select 144 sample farmers. Badami, Bagalkote, Hungund, and Jamkhandi taluks were selected purposively, where the crop diversification was concentrated. In Badami taluk, the average cost of cultivation per acre of green gram and groundnut was Rs. 18,334 and Rs. 22,174, respectively. Farmers of Bagalkote taluk cultivated red gram with an average cost of cultivation of Rs. 20,124. In Hungund taluk, the costs of cultivating green gram and Bengal gram were Rs. 18,889 and Rs. 16,375, respectively. In Jamkhandi taluk, the per-acre cost of cultivation of wheat and Bengal gram was Rs. 20,367 and Rs. 16,665, respectively. Diversified crops in selected taluks are getting good economic returns, and almost all diversified crops are pulses, which enhance the soil health. This adaptive strategy helps farmers mitigate the adverse effects of droughts, floods, and temperature fluctuations, leading to sustainable agriculture.

Keywords: Diversified crops, economics, climate adaptation

Drivers of GHG Emissions in Major Agricultural Emitter Countries Across the World

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Agriculture impacts the economy and society globally. But it also contributes significantly to global greenhouse gas (GHG) emissions. It poses challenges to sustainability amidst a growing population and rising food demands. Thus, to understand the factors affecting agriculture, GHG emission plays an important role in designing effective mitigation strategies. This study analyzes the drivers of agriculture GHG emission for top emitters across the World from 1992 to 2022 by disintegrating the emission into agriculture emission intensity effect, agriculture structure effect, productivity effect, mechanization effect, and the labor effect. Also, to assess and track the pattern of sustainability across countries over time, a sustainability index (SI) was constructed. The results showed that the index for India increased till 2013-15 and decreased thereafter. For the rest of the top emitters, it increased throughout, indicating unsustainability.

Keywords: GHG emissions, sustainability, mitigation strategies, sustainability index

Policy and Governance: Institutional Innovations and Governance (FPOs, Collective Action and Participatory Approaches) In Out-Scaling of CRA Practices

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Farmer Producer Organizations (FPOs) are legal entities facilitating profit-sharing among member farmers, as amended under the Indian Companies Act, 1956. This study examines the governance and policy of FPOs in the Madurai district. Two FPOs—Madurai Maavatta Tennai Matrum Itara Payirgal FPO (MM FPO) in Chellampatti block and Kotampatti FPO (KOT FPO) in Kotampatti block—were purposively selected. In each block, two villages were randomly selected, with 30 FPO members and 30 non-members surveyed, resulting in a total of 60 respondents. FPOs in the study had an average age of seven years and a share value of Rs. 1,000 per member. Funding sources included NABKISHAN, Axis Bank Federation, NABARD (grants), and Samunnati and SFAC (loans), amounting to Rs. 86.50 lakhs. Major commodities procured were paddy and coconut, with purchase prices slightly higher for members than market rates. FPOs provided tractors and combine harvesters to members at subsidized rates (10% and 16.67% less, respectively), used for 400–700 hours annually. Inputs like seeds and fertilizers were offered at Rs. 2–3 per kg less than market prices. Training programs rose from 4 in 2017 to 12 in 2021, covering FPO vision, crop insurance, and marketing awareness.

Keywords: Farmer producer organizations, governance, agricultural inputs, subsidy, procurement, training programmes, credit, grants

The Nexus Between Climate-Smart Irrigation Technology Adoption and Food Security Among Horticultural Maize Farmers in Botswana: An ESR Model

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Over the last century, global water consumption has risen more than twice as fast as population growth. In Botswana, drought and declining water levels have severely impacted crop production, resulting in significant crop loss, reduced income, and a decline in the well-being of resource-poor farmers. To address this, the dissemination of Climate-Smart Irrigation Technologies (CSITs) was being pursued. This study examines the effects of adopting Climate-Smart Irrigation Technologies on the welfare status of farm households. Data was collected from 271 smallholder maize farmers and analyzed using an Endogenous Switching Regression Model. The Wald chi-squared test and the likelihood ratio test yielded statistically significant results at the 5% level, indicating a good fit of the model. A significant correlation coefficient between the error terms of the selection equation and outcome equation indicates the existence of a selection bias among the adopters and non-adopters. The ATT and ATU are positive and significant for both adopters and non-adopters, indicating that the adoption of CSIT has had a significant positive impact on the welfare of farmers. Higher expected values for farm income and consumption expenditure for adopters evidence that. Treatment and heterogeneity effects indicate that adopter farm holders would have had lower farm income by 28% per hectare if they had not adopted, and adopter farm holders could have afforded 69% less consumption expenditure if they had not adopted. Hence, the study confirms the importance of adoption and recommends enhancing credit access, strengthening training and education, increasing the number of extension officers, and creating farmer clusters and cooperatives to improve adoption.

Keywords: CSIT, welfare, food security, smallholder, Botswana, endogenous switching model

Evaluating the Equitable Distribution of Climate Finance in Asia's Agricultural Sector

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This study investigates the allocation and impact of climate finance in the agricultural, forestry, and fishing (AFF) sectors across 38 Asian countries from 2002 to 2023, with a focus on studying adaptation and mitigation funding patterns. Using the data from OECD, WRI, World Bank, and ND-GAIN, the analysis employs descriptive statistics, percentage analysis, and system GMM to assess the impact of agricultural climate finance on greenhouse gas emissions from the AFF sector. Results reveal that Asia receives very low finance for the AFF sector, with the adaptation fund being higher than the mitigation fund. Southern and Central Asia receive the majority of funds. India ranks first in both total and sector-specific climate finance. System GMM estimates indicate that climate finance has a significant lagged negative effect on GHG emissions, with 0.3MtCO_2e reductions observed from the third year onwards per US$1 million invested. The findings underscore the significance of sustained, multi-year investments, tailored project design, and capacity building to achieve long-term emission reductions, while highlighting critical allocation gaps that need policy attention.

Keywords: Climate finance, adaptation fund, mitigation fund, AFF sector

An Economic Analysis of Sugarcane Trash Burning and Sustainable Alternatives in Selected Districts of Karnataka

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Sugarcane trash burning remains a common but environmentally detrimental practice in Karnataka, driven by economic and operational challenges. This study analyzes the factors influencing trash burning and evaluates sustainable alternatives among sugarcane farmers in Mandya and Belagavi districts. Primary data were collected from 128 farmers during the 2023–24 crop year using structured interviews. Analytical tools included logistic regression, correlation analysis, and ranking techniques. Results revealed that educational status, possession of farm implements, mass media exposure, and social participation were significantly and positively associated with the adoption of sustainable trash management practices. Despite environmental awareness, many farmers still prefer burning due to quick land preparation, high machinery costs, labour scarcity, and pest concerns. Benefits of adopting trash management included increased cane yield, soil moisture conservation, improved fertility, and better soil structure. However, constraints such as lack of knowledge, insufficient incentives, and equipment limitations remain. The study emphasizes the need for policy support, financial incentives, training, and machinery subsidies to encourage wider adoption of eco-friendly practices. Promoting sustainable trash management is crucial for improving farm economics, environmental health, and long-term agricultural sustainability.

Keywords: Sugarcane residue management, crop residue burning, sustainable agriculture, adoption behavior, environmental economics

Impact Assessment of Good Agricultural Practices (GAP) in Pearl Millet Cultivation in Rewari District of Haryana

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This study analyses the good agricultural practices of pearl millet (Bajra) in Rewari district, Haryana. Primary data were collected using a multistage purposive sampling approach from 120 farmers across the Rewari district. The region experienced 913.4 mm of rainfall over 50 days (June to July), with temperature extremes ranging from 4.0°C (minimum) to 46.0°C (maximum) and an average relative humidity of 67.3%. Pearl millet sowing took place in the first fortnight of July using the recommended seed rate. However, crucial practices such as seed treatment and intercropping were absent. Only 37% of farmers performed gap filling and thinning, while all used farmyard manure (FYM), though application timing varied based on availability and landholding size. Nutrient management involved applying 25 kg/acre of nitrogen a month after sowing and 11.5 kg/acre of phosphorus at sowing. Weed control was largely manual (63%), with limited herbicide use (32%), and 5 percent of farmers adopted both practices (manual + herbicide). Use of insecticides, fungicides, and integrated pest management was nearly non-existent. Among the comparative treatments, the combination of fertilizer and irrigation yielded the highest average yield (10.45 quintals/acre), net returns, and benefit-cost ratio, highlighting the significant impact of irrigation on productivity in Bajra cultivation.

Keywords: Economic analysis, good agricultural practices (GAP), pearl millet

India's Agrifood System in Voluntary Carbon Market-Some Insights

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In this paper, an attempt is made to examine the current status of the Indian agrifood system in VCM and identify factors that will influence future prospects. For this purpose, data from the websites of two registries, i.e., Verra and the Gold Standard, were collected and analyzed. It is observed that different registries categorize agrifood system projects under different categories. Accordingly, India's share at the global level of VCM varied with registry. Future prospects for carbon credits from the agrifood system in VCM will depend on the implementation of the Carbon Credit Trading scheme,2023, in terms of sectors identified as obligated entities, their growth, regulatory limits to which these sectors can depend on VCM, the quality of carbon credits from different agrifood system projects, and interoperability in international compliance carbon markets. Several challenges, including Measuring, Reporting, and Verification (MRV), proving additionality in emission reductions, and scaling projects to reduce transaction costs, are present in carbon credit projects in general and Agrifood system-based projects in particular. Ensuring a fair share of carbon credit revenue to farmers is an additional challenge for Agrifood system-based carbon projects. Hence, technological and institutional innovations are needed to address these issues.

Keywords: Carbon credit, voluntary carbon market, compliance carbon market, agrifood system

Climate-Proofing Tradition: Socioeconomic Dimensions of Livelihood Vulnerability and Adaptation in Traditional Rice Farming under Climate Change

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Climate change exhibits significant threats to traditional rice farming systems in South and Southeast Asia, necessitating comprehensive vulnerability assessments and adaptation strategies. This study evaluates livelihood vulnerability among traditional rice farming households in Ramanathapuram district, Tamil Nadu, using the Livelihood Vulnerability Index (LVI) and LVI-IPCC frameworks. Through structured surveys of 120 randomly selected farmers over three drought-prone blocks, we analyzed 41 vulnerability indicators covering human, social, physical, financial, and natural capital dimensions. Results indicate moderate overall vulnerability (LVI = 0.446), with livelihood strategy (0.593) and climate-related factors (0.580) showing the highest vulnerability levels. The LVI-IPCC analysis reveals exposure (0.580) as the primary vulnerability driver, exceeding sensitivity (0.362) and adaptive capacity (0.390). Farmer perceptions demonstrate strong climate awareness about 73% recognize temperature increase and 67% report irregular rainfall pattern. Adaptation strategies show remarkable innovation, including modified planting schedules (72%), drought-resistant varieties (56%), water conservation practices (55%), and livelihood diversification (67%). Natural capital remains relatively secure (0.133) while financial constraints (0.398) and limited diversification create resilience barriers. Findings suggest climate-proofing requires targeted interventions that strengthen adaptive capacity while leveraging existing farmer innovations and indigenous knowledge systems for sustainable rice production.

Keywords: Climate change, livelihood vulnerability, perception, adaptation strategies, traditional rice

Assessing Total Factor Productivity and the Impact of Research Investments on Maize Productivity in Middle Gujarat

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This study aims to evaluate the performance of total factor productivity, analyzing the impact of technological changes over time, identify the key sources of productivity growth, and estimate the marginal and internal rates of return for maize cultivation in the Middle Gujarat region of Gujarat state. Maize is a vital crop in Gujarat, serving as both a food and fodder source, and contributing significantly to the state's agricultural economy. Its adaptability to diverse agro-climatic conditions makes it an important choice for farmers in regions like middle Gujarat. The Divisia Tornqvist Theil index method was used to calculate the total input index, total output index, and TFP, with the output index including main and by-products valued at farm harvest prices. The study period was divided into three sub-periods: Period-I (2001-02 to 2011-12), Period-II (2012-13 to 2022-23), and the overall period (2001-02 to 2022-23), each with respective base years. To identify TFP determinants, factors like research and extension stocks, cropping intensity, balanced nutrient use, infrastructure, and rainfall were regressed against the TFP index. Returns to research investments were estimated using the marginal product method, and the internal rate of return was calculated from cash flow benefits assuming a 10% interest rate. Results highlighted that between 2001-02 to 2022-23, maize cultivation in middle Gujarat reported a decline in productivity efficiency, with TFP decreasing from 0.80 in Period-I to 0.75 in Period-II and slightly improving to 0.89 in entire period. Despite substantial input growth in maize, the output gains were not proportionate, leading to moderate TFP contributions to overall growth. However, regarding factor affecting TFP growth, research expenditure and rainfall had a positive and significant impact on TFP growth in maize cultivation, while extension services and literacy rate had no significant effect. Estimated Value of Marginal Product (EVMP) for research investments demonstrated that each additional rupee invested in maize research yields returns of ¹ 9. Furthermore, IRR on research investments is noteworthy, with annual returns of 14 per cent for maize, indicating that public agricultural research investments provide substantial economic benefits. The study suggested that to address declining productivity in maize cultivation a key strategy involving prioritizing higher seed replacement rates in maize cultivation areas may boost productivity. This can be achieved by increasing operating funds for extension activities, encouraging the adoption of new varieties to tribal areas.

Keywords: Theil index, TFP, estimated value of marginal product

Adoption of Climate Risk Management Strategies and Income Aspiration Gap? Evidence from Apple Growers in India

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This study investigates the impact of the adoption of climate risk management on the income aspiration gap among apple growers. The study uses an instrumental variable generalized method of moments (IV-GMM) approach on survey data from apple growers. The findings reveal that adopting agronomic and technological management strategies reduces the income aspiration gap, thereby enhancing the welfare of apple growers. The other factors significantly reducing the income aspiration gap include orchard size, farming experience, and distance to the local market (mandi). Policymakers could also call for an awareness campaign, along with other development agents, to educate and inform farmers about the benefits of adopting an early weather warning system.

Keywords: Extension, adoption, economic welfare, IV-GMM, farm income

Climate-Resilient Maize Production: Growth Trends, Yield Forecasting, and Farmer Adaptation Strategies in Bihar and Karnataka

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This study examines maize production trends in Karnataka and Bihar, crucial to Indian food security, employing advanced statistical modelling and socio-economic analysis to guide climate-resilient interventions. Employing 1990–2021 time series from the Department of Economics and Statistics and India Agri Stat, growth trends were analysed through Compound Annual Growth Rates (CAGR), noting increasing area, production, and yield in Karnataka compared to decreasing area but increasing production and yield in Bihar. ARIMA models, selected through t-tests, chi-square tests, and selection criteria (MAPE, MAE, RMSE, BIC), found ARIMA (2,0,1) best suited to yield forecasting in Karnataka and ARIMA (2,0,0) in Bihar. 2022–2024 forecasts project a consistent decline in yield, 95% confidence intervals, which indicate climate vulnerabilities like floods in Bihar and drought in Karnataka. Socio-economic analysis from Dharwad district finds farmers' incomes (₹ 1–5 lakh) positively correlated with age, schooling, and farm size, yet gender disparities in input access persist. These findings are in accordance with AERA's priority by recommending climate-resilient hybrids to stabilize yield, agribusiness innovations like start-up-driven seed distribution to aid exports, and women-led cooperatives to counter gender disparities. On integrating strong forecasting and farmer adaptation interventions, the study offers policy recommendations to enhance maize resilience, empower rural India, and propel sustainable agribusiness, leading to food security and equity in India's maize core regions.

Keywords: Trend analysis, forecasting of maize yield, ARIMA models, socioeconomic condition

Social Impact of Natural Resource Management Interventions: A Case Study from Bundelkhand Region of Uttar Pradesh

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The present study using cross-sectional data from 400 farmers assessed the determinants of adoption of natural resource management (NRM) interventions and its social impact in Bundelkhand region of Uttar Pradesh. Propensity score matching (PSM) technique was used for impact evaluation and sensitivity analysis was performed to examine the effect of uncontrolled confounders on the estimands. Our findings suggest that farmers' adoption of NRM practices depends significantly on their age, experience, dependency ratio, off-farm income, farm size, training access and water source distance. The adoption led to a significant reduction in drudgery for collecting water and promoted reverse migration in the study area. Moreover, financial investments in children's education as well as hours spent by them in studying in school, doing homework and in attending tuition per day have increased significantly. Results of sensitivity analysis show that impact of adoption of NRM based interventions on the selected social parameters is less sensitive to the unobserved bias in the study area.

Keywords: Natural resource management, adoption, social impact, propensity score matching, Bundelkhand

Growth Trends in Area, Production, and Productivity of Mango in India and Karnataka

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Mango, often hailed as the "King of Fruits," holds significant cultural, economic, and nutritional value in India, a global leader in mango production. This study conducts a comprehensive growth analysis of mango cultivation in India and Karnataka over the past two decades, focusing on area, production, and productivity trends. Using compound growth rate analysis, instability indices, and structural break tests, the study highlights the dynamic shifts in mango cultivation driven by technological adoption, climatic variations, market demand, and policy interventions. The findings reveal that while the area under mango cultivation has steadily expanded in both India and Karnataka, the growth in productivity presents mixed trends across different periods and regions. Notably, structural breaks observed in productivity indicate potential impacts of climate variability and changing agronomic practices. Karnataka, emerging as a significant mango-producing state, shows promising growth, yet faces challenges in stabilizing yield levels. This analysis offers valuable insights for policymakers, exporters, and agribusiness stakeholders aiming to promote sustainable mango production and exports. Aligning with the conference theme, the study underscores the role of agribusiness innovation and climate-resilient strategies in enhancing mango sector performance and food security. The outcomes stress the need for targeted interventions to bridge regional gaps and unlock the export potential of Indian mangoes.

Keywords: Mango, trend analysis, instability index, structural break

Vulnerability Assessment of Farming Households to Climate Shocks: A Case Study of Eastern India

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Climate shocks are unequivocal in nature. Climate shocks in the form of flood, cyclone, drought, inundation, earthquake, tsunami and hurricane are associated with risk which outweigh human capacity to control and cope. Agricultural households in eastern India, who are solely depends on rainfall for the cultivation are the biggest sufferer to climate shocks. Therefore, this study assessed the vulnerability of farmers in Odisha, a poor state in eastern India. Using Vulnerability as Expected Poverty (VEP) approach, primary data collected from four districts of Odisha i.e. coming under two different ecosystems this study finds 60.7 percent and 87.05 percent agricultural households are vulnerable to climate shocks as per Tendulkar and Rangarajan referenced poverty line respectively. 93.2 percent farming households in drought prone region and 80.7 percent farming households in flood prone region are vulnerable to climate shocks as per Rangarajan referenced poverty line. Hence, policy recommendations are systematic development of irrigation facilities in drought prone regions. On the other hand, policies should be made on free climate related education through projector and pictures on short-term coping strategies. Keeping other thing constant, meeting farmers minimum requirement and strengthening their financial condition are the preliminary solutions to reduce their vulnerability.

Keywords: Vulnerability, climate shock, Odisha, eastern India

Input Application and Economic Outcomes of Organic vis-à-vis Conventional Agriculture Practices in Indo-Gangetic Plains of Uttar Pradesh in India

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The adoption of sustainable agricultural practices, particularly organic farming, is gaining attention as a viable alternative to conventional methods in addressing food security and environmental concerns evolved from excessive fertilizer and chemical application. The primary survey was undertaken to evaluate the impact of organic and conventional farming on farmers' livelihoods and their determining factors of adoption. A cross-sectional study was conducted across five districts of Uttar Pradesh, surveying 604 farmers through structured questionnaires during 2023-24. The study employed binary logistic regression to evaluate the factors responsible for the adoption of organic farming and the Coarsened Exact Matching (CEM) method to assess its impact on economics and organic input application. The findings reveal that organic farming adoption is significantly influenced by education level, access to irrigation, and livestock ownership. Additionally, organic farming is associated with a higher gross income compared to conventional practice. The application of bio-input like jeevamrit and beejamrit, and organic manure is notably higher among organic farmers, demonstrating improved sustainability practices. The study emphasizes the need for targeted policy interventions, including better financial incentives, improved irrigation infrastructure, and enhanced farmer awareness programs to promote organic adoption. The findings offer practical recommendations for policymakers to enhance the viability of organic farming, ensuring long-term sustainability and improved livelihoods for smallholders in India's Indo-Gangetic Plains.

Keywords: Organic farming, economic impact, organic manure, yield gap

Forecasting of Milk Production of Various Animal Species in India

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The expansion of the Indian economy is greatly aided by the dairy sector. An accurate estimate of milk production is crucial since fluctuations in the amount of milk produced will have a significant impact on dairy products, as well as on farmers, investors, and policymakers in the nation. This study represents an ARIMA modelling approach for forecasting the milk production in India and milk production by five major milk producing animal species namely, Cow, Buffalo, Goat, Sheep, and Camel by using annual data from 1961 to 2018. ARIMA (0,2,1) model was selected as the best model in forecasting milk production in India.The analysis indicates that there will be an increase in India's total milk production. Moreover, milk production from buffalo, cows, and goats would rise, whereas milk production from camels and sheep will fall.

Keywords: ARIMA, milk availability, milk production

Millets for Climate Change: Strategies for Adaptation and Food Security

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Climate change poses significant threats to global food security, with rising temperatures, erratic rainfall, and increased frequency of extreme weather events disproportionately affecting smallholder farmers in arid and semi-arid regions. In this context, millets often termed "climate-smart crops" are gaining renewed attention for their unique ability to thrive under harsh conditions while contributing to ecological sustainability, nutrition, and rural livelihoods. This review synthesizes recent evidence on the multiple roles of millets in advancing climate-resilient agriculture. It examines their agronomic adaptability, including drought and heat tolerance, short growth cycles, and low input requirements, which make them highly suitable for resource-poor environments. Environmental benefits, such as lower greenhouse gas emissions, soil health improvement, and biodiversity enhancement, are highlighted alongside their nutritional advantages in addressing hidden hunger and reducing the risk of non-communicable diseases. The review further explores economic contributions to smallholder resilience, the potential of genetic and breeding innovations, and the role of digital technologies in strengthening millet value chains. Policy measures, including subsidies, inclusion in the Public Distribution System (PDS), and support for Farmer Producer Organizations (FPOs), are analyzed as enablers for mainstreaming millets into food systems. Taken together, the evidence positions millets not as relics of traditional diets but as future-oriented crops central to food security, climate adaptation, and sustainable development.

Keywords: Millets, climate resilience, adaptation strategies, food security, sustainable agriculture

Urban Waste to Securing Livelihoods: Valuing Provisioning Services in the East Kolkata Wetlands

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The East Kolkata Wetlands, a 12,500-ha Ramsar site near Kolkata, is one of the world's largest natural wastewater recycling ecosystems. It supports over a million livelihoods through key provisioning services such as fisheries, paddy-based farming, and garbage-fed farming. This study assesses the economic value of these services and proposes evidence-based strategies to enhance fisheries production and management. A purposive proportional sampling approach covered 32 bheries (22 private, 8 cooperative, 2 government-managed), 12 paddy-based farms, and 6 garbage-fed farming sites, representing 20% of the area for each practice. The market price method estimated the total economic value of provisioning services in 2023–24 at ₹ 171 crore, with fisheries contributing 53%, paddy farming 20%, and garbage-fed farming 27%. The respective areas were 2,481 ha (fisheries), 4,719 ha (paddy), and 603 ha (garbage-fed farming). All systems relied entirely on nutrient-rich sewage. One-way ANOVA showed no significant differences in productivity among different fisheries management regimes. Average productivity was 4 t/ha (fisheries), 3 t/ha (paddy), and 27 t/ha (garbage-fed farming). Private bheries showed the highest profitability (B:C ratio 1.79), while cooperative and government ones were less viable (0.93 and 0.77), relying on tourism and cultural services. Key challenges include technical inefficiencies, weak institutional coordination, poor regulatory enforcement, and limited access to developmental support—necessitating targeted interventions for sustainability.

Keywords: East Kolkata wetlands, provisioning services, economic valuation, market price method

Multidimensional Assessment of Farmers' Resilience Capacity to Changing Climate in Lower Gangetic Region of India

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Climate change severely threatens agricultural sustainability in the Gangetic Plain, a globally significant vulnerability hotspot. This study addresses critical research gaps by quantifying multidimensional resilience and adaptation determinants across three agro-climatic zones (New Alluvial, Coastal Saline, Red & Laterite) in Gangetic West Bengal. The region experiencing compounded climate risks (40% flood-prone, 16% drought-affected). A novel PCA-weighted Farmer Resilience Index (FRI) integrating economic, social, technical, and physical dimensions was developed. Primary data from 360 farm households (2023-2024) were analyzed using Spearman correlation and ordered logit regression to establish empirical linkages between resilience strata and adaptation adoption. Results revealed significant zonal divergence, the New Alluvial zone exhibited highest resilience (FRI=0.515), driven by economic stability (0.548) and social capital (0.532), while the Coastal zone showed lowest resilience (FRI=0.482) with physical infrastructure deficits strongly correlating with overall resilience (r=0.72). Changing planting dates (adoption index=0.793) and resistant varieties (0.758) emerged as dominant adaptation strategies. Critically, non-farm income access reduced high-adoption probability by 4.7% ($p<0.01$), whereas education increased it by 4.9% ($p<0.001$) and operational landholding by 2.7% ($p<0.05$). The findings necessitate zone-specific interventions prioritizing physical infrastructure enhancement in coastal areas and educational extension in lateritic zones. This integrated FRI framework provides a transferable methodology for climate-vulnerable agrarian regions globally.

Keywords: Farmer resilience index, climate adaptation, Gangetic West Bengal, principal component analysis, ordered logit

Socioeconomic Determinants of Food Security of Farm Households in Flood-prone Region of Bihar

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This study assesses socio-economic determinants of farm household food security in the flood-prone region of Bihar. The Household Food Insecurity Access Scale (HFIAS) was employed to assess food security substantiated with caloric consumption. Across the study area, 69.44 per cent of households experience some degree of food insecurity, with mild food insecurity being the most common category at 38.33 per cent. Socio-economic determinants of food insecurity were analyzed using the generalized ordered logit model. Results reveal that landholding, income, and education significantly influence food security status. Findings highlight the need for targeted interventions to mitigate food insecurity risks in disaster-prone agricultural regions.

Keywords: Food security, flood-prone region, HFIAS, generalized ordered logit, Bihar

Green Manufacturing in Indian SMEs: A Bibliometric Mapping and Research Trend Analysis

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In recent years, the urgency to adopt Green Manufacturing (GM) practices in Indian SMEs has intensified, particularly in sectors like sustainable food manufacturing, due to growing environmental concerns and the shift toward Industry 4.0 technologies. According to (Ana Beatriz Lopes de Sousa Jabbour, July 2018), the incorporation of Industry 4.0 technology has been acknowledged as a revolutionary force for ecologically friendly manufacturing. This study employs a bibliometric analysis of 284 articles sourced from Scopus and Web of Science databases between 2016 and July 2025. Using Biblioshiny in R, the research examines publication trends, influential sources, authorship patterns, institutional contributions, and key thematic areas. Results indicate a notable increase in GM-related publications post-2020, peaking in 2024. India, the United Kingdom, and the United States emerge as the most productive countries, with leading journals such as Journal of Cleaner Production, Science of The Total Environment, and Technological Forecasting and Social Change. The study highlights the evolving intellectual and thematic landscape of green manufacturing, especially within Indian SMEs and food firms. This paper provides insights valuable to researchers, policymakers, and practitioners seeking to enhance sustainability in manufacturing. It contributes a structured overview of the field's development and suggests future research directions in sustainable and eco-efficient manufacturing.

Keywords: Green manufacturing, India, SMEs, sustainable food manufacturing, bibliometric analysis, eco-efficient manufacturing, sustainable practices

Climate Change Impacts on Livestock and Adaptation Strategies to Sustain Livestock Production in South Gujarat Region: A Ricardian Analysis

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The study examines the climate change impact on livestock production and adaptation strategies to climate change in South Gujarat region.Farm-level data on net-revenue and its determinants were collected from 1200 livestock farmers from South Gujarat region. The Ricardian approach used to determine the economic impact of climate change on livestock in South Gujarat. The approach regresses net farm revenue against various climate, socio-economic and adaptation variables to help determine the factors that influence variability in net farm revenues. The results have shown that marginal increase in rainfall significantly increases the net revenue per farms in the South Gujarat region by ₹ 142.75, while a marginal increase in temperature significantly reduces the net revenue per farms in South Gujarat by ₹ 9254.29. The households' adaptation measures against the climate change i.e. change in animal bread, feed & fodder management, disease management, supplementary feed, crop and livestock interactions and modification of animal shed has a positive relationship with the net revenue. The results of uniform climate scenario shows that a 2.5 ℃ increase in temperature would result in a decrease in net farm revenues by ₹ 292.95 crore for all the farms. These findings have shown an urgent need of technological development of adaptation packages for dairy production in the years to come. There is therefore a need for investment in research and development so researchers can develop a farming package for livestock farmers that will enable them to remain in dairy by the years 2050 and 2100.

Keywords: Climate change, recardian, adaptation, socio economic

Crop Loss by Human-wildlife Conflicts in Bannerghatta National Park and Farmers' willingness to Pay to Insure Crop under Pradhan Mantri Fasal Bima Yojana

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The concept of "coexistence" has replaced the traditional human-wildlife conflict (HWC), since human interactions with wildlife have become inevitable. Under this scenario, this study examines the pattern, determinants, and extent of economic losses due to wildlife damage in agriculture and assesses farmers' Willingness to Pay (WTP) to insure crop loss from HWCs. The study is based in 31 villages in the Eco-sensitive Zone (ESZ) of Bannerghatta National Park (BNP), Karnataka, and uses primary data related to crop details, household details, animals causing conflict, and HWC details, collected from 426 farmers through a pretested schedule using a Convenience sampling technique. The study uses descriptive statistics, Poisson regression to analyse the determinants of HWCs and Beta regression to analyse the agricultural damage function of ragi crop. Elephants and wild boars were the main crop raiders, with new threats from Indian gaur and deer. Crop losses ranged from 8.9 % in mulberry to 50.13% in paddy; ragi losses were 29.5%. Contingent valuation revealed that farmers are willing to pay an additional 1.3% premium under the Pradhan Mantri Fasal Bima Yojana (PMFBY) if HWC-related losses for the ragi crop are covered under the scheme. The study suggests including HWC losses under PMFBY and accelerating its implementation in high-conflict areas.

Keywords: Human-wildlife conflicts, crop loss, Bannerghatta National Park, insurance, willingness to pay

Evaluating the Economic Effectiveness of Climate Adaptation Strategies in Chhattisgarh's Agriculture

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Chhattisgarh, a predominantly agrarian state with over 70% of its population dependent on agriculture, is highly vulnerable to climate variability due to its reliance on monsoon-fed paddy cultivation. Recurrent droughts, irregular rainfall, and temperature fluctuations have heightened risks to both crop productivity and farm incomes. Over the past decade, multiple adaptation interventions such as the Pradhan Mantri Fasal Bima Yojana (PMFBY), micro-irrigation schemes, drought relief packages, and the promotion of climate-resilient crop varieties have been implemented to mitigate these risks. This study evaluates the economic effectiveness of these climate adaptation policies and practices across various agro-climatic zones of Chhattisgarh. The analysis uses data from government reports, scheme evaluations, and statistical series to assess the coverage, cost-benefit, and risk-reduction outcomes of these interventions. Comparative district-level trends reveal significant variations in adoption rates and benefits, with better performance in irrigated and policy-prioritized regions, while rainfed areas continue to face vulnerability. Findings indicate that while crop insurance and irrigation support have reduced short-term climate risks, gaps in awareness, timely compensation, and technology dissemination limit their long-term impact. The study suggests scaling digital weather advisory services, integrating crop diversification incentives, and strengthening local institutions to enhance adaptive capacity. The results provide evidence-based recommendations for improving policy design and aligning climate adaptation strategies with sustainable agricultural development in Chhattisgarh.

Keywords: Climate adaptation, agricultural policy, risk mitigation, crop insurance, Chhattisgarh

Technical Efficiency of Climate-resilient Potato Production in Karnataka, India: A Data Envelopment Analysis (DEA) approach

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The present study evaluates the technical and scale efficiency of climate-resilience potato farms in Karnataka using primary data of 160 sample respondents from two distinct climate vulnerable districts: Kolar (more climate-vulnerable) and Hassan (less climate-vulnerable). Both districts are prominent potato-growing regions and were categorized based on the level of climate-resilient technology adoption like, low adopters and high adopters. Data Envelopment Analysis (DEA) was employed to assess technical efficiency. The findings revealed that high adopters demonstrated superior technical efficiency, with average scores of 0.83 in Kolar and 0.72 in Hassan. Additionally, high adopters were found to be more scale-efficient compared to low adopters. About 50 per cent of the surveyed potato farmers operated either at or near the optimal production scale. Notably, most low adopters in both the districts were operating under increasing returns to scale, indicating significant potential for enhancing productivity and efficiency through scale adjustments and better technology adoption.

Keywords: Climate resilient, climate vulnerable, potato production, technical efficiency, adaptation strategies, returns to scale

Economic and Risk Mitigation Impacts of Climate-Resilient Wheat Varieties: Evidence and Implications for Policy

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India, the world's second-largest wheat producer, faces significant challenges in sustaining wheat production due to climate change effects, particularly in the Indo-Gangetic Plains. Rising temperatures, erratic rainfall, and heat stress threaten crop yields, with projections indicating a potential decline of 6-25% by 2100. Climate-resilient wheat varieties (CRWVs) like DBW187, DBW222, DBW303, and DBW327, developed by the ICAR-Indian Institute of Wheat and Barley Research, offer a promising solution. This research evaluates the economic benefits and risk mitigation benefits of CRWVs using the Economic Surplus Model and, risk (reduction in yield variability due to climatic aberrations) reduction benefits. As of 2023, CRWVs have been adopted by 22.47%, generating an economic surplus of Rs. 8,086.5 Crores from 2018 to 2023, with consumer and producer surpluses of Rs. 3,176.8 Crores and Rs. 4,909.7 Crores, respectively. By 2030, with a 40% adoption rate, the total economic surplus is projected to reach Rs. 104,404.0 Crores. Risk-reduction benefits amounted to Rs. 2,663.4 Crores from 2018 to 2023, expected to rise to Rs. 26,596.6 Crores by 2030. These findings underscore the potential of CRWVs to enhance food security and economic resilience. Policy recommendations include increased investment in CRWV research, improved seed supply chains, and better extension services to accelerate adoption, ensuring sustainable wheat production amid climate variability.

Keywords: Climate resilient wheat varieties, Economic benefits, Risk reduction benefits, Economic surplus model

Drivers of Agricultural Green House Gas (GHG) Emissions: A Decadal Decomposition Analysis of Activity and Intensity Effects (2010-2022)

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Greenhouse gas (GHG) emissions from agricultural activities constitute a significant portion of global anthropogenic emissions, driven by practices such as enteric fermentation, manure management, rice cultivation, and fertilizer application. Understanding the dynamics of these emissions is critical for developing targeted mitigation strategies. This study employs trend analysis, annual compound growth rate (ACGR) calculations, and Logarithmic Mean Divisia Index (LMDI) decomposition to assess emission patterns across key agricultural sectors from 2010 to 2022. The LMDI method, applied in both additive and multiplicative forms, isolates the contributions of activity (scale) and intensity (efficiency) effects, providing insights into whether emission changes stem from production scaling or technological improvements. The analysis reveals stark inter-sectoral contrasts: enteric fermentation emissions are predominantly intensity-driven, rice cultivation demonstrates successful decoupling through efficiency gains, fertilizer emissions are entirely activity-dependent, and manure management exhibits extreme volatility due to inconsistent practices. By quantifying these drivers, the study highlights the need for sector-specific policies, combining technological interventions and activity control, to achieve meaningful emission reductions in agriculture. The findings underscore the urgency of addressing both production scaling and management practices to mitigate the sector's growing climate impact.

Keywords: GHG emission, compound growth rate, logarithmic mean divisia index, decomposition analysis

Mapping Fertilizer Use Dynamics in India: A Multiscale Analysis Using Spatial Autocorrelation and Hotspot Techniques

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Understanding the spatial and temporal dynamics of fertilizer use is critical for achieving sustainable agricultural growth and food security in India. This study employs a multiscale analytical framework to examine trends in fertilizer production, imports, and consumption at national, state, and district levels from 1980 to 2023. Growth rate analysis reveals a marked deceleration in overall fertilizer consumption in the past decade, with continued predominance of nitrogen (N) use and a pronounced decline in potassium (K_2O) application. Spatial autocorrelation and Getis-Ord Gi* hotspot techniques identify persistent high-use clusters in the Indo-Gangetic Plains and southern states, while low-use "cold spots" are concentrated in the northeast and arid western regions. Emerging hotspots are observed in parts of central and eastern India, indicating the diffusion of input-intensive agriculture beyond traditional Green Revolution zones. The results suggest pronounced regional disparities in fertilizer intensity and nutrient balances, with implications for soil health and resource sustainability. By integrating detailed spatial analysis with long-term temporal trends, this study provides evidence to inform regionally differentiated fertilizer policies, subsidy reforms, and nutrient management strategies. These findings contribute to ongoing debates on input use efficiency, agricultural sustainability, and the design of targeted interventions to bolster both productivity and environmental resilience.

Keywords: Fertilizer production, nutrient imbalance, spatial autocorrelation, hotspot analysis, fertilizer use intensity, India, sustainable agriculture

Perception vs. Reality: Assessing Farmers' Views, Meteorological Trends and Determinants of Climate Adaptation Strategies in Arid Region of India

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This study explores meteorological trends, farmers' perceptions about climate change, their adaptation strategies, and influencing factors determining adaptation in the Thar Desert region, Rajasthan, India. We collected daily temperature and rainfall data from the Indian Meteorological Department (IMD) for 1991 to 2021 and primary data from 240 farmer households from Bikaner and Jaisalmer districts during 2023. The results indicated that annual mean temperature and rainfall were higher during the Kharif season. Pettitt's test revealed an upward shift in temperature and rainfall from the mid-1990s to the early 2000s, indicating the occurrence of climate change in the study area. Farmers have perceived climate change through intense heat in Kharif, cold in Rabi, drought, and erratic rainfall, resulting in water scarcity, lower crop yields, crop failures, and surging pests and diseases. In response, farmers adopted strategies such as increased fertilizer use, altering sowing dates, crop rotation, water conservation, and planting drought-tolerant varieties. Education, farming experience, income, and access to farm credit were the important factors influencing farmers' adaptation decisions. The study suggests implementing effective adaptation policies, including agro-advisory and weather forecasting services, training programs, agricultural extension, expanding areas under drought-resistant crop varieties, and diversifying into livestock enterprises, alongside existing farming practices, to minimize climate change risks.

Keywords: Climate change (Q54), adaptation strategies (Q54, Q15), the Thar desert (Q56), multivariate probit model (C35)

Micro Irrigation and Multidimensional Poverty Reduction: A Policy-Relevant Analysis from Saurashtra, India

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Several studies have explored the effects of micro irrigation on food security, agricultural productivity, livelihoods, and water conservation. However, limited research has focused on the connection between micro irrigation and poverty reduction. This study aims to address that gap by examining the relationship between micro irrigation and poverty alleviation in the Saurashtra region. A survey was conducted involving 150 adopters and 150 non-adopters of micro irrigation from three major districts in Saurashtra. Linear Discriminant Analysis (LDA) was employed to identify the key factors influencing the adoption of micro irrigation systems. The Multidimensional Poverty Index (MPI) was used to assess the impact of micro irrigation on poverty levels. Findings indicate that socio-economic and infrastructural factors play a significant role in the adoption of these systems. While the direct impact of micro irrigation on poverty reduction remains limited, households using these systems were found to be relatively less poor than non-adopters. Based on these insights, the study recommends strengthening rural infrastructure and promoting the adoption of micro irrigation among farmers in Saurashtra as a strategy for poverty reduction.

Key words: Micro irrigation system, poverty, linear discriminant analysis, multidimensional poverty index, Saurashtra

Determinants and Elasticities of Household Food Demand: A Rural–Urban Perspective from Junagadh District, Gujarat

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Consumption is an integral part of our life. Consumer patterns change for both micro and macro reasons. Therefore, it is important to understand household food consumption pattern, consumption expenditure, and various aspects associated with consumption pattern in rural and urban areas. In view of this, the study in rural and urban households of Junagadh district has been undertaken to estimate the income elasticity, price elasticity and cross elasticity of demand for various food commodities. The income elasticities of all food commodities were found positive in rural and urban households, indicating that these goods were necessary. Uncompensated own-price elasticity of demand for all food groups was negative and consistent in rural and urban households, indicating these goods as non-Giffen goods. The results indicated that in most of the food groups, the uncompensated cross-price effects were very small in rural and urban areas. The compensated own-price elasticities were found negative for all commodity groups in rural and urban areas. The compensated own-price elasticities in absolute terms were lower than the uncompensated own price elasticities for all commodity items in rural and urban households.

Keywords: QUAIDS model, compensated own and cross price elasticity, uncompensated own and cross price elasticity

Promoting Resource-Smart Rice Farming: Insights from the Adoption of Direct Seeded Rice in Punjab

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This study investigates the input use pattern and factors influencing the adoption of Direct Seeded Rice (DSR) in Punjab during the year 2023–24. The primary data were collected from the selected respondents by the survey method using well designed and pretested using multi stage random sampling technique. A total of 100 farmers, comprising 50 adopters and 50 non-adopters of DSR technology was selected for the present study. Quantitative data were collected and analyzed using descriptive statistics and binary logistic regression to understand the adoption behavior. The study found that the average variable cost of cultivation under DSR was significantly lower (Rs. 17,252.11/acre) compared to TPR (Rs. 23,977.18/acre), primarily due to savings in land preparation, labor, and irrigation costs. While DSR yielded marginally lower output ((25.66 q/acre) than TPR (27.73 q/acre), the net return was 5.82 per cent higher than that of TPR due to a 28 per cent reduction in input cost A binary logistic regression model was used to study the adoption behavior of DSR technology and the estimated odds ratio for farm size, lectures attended of DSR technology/training, experience and scarcity of hired labour were 1.22, 6.82, 2.55 and 4.53, respectively. Major constraints to DSR adoption included weed infestation (90%), non-availability of seed drills (86%), and limited knowledge (72%). The findings highlight DSR as a resource-smart and cost-effective alternative to conventional rice cultivation in Punjab, especially under increasing water and labor constraints. The study suggested that training programmes and extension services should be provided to the farmers about the numerous advantages that DSR offers, such as the potential to significantly reduce production costs, water saving and reduction in the emission of GHGs.

Keywords: DSR, TPR, adoption, constraints, savings

Consumption Dynamics in Junagadh: An Engel Function Approach to Food and Non-Food Expenditure with Emphasis on Fruits and Vegetables

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The study on food consumption pattern or expenditure pattern is very important as it is related to poverty and standard of living of our society. It is necessary to study the changes in food consumption pattern under the changing situations of liberalization, privatization and globalization. The research study is based on primary data of the household from Junagadh district were collected with the help of interview method. The reference period for the study was year 2019-20 i.e. winter (November-2019 to February-2020), summer (March to June-2020) and monsoon (July to October-2020). The data were analyzed using the different forms of Engel function. The result depicted that in TFV and TF commodity groups, parabolic (P) form of Engel function was the best fitted function, whereas, for TNF commodity groups, LLI form was the best fitted. In case of TFV commodity groups, expenditure elasticities were found higher in urban households. In TF commodity groups, elasticities were found higher in rural households in winter and monsoon seasons, whereas in summer season, it was almost equal in both categories of households. In TNF commodity groups, the expenditure elasticities were higher in rural households in all the three seasons.

Keywords: Engel function, TFV, TF, TNF, TOT, expenditure elasticity

Resource Use, Technical and Economic Efficiency of Drip vs Conventional Irrigated Coconut Farms

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This paper evaluated resource use efficiency, technical efficiency, and economic efficiency of coconut cultivation under two irrigation regimes *viz*., conventional and drip irrigation in Palakkad district, Kerala. A total of 100 coconut farms comprising 50 drip irrigated farms (DIF) and 50 conventionally irrigated farms (CIF) were surveyed for the study. Cobb-Douglas production function and stochastic frontier analysis were employed to assess the influence of inputs on yield and efficiency. Among the input variables, irrigation water (with coefficient 0.27 at 1 per cent level), fertiliser and FYM were having significant influence on yield among DIF. However, water was not significantly influencing yield among CIF. Both the categories of farms had underuse of FYM and fertilizer inputs; DIF had slightly better position than CIF. Resource Use Efficiency (RUE) value of irrigation water among DIF was 0.93 (~1) indicating near optimum use of water quantity. However, RUE value of water among CIF (0.16) showed significant overuse of the resource. DIF could lower irrigation water quantity (2685 m^3/ha/year) to less than half that of CIF (6745 m^3/ha/year) even while achieving 10 per cent higher yield. The stochastic production frontier analysis indicated that DIF could achieve mean technical efficiency of 94% and mean economic efficiency 90% which were higher compared to CIF (82% and 86%, respectively). The average yield of coconut under both the irrigation regimes was more than double the state average yield. The findings emphasized the potential benefits of adopting drip irrigation systems to improve resource utilization, productivity and sustainability in coconut farming.

Key words: Economic Efficiency, Coconut Farming, Water Resource Sustainability, Drip irrigation

Mitigating Environmental Impact: Strategies for Effective Paddy Straw Management

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Paddy straw burning, while quick and cost-free, emits up to 7,300 kg CO_2 equivalent per hectare and depletes vital soil nutrients—5.5 kg nitrogen, 2.3 kg phosphorus, and 15–20 kg potassium—causing severe air pollution, soil degradation, and health risks. This study, conducted in Gaddamallaiahguda village, Telangana, evaluated sustainable alternatives: composting, mulching, biomass conversion, and mechanical baling. Mechanical balers, operating at 1–2 tons/hour (₹ 2,500–₹ 3,000/ha), reduced straw volume by 60% and enabled reuse in energy, fodder, and compost. Composting improved soil organic carbon by 20% (0.35% to 0.42%) and enhanced NPK levels by 20–25%, though it required more labor and cost (₹ 1,800–₹ 2,200/ha). Mulching (₹ 1,500–₹ 2,000/ha) improved moisture retention by 35%, reduced irrigation needs from every 4 days to 8–9 days, and stabilized soil temperatures. Biomass conversion produced biogas and digestate but was limited by high setup costs (₹ 3,500–₹ 5,000/ha). Air quality assessments showed that burning exceeded WHO PM2.5/PM10 limits, while sustainable methods remained within safe thresholds. The study emphasizes integrating eco-friendly practices with farmer education and policy support to promote sustainable agriculture and reduce the environmental footprint in India's paddy-growing regions.

Keywords: Paddy straw management, paddy baler, residue management, bioenergy production, composting and organic mulching

Impact of Soil Health Card Scheme on Crop Production in Chhattisgarh

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The soil health card (SHC) scheme, launched by the Government of India and implemented across states including Chhattisgarh, has emerged as a key initiative to promote sustainable agricultural practices through scientific soil nutrient management. The scheme aims to provide farmers with detailed information on the nutrient status of their soils, along with crop-and soil-specific recommendations for optimal fertilizer use. In Chhattisgarh, the SHC scheme has demonstrated measurable positive impacts on farm productivity, input efficiency, and farmer awareness. One of the most significant outcomes observed is the reduction in chemical fertilizer use, which is a critical step towards sustainable agriculture. Studies indicate that farmers who utilized SHC reduced the indiscriminate use of chemical fertilizer by approximately 8-10%. The scheme has contributed to a 5-6% increase in crop yields(Patel et al.). the SHC scheme enables better nutrient uptake by crops, leading to improved agricultural productivity. The adoption of integrated nutrient management practices has further inforced the benefits of the SHC scheme. The scheme has also played a vital role in enhancing farmer awareness. With increased exposure to soil testing and fertilizer recommendations, farmers are now more informed about the science behind nutrient management.

Keywords: Soil health card, production-productivity, balance nutrition, sustainability

Analyzing Internet of Things (IoT) Adoption in Agriculture through the Triple Hurdle Model: A Pathway to Climate-Resilient Farming among Small and Marginal Farmer

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This study investigates the adoption of Internet of Things (IoT) technologies among small and marginal farmers in Coimbatore, Tamil Nadu, using the Triple Hurdle Model to capture the multi-stage nature of adoption behaviour. Unlike traditional binary models, the Triple Hurdle framework distinguishes three sequential decisions: initial adoption, extent of use, and investment level. Based on primary data from 30 farmers, the study identifies key enablers and barriers at each stage. Results from the Probit model show that age negatively influences adoption, while education, training, farm size, and perceived usefulness have positive effects. The truncated regression highlights that larger farms and ease of use drive more extensive IoT application, while perceived usefulness surprisingly showed a negative coefficient. The final hurdle, modelled through a log-linear OLS regression, reveals that training, infrastructure access, and perceived usefulness increase expenditure, while high perceived cost acts as a deterrent. Findings underscore the importance of stage-specific interventions to promote climate-resilient agriculture through digital transformation. Emphasizing capacity-building, infrastructure improvement, and financial incentives can facilitate broader and deeper IoT integration. This nuanced understanding enables policymakers to tailor strategies that overcome specific bottlenecks and unlock the full potential of IoT for sustainable and adaptive farming.

Keywords: Internet of things (IoT), triple hurdle model, climate-resilient agriculture, farmer decision-making

Sources of Risk and Risk Management Strategies: Crop Insurance

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Risk is an inherent part of agriculture. In India, agricultural risks are worsened by various factors, including climate variability, frequent natural disasters, uncertainties in yields and prices, weak rural infrastructure, imperfect markets, and limited financial services. Farmers are not guaranteed a high-quality, disease-free crop, which is essential for achieving a sufficient yield to cover expenses. Crop insurance is a key risk management strategy to mitigate these risks. It is regarded as an essential component of a comprehensive agricultural program designed to protect farmers from crop failure caused by weather and other natural hazards. This paper aims to examine the sources of risk for both PMFBY and RWBCIS beneficiaries, as well as non-loanee farmers, in the districts of Jalore and Jaipur, Rajasthan, along with their risk management strategies. The study involved face-to-face interviews with 88 farmers to identify risk sources and preferred risk management methods, considering different resource levels and income groups. Addressing issues such as delays in claim settlements, raising farmer awareness about risk reduction strategies, developing suitable crop insurance products, improving implementation infrastructure, investing in R&D for insurance product design partnering with private insurers, replacing relief payments with crop insurance, and covering both price and weather risks are crucial moves.

Keywords: Agricultural risks; risk management, crop insurance, PMFBY, RWBCIS

District-Level Agricultural Risk Mapping of a North-Eastern State of India using Entropy-based-TOPSIS and IPCC - AR6 Risk Framework

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India's Eastern Himalayan Region (EHR) is particularly susceptible to climate-induced transformations, making it one of the most sensitive ecological zones in the country. The EHR of India, houses eight Indian states, namely – Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and Assam. These North Eastern states are home to some of the world's rarest flora and fauna endemic to this region. This region is also classified under two biodiversity hotspots – (1) Indo-Burma and (2) Himalaya. All the north eastern states are a part of these hotspot zoning, except Assam, whose hill districts are only included. Blessed with diverse vegetations, the entire north-east is primarily engaged in agricultural activities to earn a livelihood. Among all the north-eastern states of India, Assam is the only state, that is not classified as a hilly state. This is because the state of Assam is endowed with a mix of hills, valleys, and plain regions. And most of the state comprises of plain regions (or flood plains). The state of Assam, is of particular interest, as the state lies at the heart of the Brahmaputra valley. The state receives abundant water supply throughout the year through the perennial rivers of Brahmaputra and Barak (and their tributaries); that support the thriving agricultural sector of Assam. But the state also faces annual floods during the monsoon season (JuneOctober), when the river water swells up, eroding the river banks and affecting the standing crops; disrupting the daily life. Additionally, the state is also plagued with annual hazards like – droughts, landslides, storms, forest fires, seismic activities etc. Although, an important part of the economy, the agricultural sector of Assam, remains under noticed from the climate change induced risks perspective. More than 70% of Assam's population is directly dependent on agriculture (and allied activities) to earn their livelihoods, as such it is important to look into the potential risks arising in the agricultural sector of Assam. Therefore, through this study an attempt has been made to study the climate change related risks associated with the agricultural sector of Assam. The primary objective of the study is: to construct a district level composite risk index for the state of Assam; to identify the factors contributing highly to the climate change induced risks; to generate cartographic products to assist with better understanding of the risk scenario. The secondary objectives include: to contribute to the literature on climate change induced risks, food security, sustainable agriculture etc.; to assist the policymakers and stakeholders, to make informed decisions through the results obtained through this extensive study.

The methodology for the study utilises IPCC (AR5 & AR6) risk framework with entropyweighted TOPSIS. In the latest report, IPCC (Inter-governmental Panel on Climate Change) defines risk as the product of hazard, vulnerability, exposure. Symbolically, it can be represented as – Risk (R) = f [Hazard (H) × Vulnerability (V) × Exposure (E)]

IPCC defines, hazard, vulnerability, and exposure, as follows –

Hazard – IPCC defines hazard as "the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources."

Vulnerability – IPCC defines vulnerability as "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt."

Exposure – IPCC defines exposure as "the presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected."

Based on this framework, entropy-weighted TOPSIS is used for further analysis of risks associated with the agricultural sector. TOPSIS means Technique for Order Preference from Similarity to Ideal Solution. TOPSIS is a MADM (Multi-Attribute Decision Making) technique, and is a popular tool for assisting the decision makers with decision making by obtaining the best ideal solution to a problem. Shannon's entropy weighting is utilised for generating weights for the attributes of TOPSIS to determine the factors that contribute the highest and the lowest to the entire decision making process. In this study more than twenty indicators (or attributes) are used for studying the risk scenario.

The results draw some interesting insight about the risk scenario of Assam. The results can be summarised as: All the 33 the districts of Assam are prone to climate change induced agricultural risks; It is observed that there is considerable difference in the risk proneness among the districts of the same agro-climatic zone; The districts of Kamrup Rural and West Karbi Anglong, are the districts with the highest risk proneness. Although there are more number of districts in the category of lowest risk proneness, but it is worth noting that risk proneness exists for all the districts under study.

Keywords: Entropy-based-TOPSIS, IPCC - AR6 Risk Framework, agricultural risk mapping

Virtual Water Trade in Indian Agriculture: Trends, Patterns and Influencing Factors

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India, alongside the United States and China, ranks among the world's largest consumers of virtual water. The country faces mounting challenges in balancing rapid population growth, rising food demand, and higher living standards with declining per capita water availability. Despite the significance of virtual water trade, systematic research on its evolving role in India remains limited. Much of the existing literature relies on outdated climatic data or crop water requirement estimates from more than a decade ago As a result, earlier studies fail to reflect major shifts in cropping patterns, irrigation practices, and trade structures over the past two decades. Moreover, limited attention has been given to the determinants of trade, particularly the role of relative land-water endowments, which shape trade flows between countries. Addressing these gaps is vital for designing policies that enable India to use virtual water trade more effectively in the face of intensifying water scarcity. This study was designed with three objectives: (i) to calculate the virtual water content of major crops cultivated in India; (ii) to analyze trends in India's virtual water trade in crop products; and (iii) to identify economic and biophysical factors influencing trade with partner countries. The analysis drew upon multiple datasets, including climatic information from the Indian Meteorological Organization and Ministry of Earth Sciences, trade data from FAOSTAT and the World Bank, and soil and cropping pattern data from official reports. Crop water requirements were estimated using FAO's Cropwat 8.0 software, applying climatic data from state headquarters for rice and wheat, and regional data for other crops. Trade flows were assessed through descriptive statistics, while determinants of trade were examined using a gravity model with panel data regression (Kannan & Kumar, 2023), covering 23 years (2000–2022) and 13 key trade partners. The results offer important insights into India's virtual water economy. Cashew nuts were identified as the crop with the highest virtual water content. Among staple crops, wheat in Karnataka required 8,405 m^3/ton of water, while rice in Madhya Pradesh had the highest requirement at 9,562 m^3/ton. Trade analysis showed that rice dominated virtual water exports, contributing more than one-third of India's total and making it the largest net exporter. Conversely, vegetable oils—including palm, soybean, and sunflower oil—formed the bulk of net virtual water imports. Regression analysis confirmed that relative land-water endowments significantly influenced trade flows, consistent with factor endowment theory. Exports were directed toward countries with lower land-water availability, while imports came from resource-rich regions, highlighting the efficient reallocation of water resources through trade.

Keywords: Indian agriculture, virtual water trade

Boosting Millet Production in India: Identifying the Supply Side Drivers

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The stagnation in millet production in India, despite its potential for addressing food security and climate change challenges, necessitates a deeper understanding of the supply-side constraints. The empirical analysis, based on data from Comprehensive Cost of Cultivation Survey (2021-22), reveals that rainfall, input use, technology adoption, and expected net returns significantly influence the yield gap. The findings underscore the need for targeted interventions, including investments in irrigation, promotion of hybrid seeds and mechanisation, and ensuring remunerative prices for farmers, to unlock the full potential of millets and foster a sustainable and resilient agricultural sector in India.

Keywords: Millet production, India, supply side, drivers

Farm to Retail Carbon Footprint of Crossandra (Kanakambara): A Study from Chikkaballapur District, Karnataka, South India

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The study quantifies the farm-to-retail carbon footprint of Crossandra (*Crossandra undulaefolia Salisb.*) production in Chikkaballapur district, Karnataka, using primary data from 60 farmers. A life cycle assessment (LCA) framework was applied to calculate stage-wise greenhouse gas (GHG) emissions (kg CO_2e) from cultivation, post-harvest handling, transportation, and retail. Results indicated that irrigation is the dominant emission source, contributing 96.34 per cent (4,243,508.17 kg CO_2e) of total emissions, primarily due to energy-intensive groundwater pumping from deep borewells powered by grid electricity. Fertilizer use accounts for 2.22 per cent (97,850.12 kg CO_2e), and packaging contributes 1.42 per cent (62,559.08 kg CO_2e). while Pesticides, transport, and retail electricity use have negligible shares, reflecting localized market channels with minimal cold-chain or long-haul logistics. The average emission intensity was 64.51 kg CO_2e per kg of flowers, with substantial variation (1.23–235.52 kg CO_2e/kg) linked to differences in input intensity and irrigation practices. These findings aligned with prior research emphasizing irrigation as a major emission hotspot in high-value horticulture and underscored opportunities for mitigation via solar-powered pumps, energy-efficient irrigation, and precision fertilizer application. By highlighting stage-wise emission contributions, this study provided actionable insights for policymakers, extension agencies, and supply chain actors to reduce the carbon footprint of floriculture while sustaining farmer profitability.

Keywords: Carbon footprint, life cycle assessment, crossandra, floriculture

Spillover Effects of PM Kisan Scheme at Household Levels: Insights from a CGE Modelling Framework

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This study evaluates the microeconomic impacts of PM-Kisan cash transfers on farm households using a Computable General Equilibrium (CGE) model, with data drawn from the Social Accounting Matrix (SAM) of 2019. Various transfer scenarios targeted, universal, and relative (in both absolute and percentage terms) were simulated to understand their effects on real household incomes and consumption. The results reveal that even modest transfers (₹ 6,000) to poor households can raise their income and consumption levels significantly, though broader economic gains are limited. In contrast, universal transfers benefit a wider section of the rural economy but may reduce the relative impact on the poorest. Percentage-based transfers achieve a better balance between equity and efficiency. Overall, the findings emphasize the importance of tailoring transfer schemes to enhance income, stimulate rural consumption, and support inclusive agricultural growth.

Keywords: Spillover effects, PM Kisan scheme, CGE modelling framework

Climate-smart Agriculture: Strategies for Resilience and Adaptation

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Climate change poses significant risks to agricultural productivity, threatening food security and rural livelihoods worldwide. According to the Food and Agriculture Organization (FAO), climate-resilient agriculture refers to the capacity of farming systems to anticipate, adapt to, and recover from climate-related shocks and stresses. Without adaptation, projections for 2020–2039 indicate yield declines in irrigated rice (–3%), rainfed rice (–7 to –28%), wheat (–3.2 to –5.3%), and maize (–9 to –10%), with a modest increase expected in soybean yields (+2.5 to +5.5%). In response, countries have pledged to reduce greenhouse gas emissions, such as the Marshall Islands' commitment to cut carbon emissions by 32% by 2025 and achieve net-zero by 2050. A climate-smart agricultural approach integrates farmer practices with supportive technologies, policies, institutions, and financial mechanisms to enhance resilience. Key strategies include site-specific crop selection, development of climate-resilient varieties, diversification of cropping systems, integration of forecasting tools, and effective community-level resource management. Technological advancements, such as geospatial analysis and eco-friendly farming technologies, plays a crucial role in optimizing land use and enhancing food security. These measures collectively strengthen the capacity of agriculture to withstand and recover from the adverse impacts of climate variability and change.

Keywords: Climate change, agricultural productivity, climate-smart agriculture, forecasting

Advancing Sustainable Development Goals through Climate-smart Aquaculture: A Global Synthesis

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Aquaculture stands at the forefront of global food production growth, yet its trajectory is increasingly threatened by the intensifying impacts of climate change, most notably rising sea surface temperatures, ocean acidification, and escalating extreme weather events. These environmental shifts threaten the sector's productivity, sustainability, and the livelihoods it supports, necessitating the adoption of climate-smart strategies. This global review explores how Climate-Smart Aquaculture (CSA) contributes to achieving the United Nations Sustainable Development Goals (SDGs). Using a multi-method approach combining systematic evidence synthesis, meta-narrative review, and realist synthesis, 185 peer-reviewed and policy sources were analysed through the Aquaculture Resilience Quadrant (ARQ) framework. This framework categorizes CSA strategies into four domains: Adaptation, Mitigation, Enabling Technologies, and Governance. The study reveals that integrated practices such as seaweed farming, Integrated Multi-Trophic Aquaculture, biofloc technology, indigenous systems, and eco-certification significantly enhance ecological resilience, food security, and economic sustainability. Case studies from Asia, Africa, and island nations illustrate real-world applications. Strategies were mapped to SDGs, showing linkages to 10 of the 17 SDGs, highlighting aquaculture's transformative role in climate adaptation and sustainable development. The review concludes with policy recommendations for scaling CSA through innovation, inclusivity, and cross-sector collaboration, positioning aquaculture as a pivotal sector in global sustainability and climate resilience agendas.

Keywords: Adaptation, aquaculture resilience quadrant, climate-smart aquaculture, food security, mitigation, sustainable development goals

India's Rice Export Competitiveness, Growth, Diversification and the Impact of SPS Measures

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India is the world's largest rice exporter, supplying both basmati and non-basmati varieties to over 150 countries. This study examines the growth performance, diversification, competitiveness, and regulatory challenges of India's rice exports from 2004 to 2023. The analysis shows that basmati exports experienced robust growth in the earlier period but later reached saturation, while non-basmati rice categories gained momentum in recent years, reflecting a structural shift in India's export basket. Diversification indices reveal that India's rice exports are broadly diversified, though certain categories such as broken rice and paddy remain concentrated. Comparative advantage analysis highlights India's consistent strength in basmati and non-basmati white rice, whereas Pakistan's edge in basmati has weakened over time. On the regulatory front, rejection rates in the EU remain higher for India and Pakistan compared to other exporters, signalling stringent compliance challenges. In contrast, India demonstrates relatively better performance in the US market, with lower rejection rates than Pakistan. Gravity model estimations using the PPML approach confirm that economic size stimulates trade, distance reduces it, and sanitary and phytosanitary (SPS) measures pose a significant barrier cutting India's rice exports by nearly 82% when imposed. These findings underscore the need for India to strengthen quality compliance, address SPS concerns, and diversify strategically to sustain its global dominance in rice trade.

Keywords: Rice exports; basmati; non-basmati; comparative advantage; diversification; sanitary and phytosanitary (SPS) measures; gravity model

Economic and Environmental Dimensions of Precision Farming in India: A Literature-based Analysis

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This study examines the economic and environmental implications of precision farming (PF) in India through a systematic synthesis of existing secondary data and scholarly literature. The analysis evaluates PF's potential to enhance profitability, optimize resource use, and promote environmental sustainability. Evidence suggests that PF can substantially improve yields, lower input costs, and reduce ecological degradation. However, widespread adoption is hindered by high initial investment requirements, limited technical expertise, and infrastructural challenges. The findings highlight the importance of targeted policy interventions, financial incentives, and inclusive technology dissemination to enable broader implementation and ensure that the benefits of PF reach farmers across diverse socio-economic contexts.

Keywords: Precision farming, economic sustainability, environmental impact, agriculture, India, literature review

Development of Gender Mainstreaming Model and Strategic Actions for Building Climate Resilience in Agriculture

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The present study examines the changing gender roles and gender-differentiated vulnerabilities on account of climate change extremities among different sections of farming communities to develop a gender-sensitive climate-resilient technology transfer model. The study was conducted with 180 sample size comprising both male (n=90) and female (n=90) respondents of same households from three districts (*i.e.,* Sirsa, Yamunanagar and Karnal) in the Haryana state of India. Initially, the perception of members of families on climate change parameters, and gender prioritization of vulnerability issues concerning them for climate change adaptation were analysed through a structured interview schedule. Later, group interaction meetings were organized using Participatory Rural Appraisal (PRA) techniques to understand gender-differentiated issues and prepare an action plan for addressing climate change adaptation and mitigation. Based on the interaction with experts, a 10-step climate-resilient gender-sensitive technology transfer model in agriculture was developed. This model is suggested to give a thrust to the existing technology transfer models in the field of agriculture as it is impossible to replace the existing models because of administrative, political, and economic factors. The proposed model can be deployed in any developing country as it does not involve much cost but is highly effective due to its inclusiveness and location-specific action programmes for undertaking climate change adaptation and mitigation interventions in a participatory model. Implementing this model across the countries could ensure sustainable and climate-responsive agricultural practices.

Keywords: Climate resilience, climate vulnerabilities, gender mainstreaming, Haryana, technology transfer

Mapping of Climate Change-induced Risk Profile of Andhra Pradesh, India

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The current study attempted to assess climate change-induced risk for the districts of Andhra Pradesh, India, using the IPCC AR5 framework, focusing on hazard, exposure, sensitivity, and adaptive capacity indicators. Based on the risk index, the districts were grouped into three categories: high, moderate, and low-risk. The findings revealed that approximately 40 per cent of districts were subjected to high risk, 23 per cent to moderate risk and remaining 37 per cent to low-risk due to climate change. Low adaptive capacity was observed to be the primary cause of risk in high risky districts. Further, the study highlighted the contrasting trajectories of high-hazard yet low-risk (West Godavari and Krishna) and moderate-hazard yet high-risk (Prakasam), underscoring the importance of strengthening adaptive capacity in combating climate change risk. The results emphasised the necessity of targeted and resource-efficient interventions for effective climate change risk mitigation.

Keywords: Climate change, climate change risk, IPCC AR5, risk assessment, and risk index

Impact of Climate Change and Credit Availability on Food Security in India- An Empirical Evidence

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Food security is a critical global issue, particularly in India, and it is further exacerbated by the challenges posed by climate change. This study aims to examine the influence of formal lending and climate change on food grain productivity in India, utilizing time series data from 1990-91 to 2020-21. The study employs the autoregressive distributed lag (ARDL) model to investigate the relationship between climate variables—specifically rainfall and mean temperature—and non-climate variables, including commercial bank credit, cooperative bank credit, and regional rural bank credit, in relation to food grain production in India. The findings indicate that mean temperature is positively and significantly related to food grain productivity. A 1% increase in mean temperature leads to a 0.22% increase in food grain productivity in the long run, while mean temperature is insignificant in the short run. Rainfall is also positively and significantly related, with a 1% increase in rainfall resulting in a 0.57% increase in food grain production. Formal lending by cooperative banks is positively but insignificantly related; a 1% increase in lending by these banks results in a 0.11% increase in food grain production in India. Agricultural lending by Regional Rural Banks (RRBs) is negatively and not significantly related; thus, a 1% increase in agricultural credit from RRBs leads to a decrease in food grain production by 0.09%. Formal lending by commercial banks is positively related but again not significantly; a 1% increase in lending results in a 10.8% increase in food grain production in the long run. The study highlights the importance of agricultural credit and climate in food grain productivity in India.

Keywords: Climate change, cooperative banks, commercial banks, RRBs, and ARDL

Factors Determining in Production of Tomato in Karnataka- An Empirical Dive into Karnataka's Red Gold

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Tomato (*Solanum lycopersicum*) are widely cultivated vegetable, originating from western South America and now integral to global cuisines. They thrive in warm climates and are susceptible to frost with modern cultivars offering a variety of sizes, colors, and flavors. In Karnataka, Kolar and Belagavi are the major districts which produce tomato hence the present study aimed to analyse the factors determining in production of tomato along with socio-economic characteristics of tomato growing farmers.. A multistage purposive sampling technique was employed for the selection of sample respondents including market intermediaries using pre-tested, well-structured questionnaires. The results revealed that, provides comprehensive insights into the socio-economic characteristics of farmers and the key factors influencing tomato productivity. The analysis clearly indicated that several factors significantly impact yield in both districts. Common determinants of productivity included land holding size, availability of inputs, access to high-yielding varieties and hybrids, high market opportunities, time of sowing, and annual income were statistically significant positive influence on output. However, district-specific variations were also evident. In Belagavi, favourable climatic conditions and farming experience emerged as additional significant factors, while in Kolar, adequate availability of water and labour played a notable role.

Keywords: Determinants, production of tomato, socio-economic characteristics

Assessment of Climate Resilient Agriculture (CRA) Adoption and Impact: A Case of Bihar, India

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Present study advocates the localized incorporation of climate resilient agriculture adoption among the communities with specific reference to the Indian state of Bihar. Bihar due to its vulnerability to climate change becomes important part in country to look at. Study adopts narrative literature approach with using the peer reviewed published literature since 2010 to present year. The extracted studies have been segregated to four themes ranging as water saving measures, stress tolerant varieties, conservation agriculture and bundled practices for climate resilient agriculture. There has been significant impact in terms of adoption of climate resilient practices among the farmers which is due to the increase in yields and saving of costs. Further, policy implications have been discussed with emphasis on strengthening localized institutions to deliver impactful climate resilient strategies. Study has implications for policy makers and scholars interested in said domain.

Keywords: Climate resilient agriculture, localized strategies, bundled practices, climate change, adoption

Exploring the Interaction Between Groundwater and Energy Consumption in Agricultural Food Production under Different Water Management Technologies

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Groundwater, considered a vital resource yet finite, facing over-exploitation due to excessive abstraction, particularly for agricultural purposes. Over-exploitation was exacerbated by subsidized electricity and has led to declining groundwater tables. This surge in electricity consumption for agriculture, coupled with unregulated groundwater pumping, poses challenges for both resource management and sustainability. The study explored the intricate relationship between groundwater and energy consumption in agricultural food production, employing a simultaneous equation model. To examine this interrelationship, both primary and secondary data were utilized, whereas primary data was collected from a total of 270 sample farmers under different water management technologies. Results revealed that 1 per cent increase in energy consumption and area under water-loving crops leads to 1.39 per cent and 0.17 per cent rise in water consumption, respectively. Food production exhibited highly elastic and positive relationship with water and energy consumption, with 1 per cent increase resulting in respective production increases of 1.86 per cent and 1.08 per cent. The results highlighted that the adoption of advanced irrigation management technology over conventional method will save both water and energy consumption. Additionally, factors such as water and energy consumption, farming experience and fertilizer consumption demonstrate synergistic and significant effects on food production.

Keywords: Water-energy-food nexus, conventional irrigation, drip irrigation, electric pump, solar pump, simultaneous equation model, groundwater irrigation management technologies

A Critical Look at India's National Water Policy in the Context of Sustainable Development

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Robust water policies and governance are vital for fostering resilience to climate change. India has emerged as a leader in crafting water policies aimed at addressing the challenges of climate change and the disparities in water demand and supply. The country has launched several iterations of the National Water Policy (NWP) to adapt to the changing dynamics of the water-energy-food-environment (WEFE) security nexus, although it has not kept pace on governance issues. This paper offers an in-depth analysis of the development of India's water policies, evaluating their results, identifying challenges in implementation, and providing recommendations for future progress. The roadmap for advancing India into a climate-resilient hydraulic civilization is articulated through five fundamental areas: implementing water accounting at the river basin level, managing water demand while augmenting water supply, enforcing strict groundwater quota regulations, and adopting a triple bottom line (TBL) framework that integrates environmental (planet), social (people), and economic (profit) aspects in water resource planning. Moreover, there is an immediate need to enhance investment in the promotion of research on water policy, adoption of innovative technologies, and strengthen capacity building initiatives.

Keywords: Water institutions, climate-resilient, allocation priorities, groundwater, ecosystem

Increasing Food Security and (Climate) Resilient Agricultural Livelihood in India-scenario and Challenges

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The Indian economy showcases impressive growth alongside notable challenges. Highlighting the problem of malnutrition in a state like Gujarat with leading GDP indicators. This paper addresses the urgency to bolster policy for improved food security, ultimately benefiting the economy. Importantly, climate change presents significant limitations for agriculture in India, threatening food security and livelihoods. Erratic rainfall, rising temperatures, and extreme weather events are impacting crop yields, soil health, and overall agricultural productivity. These changes exacerbate existing challenges like water scarcity and soil degradation, making sustainable agriculture more difficult. Tools like Food Coupons targeted to deal with such uncertainties must be focussed on dealing with nutritional requirement and the climate risk that the farm household faces in his livelihood. innovative approaches be harnessed to drive reform within traditionally bureaucratic systems like the intertwined Procurement of Food from Punjab, Haryana, and Madhya Pradesh? There are existing schemes like Minimum Support Price System and the Food Subsidy System under the *Deendayal Antyodaya Yojana* - National Rural Livelihoods Mission (DAY - NRLM). But moving ahead the problem of targeting and dealing with climate risk needs to be addressed.

Keywords: Food security, resilient agricultural livelihood, challenges

Toward Climate Resilient Vegetable Farming: An Assessment of Flood Induced Yield Losses in Southern India

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Climate-induced flooding poses a significant threat to agricultural livelihoods, particularly in low-lying regions of developing countries. This study explores the extent of damage and loss incurred by vegetable farmers in Alappuzha district due to seasonal flooding- a flood-prone agricultural system. The findings indicated that farmers in the Kanjikuzhi block experienced significant yield loss due to inadequate drainage following heavy rainfall. The study highlighted the need for investment in permanent drainage infrastructure, such as the construction of drainage channels, reinforcement of field bunds, and installation of pumping systems to manage waterlogging. The study provides critical insights for policymakers and stakeholders aiming to enhance the resilience of small and marginal farmers in flood-prone regions.

Keywords: Climate change adaptation, flood resilience, smallholder agriculture

Estimation of Resource Use Efficiency and Technical Efficiency in Traditional Apple: A Case Study of Himachal Pradesh

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The present study has made an attempt to estimate the resource use efficiency and technical efficiency of traditional apple in three selected districts i.e Mandi, Kullu and Shimla of Himachal Pradseh where apple production is the highest using a sample of 200 respondents (60 from Mandi, 70 from Kullu and 70 from Shimla) and it was revealed that all the explanatory variables considered together in traditional apple explained about 76.70 percent to 81.60 percent of total variations in gross returns in selected districts of Himachal Pradesh and returns to scale which described the output response to a proportionate simultaneous increase in all the inputs was found more than one which meant for one percent increase in inputs, the output had increased by 100.09 percent in overall i.e increasing returns to scale. In terms of technical efficiency, most of the apple growers operated at efficiency level of 75percent and they had a mean technical efficiency of 77.30 percent in overall, based on the estimate of Cobb-Douglas frontier function. This implied that on an average, apple growers required 22.70 percent as much as cost saving technology to attain the status of most efficient apple growers, given the Cobb-Douglas frontier model, respectively.

Keywords: Traditional apple, resource use efficiency, technical efficiency and Cobb-Douglas frontier model

Identification of Factors Affecting the Food Security of Indian Rural Households' Insights from Ground Reality

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This paper examines shifting consumption expenditure patterns in rural areas, with a focus on Scheduled Castes (SC) and other social groups. Analysis was done with 2023–24 primary survey conducted in six villages across Uttar Pradesh, Haryana, and Rajasthan. Data on household food and non-food spending, along with socio-economic variables, were analyzed using STATA 15.0. Results show that urbanization, rising incomes, nuclear families, changing lifestyles, and increasing female employment are reshaping spending. SC households spend about 2% more on food, while others spend around 1% more on non-food items. Policies should consider these factors when addressing food security.

Keywords: Socio economic characters, Consumption patterns, Food and non-food consumption, Caste, Education

Transforming India's Agricultural Exports towards ASEAN: Strategic Insights and Policy Implications

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India-ASEAN agricultural trade has grown significantly in the past two decades, though challenges remain in achieving balanced growth. India's agricultural exports to ASEAN have increased, but overall, it has faced a trade deficit, with imports consistently surpassing exports except in a few years. The ASEAN-India Free Trade Agreement (AIFTA), signed in 2008 and implemented in 2010, aimed to boost trade by reducing tariffs on agricultural and other goods. Early Harvest Schemes, such as the 2006 agreement with Thailand, were initial steps toward gradual tariff reductions on select products. Despite these concessions, India's export growth has been constrained by non-tariff measures (NTMs), including sanitary and phytosanitary (SPS) regulations and technical trade barriers (TBT). While some NTMs declined after the FTA, market access remains limited. Trade intensity indices indicate a strong preference for agricultural exports to ASEAN, with Indonesia, Malaysia, Vietnam, and Myanmar as key partners. However, ASEAN's competitive position in agricultural trade has resulted in a trade balance favouring ASEAN. This paper explores the opportunities and enlists the strategies to strengthen India's agricultural exports by improving product standards, diversifying exports, enhancing trade facilitation, and leveraging India's proximity to ASEAN markets (Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam) for logistical advantages.

Keywords: Export, FTA, strategies, trade

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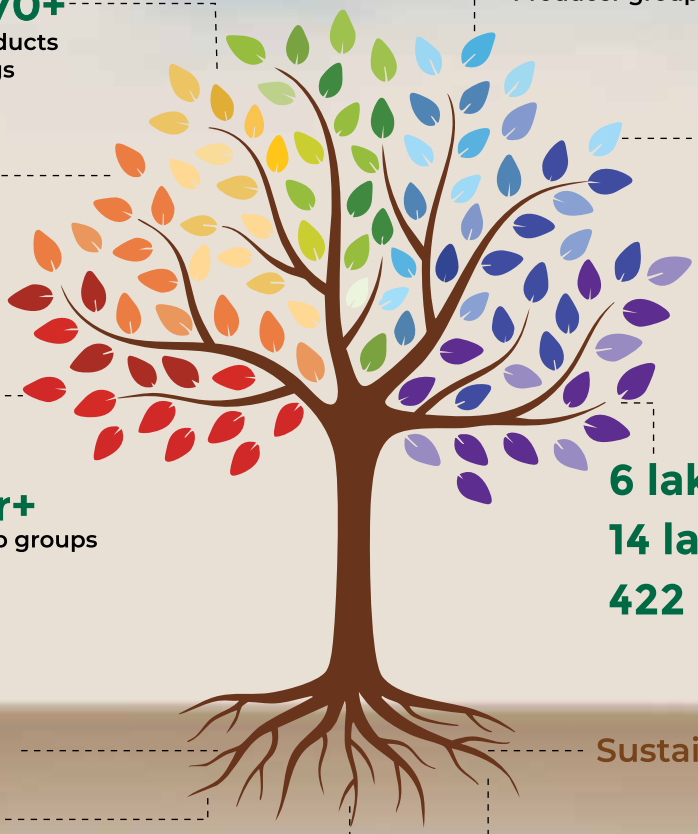

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